2007

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http://hdl.handle.net/10026.1/1856

http://dx.doi.org/10.24382/3731

University of Plymouth

PRODUCTIVITY MANAGEMENT OF THE CACAO AGRO-FOOD SYSTEM IN TABASCO (MEXICO): A FITNESS APPROACH

by

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A thesis submitted to the University of Plymouth in partial fulfilment for the degree of

DOCTOR OF PHILOSOPHY

School of Geography

Faculty of Social Sciences and Business

2007

ABSTRACT

PRODUCTIVITY MANAGEMENT OF THE CACAO AGRO-FOOD SYSTEM IN TABASCO (MEXICO): A FITNESS APPROACH

Cesar Jesus Vazquez Navarrete

The farming industry and the agro-food system as a whole are now required to adapt to a challenging and more competitive environment. How the food industry can fit itself into such environment is the main question that is addressed in this study. The fitness approach, an exploratory framework, is applied in order to study the Cacao Agro-food System (CAFS) in Tabasco, Mexico. The final sample consisted of 356 farmers, 37 curing plants, 6 wholesaling firms, and 7 chocolate firms. An anatomical model using correspondence analysis was adopted to understand the main features of every industry in the CAFS. The Fitness Appraisal Instrument (FAI) was constructed and applied to determine the relationships between factors and aspects of organisational configuration with 5 key performance indicators of the CAFS farming industry.

The anatomy of CAFS revealed that it is based on raw and bulk products, has a potential to diversify vertically and horizontally, and has a dual structure private and union related –which is not appropriate to deal with issues such as free market pressures or lethal fungal diseases. Results of the FAI analysis revealed that both the factors and the aspects of organisational configuration are significantly related to performance indicators. Indeed, 14 of the 20 productivity management elements are significantly related to performance indicators. Moreover, the results show that a set of fittest solutions, rather than a unique solution, exists among farmers. Visualisation of the productivity management elements reveals that participation of organic cacao, education levels, and price setting exert the strongest influence on productivity indicators. The key implication of this study is that both efficiency and effectiveness are the two valid strategies that enable the farming industry to cope with the challenging and competitive environment. The Policy makers should be aware of a set of solutions (fitness landscape) instead of just focusing on individual (often narrow) solution.

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ACRONYMS

AFS	Agro-Food Systems
CAFS	Cacao Agro-Food System
CONADECA	Mexican Cacao Board
DWLS	Distance Weight Least Squares
EU	European Union
FAI	Fitness Assessment Instrument
FAO	Food and Agriculture Organisation
FRP	Frosty Rot Pod (lethal fungal disease)
GDP	Gross Domestic Product
ICCO	International Cocoa Organization
ICS	Industrial Classification System
INIFAP	Mexican Institution of Agricultural Research
NAFTA	North American Free Trade Agreement
NEWLS	Negative Exponential Weighted Least Squares
NGO	Non-Governmental Organisation
PCF	Production and Consumption of Food
PME	Productivity management elements
PME	Productivity Management Elements
QAA	Quick anatomical appraisal
R&D	Research and Development
SAGARPA	Mexican Department of Agriculture
SPT	Surface Plot Tool
TFP	Total Factor Productivity
UK	United Kingdom
UNPC	National Cacao Union of Farmers

ACKNOWLEDGMENTS

The author wishes to thank all the people who were involved with this PhD study, in one way or another.

First of all, I would like to thank Dr. Sanzidur Rahman for his endless enthusiasm and encouragement throughout the study. Also many thanks to Prof. Geoff Wilson for his positive criticisms and especially for the wider perspective during numerous meetings. I am also indebted to late Prof. Andrew Errington who makes it possible to start this academic journey.

I would like to thank CONACYT for funding my PhD and research project. Also many thanks to the Seale Hayne Educational Trust for supporting my field research to Tabasco, Mexico.

I would like to thank for the kindly participation in my research of all interviewed cacao farmers, curing industries, wholesaler and chocolate firms. As promised, I will be working on the feedback soon.

In Tabasco, many people of CP-Campus Tabasco helped me to carry out my field research. Many thanks to all of them. Also many thanks to all people who made my life in Geography School of University of Plymouth bearable. Especially Pauline who helped me with my computer many times and Sylvia with my proofreading.

Thanks also to my wife Ena for supporting me and listening to my walks through the "fitness" landscape.

This fascinating academic journey would be unfulfilled without all the friends who shared with me their knowledge, wisdom and charisma. Many thanks.

1. Introduction

"What is productivity but making the most of one's time and talent and energizing the whole surrounding environment so that men and women are inspired and motivated? That is to make the most of themselves, both as individuals and as members of society on all planes of living, thinking and acting: whether it is politics or economics or home or village or factory, life at the ground level or life of the spirit" - Mahatma Gandhi (Monga, 2000:10). This broad and wise perception of productivity provides an idea of its importance and potential. However, one would like to know: "what for?" Productivity permits a competitive environment to be dealt with. A competitive and challenging environment is transforming the lives of many people around the world (Robinson, 2004). It is suggested that such a competitive environment is the most appropriate framework to develop our potential (Calva, 2004). For instance, it is argued that production would become more efficient, the benefits of productivity would be distributed more evenly and the quality of life would be improved, and this applies to agriculture as well (Polan, 1995; FAO, 1997; Calva, 2004; Robinson, 2004). In fact, this framework of competition has been implemented in many policies of developing countries, which in turn has resulted in the restructuring of their agricultural sector (i.e. reducing funds for infrastructure, extension service, research and development, marketing boards, credit) (Taylor and Nuñez,1996; Trapaga, 1996; Pineda, 2004; Sanz, 2004). One outcome of this restructuring is that the food supply system is changing rapidly and becoming highly competitive due to policy reforms. Another

AUTHOR'S DECLARATION

At no time during the registration for the degree of Doctor of Philosophy has the author been registered for any other University award without prior agreement of the Graduate Committee.

This study was financed with the aid of a studentship from the Consejo Nacional de Ciencia y Tecnologia (CONACyT) and carried out in collaboration with Colegio de Postgraduados, Campus Tabasco (Mexico).

A program of postgraduate skills was undertaken, which included postgraduate course on Statistics, English for academic purposes courses and information technology training courses.

Relevant scientific seminars and conferences were regularly attended at which work was often presented.

Publications (or presentation of other forms of creative and performing work):

Vazquez-Navarrete, CJ., (2006) "Dynamic of the cocoa agro-food system in Tabasco (Mexico): an anatomy approach", for the 15th International Cocoa Research Conference, San José, Costa Rica – 9th to 14th October 2006.

Conferences Attended:

Mansholt PhD-day 2006 and Chains and Networks Conference Doctoral Symposium May 31st, 2006 Wageningen, the Netherlands.

7th International Conference on Management in AgriFood Chains and Networks, Conference Centre De Reehorst, Ede, The Netherlands, 1-2 June 2006.

The 15th International Cocoa Research Conference, San José, Costa Rica – 9th to 14th October 2006.

Word count of main body of thesis: 88,960

Signed [signature]

Date 26 October 2007

important outcome is that the agro-food systems have to deal with the challenges themselves in order to fit into this new competitive environment (Solleiro and Valle, 1996; Cuevas, 2004). Thus, each industry of the agro-food system (i.e. from the farming industry, throughout to the processing industry and wholesaling industry) needs to develop a set of strategies that permits it to fit into and cope with a changing competitive environment (Heinrich, 2003; Cuevas, 2004; Fritscher, 2004). In fact, most of the agro-food systems are still carrying out the development of strategies on their own (Casaburi, 1999). Thus, this situation has dramatically influenced the structure of agro-food systems (Folkerts and Koehorst, 1997). Furthermore, the current structure of many agro-food systems is unknown or not updated in developing countries, because there are reduced public funds to study agro-food system (Requier et al., 2003; Echanove, 2005).

Under this changing agricultural scenario, the importance of the above perception of productivity is clear. The increase of agricultural productivity has been one of the core strategies for success in competitive environments, because the "efficiency" strategy permits the creation of value from agricultural activities (Polan, 1995; Zepeda, 2001). For instance, the influence of extreme climatic conditions and biological attacks has been reduced; more homogenous agricultural products are obtained; palatable attributes have been fixed; the increase in yield per hectare which "ceteris paribus" should result in higher returns (Turrent et al., 2005). Nevertheless, the increase in productivity also leads to other problems in the short and long term such as overproduction and falling prices, environmental damage (i.e. desertification, pollution), and loss of diversity (Marshall, 2001; Wilson, 2001; Bassols, 2004; Donald, 2004). It is also argued that such "efficiency" strategy is not sufficient to meet the market's needs. It is necessary to look at the "outputs" to attract value from the market (Polan, 1995; Bernolak, 1997; Monga, 2000). Therefore, it is also important to know the needs, regulations, and transaction conditions of the intended consumer in order to be "effective" (Bernolak, 1997; Shimizu et al., 1997; Monga, 2000). All this means that an organisation could be inefficient but cannot be ineffective under competitive conditions (Stanton and Futrell, 1987). In agriculture, such "effectiveness" strategy has been carried out by the government in many developing countries (Requier et al., 2003; Zylbersztajn and Pinheiro, 2003), but nowadays every industry of an agro-food system has to deal with the enhancement of "effectiveness" in their own (Reyes and Muñoz, 1997). "Productivity management" perspective is dealing with this lack of connection (Monga, 2000). Under this managerial perspective, some attempts have been made to study both strategies: "efficiency" (create value) and "effectiveness" (attract value) (Sanz, 2004; Scherr, 2004). However, there is still a practice of studying both strategies separately in the productivity literature which leads to inconsistent and limited results (Paul, 2000).

From the above discussion, the importance of developing strategies to fit into a challenging environment is clear. However, now it is necessary to consider the extended concept of productivity which includes both "efficiency" and "effectiveness" strategies. In fact, the seeking of an relationship between both strategies of an organisation and the external environmental conditions has been a core subject of study in the "productivity management" literature (Prokopenko and North, 1997; Monga, 2000). It is argued that a compatible arrangement between internal actions and external conditions permits organisations to survive and grow (Baum and Singh, 1994; Nelson, 1996). Other authors suggest that such arrangements are always different. In fact, unique configurations have been identified that are difficult to own or emulate (Nelson, 1996; Bernolak, 1997). These particular arrangements are considered to be extremely important in order to develop competitive advantages which in turn permit organisations to adapt to changing environments as well as to successfully interact with other organisations (Porter, 1985; 1990). "Fitness" is a fresh approach to studying the development of competitive advantages (McCarthy, 2004). This approach permits the identification of the configuration of a system, and the analysis of the influence of such configuration on the performance of the organisation (Jermias and Gani, 2004). The implementation of this approach would help to study the relationship between the configuration (set of strategies) of a system and its performance which is linked to its environment.

In sum, organisations need to develop a set of strategies that permits them to fit into and cope with a changing competitive environment. It is expected that organisations in agro-food systems also need to develop particular configurations in order to survive and compete in a changing environment. This is particularly important in developing countries where the impacts of such competitive environment are very controversial. Two process of adaptation in the agro-food systems have been identified: (i) that is carried out by the whole agro-system and (ii) that is carried out by each industry of such agro-food systems. Furthermore, "productivity management" perspective considers both core strategies to achieve success: "efficiency" and "effectiveness". These strategies are built in the internal structure (or "organisational configuration") of the organisation and every "organisational configuration" is considered unique. The uniqueness of an "organisational configuration" stems from the environmental conditions and internal capabilities. Finally, the "fitness approach" permits the study and analysis of the relationship between "organisational configuration" and "environmental conditions". Therefore, in order to address the research question "how can an organisation consistently move from the current position to a more pertinent position in order to survive in a competitive environment?" this study attempt to develop an exploratory framework based on the "fitness approach" to analyse the relationships between the "organisational configuration" and "performance indicator" of an organisation. Four core concepts help to achieve the aim of the study: "Production and Consumption of Food", "Agro-Food Systems", "Productivity Management", and the "Fitness Approach". These core concepts are scrutinised below.

1.1. The core concepts

Production and Consumption of Food

The first task in this research is to pinpoint the driving factors that influence the production and consumption of food. To meet this end, an examination of the "Production and Consumption of Food" (PCF) paradigm is useful. The term PFC, in this study, covers all the activities of producing, processing, supplying, and preparing and ingesting food

(Marshall, 2001). The PCF is influenced by key factors such as agro-ecological, biological and socio-economic factors. The combinations resulting from interplay of these factors can be seen across the spectrum of results (Marshall, 2001). This spectrum is referred to this study as environment. It is clear that no single producer or consumer is isolated. Agro-food systems play an important role to bridge production and consumption sides (Lang and Heasman, 2004). In brief, the need of the individuals and organizations to be linked into society calls for a process of "fitting" (or adaptation). This "fitting" process implies that agro-food systems should continuously search for strategies to fit into both the local and/or the global environments. Furthermore, this process of adaptation also takes place in every "industry" of an agro-food system (e.g. farming, processing, wholesaling, and catering). Therefore, two core layers are important: the whole agro-food system and the key "industry" of such agro-food system. A study of both of layers is important to understand the "fitting" process.

Agro-food systems

An analysis of the anatomy (physical structures) of the agro-food system is another important dimension of this research. It is needed in order to understand the "fitting process" of the whole agro-food system. Thus, different aspects are analysed to address this adaptation process: a definition of an agro-food system and a discussion of its importance in the society, the main tools to diagnose an agro-food system, and the "chain mapping" tools to analyse the agro-food system. Agro-food systems play an important role in the supply of food. Most countries set a series of policies to achieve this fundamental goal. Furthermore, agro-food systems also have a great impact on the economy of most developing countries. But it is also accepted that many changes have taken place since these countries implemented free market economy policies (Calva, 1996). A lack of current information on agro-food systems (i.e. performance, structure, dynamic) is one of the main results (Solleiro and Valle, 1996). The lack of current information on agro-food systems needs to be considered in this study. As an Agro-Food System is defined as the 'physical and organisational systems linking producers and consumers and is constantly adapting in response to a changing environment (Spedding, 1988; Street, 1990; Trienekens and Zuurbier, 2000), a "systems approach" is a very useful tool that highlights what should be considered in studying an agro-food system. Identification of elements and interactions are a good starting point (Spedding, 1988). The process of adaptation could be traced by analysing the changes of an agro-food system. "Chain mapping" tools are used to identify problems and opportunities in a supply chain management (Trienekens and Zuurbier, 2000). Therefore, such tools could help to analyse the structure of an agro-food system which in turn provides more information about its current "anatomy".

Productivity

As mentioned earlier, the term productivity means different things to different people. The conventional economic definition of productivity generally focuses on a single property – a measure of efficiency defined in turn as the ratio of the outputs that a system produces to the inputs that it uses (Shimizu et al., 1997; Coelli et al., 1998). The expanded definition of productivity embraces two properties: a combination of efficiency and effectiveness (i.e., the ratio of outputs to goals) (Lawlor, 1985; Pritchard, 1995). The neoclassical economists used the traditional definition of productivity as a key variable to explain a wide range of economic phenomena (Coelli et al., 1998; Zepeda, 2001). However, application of this narrowly defined concept fails to explain many other areas of interest of the economic phenomena. Therefore, it is ssugested that the concept of productivity should be expanded and related to other factors such as 'organisational behaviour' (Nelson, 1996; Dosi et al., 2000). The latter perspective is compatible with the broader view of productivity; that is "productivity management". The management perspective permits organizations to best utilize their precious resources (the efficiency dimension), to meet their societies' needs (the effectiveness dimension), and to survive in the changing environment (the competition dimension) (Pritchard, 1995). The management perspective implies that the productivity concept is to be used not simply to obtain and keep performance scores only, but also to enhance organisational performance at an individual as well as at sectoral level (Prokopenko and North, 1997). The present study utilizes this broader view of the productivity concept: the management perspective as the source to draw the elements that characterise the interrelationships of various internal and external environments in an agro-food system.

Fitness approach

The study of the characteristics of a system and the relationships between the system and its environment, as an 'evolutionary' view stems from biological science. The knowledge generated by this 'evolutionary' perspective is very impressive, and it has also been applied to social science and nowadays expanded to study the dynamics of the manufacturing sector (Baum and Singh, 1994; Dosi et al., 2000; McCarthy, 2004). The application of this 'evolutionary' approach, however, remains almost unused in the analysis of agricultural systems, particularly in the agro-food system (Trienekens and Zuurbier, 2000; Cuevas, 2004). The strength of the "fitness approach" results from the systematic visualisation of all possibilities generated by organisations. Using a 'landscape' tool, it is possible to generate a walk from the initial position to the desired position. The relative positions are the results of particular characteristics of the organizations and their relationships that shape the landscape. Therefore, by mapping this landscape, it is possible for an organization to choose a feasible path from various paths to reach from its initial position to the desired position (McCarthy, 2004).

Cacao agro-food system (CAFS) in Tabasco (Mexico)

As most of the agro-food systems around the world, cacao agro-food system (CAFS) in Tabasco (Mexico) needs to find a match between its internal configuration and the environment. This particular CAFS has been selected to be the setting of the study for three main reasons: (i) the location of production and consumption are separated. That is production is based in tropical regions and the main consumption is located in temperate zones, (ii) consumption is through value added products which in fact are controlled at the consumption side, (iii) cacao is likely to be the main source of income growth for many small-holding farmers, when public infrastructure investments are also made. This could create a powerful synergy for growth in rural non-farm economies. Many crops share similar characteristics around the world. Therefore a better understanding about the "fitting" processes would lead to the development of a pertinent strategy for these agro-food systems.

All four concepts provide key tools, frameworks and models to achieve the aim of the research question of this study: "how can an organisation consistently transit/move from the current position to a pertinent (desire, competitive, sustainable) position in order to survive in a competitive environment".

1.2. Aims and objectives

As mentioned earlier, this study realises that organisations need to develop a set of strategies that permits them to fit into and cope with a changing competitive environment. Therefore, the main aim of this study is to develop an exploratory framework based on the "fitness approach" to analyse the relationships between the "organisational configuration" and "performance indicator" of an organisation.

The specific objectives of this research are:

1. To broaden our understanding of the anatomy of an agro-food system using a combination of a systems approach and supply chain management perspective. The analysis of the anatomy of the cacao agro-food system in Tabasco (Mexico) permits the study to pinpoint the key industries and their relationships that integrate the CAFS.

2. To develop an exploratory framework under a "fitness approach" that permits the identification of the factors and aspects of "organisational configurations" of an organisation.

   In order to address this identification, it will be necessary to (a) select the most important organisational elements by applying the "productivity management" perspective and (b) select the most suitable analytical tools from a set of alternatives to analyse the relationship between the selected "organisational configurations" and the "performance indicators".

3. To implement this exploratory framework – the "fitness approach"- to analyse and evaluate the farming industry of the cacao agro-food system in Tabasco, Mexico.

Two main "fitting" processes have been identified in this study: the whole agro-food system and the "farming" industry of the agro-food system. Therefore, the first objective of this study concentrates on the examination of the "fitting" process of the whole agro-food system by analysing its anatomy. The second and third objectives of this study focus on the assessment of the adaptation process of the "farming" industry of the agro-food system by examining three key factors (i.e. "technology", "competence" and "operational climate") and aspects (i.e. "innovation", "diffusion", "labour", "skills", "complementarity", "vertical integration" and "diversification"). All these objectives complement each other in order to address the key question: "how can an organisation consistently transit/move from the current position to a pertinent (desire, competitive, sustainable) position in order to survive in a changing and competitive environment".

Thus, the present study will make significant contributions to existing literature on agro-food systems in many ways. First, it will stimulate the debate on the survival of local agro-food systems in developing countries. Second, this study provides evidence of the importance of utilising the "productivity management" perspective in order to develop a theoretical framework. And in addition the need to apply it at a firm level in order to assist organisations (individual and entrepreneurs) to pinpoint their current "organisational configuration", their desired configuration and the pathways to realise them. Third, the study contributes towards a better understanding of how to address the key "productivity management" elements affecting the performance of an individual or a firm by considering an organisation as a life system, rather than a narrowly viewed rational, mechanical and deterministic system. Fourth, this study critically examines existing works that have utilised the "fitness approach" in other realms of study, e.g., the manufacturing industry. Finally, the study develops and extends this "fitness approach" framework and aims to examine for the first time a key industry in agro-food systems (the "farming" industry) – the "organisational configuration" of the farmers, the performance of the farmers, and the internal and external environments affecting the performance of the farmers.

1.3. The structure of the thesis

The methodology adopted to achieve the research objectives is composed of three phases with subsequent sub-phases (Figure 1-1). The main three phases are:

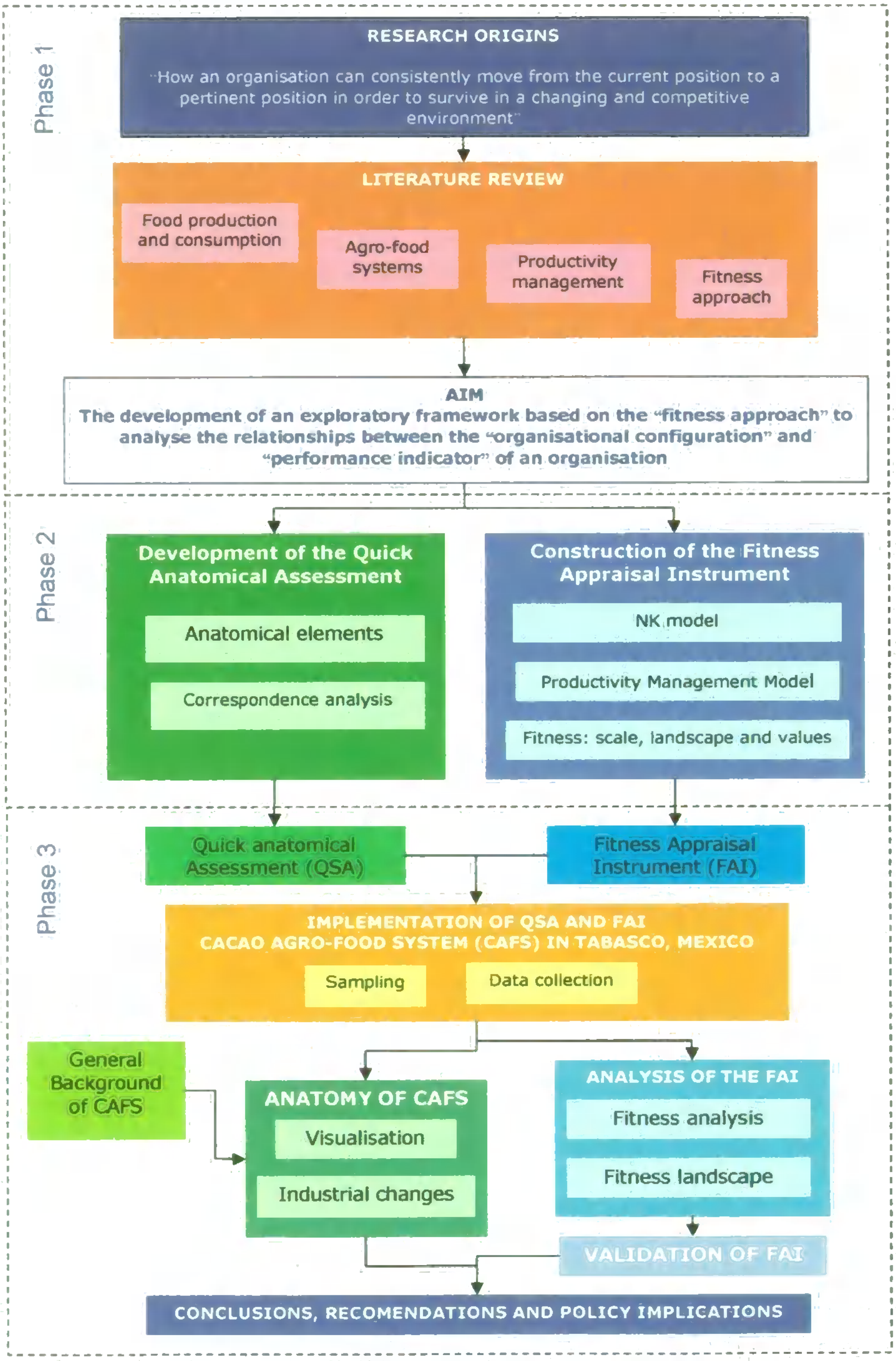
1. Research problem definition and identification: (a) creating awareness, (b) defining and describing the problem, (c) finding and analysing the existing facts, and (d) establishing research gaps;

2. Development of the exploratory framework: two exploratory frameworks were developed (e) Quick Anatomical Assessment and (f) "Fitness Appraisal Instrument" ; and

3. Implementation phase – (g) implementing the two frameworks to analyse the agro-food systems and its key industry (i.e. the farming industry).

The flow diagram in Figure 1-1 also represents the overall structure of the thesis. The research problem starts with the realisation that organizations and individuals are constantly faced with the challenge of fitting into and coping with their ever changing environment. Therefore, the key question to explore is how an organisation can consistently transit/move from the current position to a pertinent (desire, competitive, sustainable) position in order to survive in a changing and competitive environment. A detailed examination of the context within which an agro-food system is situated, that is the Production and Consumption of Food paradigm, is the starting point in this study.

Figure 1-1. The structure of the thesis



Then an analysis of agro-food systems in developing countries is carried out which sheds light on its present constraints, particularly the lack of current information regarding its structure (anatomy). The "productivity management" perspective is utilised to identify and select elements that characterise the "organisational configuration" of an agro-food system. Several approaches are available to analyse an agro-food system. In this study, an exploratory framework – the "fitness approach", is adopted for the purpose.

The next phase then is the design phase. In this phase, two main tasks are carried out: the development of the Quick Anatomical Assessment and the construction of the Fitness Appraisal Instrument. The principal task is to develop and extend this exploratory framework: the "fitness approach", by critically examining its previous use in other realms of study, for example, in the manufacturing sector. The "Fitness Appraisal Instrument" is constructed from the selection of factors and aspects of "organisational configuration" drawn from "productivity management" perspective. The analysis of the instrument is selected from a wide range of analytical techniques available to test the 'fitness' framework. This particular technique is the NK-model.

Another major task is to analyse the "chain mapping" tools in order to select the key elements to analyse the anatomy of an agro-food system. Afterwards, the Quick Anatomical Assessment is developed by the use of four key anatomical elements: the industries, products, by-products and interactions.

The final phase is the implementation phase. The first task is to provide a general background of the cacao agro-food system (CAFS) in Tabasco, Mexico. Next, the Quick Anatomical Assessment is implemented to analyse the anatomy of the CAFS. Finally, the freshly constructed and extended 'fitness approach' is implemented and empirically tested for the first time in the analyses of a farming industry of CAFS.

Outline of the thesis

Chapter 1 discusses the research origin of this study by providing a justification of the importance of drawing attention to the question "how can an organisation consistently transit/move from the current position to a pertinent (desire, competitive, sustainable) position in order to survive in a competitive environment". Four core concepts are discussed in order to shed light on this key question (i.e. Production and Consumption of Food, agro-food systems, productivity, and "fitness approach"). Then, the aims and objectives of this study are set and the structure of the thesis is presented.

Chapter 2 scrutinises the four core concepts. (i) "Production and Consumption of Food" provides a review of the driving factors (e.g. natural, technological, and socioeconomic) that influence the supply of food, and the impacts of these "Production and Consumption of Food" factors on the main structures that supply food (i.e. agro-food systems and key industries). (ii) agro-food systems considers an examination of the importance of agro-food systems with special attention to developing countries, the available diagnostic tools to analyse an agro-food system, and the anatomical layers of agro-food systems based on the "chain map" tools. (iii) "Productivity management" provides a critical assessment of its concept, the extended managerial perspective and the driving factors (i.e. technology, competence, and operational climate) that influence the performance of organisations. (iv) "Fitness approach" considers a review of this important concept, and its application to the analysis of other sectors by employing a landscape perspective. The development of an exploratory framework that permits analysis and classification of "organisational configuration" is one of the main aims of the amalgamation of these four concepts which is discussed at the end of this chapter.

Chapter 3 discusses two methods to analyse the anatomy of an agro-food system (3.1) and to analyse the "fitness" of a key industry of an agro-food system (3.2). Both methods help to achieve all the objectives of this study.

Chapter 4 provides a general description of the cacao agro-food system (CAFS) in Tabasco (Mexico), and Chapter 5 considers the development and implementation of the Quick Anatomical assessment to analyse the CAFS, and the main results of this anatomical exploration.

Chapter 6 looks at the development of the "Fitness Appraisal Instrument". This chapter scrutinises and selects the key factors, aspects and elements based on the "productivity management" perspective. This chapter also develops three analytical elements of the "fitness" approach: scale, landscape and values.

Then, Chapter 7 analyses the implementation of the "Fitness Appraisal Instrument" by considering two methods: correlation analysis and exploration of the "fitness" landscapes.

Chapter 8 provides the discussion of the results obtained in chapter 7 and Chapter 9 summarises the conclusions of this study.

2. Literature review

Under competitive conditions, the structure, strategies and resources of the different industries (e.g. farming, processing, and wholesaling) involved in an agro-food system should meet the changing environment in order to supply food in cost-effective, innocuous and sustainable terms (Solleiro and Valle, 1996; Cuevas, 2004). Every organisation (e.g. farmer, NGO, and firm) of the different industries that belong to an agro-food system has to develop an internal configuration which aligns with such an environment (Requier et al., 2003; Reig, 2004). There is a key question that arises from this discussion "how can one consistently transit/move from the current position to a pertinent (desire, competitive, sustainable) position" (i.e. "fitting" or adaptation process). Two processes of adaptation have been identified: (i) that carried out by the whole agro-system and (ii) that carried out by each industry of such agro-food systems. This chapter provides a review of the core concepts to address this key question.

As mentioned in Chapter 1, "Production and Consumption of Food" is the starting point The review of this appealing concept is based on the realisation that the supply of food has turned more complex (Section 2.1). This complexity arises from different "Production and Consumption of Food" factors such as agro-ecological, technological and socioeconomic. A comprehensive review of "Production and Consumption of Food" factors provides a better understanding of how organisations should align their structures and resources to fit into such complexity. Thus, three main questions need to be asked: "what is the current configuration of an organisation?", "what is the most pertinent configuration?" and "how should this desired (pertinent) configuration be realised?" In order to answer these key questions, three inter-related concepts are reviewed in this chapter: (i) the agro-food system, (ii) the "productivity management" perspective, and (iii) the "fitness approach".

"Agro-food system" embodies an examination of the importance of agro-food systems with especial attention to developing countries, the available diagnostic tools to analyse an agro-food system, and the anatomical layers of agro-food systems based on the "chain map" tools. This theoretical approach permits a better understanding of how to analyse an agro-food system, identifying its essential components, its interactions and processes, its boundaries, and its driving factors (i.e. technology, competence, operational climate), and finally how to analyse the "fitting" process of a whole agro-food industry by examining its anatomy (Section 2.2).

The second concept, "productivity management" perspective is reviewed, while taking into consideration a critical assessment of its concept, the extended managerial perspective and the "productivity management" factors (i.e. technology, competence and operational climate) that influence the performance of organisations. This approach seeks to respond to the question of why firms, sectors and countries have differences? After identifying these differences (e.g., the "productivity management" factors), it is possible to set a model to analyse the "fitting" process of a key industry of an agro-food system (Section 2.3) For this purpose it has been suggested that an exploratory framework is employed and this is discussed below.

As mentioned in the introduction, a new perspective is needed to understand the survival strategies of organisations. One approach followed here is to adopt an exploratory framework: the "fitness approach", which permits us to find the relationship between the "organisational configuration" based on the "productivity management" factors, and the environmental conditions. This relationship permits us to understand the "fitness" process of a key industry in the agro-food system, i.e. the farming industry.

These four concepts are amalgamated in the last section of this review and the research questions raised for the present study are discussed. This chapter, therefore covers the Phase I of this research project: the problem definition and identification phase; and provides core concepts to develop both the "anatomy approach" and the 'fitness approach' agreed in the design phase (Phase II) and then to implement them in the farming industry of an agro-food system (Phase III). An important outcome of the study is the identification and categorisation of various paths of integration strategies that each player (i.e. each farmer in the farming industry) in an agro-food system undertakes in order to move from its current position to a desired one (optimum, future and planned).

2.1. Production and consumption of Food (PCF)

The production and consumption of food (PCF) have changed dramatically in the last few decades. Such changes of PCF arise from different factors which include economic, technological, political, social, and natural. The influence of these factors has varied in time and space, so different results can be seen (e.g. famine, undernourishment, obesity) in the world. Many scholars still concentrate on studying the PCF paradigm by analysing its driving factors in order to characterise the "environmental conditions" that organisations that produce and supply food have to cope with. The study of the PCF sheds light on how organisations create and adapt their strategies to achieve their goals and to meet the needs of the current and potential food consumers under different "environmental conditions". This section is divided into two subsections: subsection 2.1.1 examines key driving factors which influence the production and consumption of food (PCF) of both developed and developing countries, and subsection 2.1.2 discusses how organisations respond to different environmental conditions.

2.1.1. Driving factors

The PCF around the world has become very complex. Bergier (1998:2) provides a helpful description of such complexity: "Food is gone as soon as it is eaten – it has to be renewed all the time. For each individual or household, food is a demand that has to be satisfied on a daily rhythm. For the individuals, the household or group, it thus implies a special strategy, continually renewed, and complex of collective practices in order to obtain the necessary (or desired) foodstuffs, to preserve them, to render them suitable for eating by cooking, to serve them at table (or elsewhere) and, finally, to ingest them. This daily strategy has diversified enormously over time and space. This is partly due to exogenous and objective material factors – the accessibility of resources, climate, the degree of the group's material and technological development – and also as a result of the endogenous, social (housekeeping, budget, the consumer's occupation category) and cultural factors which assign to each group familiar tastes, customs and rites".

This description emphasises two important issues (i) there is a large number of different patterns not only of food production but also of food consumption, and (ii) there is a close interaction between producers and consumers. This description, however, is a small piece of the whole snapshot, since the global PCF is shaped by different driving factors. There are 5 core factors that influence the PCF i.e. natural, technological, social, economic, and political. Some variables of these factors influence dramatically the production of food (e.g. climate, research, price, trade), and other variables influence the consumption of food (e.g. gender, ageing, information).

Table 2-1 shows some variables that influence the PCF of two groups of countries i.e. developing and developed. These variables are grouped into five factors (i.e. natural, technological, social, economical and political). As mentioned before, 5 main factors i.e. natural, technological, social, economic and political factors influence the production and consumption of food.

Table 2-1. A comparison of key factors which influence production, supply and consumption of food in developing and developed countries

VARIABLES	DEVELOPING	DEVELOPED
	Natural Factors	
Land expansion	potential expansion: rainforest and arid zone	Limited, potential expansion: forest and arid zone.
Erosion	Low to moderate	Moderate to High
Climate	Tropical and arid	Template
Biodiversity	Very high	Low
	Technological Factors	
Research	Less than 0.5 of GDP	1-2 % of GDP
Orientation	Agronomic	Integral
Yields	Low	Very high
Knowledge	Low and public	Very high, public and private
	Social Factors	
Reproduction	Increasing 1-4 %	Stagnate
Gender	Housewife function	More participation
Ageing	Predominance of young people	Predominance of senior population
	Economic Factors	
Price	Liberalisation process	Highly protected
Consumption pattern	Simple, and traditional	Complex from convenience to slow food
Food expenditure	More than 30% on food	Up to 15% on food
Macroeconomics	Unstable	Stable
Food supply	Dispersed and decoupled	Organised and coupled
	Political Factors	
Planning	Short term	Long term
Programs	Process of dismantling	Transformation process
Trade philosophy	Comparative advantage	Competitive advantage
Importance	Negotiable	Sovereignty

Source: (After FAO, 1997; Wood et al., 2000; OECD, 2001)

The discussion of these core factors has two main goals (i) to identify the main characteristics of the production driven-supply force which is based on among others, the availability of resources, technological capacity and supply and market structure and (ii) to identify the main characteristics of the customer-driven supply force which is based on economic, social and cultural characteristics of the consumer and government regulations. The discussion of both forces sheds light on how to analyse and/or improve the supply of food considering a holistic view.

Natural factors

According to many scholars, the supply of food is limited by natural factors (e.g. weather, soil, topography). These natural factors vary in different regions and across the year. For instance, there will not be enough suitable land to produce sufficient food under a current human growth rate; therefore one way to address this problem is to intensify the production of crops and livestock and this leads human to transform many regions and prepare them for agricultural use (i.e. deserts have been transformed into vineyards; swamps into grasslands, and so on). This agricultural conversion has dramatically influenced the landscape (Wood et al., 2000; Marshall, 2001; Donald, 2004; Robinson, 2004). A global climate change has been recently identified, which is also expected to have an impact on the food production areas in the longer term (Marshall, 2001; Donald, 2004; Robinson, 2004).

The term "food" used here, refers to all substances that provide energy and nutritional elements to the human body. Outside the human system, they are "living things" tied to biological laws from reproduction to death. Therefore, once food is harvested or slaughtered, their components are influenced by biological and physical processes (e.g. oxidation, fungal infection, dryness, etc.) (Frewer et al., 2001). This natural property of food has led scientist to develop a mosaic of techniques (such as pesticides, fertilisers, transgenic crops and livestock, preservatives, enzymes, gamma rays, among others) to improve the life span of all food products ranging from raw materials to the manufacturing stage. However, several critics have pointed out the hazards associated with these advances, especially related to human health, biodiversity loss and degradation (Goodman and Watts, 1997; Delgado et al. 2001; OECD, 2001).

Social factors

The social factor includes at least one of the following aspects (Marshall, 2001) reproduction, gender, religion, beliefs, desires, motivation, etc. The study of human population variables is very useful to identify the main characteristics of a population, such as growth, gender, age among others (FAO, 1997). Ageing is a process that influences both consumer and producer groups. On the consumption side, ageing modifies the preferences of consumers dramatically, and has a huge impact where elderly people have a high income. As a consequence, the needs focused on basic food are transformed into concerns on ethics and environmental implications of production and consumption of food. On the production side, this phenomenon affects the efficiency of food production because elderly farmers are more likely to have less production capacity. This effect is worsening, since young people are now less interested in working on farms (FAO, 1997). The gender variable plays an important role in the consumption side. Women are participating in more economic activities, and this allows families to have an extra income. However, this also forces the families to change their food preferences and feeding pattern. Convenience food (i.e. fast food, processed food) has been an option sought by these types of families in the last 20 years (Evans, 1998). Recently, families have also become concerned about being healthy and are showing a preference for food products that focus on quality, taste or social and environmental attributes in the procurement, processing and preparation of food. This type of food is known as slow, organic and fair trade food (Jongen and Meulenberg, 2001). Finally, growth and migration are key human population aspects which definitely influence the demand for food. However, these aspects have not been examined in great detail even though they are critical in developing countries where most of the social problems related to food (i.e. famine, malnourishment) normally occur. This is a complex and delicate political subject, as other social aspects (i.e. culture, religion, beliefs) have to be considered in order to establish a reproduction strategy according to the food production capacity of each country (Kiple and Ornelas, 2000).

Economic factors

The economic factor includes (Marshall, 2001) price, farm costs, marketing costs, packing, processing, transport, storage, consumer demand, income, patterns of expenditure, among others. Every economic organisation has to be profitable in nature. The difference between costs and benefits needs to be covered. Food production is a conglomerate of activities which include production, transformation, distribution and preparation. Each activity has a specific cost which has to be reduced in order to gain efficiency. Therefore, it is necessary to design, implement and evaluate strategies oriented to the efficient allocation of the available resources and to develop capabilities in order to continuously improve these strategies (Ballestero, 2000). Cost analysis permits organisations to be more efficient. However, this is not enough to succeed in environments based on the rules of an international process of globalisation, because in this particular case, food products must meet the needs of the customers. The identification of needs and wishes of any market is a paramount task which requires a complete knowledge of other economic variables (e.g. consumer-demand, income, patterns of expenditure, and a full capacity to take decisions and to be responsible for the actions taken). If organisations can manage the needs and wishes of consumers, then, they will achieve great levels of effectiveness.

Political factors

This factor includes agricultural policies, subsidies, business controls, legislation, distribution, welfare programs, rationing, nutrition policies and guidelines, government sponsored research programmes, trade and aid policies, tariffs and quotas. Agriculture has been a controversial sector over the last 50 years and the main point of discussion refers to a simple political decision: protection or liberalisation of the agricultural sectors (Çalva, 1996; 2004).

Under a protected agriculture policy, agriculture is a strategic sector (e.g. sovereignty, power, multi-functionality), and therefore, the production of food has received the highest priority. Such policy was implemented as a response to the problems of rationalisation of food during and after World War II. Lately, governments with a protected agricultural policy have set food production goals in terms of achieving self-sufficiency, maintaining domination, and protecting sovereignty. The implementation of such agricultural policies permits these countries to satisfy the food supply of their population, and also to introduce the surplus in global markets. (Kiple and Ornelas, 2000; Fritscher, 2004).

Under a liberalised agriculture policy, agriculture is another negotiable point of the international trading or financing agenda. This means that the principle of food self-sufficiency has given way to an outward-oriented and free-market strategy of growth; the promoters of such policy argue that it is expected to bring more benefits for everyone under free market conditions (Robinson, 2004). However, there are also other outcomes which irreversibly affect people and natural resources (Calva, 1996; Steinberg and Josling, 2003; Reig, 2004).

Developed countries

Considering the core factors mentioned above, it is possible to characterise the production and consumption of food of two main groups of countries i.e. developed, and developing. The description of both groups provides useful information about the current conditions in which organisations interact in order to satisfy the food needs (and wishes) of the consumers.

In general, the people in developed countries incur the highest food consumption expenses in the world (circa a USD 10 as daily expenses for food). The wealth of this group of countries permits its population not only to access local but also global food and to demand higher quality standards (Hill, 2000; Kiple and Ornelas, 2000). Technology permits these countries to lead and control a mosaic of products and services which are used in the production, transformation, distribution and preparation of food (Kiple and Ornelas, 2000; Swinnen et al., 2000; Cramer et al., 2001). The current variety of food is barely the tip of the food-diversity iceberg and many food suppliers realise this fact after exploring their national and regional potential. Developed countries have also developed regulatory markets for staples, and their position permits them to control market price, quality, and regulations (Kiple and Ornelas, 2000; Frewer et al., 2001). The bridge between consumers and producers has been built on structured and dominant chains (Lang and Heasman, 2004). In general, private intermediaries have become leaders in these chains, either by processing raw materials or by retailing food to the final consumers. Under the explicit agricultural protection policy of these countries, this leadership of suppliers permits them to go abroad and to compete against their counterparts. This opportunity brings them an experience in the food supply management which nowadays is a key criterion in the domination of the liberalised agricultural market (Goodman and Watts, 1997; Millstone and Lang, 2003).

Developing countries

In contrast, developing countries constitute up to 50 percent of the world's poorest population (where individuals live on less than a daily wage rate of USD 2 dollars). Food expenses of this population represent up to 50 percent of the total consumption budget, but in some cases this is not enough and therefore is complemented with self-produced food in many regions (Pineda, 2004). Most of the countries in this group are located in tropical zones (highland, humid and arid). Most of the technology developed in these countries has been based on inappropriate temperate guidelines, relegating the potential of their biodiversity both natural and cultural. All this becomes more complicated when one takes into consideration the reduction of funding for agricultural research, education and extension services. In such areas also, there is a risk of being entirely dependent on the technology produced and promoted by the first group of countries who are self-sufficient in food production (Bassols, 2004). For many countries, the bridge between consumers and producers was controlled by national institutions which took care of most of the food supply activities. However, once the free market strategy was implemented, the transition of these functions to private initiatives has been slow and on many occasions with some reversal in direction (Calva, 2004). Multinational companies have been covering these public functions (e.g. storage, distribution, processing), but economic and cultural factors do not permit these companies to cover all the public functions in these countries completely._There are local food supply chains that are trying to evolve and fit into this ever changing world but it seems to be a big challenge for them, considering the current agricultural policies prevailing in their countries (Goodman and Watts, 1997; Katz et al., 2003; Echanove, 2004).

Environment: production and supply of food

In brief, the production and consumption of food is a complex process which has turned more competitive. Many developed countries still protect their food production and there seems to be no way of solving this situation soon. The consumption of food has also become a competitive field where producers try to attract their customers.

Furthermore, customers also start to influence the food supply chains by demanding specific standards. Therefore, this study set the "competitive environment" as the framework with wich organisations have to cope to and deal with. From this point, agro-food systems and organisations need to develop their strategies.

2.1.2. Fitting into the competitive environment

The discussion of PCF provided useful information about the conditions related to the complex process of food supply. It was found that there are constrains on the food production side, but also several changes on the food consumption side due to the increasing bargaining power of customers. Therefore, the food supply structure has also changed, and the set of strategies of each chain, linkage, and individual firm needs to be evaluated and improved in order to meet potential and current food consumers. A brief discussion follows of the main structures to supply food: agro-food systems and the strategies that such systems employ to meet customer's needs.

Agro-food systems

As mentioned above, the PCF is different across time and regions. An agro-food system is the set of individuals and organisations that have to deal with the impacts of changing the driving factors of the PCF. This basic organisational arrangement is very important because it is the bridge between the consumption and production side and the place to achieve food products in economic, innocuous, and environmentally friendly terms (Wilkinson, 2002). In developing countries, agro-food systems also play an important role, since they have helped to create value in different social periods (i.e. colonial, independent, global).

The changing patterns of PCF have also led also to a different perspective of agro-food systems to be proposed. Such production and supply perspectives try to meet broader objectives such as conserving landscape, retaining patrimony, perpetuating cultural heritage, providing complementary food and goods, etc (Lang and Heasman, 2004; Quintana, 2004). This perspective is shaping several agro-food systems and it seems that this will be the answer for many regions. On the other hand, the failure to adapt to changing environments also has repercussions, for instance the exit of organisations (e.g. farmer), industries (e.g. farming, processing and wholesaling), or even whole agro-food systems is one of the main results (Goodman and Watts, 1997; David et al., 2000; Echanove, 2004).

Furthermore, it is argued that the interaction between producers and consumers is based on a "fitness" process where all organisations of each industry throughout the agro-food system (i.e. farmer, processor, wholesaler, retailer) should align their structure, strategies, and resources with the consumers' needs (i.e. local, national or international) (Trienekens and Zuurbier, 2000). Thus, agro-food systems are asked to achieve this relationship if they want to survive in an ever competitive and changing environment.

Strategy: production and supply of food

Every organisation of an agro-food system is seeking different strategies to adapt to this changing environment. Productivity has been an important strategy to create value (Prokopenko and North, 1997). This value is created by achieving higher levels of efficiency which in turn permits organisations to grasp more value which would be invested in new ways to increase efficiency. This means paying more attention to reducing inputs. However, other management scholars suggest that as the equation consists of two parts (i.e. outputs and inputs), productivity cannot rely only on an "input view" (Valdes and Gnaegy, 1996; Monga, 2000). So, productivity also attracts value from the market, which is attracted by achieving higher levels of effectiveness. Thus, effectiveness focuses on the improvement of the quality, the diversification of products, and the identification of the new needs and wishes of consumers. However, it is recognised that an "output view" is not seen in all agro-food systems (including their industries and organisations), especially in developing countries (Solleiro and Valle, 1996). This could be accounted for in different ways, but a lack of such an "output view" would lead to the exit of any agro-food system in the current competitive environment.

Therefore, based on this review, it can be concluded that agro-food systems need to know where they are, where they should be and how to get to this new position in order to adapt in the global supply of food. These key questions are also valid for each industry and organisation that comprises the agro-food system.

2.2. Agro-Food Systems (AFS)

This section refers to the importance of having current and opportune information regarding Agro-Food Systems (AFS). This section is divided into three subsections: subsection 2.2.1 reviews some of the main features that characterise the importance of Agro-Food Systems (AFS), subsection 2.2.2 scrutinises the approaches to diagnose agro-Food Systems (AFS), and subsection 2.2.3 discusses the mapping tool to analyse agro-food systems.

2.2.1. Importance of Agro-Food Systems (AFS)

As mentioned in section 2.1, the supply of food has become a complex process which involves a series of individuals and organisations. From this extended perspective many scholars suggest studying this complex process under a systems view. So, an Agro-Food Systems (AFS) is the operational unit belonging to the physical and organisational system linking producers and consumers, and is constantly adapting its response to a changing environment (Street, 1990). According to many authors an AFS is important because of the global outcomes it produces (and not only food), the employment generated (directly and indirectly), and the role it has in shaping the countryside (Spedding, 1988; Jones and Street, 1990).

The environmental conditions of every AFS are different, and as mentioned in section 2.1, they are more critical in the developing countries for several reasons. First, "Developing Countries are currently experiencing a profound process of agricultural restructuring as part of the transition from an inward-oriented, import-substitution policy of industrialisation to an outward-oriented, free market, strategy of growth" (Bey, 1996; Taylor and Yuñez, 1996; Trapaga, 1996; David et al., 2000; Requier et al., 2003; Echanove, 2004; Reig, 2004). Second, "the replacement of the principle of food self-sufficiency by a strategy of comparative advantage has condemned many AFS, especially peasant farmers, to a gradual disappearance". Third, "Many Developing Countries governments have not provided incentives for the productions of local staples, as they can be imported at lower prices. They would rather prefer to promote expansion of cash-crop products in the world market (mainly vegetables and fruits) as the correct competitive strategy" (Bey, 1996; Taylor and Yuñez, 1996; Trapaga, 1996; David et al., 2000; Requier et al., 2003; Reig, 2004). In brief, the considerable importance of the AFS in most of countries in the developing world rests on three primary factors: the considerable weight of AFS in the overall GDP, its large contribution to exports and, lastly, the very substantial proportion of the total population and the population below poverty line in rural areas (Cuevas, 2004).

Furthermore, the study of AFS as a whole is weak and dispersed in developing countries (Torres et al., 1996; Cuevas, 2004; Valle, 2004). There are still many AFS that require current information about the changes resulting from the implementation of the above policies and the alteration of environmental conditions (Solleiro and Valle, 1996). This lack of knowledge leads incorrect decisions being taken at different levels such as political, economic, entrepreneurial, and academic (Cuevas, 2004; Valle, 2004). Therefore, the need to increase the current information of AFS is underscored in the first objective of this study. The next subsection discusses the approaches required to address the first objective of this study.

2.2.2. Diagnostics of agro-food systems

A "systems" view is used to simplify complex interactions into diagrams that can be analysed visually. Such "system" visualisation ensures that those involved in the analysis understand all of the interactions and consequently the implications of changes that may be suggested (Spedding, 1988).

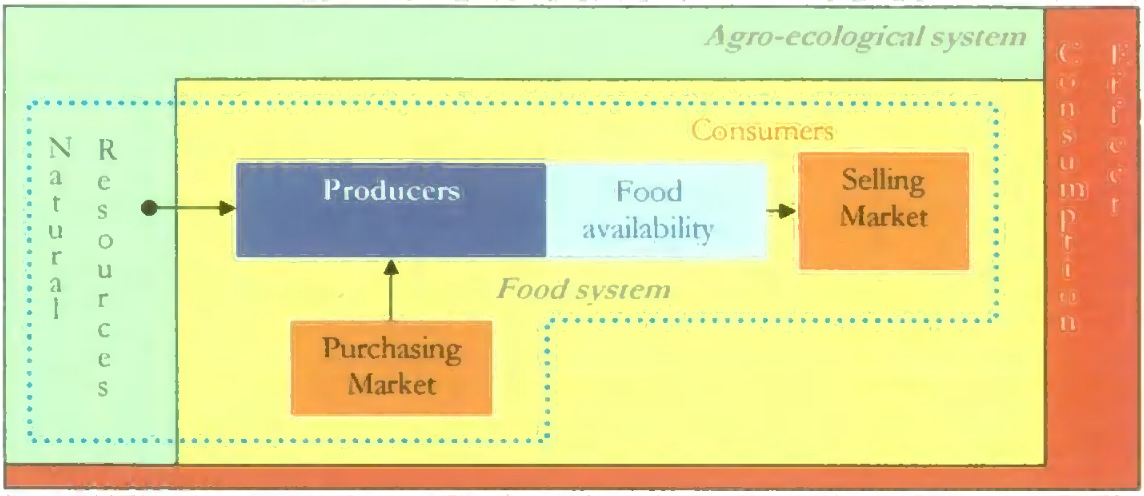
The strength of a "systems" view is the identification of elements, the recognition of 'space and time" boundaries, and finally the discovery of interactions among elements and the system with its environment. (i) The identification of the elements in a system is the first logical task. However, different dimensions can be used for this identification process; for instance, a food supply chain can embody social elements (e.g. Farmers, intermediaries and marketing organisations, food manufactures and processors, retailers and caterers), physical elements (seeds, grain, flour, bread, sandwiches), economic elements (income, profit, expenditure, taxes), or regulatory elements (innocuousness, traceability, quality). The number of dimensions required to analyse the elements of a system depend on the ability to explain its interactions (Spedding, 1988; Jones and Street, 1990). (ii) The elements are generally bounded in space and time. While the former can be referred to volume (cow, person, tank, etc.) or surface (hectares, km^2, etc.) among others, the latter can be measured in minutes, days, years, etc.

These properties permit a point of reference to analyse the elements. This is very useful because these are physical properties that remain unchanged (Spedding, 1988; Jones and Street, 1990). (iii) The discovery of interactions among the elements is an important task. The most common technique to analyse interactions is to use an input-process-output-feedback path. Although the power of this application is very well known, recently other techniques have been brought to study those interactions. These techniques include a holistic or multi-element approach or at least propose the integration of different mechanical systems separated by the moments of instability during which an initially insignificant item, entity, behaviour or concept appears (Rose et al., 2005).

This "systems" approach permits the development of solutions for those systems which need to be changed (or improved). This however, turns complicated when taking into consideration that "what is an improvement for one person (or a situation) may not be so for his (its) neighbour" (Spedding, 1988). In the agricultural realm, three main relevancies have arisen from the application of the systems approach: classification, problem analysis, and improving the system. (i) Classification embodies the value of recognising an individual item as belonging to a class of sufficiently similar items. This analytical process permits a comparison and understanding of the arrangement of elements and interactions (Spedding, 1988; Jones and Street, 1990; Doppler, 1991). (ii) Problem description is a specific case of classification. This means the selection of multiple pictures which permit the full identification of a problem, describing the 'substance" of the problem, the location, the problem of ownership, the magnitude, and time perspective (Spedding, 1988; Jones and Street, 1990). (iii) Improving system emanates from the necessity to make something related to the discovered differences by classification or problem analysis. The improving process can include several strategies such as advising, innovating, and copying. The improvement of systems dominates the agricultural literature (Spedding, 1988; Jones and Street, 1990).

According to many authors an AFS is important because of the global outcomes it produces (and not only food), the employment generated (directly and indirectly), and the role it has in shaping the countryside (Spedding, 1988, Jones and Street, 1990). Which industries and organisations integrate an AFS, what interrelationships surge from the interaction between industries and their organisations, what are the environments surrounding an AFS and what are their most probable resulting scenarios are some of the key questions that need to be addressed. The system approach will be used for this discussion. Furthermore, the supply chain perspective will also be considered in order to extend this review. Spedding (1988), Street (1990) , Eastham et al. (2001), Knight et al. (2002), Luning et al., (2002), Bourlakis and Weightman (2004) provide a consensus that AFS links two main systems: social and agro-ecological, which includes the biological (Figure 2-1).

Figure 2-1. Production and Consumption of Food system

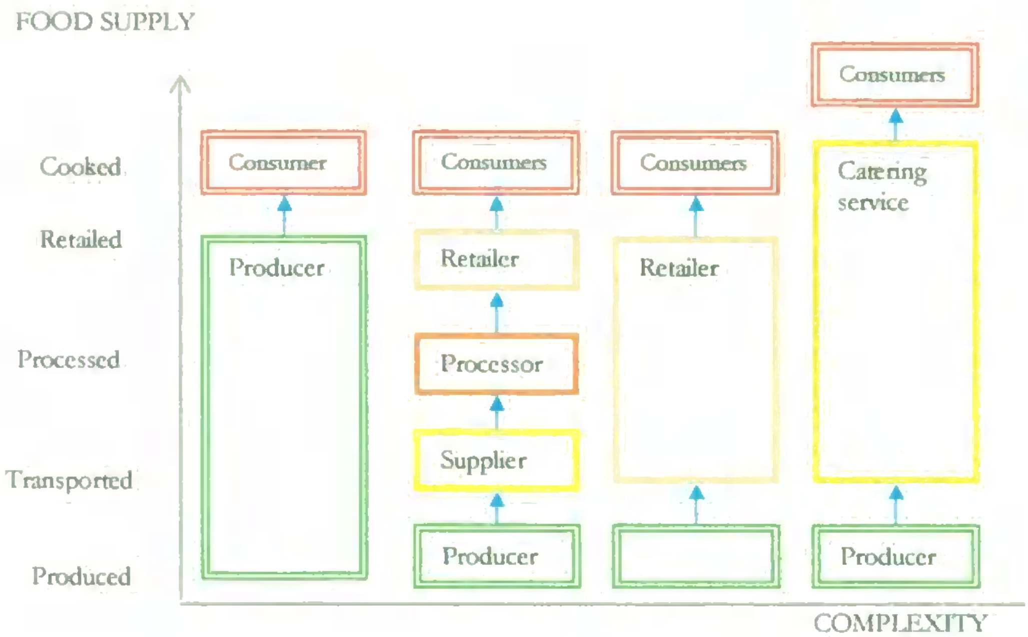


Source: adapted from Spedding (1988), Street (1990)

This powerful perception has permitted an understanding of the connections between humans and their environment, finding that we are able to comprehend many of these relationships and also benefit from them. However, as some authors argue the final balance is not beneficial at all. In the search of the industries of an AFS, it is necessary to use the 'food supply chain' perspective. The "food supply chain" perspective is based on the relationship between producers and consumers. From this starting point, this supply chain perspective permits to visualise the different industries that are linked between these extreme points.

As Figure 2-2 shows, not only is it possible to find non-existence of any "intermediate"' organisation between consumers and producers, but also a long 'chain' of organisations between them. Thus, different patterns can coexist. Many authors recognise also a reduction of organisations and industries (Eastham et al., 2001). This reduction, however, has not been favourable in many parts of the world, and 'primary' producers are the most vulnerable sector (Goodman and Watts, 1997; Requier et al., 2003).

Figure 2-2. Elements arrangement in AFS,



Source: after Knight et al. (2002), Bourlakis and Weightman (2004)

Recently the understanding of relationships between organisations has become the most important subject in 'supply chain' studies and this applies to AFS. There are many perspectives from which to analyse relationships, hence this section reviews a few of them.

From a marketing perspective, relationships are developed considering the competitive advantage principle, and are particularly important if an AFS is set under market forces (Street, 1990). This means seeking to utilise the strengths of all the organisations in an extended value chain, including diversification. This perspective can be led by the ownership model, as Porter (1985, 1990) suggested, or by a co-responsive model (Christopher, 2004). Value chain focuses principally on the creation of a market-driven supply chain. Therefore, it is necessary to understand the value preferences of key market segments, realign the organisations around the processes that deliver customer value, engage customers and suppliers in end-to-end process management, create cross-functional teams to manage those processes, transform the management's role from 'command and control' to a 'process leadership', develop performance metrics to support cross-functional, customer driven processes, and promote multiple competencies in individuals (Kaplinsky and Morris, 2000; Fitter and Kaplinsky, 2001; Christopher, 2004; Kaplinsky and Fitter, 2004). The complementarity principle has become more acceptable, considering the globalisation viewpoint. Thus, a network perspective is brought into consideration. Network embodies the bi-directional flows, lateral ties and paths that are often segmented and articulated, which contrast with the term 'chain' (Nassimbeni, 2004). Three characteristics are important: the agents (two or more) involved, which are legally independent but economically interdependent, the presence of an exchange relationship, and the modalities of exchange governance (Nassimbeni, 2004). As the environment is very dynamic and changes over time, so the relationships are being transformed continually according to new requirements. Some of these changes result from a continuous evolution in technology such as, information and communication technology, transportation systems, etc. However, organisations do not perceive these signals as quickly as the environment changes.

The managing of information is the key to react and then survive (Naim et al., 2004). Relationship involves human behaviour exchanges, so three perspectives are called for: complexity, learning, transparency and ethics. The first refers to the complexity of this permanent closer integration between suppliers and customers, a complexity measure is used to compare the information required to describe a system (Sivadasan et al., 2004). Learning perspective focuses on the use of human abilities to survive in organisations, generally called learning capability (Besant, 2004), and finally transparency and ethical perspective has been employed in the study of the equal distribution of benefits and obligations between agents and the environment (customers) (Lamming, 2004; New and Westbrook, 2004). The green perspective has become very important in recent times, not only because we now can see and correlate our decision-making actions with the impacts directly related to both human and natural spheres but also the proactive attitude that is awarded by the extended stakeholders, especially customers and the government. An environmental management orientation takes place in the daily base activities of the supply chain (Katz et al., 2003; Klanssen and Johnson, 2004).

This "systems" view permits a move from a narrow view which concentrated mainly on 'activities" (production and/or post-harvesting activities) to an expanded view which includes group of organisations that participate in all the different activities (e.g., farming, transportation, processing, distribution, etc.) required to supply food to the final consumer (Street, 1990; Solleiro and Valle, 1996). From this extended perspective, many scholars provide new definitions and approaches to study 'agro-food systems' (Solleiro and Valle, 1996; New and Westbrook, 2004; Valle, 2004; Stadtler and Kilger, 2005). Table 2-2 provides a selective summary of various terms, its organisations and type of interactions considered in the study of AFS. This summary provides useful information about the way AFS are analysed.

Table 2-2. Approaches to analyse AFS

AUTHORS	TERMS	ORGANISATIONS	INTERACTIONS
Goldenberg, (1974)	"agribusiness"	Producers, processors, wholesalers, suppliers, governmental agencies	Social interrelationships among organisations
Friedland (1987; 1994)	"one-food product system"	Considering national and international organisations (producers, processors, wholesalers, suppliers, governmental agencies)	Local and global interrelationships
La-Gra (1997)	"Agro-food chains"	Actors identified by production activities	Mostly technical and managerial
Hopkings and Wallerstein (1986)	"Commodity chain"	Considering national and international organisations (producers, processors, wholesalers, suppliers, governmental agencies)	Social interrelationships work as a chain and/or web
Oliver and Weber (1982)	"Supply chain management"	All organisations	Construction of supply chains

Source: after Solleiro and Valle, (1996); New and Westbrook, (2004); Valle, (2004); Stadtler and Kilger, (2005).

The organisations of an AFS and their interactions are very important for this analysis. Many studies explore these operational management capacities in several AFS of developed countries (Folkerts and Koehorst, 1997; Cox, 1999). However, there are few investigations in developing countries (Zylbersztajn and Pinheiro, 2003; Scherr, 2004), and AFS related tropical crops are almost avoided (Norman, et al., 1984; Samson, 1986; Solleiro and Valle, 1996; Cuevas, 2004). Therefore, this study emphasises the importance of drawing the attention to the agro-food systems in developing countries.

2.2.3. Anatomical perspective of an agro-food system

One of the main tools for analysing an AFS has been to look at its structure and interactions. So the analysis of an AFS is carried out by depicting the interaction between organisations (Kaplinsky and Morris, 2000; Eastham et al., 2001; Zylbersztajn and Pinheiro, 2003). These diagrams have been called "chain maps" as they indicate which organisations or department is involved. The advantages of using this mapping tool are (Trienekens and Zuurbier, 2000): (i) to get a general overview of the AFS, and (ii) to trace the physical flow of products, information, and managerial controls between organisations.

Storer et al. (2003) revises these mapping tools by classifying them into different levels. (i) A "Zero" level shows the interactions from supplier to further upstream in the chain or vice versa. This Zero level helps to identify different types of problem areas and opportunities for improvement. It is possible to add diagrams to show the frequency of interactions between industrial organisations. Interactions at this level concentrate on physical product flow and information flow without considering the inter-departmental relationships. (ii) "Multiple" level refers to a "chain map" which is broad in approach, since it tries to identify the departments and the organisational hierarchical positions which are involved in these interactions. (iii) "Process" level focuses on the identification of the key people and processes that are involved in the interaction. In brief, all these "chain maps" are used in an iterative manner. They are useful in demonstrating outcomes back to participants which in turn permits the identification of the nature of problems and opportunities in those systems.

Thus, this approach seems to be a robust way of analysing an AFS. It has already been argued that the analysis of AFS requires a further investigation, considering the different attributes that can be added in the attempt to understand AFS and to identify opportunities for improvement as well as the main obstacles of cooperation.

As proposed before, there are different levels at which to study a supply chain. This study argues that such understanding can be known as an examination of a series of layers (e.g. functions, products, interactions). The use of this layer view is known as an anatomical perspective which has been very useful in several studies in biological science (Kapoor et al., 2003; Fung et al., 2005) and has started to influence social science (Jagdev and Thoben, 2001; Mendelson et al., 2003). This anatomical perspective will be developed by using the "chain mapping" tool. The development of the "anatomical perspective" is discussed in the Chapter 3.

2.3. Productivity Management

In section 2.1 and section 2.2, it was highlighted that the patterns of food production and consumption are changing faster than ever. Several external factors explain some of these changes, and show that a changing and competitive environment will be the constant. Therefore, the internal configuration of an organisation plays an important role in adapting such environment. In fact, it is argued that the lack of a set of appropriate strategies results in the exit of several organisations in the food system. Two questions arise on the lack of a set of internal strategies (i) what internal factors are important and (ii) how their interaction influences the overall performance. Agricultural production is a mosaic of scientific disciplines, and to keep a balance between such priorities of each scientific realm is a challenge. Therefore, the search for such internal factors requires a particular approach which pinpoints the influence of "organisational configuration" on the overall performance. "Productivity management" perspective is used to achieve this. Three main points are covered in this section: subsection 2.3.1 defines competition and competitive environment, subsection 2.3.2 focuses on efficiency, its definition and implication on performance analysis; subsection 2.3.3 concentrates on effectiveness, its definition and implications on performance analysis; subsection 2.3.4 discusses productivity definition and its implication on performance analysis, and also refers to productivity management approach, and its elements (variables) that influence performance.

2.3.1. Competition and competitive environment

The term productivity has become part of the economics and business jargon. This term explains how organisations succeed in a changing and more "competitive environment". Therefore, in this subsection, two main concepts are discussed: "competition" and "competitive market" in order to define "competitive environment".

Competition

One of the main concerns in social science is the study of the satisfaction of human needs (Hausman, 1995). By studying this particular concern, the science of economics suggests that one of the most comprehensive models to explain the satisfaction of human needs is competition. That is explained colloquially by Stiglitz and Walsh (2006: 26): "when producers, who compete with one another for customers, will offer consumers the desired products at the lowest possible price. Consumers also compete with one another. Only a limited number of goods are available, and they come at a price. Consumers who are willing to pay that price can enjoy the goods, but others are left empty – handed." This basic competitive model implies a "self" regulated system which has been used as the main framework to guide how humans interact and satisfy their needs.

To obtain a "self" regulated system, two core assumptions are required: rational choice and competitive market. Rational choice refers to the assumption that people weigh the cost and benefits of each possibility whenever they must make a choice. The rationalisation of both consumers and producers could be different but it must complement each other by maximising the benefits (Ballestero, 2000; Rickard, 2006; Stiglitz and Walsh, 2006). The second assumption is about the places where (self-interested) consumers and (profit-maximising) producers meet: markets. Thus, the optimum market for competition is that where the producers are "price takers", which simply means they have no influence on the market price. Producers take this particular position because they cannot raise their price without losing all sales, and at the market price they can sell as much as they wish (Ballestero, 2000; Rickard, 2006; Stiglitz and Walsh, 2006). The main implication of this "self" regulated system is to have a system which is efficient and fair. This implication will be discussed later in the following sections.

Competitive environment

Some disciplines have used competition as a model to study different social phenomena and therefore have proposed the use of new concepts to define the boundary where producers and consumers interact (Porter, 1985, 1990; Chaffe, 1985; Miller 1987; Amboise and Muldowney 1988). In fact, since some concepts from the evolutionary approach support the competitive model, they were introduced to extend this boundary (Baum and Sinh, 1994). This leads to a consideration of such a place as a "competitive environment".

A "competitive environment" is appropriate because it emulates a free market economy. In such an environment, organisations interact with one another and this interaction allows them to meet their customers' needs. Sometimes the interaction encourages cooperation between organisations, but at others it results in very competitive actions which, in fact, force some organisations to exit the environment. The latter outcome is seen as a failure of this model (Calva, 2004). Therefore, many governments do not want to involve some of their industries in such competitive situation. This concept is very useful, since it includes not only the market but also the surroundings which also influence the decision of a producer and a consumer, and it will use in this study.

2.3.2. Efficiency

Several indicators have been devised in order to measure the performance of economic systems (e.g. profitability, liquidity), and efficiency, effectiveness and productivity are some of the most appealing indicators (Ballestero, 2000). This section reviews the concept of efficiency by discussing its definition, classification, and scope.

As mentioned before, one of the main implications of a competitive environment is the necessity to be efficient which in turn permits organisations to adapt and deal with such a competitive environment. What being efficient means, how efficiency is measured and what main implications arise from being efficient are some of the questions that are discussed below. Economics and management approaches are employed in order to scrutinise the term efficiency.

As mentioned earlier, economists define efficiency in simple terms: scarce resources must not be wasted (Ballestero, 2000). This statement addresses the question of how any activity, which is done, can be better executed in order to improve resources use. And such improvement is highly related to the production technology which permits to the reduction of waste, defects, and claims, to increase the number of different products and their quality, among other outcomes (Rickard, 2006; Stiglitz and Walsh, 2006). The development of mathematical models and empirical studies are still reshaping the definition, measurement and interpretation of efficiency at theoretical and practical levels. For instance, Prokopenko (1987) proposed that efficiency means producing high-quality goods in the shortest possible time. Sumanth

(1998) explained efficiency as the ratio of actual output generated to the expected (or standard) output prescribed (e.g. actual production = 80 units, and expected or standard production = 100, then efficiency = 0.8).

$$Efficiency = \frac{Actual}{Expected}$$

Lawlor (1985) suggested that "efficiency tells how well actually a needed output is generated from available input and indicates the use of available capacity". Efficiency measurement reveals the output to input relationship and the degree of use of resources compared with the total capacity (potential), so efficiency should tell where the inefficiencies lie.

$$Efficiency = \frac{Output}{Input} = \frac{Input + profit}{Input} = 1 + \frac{profit}{Input}$$

Under an economics approach, theory is based on the assumption of optimising behaviour. Thus it is assumed that producers optimise from a technical or engineering perspective by not wasting resources. In other words, this means that producers operate somewhere on the boundary, rather than on the interior, of their production possibility sets (Chiang, 1985). Producers are also assumed to optimise from an economic perspective by solving some allocation problem that involves prices. Under cost minimising, producers are assumed to allocate resources efficiently so as to operate on, rather than above, minimum costs boundaries, and similarly for producers seeking other economic objectives. However, for a variety of reasons not all producers succeed in solving both types of optimisation problem in all circumstances (Rickard, 2006).

As mentioned above, theoretical production analysis has always focused on production activity as an optimisation process. The basic tools have been the production function, the cost function, and the profit function, and so on. Therefore, there are two main approaches to analyse productive efficiency. The first, parametric approach, has focused on central tendency, or average, or most likely relationships constructed by intersecting data with a function. This approach has dominated the production analysis, so a set of useful findings arose from its implementation (Färe et al., 1994; Coelli et al., 1998). It has contributed to the comprehension of the measurement of efficiency in many strands: (i) to shed light on the dual relationship between the production function representation of a production technology and the minimum cost or maximum profit function representation of a production technology, i.e. duality in production, (ii) to develop functional forms of the production, profit and cost functions, (iii) to measure technical change, and (iv) to shed light on multi-output production and distance functions (Coelli et al., 1998).

The second, non-parametric approach, has focused more on measurement rather than causation, because uncovering the pattern of efficiency comes first, and because the comparative advantage of this method lies with the measurement rather than hypothesising about causal factors (Färe et al., 1994). Koopmans (1951) and Debreu (1951) provided the first rigorous analytical approach to the measurement of efficiency in production. Koopmans defined technical efficiency as a point in the commodity space as efficient whenever an increase in the net output of goods can be achieved only at the cost of a decrease in the net output of other goods, i.e. definition known as the Pareto-Koopmans which is an obvious similarity with the condition for Pareto optimality. Debreu, in contrast, defined the coefficient of resource utilisation as a measure of technical efficiency for the economy as whole, and any deviation of this measure from unity was interpreted as a deadweight loss suffered by the society due to inefficient utilisation of resources (Färe et al., 1994; Ray, 2004). Farrell (1957) made a path-breaking contribution by constructing a linear programming model which in turn is the same as the distance function proposed earlier by Shephard (1953). This model yields a numerical measure of the technical efficiency of an individual firm in the sample and also identifies allocative efficiency as another component of overall economic efficiency (Färe et al., 1994; Ray, 2004). All this has permitted researchers to shed light on producer behaviour.

There are three main definitions of efficiency (Färe et al., 1994; Coelli et al., 1998; Cooper et al., 2000; Zhu, 2003; Ray, 2004): (i) *Technical efficiency*: reflects the ability of a firm to obtain maximal output from a given set of inputs. (ii) *Allocative efficiency*: reflects the ability of a firm to use the inputs in optimal proportions, given their respective prices and the production technology. (iii) *Overall efficiency*: refers to the combination of technical and allocative efficiencies.

The calculation of efficiency measures is based on different assumptions and some of the most important are depicted below:

ASSUMPTIONS	OPTIONS	DESCRIPTION
Technology	Constant returns to scale	Constant linear piecewise representation of technology
	Variable returns to scale	Convexity piecewise representation of technology
Input or Output oriented	Input oriented	Aiming at reducing the input amounts by as much as possible while keeping at least the present output levels
	Output oriented	Aiming at maximising output levels under at most the present input consumption
	Additive model	Dealing with the input excesses and output shortfalls simultaneously in a way that maximises both

Source: Färe et al., 1994; Coelli et al., 1998; Cooper et al., 2000; Zhu, 2003; Ray, 2004

An efficient organisation could be inefficient, once a more efficient organisation is added in the set of organisations analysed or the efficiency of other organisations increase across time (Cooper et al., 2000; Zhu, 2003; Ray, 2004). This particular characteristic is known as relativeness and permits efficiency to be an excellent benchmark. Nevertheless, the methods for calculating efficiency bring other problems (such as the selection or exclusion of important inputs and outputs may bias the results, the efficiency scores are only relative to the best organisations in the sample), so the addition or reduction of organisations may reduce efficiency, there may be measurement error in the data and not accounting for environmental differences both physical and regulatory may give misleading results. However, as Coelli et al. (1998) recommend efficiency can provide valuable information in many situations only if one pays careful attention to the issues mentioned above. The calculation of these efficiency scores can be computed by commercial programs, so the possibility of application has recently expanded.

The main outcome of being efficient is to "create value", and there are three relevant implications regarding such an outcome (Rickard, 2006). First, the creation of value starts by transforming inputs into outputs by considering the best practice. The achievement of an organisation's goals is subject to the quality of resources that the organisation has at its disposal and in particular the quality of its management resources (Rickard, 2006). Second, the creation of value is an on-going process. That is efficient organisations are permanent seeking new ways to be more efficient in order to achieve their goals. Such behaviour arises from three main assumptions (Rickard, 2006): the scarcity of the resources, the competitive environment, and the persistence of organisations to survive. Third, the creation of value is heterogeneous among organisations (Cooper et al., 2000; Zhu, 2003; Ray, 2004). That is efficient and inefficient organisations co-exist. Some studies show that inefficient organisations are less likely to cope with a competitive environment and therefore they do not survive and exit from it. Other studies, however, show that in spite of lower efficiency values, organisations endure the competitive environment. Whilst, this particularity shed light on competition mechanism and the evolution of organisations into competitive environments, it also highlights a limitation of the creation of value approach and suggests that an organisation could be inefficient at some point, but must be effective (Rickard, 2006). Effectiveness, therefore, is brought into the discussion as a complementary approach that permits organisations to cope and deal with competitive environments.

2.3.3. Effectiveness

Considering some authors efficiency does not guarantee that an organisation's customers will be prepared to pay a price for its output that covers the costs of production; indeed, customers might not be prepared to buy its products at any price (Prokopenko and North, 1997; Monga, 2000; Rickard, 2006; Stiglitz and Walsh, 2006). An "effective" organisation is when its resources are aligned with the markets in which demand for its products is highest. In practical terms, another core goal of an organisation is to address effectively the needs of the consumers.

Nevertheless, effectiveness has been defined in different ways. Prokopenko (1987) define effectiveness as the degree to which goals are attained. Lawlor (1985) considers that effectiveness compares present achievement with what could be done if resources were managed more effectively. This concept includes an output target achieving a new standard of performance, or potential. Sumanth (1998) suggests effectiveness involves determining the relevant (right) goals or objectives first and then achieving them. Other authors propose that effectiveness could be analysed by looking at the capture of value that an organisation creates by means of effective price strategies (allocation). This leads to use the term of allocative efficiency (Coelli et al., 1998; Cooper et al., 2000; Zhu, 2003; Ray, 2004). When market prices of inputs and outputs are available one can use them to measure the level of economic efficiency of a firm (Farrell et al., 1994). The minimum cost of producing the observed output level of an organisation can be obtained from the optimal solution of the relevant cost-minimisation problem. The ratio of this minimum cost and the actual cost of the organisation measures its cost efficiency, which can be decomposed into two separate factors representing its technical and allocative efficiency, respectively. The main difference between both measures relies on the fact that whilst technical efficiency provides a set of efficient organisations which can share the solution line, allocative efficiency provides a unique solution as a result of the either the minimisation of costs, maximisation of outputs, or both (Coelli et al., 1998; Cooper et al., 2000; Zhu, 2003; Ray, 2004).

From this discussion, it seems that a managerial approach emphasises the achievement of desired right set of objectives. Such objectives would include market share, innovation, physical and financial resources, profitability, manager performance and development worker performance and attitude, public responsibility, among others. In contrast, with an economic approach, effectiveness ultimately comes down to setting the correct price for products.

The main outcome of being effective is to "attract value from the market", and there are two core implications related to such outcome. First, in order to capture value from the market, organisations have to know the customer needs. This, however, has become more complex as the "needs" start to mix with "wishes" which cover ethical, beauty, environmental aspects (Prokopenko and North, 1997; Sumanth, 1998; Monga, 2000; Rickard, 2006). Furthermore, information about customer is incomplete or simply not available for producers. Therefore, many authors refer to effectiveness as the process of building knowledge and understanding of current and potential customers which permit organisations to make customers aware of how their products' attributes align with customers' demand, and to construct a reputation that will help the firm maintain demand for its products over the time (Porter, 1985, 1990; Prokopenko and North, 1997; Monga, 2000). Second, in order to capture value from a market, organisations interact with other organisations. Competition and cooperation are the main types of interaction. Under a competitive environment, organisations are regulated by competition. Therefore, a special issue in business studies is to learn how to deal with competitors. It is argued that understanding competitors provides valuable information about how to attract more value from the market and several studies clarify the importance of such competitors' knowledge (Rickard, 2006). On the other hand, considering a supply chain perspective many producers become consumers as well (Trienekens and Zuurbier, 2000). Price is still a key instrument to effectively obtaining a sale. However, in order to guarantee a successful interaction between these particular buyers and sellers there are other attributes which play an important role (i.e. loyalty, incentives, information) (Trienekens and Zuurbier, 2000; Rickard, 2006). Cooperation could also involve competitors. Such interaction permits competitors to obtain a better outcome by engaging in cooperation rather than ruthless competition. Brandenburger and Nalebuff (1996) have coined this behaviour, co-opetition. Nevertheless, the outcome arrived at by adjusting behaviour to take account of the responses of rivals is not necessarily the best outcome for consumers. Hence, as Rickard (2006) points out the use of legislation is very important to prevent one organisation, or group of organisations acting in concert, from dominating a particular market (e.g. price collusion).

Therefore, given the uncertainty surrounding the development of new products and processes, the cost efficiencies associated with economies of scale and the longer-term damage inflicted by price wars, it is fundamental for organisations to manage effectively the attraction of value (Porter, 1985, 1990).

Productivity

Under a competitive environment, a business strategy called price recovery, in which the costs of production/operations, plus a profit margin (usually determined by what the market can bear), are simply passed on to customers, has been changed. Hence, it has become a necessity for organisations to be more productive if they are to survive and compete, rather than just only to rely on price recovery (Prokopenko and North, 1997). The scenario just described implies that organisations also need to modify the way they measure their performance. Instead of just measuring profitability, which may be driven mostly by price recovery, there is a need to know whether an organisation is able to produce more and/or better products and services with relatively fewer resources to be competitive which leads a focus on productivity.

Productivity is an indicator which unravels the performance of a system. The system performance is based on the ratio of the output(s) that a system produces to the input(s) that the system uses (Sumanth, 1998).

$$PRODUCTIVITY = \frac{Output(s)}{Input(s)}$$

Considering the type of outputs and inputs used, this definition can provide different results, which can be either dimensional or non-dimensional. Input and output values can be single or composite, and this refers to a classification of productivity: partial and total (Table 2-3). Total productivity is very relevant if one wants to integrate "all" the factors involved in the system. This is possible by transforming inputs and outputs into similar values i.e. monetary value (Coelli et al., 1998).

Table 2-3. Classification of productivity

	Single Output	Multiple Outputs
Single Input	Production per Hectare	Production value per hectare
Multiple inputs	Production per total costs	Production value per total costs

Source: Adapted from Polan, 1995, FAO, 1997; Turrent et al., 2005.

These basic productivity measurements are widely used at firm level, because organisations are more likely to use standardised performance indicators. These indicators can be a combination of technical and economical terms. These indicators are provided by suppliers, empirical experience, official regulations, buyers, etc. Therefore, it is also a possible to find standardised lists of performance indicators (Ahlstrand, 1990; Bernolak, 1997).

The study of basic productivity measures has provided useful information about the performance of organisations and countries. However, it is argued that such basic measures may mislead the real performance (Prokopenko, 1987; Prokopenko and North, 1997; Sumanth, 1998; Monga, 2000). Therefore, it is suggested to consider the total factors (i.e. inputs and outputs) in the calculation of productivity. This leads an introduction of the term total factor productivity (TFP). TFP is based on three main properties (Prokopenko, 1987; Coelli et al., 1998): (i) relative, (ii) aggregative, and (iii) compatible. Relativeness is a property which refers to the changes of productivity. These changes arise from the internal elements (i.e. input-outputs), time, and external elements (e.g. other organisation's productivity performance, environmental factors). Relativeness permits productivity to be compared. Another property of productivity is aggregation. Productivity can be constructed of single or multi or total input-output elements. However, only the total level of aggregation provides useful information to analyse different layers (i.e. organisations, sectors, countries). Finally, productivity can be a standard measure by selecting specific inputs and outputs. The comparison across time and among organisations is possible. From these properties, different methods of calculation and new approaches of interpretation have been developed and implemented to analyse TFP.

Index numbers are the most commonly used instruments to measure changes in levels of various economic variables. There are various formulae in the index number literature (such as the Laspeyres, Paashe, Fisher, Malmquist and Tornqvist index numbers) which serve on the construction of price and quantity index numbers (Coelli et al., 1998). Quantity index numbers formulae are applied to input and output data leading to quantity index numbers which in turn are used in measuring of total factor productivity in the form of a TFP index. The TPF index provides a measure of output change over a given period net of input quantity use over the same period. For a long period of time, and even now, some empirical economists have interpreted the TFP index as a measure of technical change or progress that has taken place over time. Nevertheless, this interpretation has not been fully justified, because this TFP index does not provide sufficient information to know what was improved (worsened), what external elements influenced a change of performance, what other factors (i.e. input output) are needed to fully evaluate the performance (Coelli et al., 1998). One of the main assumptions on which to base a calculation of a TFP index is that all organisations are efficient and therefore it is of little interest to analyse input and output separately because changes arise from a technological improvement (Coelli et al., 1998; Ray, 2004). Nevertheless, other studies decompose TFP to study efficiency (i.e. technical, allocative), so this also permits researchers to complement some of the restrictions of cross-sectional nonparametric methods (Farrell et al., 1994).

Productivity analysis is important for performance improvement. Even as a separate element, it is a very effective tool for decision-making at all economic levels. The success of productivity measurement and analysis depends largely upon a clear understanding by all parties concerned (e.g. enterprise managers, workers, employers, trade union organisations and government institutions) of "why" productivity measurement is important for the effectiveness of the organisation. The answer is that it indicates where to look for opportunities to improve and also shows how well improvement efforts are faring (Prokopenko and North, 1997). At organisational level productivity is measured to help analyse effectiveness and efficiency. From above, it is clear that there is a number of approaches to productivity, how to measure productivity and most importantly what information is obtained.

Efficiency, effectiveness and productivity are useful indicators to analyse the performance of an organisation and how to respond practical and academic questions: (i) a particular organisation has lower performance relative to other organisations in an industry, sector or country, (ii) why may this be so? It could be due to the existence of one or more organisations with higher performances, omitted variables, quality difference in inputs and outputs, measurement error, unused capacity due to lumpy investments, environment i.e. physical or regulatory. Therefore, the measurement of performance by using these indicators would be somewhat slippery, especially if one wanted to develop a competitive strategy. Information, then turns quite scarce or inaccurate, everyone wants to protect its "advantage" (e.g. technical, managerial, collusive) (Porter, 1990; Rickard, 2006; Stiglitz and Walsh, 2006). Furthermore, although it may be clear where to make an improvement (i.e. input-output-orientation), it is still obscure how to achieve the improvements (i.e. management). Therefore, a managerial approach concentrates more on what drives the performance and how to achieve an improvement rather than the calculation of the performance (Prokopenko and North, 1997).

2.3.4. Productivity management perspective

Once facts have been found and analysed, and causes been established and verified, the next important task is to enhance existing productivity performance which is a lengthy process. At the operational level, it requires developing solutions, choosing the most pertinent solutions and to implementing them. However, all this becomes more complicated in the real world and taking an incorrect decision sometimes causes struggles in the organisation (Prokopenko, 1987; Pritchard, 1995; Monga, 2000).

Organisations normally carry out their improvement activities themselves. However, this is not always the rule, and nowadays many organisations ask for external support for improvement that includes evaluation, design, and implementation. Many of these improvement alternatives come from the private sector, research and development centres, and government (Prokopenko, 1987).

The improvement can comprise of technical, economic and social tasks. Technical tasks are associated with hardware elements in all areas (production, administration, sales, etc.). Social tasks embody human resources which nowadays play a vital role not only in the improvement process but also in seeking regular improvement. The production of value and its distribution in throughout the system (and recently to other stakeholders: clients, government, actionists) is one of the economic tasks (Pritchard, 1995; Monga, 2000).

The productivity concept provides a systematic way of constructing a performance indicator. The following step is to analyse whether there are differences across the time, or between indicators of other organisations, but most importantly to find out what factors drives such changes. Productivity management achieves these important steps by employing three theoretical approaches: constraint optimisation, incentives and contracts, and heterogeneous resources (Prokopenko and North, 1997; Rickard, 2006).

Constraint optimisation is related to the Neo-classical economic paradigm. This approach states that performance is obtained by the grade of specialisation of an organisation, the maximisation of benefits, and the consideration of particular conditions such as rational thinking, perfect information and competition (Rickard, 2006). This approach has been very useful in explaining the difference between performance indicators and the key factors that influence such performance. In fact, most differences have been explained in terms of efficiency, so the minimisation of inputs in an organisation is a must in order to achieve a high level of performance. Thus technology is one of the main factors in achieving high levels of efficiency, and in turn a better performance. Technological change, however, implies the development of a set of managerial decisions at any level from government to a single organisation, and such decisions include different aspects such as funding, administration, generation and transfer, etc (FAO, 1997). Thus, this approach provides a good starting point for where to look for productivity improvement, but in practical terms, it needs a refinement as many aspects are included under such technological factors.

The optimisation focus also has some limitations, as the world is characterised by uncertainty and bounded rationality. Incentives and a contracts approach seems to have the answer about how an internal structure of an organisation influences performance. This approach, based on the governance paradigm, states that the structure, incentives and contracts are also key factors in enhancing productivity. In fact, higher performances are related to create heterogeneity, as this is one of the main strategies to differentiate an organisation under imperfect markets. This approach, however, concentrates on a particular environment: competitive. Without this essential condition an organisation seems to be stagnated (Monga, 2000).

Finally, the heterogeneous resource approach which comes from the competence paradigm explains that knowledge resource is the key factor to improve the organisational performance. The way this resource is created, storied, and utilised provides an organisation with an advantage over others, and permits it to realise how it chooses its resources which under the governance paradigm is not fully clear (Nelson, 1996).

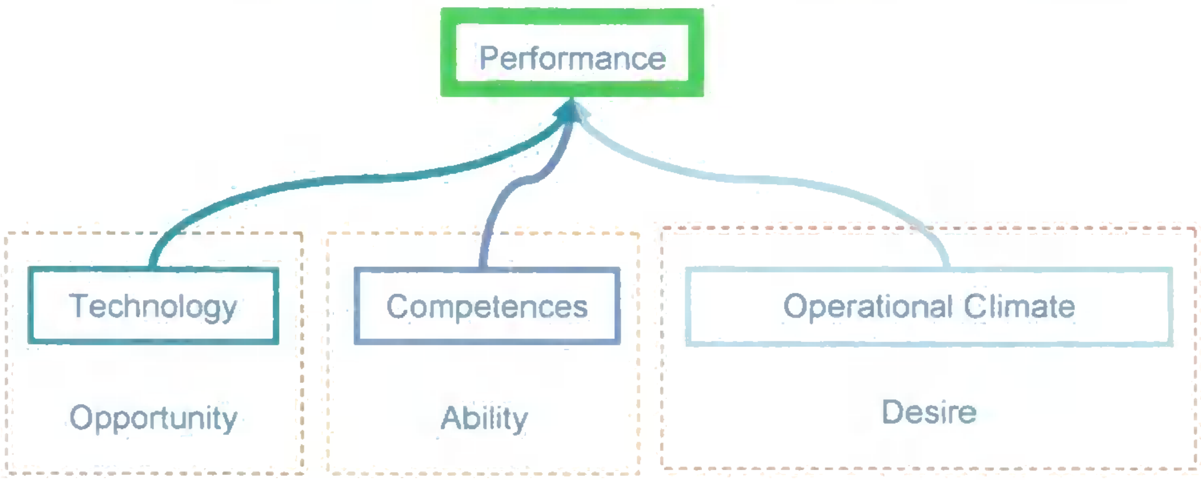
It is suggested that none of these approaches to the organisation amounts to a complete explanation of the productivity differences and also a full identification of the driving factors of productivity. But a combination of such approaches will provide a better understanding of productivity management. The next section explains what factors are important to enhance performance.

Productivity management factors

Considering the above approaches used by productivity management to analyse the differences of performance and to identify the driving factors, there are three "productivity management" factors that influence organisational performance positively: technology, competences, and operational climate (Prokopenko and North, 1997; Rickard, 2006).

Technology provides the opportunity to be efficient, competence ensures the ability to be effective, and organisational environment creates the desire to succeed and keep productive (Figure 2-3).

Figure 2-3. Productivity management factors and their contribution towards performance



Source: Adapted from Prokopenko and North, 1997.

Each "productivity management" factor needs more precision as there are different aspects that each one can cover, and in turn each aspect can also be measured by a set of different variables. This section focuses on a review of key aspects of each "productivity management" factor related to agro-food systems.

Technology

A constraint optimisation approach helps to highlight the importance of technology as a key factor which provides the opportunity to be efficient and in turn to enhance performance. Questions such as what aspects of technology have a core contribution to improve performance (e.g. funding, R&D, inputs, process), how this is measured (e.g. raw, indices, monetary values), and what other conditions are taken into consideration (e.g. time, geography, industrial level and layer) are discussed below.

There are different aspects based on technology factor: inputs (e.g. labour, materials, energy, information), research and development investment (R&D), exogenous and endogenous technical change, knowledge capital (high tech, human, and R&D capital), private and public R&D, substitution of labour based on capital, etc (Paul, 2000). Many of these aspects have been analysed under the particular conditions of the neoclassical approach (e.g. profit maximisation), but other authors propose an exploration of these aspects by considering new boundaries which are more flexible (Paul, 2000). Studies also include analysis of the next layer of the food industry, converging on the importance of R&D; knowledge capital seems to be significant to explain productivity variability in the food industry (Paul, 2000). In brief, the characterisation of the technical change is fundamental in the literature on productivity determinants, however it is also perhaps the most difficult.

It is clear that the creation of new technology or the implementation of such innovative products (or services) influence performance. However, in the agricultural sector, the activity of technology transfer still plays an important role (Bucket, 1988; Dalton, 1982; Downey and Erickson, 1987; Polan, 1995; Turner and Taylor, 1995). Since agriculture is based on an exogenous innovation base, most agricultural organisations depend on R&D institutions to acquire new products and processes which permit them to improve their performance (Dalton, 1982). Thus, diffusion activity has an important role in successfully transferring the new technology, and is normally carried out by an extension service controlled by the government (Polan, 1995). At first sight, this seems to be a straightforward process without any impediment, however, as many authors have pointed out diffusion has not been an easy task. Low levels of adoption are more likely to happen especially in developing countries (Mata, 1982). On the other hand, this technology "generation-transfer" pattern has also changed. Nowadays, some private organisations carry out several innovation activities which are related to an increase in biological yields, i.e. grain, milk, meat, etc. Here, diffusion is integrated to the cost of the new input.

Technology encourages an increase in the productivity of many agricultural activities such as soil preparation, seeding, crop protection, harvesting, among others. However, there are several crops that still need a large amount of labour, especially for perennial tropical crops in developing countries (Norman, et al., 1984; Samson, 1986). As Bucket (1988) and Dalton (1982) suggested most agricultural systems are led by a single owner, so labour division is characterised by being small-scale and owner-managed, so there are two main sources of labour force: internal when it comes from family members, and external when it comes from outside and is normally paid by the farmer. The allocation of both labour types must be on an efficient basis. The measurement of this important input is normally calculated on the cost of the activity. However, it still represents a challenge for researchers, as many farmers do not record their activities, and some activities vary dramatically considering the crop season conditions (Mata, 1982; Polan, 1995).

In brief, new technology (hereafter called innovation), diffusion and labour are key aspects that influence the performance of an organisation, so they are included in the development of the fitness appraisal instrument.

Competences

It was discussed that the heterogeneous resource approach sheds light on how an organisation develops the ability to be effective. What aspects of competences have a core contribution to improve performance (e.g. skills, experience, co-operative routines), how this is measured (e.g. raw, indices, monetary values), and what other conditions are taken into consideration (e.g. time, geography, industrial level and layer) are some of the aspects that are be discussed next.

The basic labour skill in any organisation starts from the education level, and it is postulated that the more qualifications a person has the higher performance an organisation obtains. Agriculture has also moved from the use of unskilled, through semi-skilled to highly skilled labour. However, in many countries, especially in developing countries, there are still huge educational gaps, so rural areas have the higher levels of illiteracy, and the lower level of schooling years. It is argued that such low educational levels limit the development of agricultural production (Mata, 1982; Polan, 1995).

Several agricultural crops are based on empirical knowledge, which in many cases has been complemented or substituted by exogenous training (i.e. extension services) in order to increase agricultural performance. There is still a debate about the pertinence between endogenous and exogenous knowledge, considering the new challenge of sustainable production. The recognition of both knowledge sources seems to be more useful to find the best way to improve performance, and this is especially important in perennial tropical crops (Norman, et al., 1984; Samson, 1986; Weir and Knight, 2004; 2006).

Under a highly competitive environment, organisations need to acquire and develop marketing capabilities but have agricultural organisations been successful in doing this? The answer is controversial, on the one hand, many organisations are acquiring marketing capabilities by consolidating farmer unions, food industries, etc; on the other hand, there are several farmers that do not even know who consumes their products, as they are the last linkage in a long supply chain. The empirical results, however, suggest that marketing and technological capacities are needed to adapt to this globalisation era (Swinnen et al., 2000; Spielman, 2007).

Most of the farming systems are family business units, and they are influenced by the dynamic of such family members. As discussed before, family members constitute an available source of labour, but it is also argued that they represent a source of extended knowledge, especially if the family members are acquiring further qualifications, and also represent a source of motivation from which a farmer maintains a productive impetus (Polan, 1995). Efforts to quantify this internal and dynamic influence are summarised and discussed by Weir and Knight, (2004) who indicate that some researchers have attempted to study the importance of the tacit knowledge of performance, but little has been done to integrate it with "organisational configurations".

In brief, skills and knowledge have an impact on the global performance of an organisation. They can change the structural pattern of a sector, so they are included in the development of the fitness appraisal instrument.

Operational climate

An incentive and contracts approach helps us to explain how an operational climate is fundamental to the desire to succeed and keep productive. What aspects of operational climate have a core contribution to improve performance (e.g. structure, vertical integration, imperfect information and contracts), how this is measured (e.g. raw, indices, monetary values), and what other conditions are taken into consideration (e.g. time, geography, industrial level and layer) are some of the questions discussed below.

There are different aspects that are to be considered on this governance paradigm. Vertical integration is one of the most important and its relevance covers most of the food supply chains. At a practical level, vertical integration focuses on: (i) where an organisation is located in a value chain, (ii) who is the next linkage, and (iii) what contracts and incentives are needed to maintain this transaction exchange. This understanding sheds lights on the influence between the transaction exchange pattern and the performance of the organisations (i.e. seller and buyer), and in turn explains why a failure on setting appropriate transaction conditions leads to a move from one position of the value chain to another. The explanations of such movements are not always based on the discrete side of a transaction exchange, but on the relational side. This finding seems to be more useful in order to develop a long term and win-win agreement which in the food sector seems to be a more appropriate strategy (Schmitz, 2000).

Diversification is another important aspect which highlights the multi-product scheme of an organisation. Traditional agriculture is based on diversity principles, and this diminishes the inherent risk of agricultural production. There are still many farming systems which are rather more diversified than intensified. This condition influences the performance of each productive system (e.g. crop, cattle). The food industry is another example where the diversity strategy is being implemented. This diversity has been measured considering the different products, their costs and revenues. There is still a debate about the efficiency of such diverse systems, but their existence, and even more their growth, brings into consideration their high level of effectiveness (Pineda, 2004).

Both vertical integration and diversification are core aspects in the incentive and contract approach. They influence the performance and in turn the structure of a value chain. Therefore, both will be taken into consideration to develop the fitness appraisal instrument.

AFS productivity

The productivity concept is particularly important in agriculture. Productivity measures in agriculture are: the crop or livestock yield, meals produced per machine or per hour, profit per hectare or per farming system. This perception is still very powerful not only in academic education in agriculture but also at an operational level in farming and processing (Polan, 1995). Efficiency has become the most common interpretation of productivity in AFS. However, there are other different views which influence AFS: effectiveness, value added, sustainability, etc. This subsection reviews some of these interpretations.

AFS has been using productivity as an efficiency indicator. This term is simple but also very powerful. The success of both agricultural and food industry is measured using this concept (Polan, 1995). Efficiency has been a strategic tool for organisations. Nowadays, they invest in several resources in order to increase their efficiency. Such sources could include support for research and development (R&D), acquiring patents, financing of university research programs, training of human resources, etc. Efficiency not only depends on physical but also on social aspects (Cuevas, 2004). For example, an agricultural researcher can develop a maximum yield of a crop which is three or four times higher than that of the most successful farmer, but the researcher can never take advantage of this information because of the costs and the conditions in which he/she obtained that yield. A process of transferability, validation and adaptation to the farmer is required. Otherwise, the AFS turns inefficient (Jongen and Meulenberg, 2001; Zepeda, 2001). Scientists and managers work to reduce inefficiency or try to keep it to a minimum level. But efficiency does not guarantee success, as marketing scholars state (Stanton and Futrell, 1987): 'without sales nothing happens'.

Low productivity also means production of goods that are not required by customers. Goods and services must be designed and produced in a way that satisfies customer requirements for reliability, durability, price and delivery. Therefore, management actions which are not related to the customer are meaningless (Monga, 2000). The organisational survival through delivering pertinent products and services is much more than a mere reduction in inefficiency. Therefore effectiveness must start with an understanding of who the customers are, what they need, why they need the products, how they use them, and what price they are prepared to pay for those products (Pritchard, 1995). Furthermore, AFS are asked to be effective in supplying customised products. These particular products show the importance of customer bargain power. This market power is explained as a chain reversal, which is defined as a move from production-driven supply chains to market-driven supply (Folkerts and Koehorst, 1997).

Although it is a special case of effectiveness, value added has an important place in AFS. First, value added works by linking organisations in a win-win relation. This relationship includes many organisations from producers, through suppliers to retailers and each organisation adds value to its product or service. This perspective includes development of innovative products or services (Cox, 1999; Goodhue and Rausser, 2003). Value added represents the wealth generated by a firm. Owners and employees share a part of the value added. This viewpoint represents a departure from the conventional concept in which workers are treated as a cost (Monga, 2000). It reflects the notion that employees are partners in the organization and have a share in the value generated inside the company. Value added can be increased either by improving value to customers (increasing sales) or by reducing waste and costs (Cox, 1999).

Productivity is concerned about other outcomes (APO, 2002). The residue of production (including transforming, transporting, trading, etc) has been regulated by governments so far. However, customers are now much more concerned about production and consumption of food. Although this concern covers a small proportion of the world market, AFSs have been putting in strategies and actions to take advantage of this cultural change (Raynolds, 2004; Hamprecht and Corsten, 2005). The organization has the principal obligation to develop safe and healthy working conditions (Monga, 2000). Organizations can also possibly help to develop human resources and to gain experience. Such gain in experience influences the attitude of employees towards the organization and the job, which in turn affects performance. A good, enjoyable and satisfying experience leads to positive attitudes, thereby motivating employees to increase performance (Batenburg and Rutten, 2003).

Productivity must also be related to the concept of quality. In fact, many productivity indicators have been integrated in a quality system that nowadays works as a standard guideline at international level. This system permits one organisation to be differentiated from other, thereby ensuring survival. Many AFS integrate this concept throughout. This implies that suppliers provide a higher quality product and customers demand the same. The challenge grows when this concept is carried out in several organisations. Then, reaction time to adjust to quality changes is a key factor to be in the lead position (Kornelliussen and Gronhaug, 2003).

Productivity is basically related to competitiveness. This means to possess a better position with respect to competitors, permitting adaptation into different environments and ensuring the survival of the organisation. This is essential when organisations compete for their share of the market (survival). Assuming that globalisation facilitates equal environments, the best organisations must survive and the whole of society benefits from this process because of the availability of pertinent products and services, improvement of work conditions and distribution of wealth across the stakeholders, etc (Monga, 2000). Despite the advantage resulting from this practice (which is still in doubt), the fact that other organisations must 'die' is not a result to celebrate. However, AFSs around the world are facing this scenario. They have to decide if they play or surrender to the rules of the games or transform themselves to be competitive (Zylbersztajn and Pinheiro, 2003).

Rethinking productivity management

The reviewing of productivity and its extension to its management approach shed light on how an organisation achieves both efficiency and effectiveness which permit it to adapt in a changing environment. Technology, competences and operational climate are three key "productivity management" factors that help to meet this fitness condition. They have been used separately to analyse an organisation, and different results and gaps have been discussed. The analysis of "productivity management" factors shows that (1) efficiency as the starting point, technology and diffusion help to increase this particular condition. However, efficiency is not enough to align the resources of an organisation with the market and its changing needs. Organisations need to create value or capture value from the market as "productivity management" suggests. (2) Effectiveness is obtained by the interaction between organisations (i.e. seller and buyer). There are different interaction patterns (e.g. competition and cooperation). A balance between competition and cooperation is essential to achieve effectiveness. (3) The way an organisation manages its resources helps us to understand how the organisational strategies address efficiency and effectiveness.

These three "productivity management" factors are related to the incremental performance of an organisation. Therefore, this study takes advantage of such properties and uses these "productivity management" factors to seek "organisational configurations" which aid an understanding of the adaptation process of an organisation.

2.4. Fitness approach

It is difficult to trace successful "organisational configurations" because any organisation is unique since organisations are both under the influence of a changing environment and the influence of other organisations and their respective configurations (e.g. entrepreneurship, leadership and innovativeness) (Baum and Singh, 1994; Nelson, 1996; McCarthy, 2004). This section focuses on reviewing a fresh conceptual framework, the fitness approach, which helps to study a particular dynamic condition.

2.4.1. Fitness concept

"The term fitness was first used by Herbert Spencer in 1864 in the context of survival of the fittest and natural selection as proposed by Darwin in his *Origin of Species* four years beforehand". After a long process of conceptualisation refinement of the fitness term, fitness was related to the organism's reproduction rate by Fisher (1930). From this knowledge, fitness term has two main dimensions: (i) survival fitness which is the capability to adapt and exist, and (ii) reproductive fitness which is the ability to endure and produce similar systems (McCarthy, 2004: 129).

McCarthy (2004) provides a full contextualisation of the fitness term into the management realm, bringing into account the statements of Seashore and Yuthman (1967:898): "the effectiveness of a firm is its ability to explore its environment in the acquisition of scarce and valued resources"; Katz and Kahn (1978:78): "the primary goal of a firm is the continuation of existence without being liquidated, dissolved or discontinued"; Hamel and Prahald (1994) and Miller (1992): "a balance between environmental expectations placed on the firm with the resources and capabilities in the firm". All this implies that such managerial fitting terms are closer to the biological view of fitness and its inherent property of interaction of one variable with another (called as epistasis).

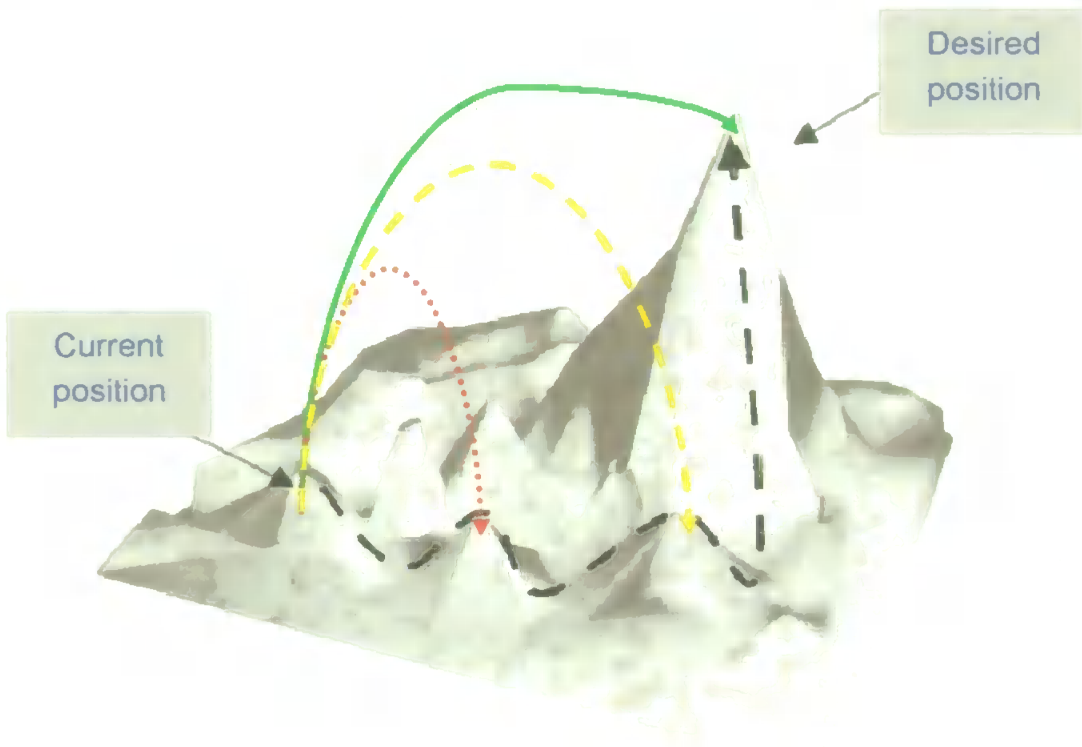
In brief, the fitness approach helps to deal with complex and dynamic systems. In the construction of organisational strategies one can be inefficient (several times) but never be ineffective, so the fitness approach sheds light on understanding how to examine this.

2.4.2. Fitness landscape

Several methods have been used to explain organisational and managerial strategy configurations: What is our current position? Where should we be? How will we get there? Among those methods are selections, interactions, and cluster analysis using Euclidian distances (cluster analysis). However, these methods have been criticised for their inability to correlate the fitness value with the different organisational combinations (Selto et al., 1995; Jermias and Gani, 2004; Sinha and Van den Ven, 2005). Therefore, the use of the NK model proposed by Kauffman and Weinberger (1989) has been suggested as an alternative method to analyse such strategy configurations.

Under the NK model, the aforesaid questions are restated on a landscape perspective. This outlook can be observed following the dashed line in Figure 2-4. There is an irregular path which influences the fitness of an organisation. Thus, the "walk" must take into consideration that an internal change must be set in the organisation by repositioning it on the landscape, and this landscape is "changing" either by the movement of the organisations and/or the environmental forces. The exploration of the landscape is the major challenge. Organisations would look for the fittest point and then work internally to achieve this position. Nevertheless, most of the improvements could stem from those organisational strategies which are placed in the immediate neighbourhood.

Figure 2-4. The fitness landscape



Source: adapted from McCarthy, 2004.

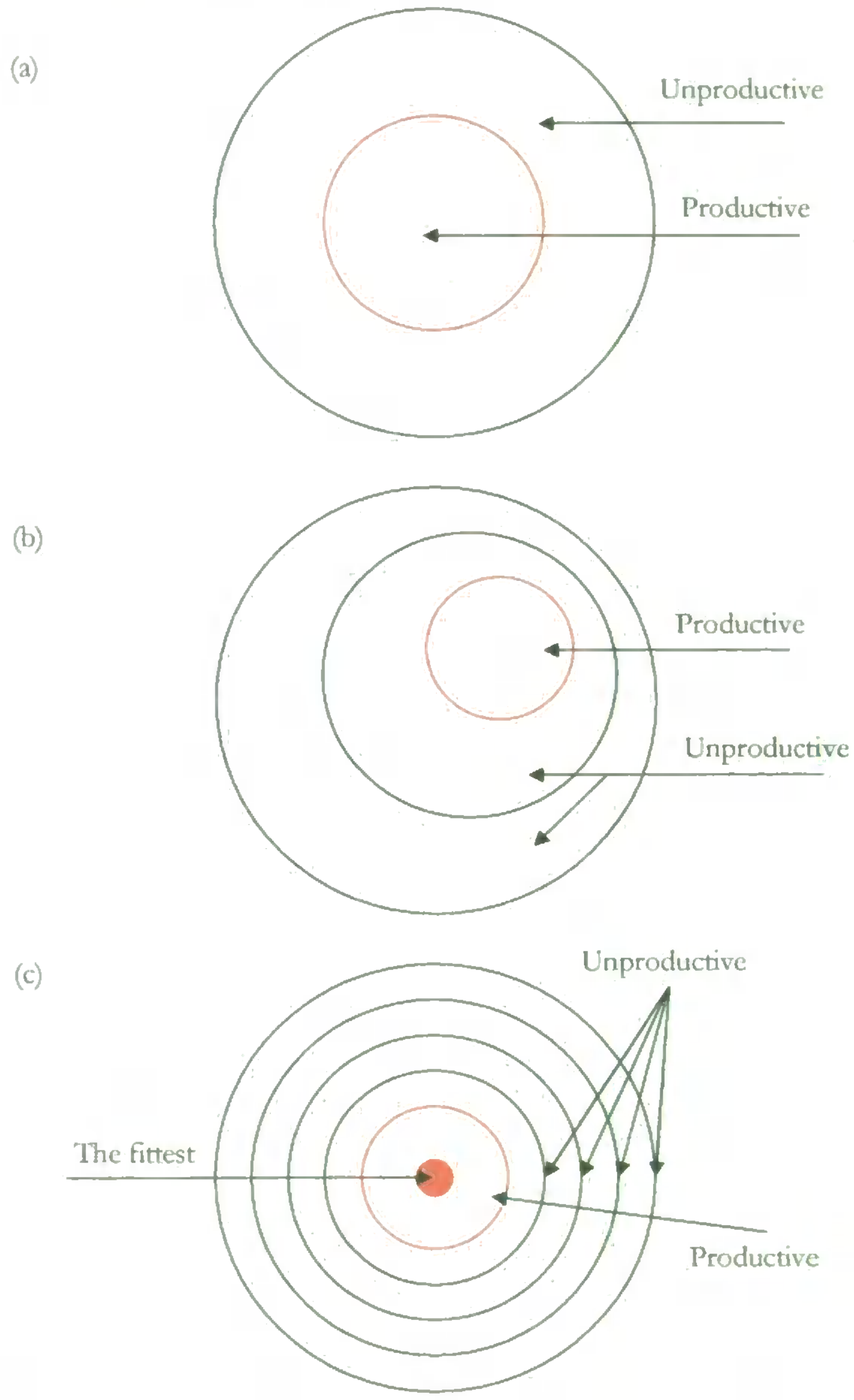
Here the fitness approach has been briefly reviewed, and a number of organisational and managerial applications have been illustrated in order to show their relevance in the analysis and identification of "organisational configurations". Although there have been several attempts to encourage the use of fitness approach into social studies (e.g. management, organisation, and economics), only contextualising and modelling "organisational configurations" are covered in most of the literature, but its empirical applications are limited. However, these fresh attempts are interesting as they shed light on the way to use the NK model can be used and test the outcomes of any particular theory. Fitness landscape is selected in order to achieve the goals of this study and is to be discussed in detail in the methodology.

2.4.3. Fitness: a performance indicator

The measurement and analysis of the performance of an organisation has become very important in the last decades. Different approaches have been developed in order to have better methods to measure and analyse performance, characterise the performance levels by considering a set of definitions or qualifications (e.g. unproductive, unprofitable, incompetent, and inefficient), and shed light on how to improve the performance by using such useful information. This study focuses on the analysis of the performance by using the productivity management approach and also proposes to use the fitness approach as the analytical tool. This section concentrates on discussing some of the core characteristics of three main approaches to analyse performance: central limit, optimisation and fitness which in turn emphasises the advantages and disadvantages of these methods. A Venn diagram representation of each method is shown in Figure 2-5.

The central limit method is based on the relation between outputs and inputs by considering assumptions from production theory. The fitting process between the data set and a selected production function (e.g. profit maximisation, cost minimisation) is carried out by implementing the least square principles. The fitting line, as normally determined in statistics, goes through the "middle" of these data points and so organisations above this fitting line could be defined as excellent and the organisations below it as inferior or unsatisfactory.

Figure 2-5. Methods to analyse performance: (a) central limit, (b) optimisation and (c) fitness



Source: after Chiang, 1984; Kauffman and Weinberg, 1989; Coelli et al., 1998.

One can measure the degree of excellence of inferiority of these organisations by the magnitude of the deviation from the fitted line. Thus, this technique analyses the performance of the organisations by examining the "average" or "central tendency" behaviour of the analysed organisations (Coelli et al., 1998; Cooper et al., 2000). The performance mean permits a classification of a set of organisations into two practical groups: those organisations "above" the mean are considered productive and those "below" it to be unproductive. Based on statistics, this method also permits the identification of the most important factors which influence such performance, and deals with randomness effectively (Coelli et al., 1998). However, there are also some disadvantages related to this method: (i) In order to achieve reliability, the central limit method adds some less productive organisations into the productive group and "vice versa". In fact, many authors suggest that in general organisations are considered productive, so this may mislead the classification and design of improvement strategies. (ii) Whilst it is clear that unproductive organisations should move to a productive area by improving the significant driving factors, the productive group seems to be stagnated and no further improvement can be achieved. (iii) Thus, all organisations are treated as efficient, so performance differences arise from those driven factors which are statistically significant (Färe et al., 1994; Coelli et al., 1998; Cooper et al., 2000; Zhu, 2003; Ray, 2004).

Optimisation is a method based on a single extreme or a set of extremes which serve as benchmark to calculate the efficiency measure. The calculation of these extremes (or frontier) takes into consideration the term efficiency. As mentioned in previous sections, three main efficient terms were identified: technical efficiency, allocative efficiency, economic efficiency (Coelli et al., 1998). In practice, the optimisation method is based on set of assumptions (Färe et al., 1994; Cooper et al., 2000; Zhu, 2003; Ray, 2004): (i) price consideration (i.e. technically and allocative), (ii) model orientation, input, output or both, (iii) the type of efficiency measure by radial (proportional) and non radial models, and (iv) the type of returns: constant (linear assumption) and variable (enveloping assumption). The optimisation method is not a rigid-completed model, so other analytical tools are developed to examine further different optimisation situations. One of the main purposes of the optimisation method is to seek the most efficient organisation, the remainder organisations are considered inefficient. This method permits the calculation of different levels of inefficiency which in turn shows how far the organisations are from being fully efficient. This provides a powerful tool to improve the performance of an organisation, because each organisation knows what resources need to be adjusted (e.g. slacks or excesses) (Cooper et al., 2000; Zhu, 2003; Ray, 2004). Nevertheless, this method also has some limitations. The optimisation process is based on the extreme (e.g. maximum or minimum) performance points; therefore, a change of these fundamental points, for instance by deleting them or adding new ones, leads to a new performance structure (e.g. size of productive set, values of efficiency). There are restrictions to apply in longitudinal and causal studies.

One way to overcome some of the above problems has been the development of the stochastic frontier method which involves the use of econometric methods. The production function is never known in practice, thus it can be obtained from sample data by using a parametric function such as the Cobb-Douglas form. This procedure was proposed by Aigner and others resulting in the development of the stochastic frontier model (Coelli et al., 1998). This stochastic frontier model permits the estimation of standard errors and tests of hypothesis using traditional maximum-likelihood methods. The stochastic frontier model is not, however, without problems. The main criticism is that there is generally not a priori justification for the selection of any particular distributional form for the non-negative random variable which is associated with technical inefficiency in production of organisations in the data set involved. The specifications of more general distributional forms proposed by Stevenson (1980) and Greene (1990) have partially alleviated this problem, but the resulting efficiency measures may still be sensitive to distributional assumptions (Coelli et al., 1998). Additionally, the most productive organisations are considered optimum and no further improvement is required to them. It is also assumed that there is no interaction between them; that is the position of one organisation does not influence the position of others (Coelli et al., 1998).

The fitness approach is a based on the NK model and this method considers a solution space (i.e. landscape) by combining variables and their responses. A performance (fitness) value is assigned randomly to each combination in the original model. This method also considers a maximum theoretical combination (the fittest) (Kauffman and Weinberger, 1989). Organisations are located in the solution space by considering its inherent combination. Thus, it is possible to have combinations without any organisation including the "fittest" combination (Kauffman and Weinberger, 1989; Frenken, 2006). For instance, by dividing the fitness value, it is possible to generate different levels of performance. Each level is characterised by specific combinations of variables and responses. This systematic arrangement also permits a separation of those organisations which are fitter from those which are not. Furthermore, the position of each organisation provides useful information of how each organisation either can move (by considering its neighbourhood) or should move (by considering a competitive environment, e.g. first come first served). That means a movement of one or two or three layer(s) to the centre in this simple example (Figure 2-5). Finally, according to some modelling studies (Sommer and Loch, 2004; Ma and Nakamori, 2005; Susuki and Arita, 2007), the fittest approach also helps to evaluate the gap between the fittest value obtained from the sample and that obtained theoretically. This gap shows the potential for improvement and the feasible combinations without being explored. Furthermore, it is important to highlight that a fitness approach helps the understanding of the possible dynamic of a system by examining (or comparing) its statics. The fitness approach use the terms local and global to refer to the points where organisations would (or could) move. This notion is fruitful in shedding light on the following "movement". However, it is clear that the resulting path of such action will still be unknown: steady, fluctuating, or oscillatory. Nonetheless, this NK model has some limitations. First, the original model was developed in biological science; therefore, there are few empirical social studies which consider the use of the fitness approach (Jermias and Gani, 2004, 2005). Second, the landscape and its fitness values are theoretically calculated, and it is assumed that each combination has been occupied by at least one organisation. This seems not to be the case in empirical studies (Frenken, 2006). Finally, the landscape is based on selected variables and their responses, so a change of any of them could modify the positions (or classification) of the organisations (McCarthy, 2004).

In brief, all these methods permit researchers to achieve three core outcomes (i) distinguish different organisations, (ii) identify some driving factors that lead to such differences and (iii) provide a guideline upon how to develop a strategy that is able to improve the performance of an organisation (or a set of organisations). However, the main difference arises from the consideration that the producer behaviour and its decisional situation is a complex adaptive system rather than a deterministic (efficient) system. Therefore, the "fitness" approach concentrates its interest on the set of decisions rather on the measurement of the implementation of such decisions, not because this approach implies that a search for the measures and causes of decisions are unimportant, but because (i) uncovering the patterns of decisions comes first, and (ii) the main advantage of this approach is to identify the set of decisions rather than to measure performance. From this point of view, the "fitness" approach provides a significant advantage when compared with other methods. The "fitness" landscape provides awareness about where the organisations are, where they want to be (local or global fitness), and how to get there (by looking at their internal configuration).

2.5. Pulling the threads together

The production and distribution of food are core activities in any society because these activities sustain the development of human populations, are the raison d'être for many people and are highly interrelated with the local and global natural ecosystems (Marshall, 2001). There are different driving factors (e.g. natural, technological, and socioeconomic) which shape the production and consumption of food in the world. This research uses the term "competitive environment" to refer to the mosaic of combinations of production and consumption patterns that arises from these important factors. The development of a strategy for the production and distribution of food represents a huge challenge for many governments particularly in most developing countries (Valle, 2004). The development of such strategies used to be designed, implemented and improved mainly by the governments, but this also has changed. Agro-food systems (AFS) are basic entities which nowadays deal with the development of such strategies. Furthermore, since AFS consists of different industries such as farming, processing and distribution industries, these industries also play an important role in the development of such strategies (Street, 1990; Solleiro and Valle, 1996; Cuevas, 2004).

Many scholars are very interested in the design, implementation and evaluation of these strategies, because nowadays they permit AFS and its industries to cope with and adapt to competitive environments. On the other hand, performance is highly correlated to the development of strategies. Therefore, by addressing the research question as to how one can transit from one level of performance to another (e.g. optimum, wished, or desired), it is possible to shed light on the development of strategies which permit organisations to cope with and adapt to competitive environments. In simple terms, this research looks for responding the following questions: where an organisation (AFS) is, where the organisation (AFS) wants to be and how the organisation (AFS) can get there. Considering the fitness approach, these three "points" provide valuable information which can be use as a framework to explain the activity (or dynamic) of a system and its elements. From the above discussion, this research concentrates on two levels AFS and farming industry, and argues that by addressing the research question it is possible to shed light on development of strategies to cope with and adapt to competitive environments.

Section 2.2 highlights the importance of analysing the production and distribution of food as a system (Spedding, 1988; Doppler, 1991; Trienekens and Zuurbier, 2000). An agro-food system (AFS), then, was the basic unit of analysis. AFS was defined as the set of industries which link producers to consumers (Trienekens and Zuurbier, 2000; Eastham et al., 2001; Knight et al., 2002; Bourlakis and Weightman, 2004). Under this broader definition, several studies cover issues related to classification, structure, performance, improvement of AFS. These studies highlighted the fact that there are more benefits by working as a system rather than as an isolated organisation (Trienekens and Zuurbier, 2000; Eastham et al., 2001; Knight et al., 2002; Bourlakis and Weightman, 2004). Other studies, however, highlighted the fact that some benefits are not well distributed across an agro-food system and some negative outputs (e.g., pollution, resources degradation, regional development, and native technology) are not considered or mostly avoided in many studies (Goodman and Watts, 1997, Wilkinson, 2002, Kirwan, 2004). It was also found that AFS studies concentrate mainly on developed countries, so there are very few AFS studies in developing countries (Torres, et al., 1996; Cuevas, 2004; Valle, 2004; Echanove, 2005). One of the main outcomes of section 2.2 was the lack of a suitable instrument which permits an examination of the structure of an AFS, and at the same time sheds light on specific changes. Considering the supply chain management approach, it was found that the "chain map" tool permits an analysis of the different layers (i.e. industries) that an agro-food system consists of. The main use of this tool is to identify opportunities for improvement as well as the main obstacles to cooperation (Storer et al., 2003). Thus, it was argued that this tool could help to analyse the anatomy or structure of an agro-food system. Furthermore, this research emphasised the importance to incorporate core elements taken from the systems approach to analyse some changes. These elements include the selection of key industries (boundary process) of an AFS, the functions and the interactions of industries and its organisations (Knight et al., 2002; Bourlakis and Weightman, 2004). The chain map tool and the core elements of systems theory were adapted to develop a Quick Anatomical Assessment which permits an analysis of the Cacao agro-food system in Tabasco, Mexico. The comparison between current elements (i.e. structure, functions and interactions) and those from the literature review provides a new picture which helps to explain the changes.

The success of an AFS relies on key industries. The farming industry plays an important role because as the starting point it provides the raw materials which are to be transformed in the following layers (industries), consists of a huge number of people, and is highly related to natural ecosystems. Additionally, each organisation of the farming industry needs to develop a set of strategies to survive under a competitive environment. These strategies are changing as a natural response to internal and external factors.

As mentioned above, the study of performance permits an identification of such strategies. In section 2.3, the importance of efficiency, effectiveness and productivity as core measures to analyse performance was discussed. Some approaches to the analysis of these performance indicators, their assumptions, and limitations were also reviewed. In order to identify and understand how to develop these strategies, the productivity concept was reviewed. Productivity as a concept has evolved in many approaches, from conceptual to practical applications and from technological to social perspective, among others. This research focuses on the managerial perspective of productivity because it goes further than traditional concepts, so it includes aspects related to implementation (Prokopenko and North, 1997).

The "productivity management" approach takes into consideration both elements of the ratio outputs and inputs. "Productivity management" is also based on efficiency and effectiveness (Bernolak, 1997; Prokopenko and North, 1997; Hamprecht and Corsten, 2005). From this broader perspective, this research considers the "productivity management" approach as the main source of the identification of the "survival" strategies of an organisation. These strategies are related to the internal and external factors that enhance productivity. Three "productivity management" factors were identified as the most important: technology, competence, operational climate.

A competitive environment implies complexity and changes. Therefore, it has been found that organisations develop different strategies. Some of these strategies are pertinent but others not and lead organisations to fail in the near future. One of the main approaches to the identification of strategies is by analysing the performance of an organisation. In section 2.4, two traditional methods were discussed and highlighted as pertinent tools to analyse performance and furthermore relate such performance to some driving factors which in turn shed light on the identification of strategies which permit organisations to cope with and adapt to competitive environments. Nevertheless, some scholars have suggested that such methods are limited. These methods assume a point (or set) of solution(s) based on the sample and not on the potential for improvement (Baum and Singh, 1994; Nelson, 1996; McCarthy, 2004).

As reviewed, the fitness approach is based on a landscape perspective. This landscape could help to identify the strategies which permit an organisation to cope with and adapt to a competitive environment. First, the construction of the landscape is based on the combination of variables and their response (referred to in business science as "organisational configuration"). Second, the fitness approach, assumes that organisational configurations must match specific external conditions (performance). Therefore, if the "organisational configuration" is appropriate it will achieve higher levels of performance. This study argues that the fitness approach provides a new insight on how to analyse the performance of organisations by concentrating more on the strategies rather than a perfect computation of the performance. The productivity management perspective supplies the elements to construct the organisational configurations (strategies) and the fitness approach, gives the framework for the analysis of the organisational configuration. This study therefore basically aims to test one of the main statements of fitness approach: there is a relationship between strategies (organisational configurations) and performance.

As mentioned above, this research seeks to answer the key question as to how one can transit from a current existing (running, real) position to a most pertinent (optimum, future and planed). To achieve this, the study has divided the research work into two main tasks, first to explore the "fitness" strategies of a whole agro-food system by analysing its anatomy, and second to explore the "fitness" strategies by analysing the relationship between the "organisational configuration" of organisations in the farming industry and their performance respectively.

By achieving, several questions have to be answered. A few pertinent ones are:

(a) Agro-Food System is the basic operational unit of "Production and Consumption of Food". Is this boundary sufficient or must it be narrowed or extended, by considering the anatomy?

(b) Productivity management embodies different elements to study the key industries of AFS. Are they compatible with internal and external conditions?

(c) An evolutionary perspective, especially the fitness approach has proved to be successful in other realms, including management science. Would it be sufficient to trace the fitness landscape of an AFS or a linear approach has to be considered?

This research will explore these questions and others by developing an exploratory instrument – fitness appraisal instrument, which will be used and tested in the Cacao Agro-food system in Tabasco (Mexico). This phase will be discussed in detail in the methodology chapter.

3. Methodology

This chapter discusses the methodology used to achieve two main objectives of this study: (i) the anatomy of CAFS, and (ii) the identification of "organisational configurations" of the key industry of the CAFS (i.e. farming industry). This chapter is divided into two sections: section 3.1 draws attention to the procedures undertaken to analyse the anatomy of an agro-food system, section 3.2 discusses the NK model to analyse the relationship between the internal configurations of a system and its environment and section 3.3 focuses on the procedure of the sampling and data collection.

3.1. Anatomical model

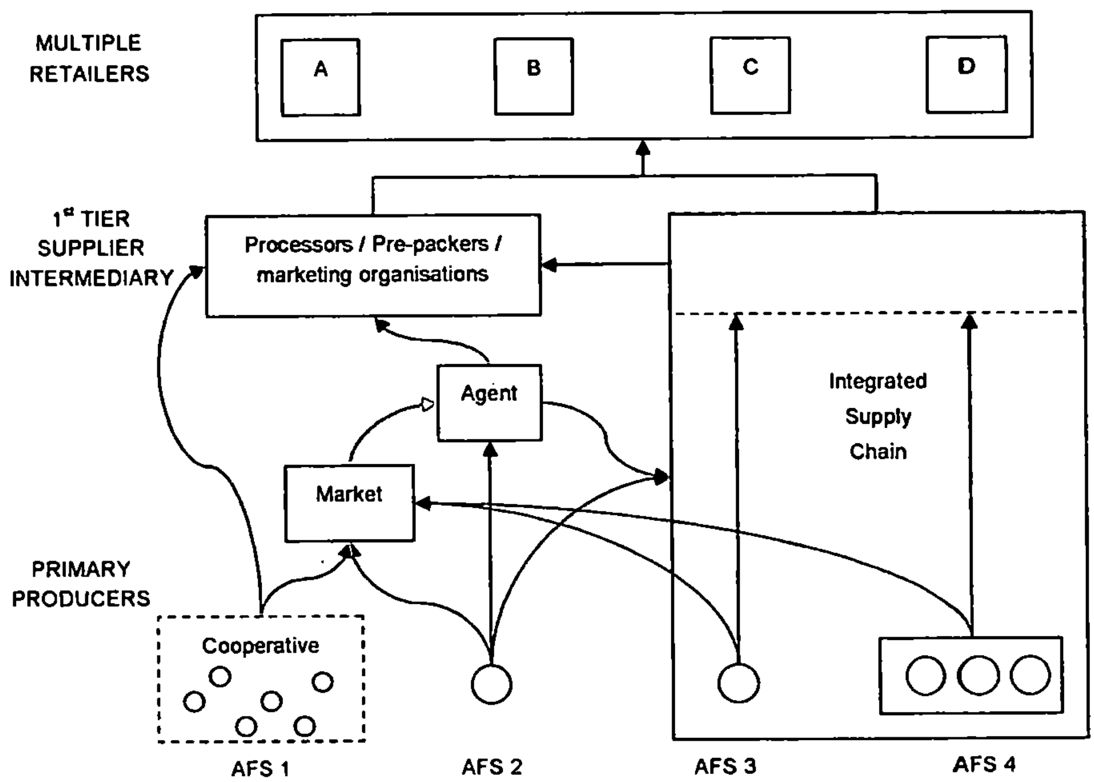
The first objective of this research is to analyse the anatomy of an AFS. Thus this section concentrates on explaining the "anatomical perspective". Such a fresh perspective is based on the study of layers proposed in the "chain mapping" tool and the use of the statistical method called "correspondence analysis". This section is divided into three subsections: subsection 3.1.1 explains an empirical application of the "chain mapping" tool, subsection 3.1.2 discusses the key elements that are used to analyse the anatomy of an AFS, subsection 3.1.3 examines a statistical method, "correspondence analysis", which is used to analyse the anatomy of an AFS and subsection 3.1.4 discusses the relationship between "correspondence analysis" and other statistical tools.

3.1.1. The complexity of an AFS

As mentioned in the literature review, "chain mapping" tools are used to improve the performance of an AFS over time by (i) identifying problems and opportunities for improvement and the greatest obstacles to cooperation, and (ii) ensuring that those involved in the analysis of an AFS understand all of the interactions and consequently the implications of the changes that may be suggested. All this is achieved by simplifying the complex interactions into diagrams that can be analysed visually. An empirical application of this "chain mapping" tool is presented below.

Agro-food systems are becoming more complex. This complexity stems from the nature of the food product, the particular characteristics of the sectors and the interactions involved in the "value added" process over the AFS (Jones and Street, 1990; Strack and Morgan, 1995; Eastham et al., 2001). This can be seen by analysing an example from the generic structure of UK supermarket supply chains (Figure 3-1). AFS 1 comprises farmers that are members of a cooperative (or producer group). These primary producers sell their products to a processor, pre-packer or marketing agent who then supplies the multiple retailers. Some of the primary producers' products are also sold to the wholesale market. Agents and brokers purchase these products from the wholesale market, and supply the first tier suppliers who supply the multiple retail market. This kind of AFS is common in the meat and fresh sectors, where wholesale markets remain but are diminishing in importance and where producer controlled organisations have developed benefit from economies of scale, without taking the significant step into value-added processing. Top fruit, soft fruit, beef and lamb would be the most prevalent sectors in which these AFS continue to represent a significant proportion of supplies to supermarkets.

Figure 3-1. Generic structure of different AFSs: UK supermarket case



Source: adapted from Bourlakis and Weightman, 2004

AFS 2 comprises primary producers who sell their products through the wholesale market or to agents that do not supply the multiple retailers directly. This kind of AFS represents an extremely small proportion of retail sales, because retailers have pursued a policy of supply base rationalisation, preferring to deal with cooperatives and large scale units, whilst simultaneously reducing their dependence on the wholesale market due to problems associated with quality and traceability. However, there remains a significant number of small scale livestock, dairy and fruit farmers who find themselves in this AFS, for whom the future looks particularly bleak, notwithstanding the current interest in farmers' markets.

AFS 3 comprises large primary producers that pack and market their own product and supply the multiple retailers directly. However, it is likely that for some of the larger multiple retailers the large independent farmers will supply these customers indirectly through a first tier supplier. These farmers also introduce some of their production to the wholesale market and might supplement their own supply with products purchased from other farmers. This kind of AFS is almost exclusively found in the fresh produce sector, in which large scale producers of brassicas, field vegetables and salad crops have been encouraged to integrate vertically and focus increasingly on supplying specific (i.e. customised) products on an exclusive basis to supermarkets seeking a unique selling proposition in these categories.

Finally, AFS 4 comprises vertically integrated production units in which companies are involved in the production, processing, packing and marketing of their products. In some cases, these companies draw the balance of their supply from independent farmers or from brokers. These companies supply the multiple retailers directly or market some of their products through another first tier supplier. These types of AFS are prevalent in the meat sector and to a lesser extent in the dairy sector, where the options for differentiation and value-adding activities are greater than in fresh produce sector, as is the level of investment required.

This visual representation provides a clear picture of the changes in the AFS. Therefore, one of the main results from this visualisation is to appreciate the diversity of sub-systems in an AFS, in this case the UK supermarket case. Such diversification seems to be related to (i) the nature of the product, (ii) the participants who are defined by the activities they perform and the resources they control, and (iii) the nature of the participants' interactions.

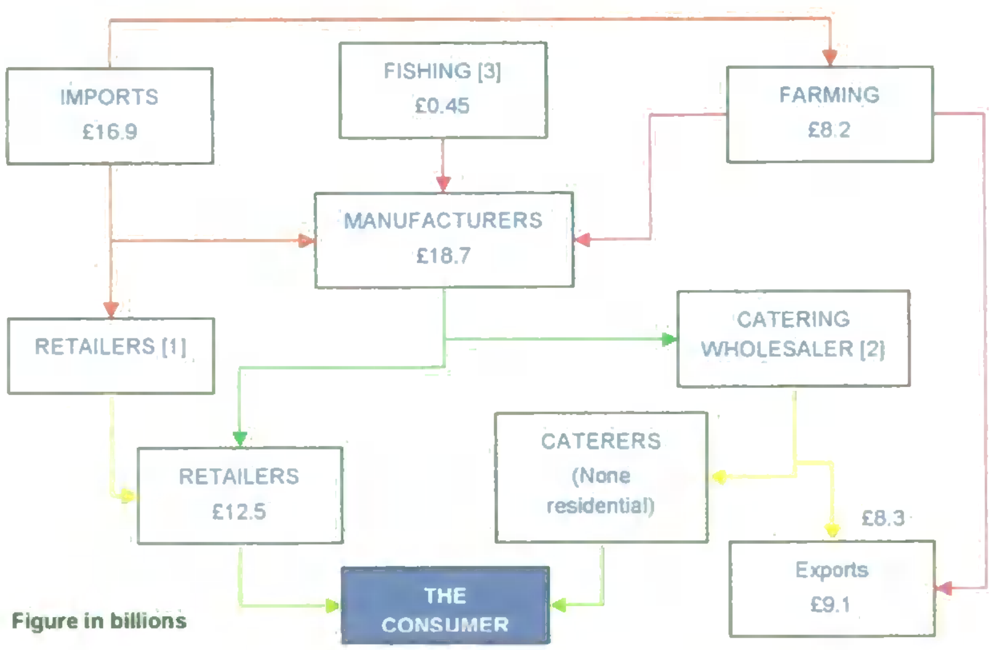
3.1.2. The anatomical elements

As mentioned in the literature review, useful methods and instruments have been developed to analyse the AFS. One of these methods is the "chain mapping" tool which permits the highlighting of the problems and opportunities of the whole AFS and its internal components (Spedding, 1988; Eastham et al., 2001; Storer et al., 2003; Bourlakis and Weightman, 2004). This subsection discussed three key elements (i.e. industries, product and interactions) which in turn are used to analyse the anatomy of an AFS.

Industry

The "Chain mapping" tool starts the analysis of an AFS by determining the AFS and its key industries. There are different perspectives from which to identify these key industries. First, the selection of key industries is based on the levels of the relationships between such organisations (Harland, 1996). Initially, the selection of organisations was based on two organisations (e.g. buyer and seller) and this relationship is known as the "dyadic" level of interaction. The "dyadic" level was extended to thinking about the level of interactions as a "chain" or pipeline. This level of interaction increased complexity of the study of AFS as it took into account different organisations from the production side to final consumer interactions. The current stage is viewing the AFS as a "network". This implies an examination of the interactions across an entire AFS, where the supply roles can be frequently reversed several times through the network structure (Harland et al. 1999, Eastham et al., 2001). Second, the selection of key industries is also obtained by considering an industrial classification system (ICS) (Eastham et al., 2001). Figure 3-2 shows that this ICS perspective provides a linear relationship based on core industry sectors (e.g. farming, fishing, manufactures, and retailers).

Figure 3-2. The agro-food system in the UK



Notes: [1] and [2] the combined value of wholesalers was £4.6 billions; [3] all other catches are covered by imports figure

Source: adapted from Eastham et al., 2001

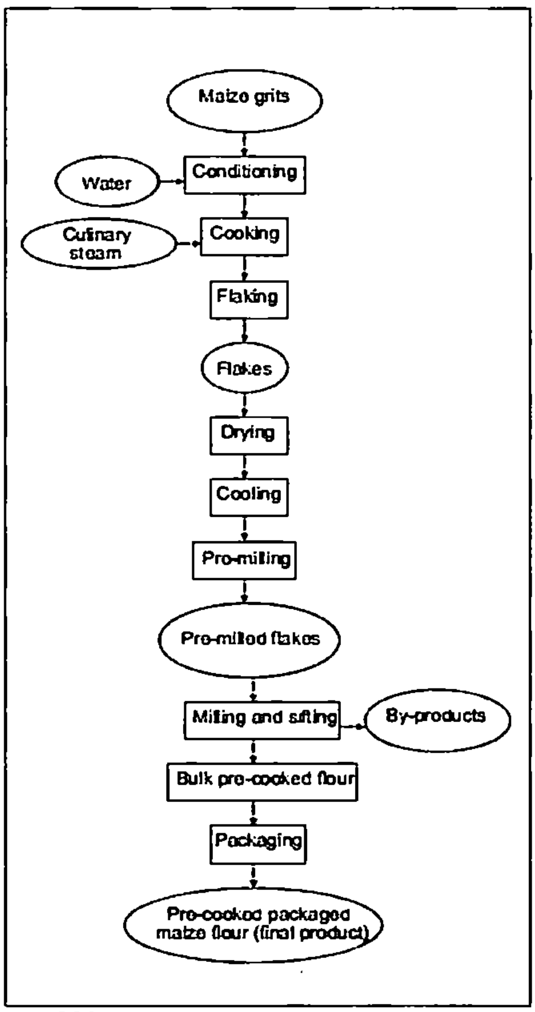
This ICS perspective permits researchers to have different levels of aggregation which cover a tremendously wide range of activities in each industry sector (e.g. producing, harvesting, preparing, transporting, and packing). The basis of this ICS is that individuals and organisations are allocated to industry groups according to their "principal product" which identifies the average "degree of specialisation" for enterprise in that group (Strack and Morgan, 1995). Figure 3-2 shows that this agro-system, for instance, also include industries not only from within the UK, but widely from all parts of the world (imports box). In this example, these industries have a high impact on the AFS.

Hamprecht and Corsten (2005) proposed the identification of the key industries by tracing back the raw material to the primary producers. This helps to clarify the current picture about the industries and their organisations involved in the supply system. Finally, the most common perspective used in the identification of key industries is by looking at the technological process of the main product of an AFS (La-Gra, 1993; Cuevas, 2004). In brief, it is argued that all perspectives complement each other. However, the technological process perspective is the starting point in the identification of the key industries of an AFS, and its final boundary takes into consideration other perspectives (Cuevas, 2004; Hamprecht and Corsten, 2005)

Product

The second stage in the analysis of an AFS is to determine the key products in the AFS. The key products are identified mainly by the technological process perspective. Such maps focus on a sample of the product or product family and visually capture two main aspects of the AFS (La-Gra, 1993; Solleiro and Valle 1996; Cuevas 2004): the steps through the physical products flows, and the steps through which selected variables (e.g. information, energy and cost) flow. As an example, Figure 3-3 shows a flow diagram specific to the industrial maize processing of precooked flour for the preparation of Venezuelan "arepas".

Figure 3-3. Industrial process for the production of precooked maize flour from maize grits



Source: adapted from Cuevas, 2004

The process is divided into its consecutive, interrelated operations, with the raw materials as the first input and the product as the final output. There is first a process that takes maize and produces maize grits, maize germ and by-products. From maize grits the precooked flour is produced. This type of flow diagram is widely utilised in food engineering subjects. However, Cuevas (2004) argues that these diagrams can be used to analyse the structure of an AFS by the identification of the industries related to each technological process.

In fact La-Gra, 1993 argues that many developing countries have used this technological approach to develop their national production during the policy of "import substitution". That is, each technological process was carried out by specific industries in order to improve efficiency. However, under a globalisation era, the developing of more diverse products is essential to achieve competitiveness (Solleiro and Valle, 1996; Kaplinsky and Morris, 2000; Hambrecht et al., 2005) and this leads a review of the allocations of the technological process over the AFS's industries.

Interactions

The last stage in analysing an AFS is to determine the key interactions within the AFS. The aim of analysing interactions is to make a strategic decision about whether to stop operating in a specific supply chain or to actively work to improve relationships with other industries of such specific supply chains in order to increase overall business performance (Storer et al., 2003). Relationships are measured in a number of ways. Attributes may be scored quantitatively or a general qualitative statement may be given about the following (Kaplinsky and Morris, 2000; Storer et al., 2003; Harland et al., 2004): (1) the overall nature of the relationships e.g. adversarial v cooperative, (2) negotiation arrangements e.g.

transaction on a purely commercial price negotiation basis –discrete v open book transparency and sharing benefits/costs and risks/rewards – relational, (3) commitment e.g. committed to developing long term relationships v only interested in short term transaction completion, (4) trustworthiness e.g. more trustworthy than others in the industry v less trustworthy ones, (5) satisfaction with performance e.g. worst performance in the industry v best one, (6) strategic importance of the relationship in terms of volume of trading, current critical importance currently (control of key raw material, market, information and technology) or potential strategic importance in the future, (7) problem solving e.g. constructive or recrimination

These attributes have been tested in different "chain mapping" studies and the results suggest that they are critical. Therefore, in order for any attempt to improve interactions between industries in AFS to be successful, these attributes need to be considered.

From here, the key elements discussed above are to be referred to in this study as the "anatomical elements" and they will be used to develop the Quick Anatomical Assessment. The variables involved in each "anatomical element" will be discussed in detail in section 5.1.

The main output of a "chain mapping" tool is to draw the key elements on a diagram in order to have a visualisation of the current state of the AFS. Furthermore, this study also seeks a new insight and proposed to analyse the relationship between "anatomical elements" and the selected industries of an AFS within a positional space. A statistical method, correspondence analysis, is used to achieve this visual (anatomical) analysis.

3.1.3. Correspondence analysis

This section provides a review of the "correspondence analysis" which is used to explore the anatomy of CAFS. The review of "correspondence analysis" includes its definition and classification, the analytical process, and its empirical applications.

Definition and classification

"Correspondence analysis" is primarily a multivariate descriptive method of analysis that graphically presents the relations between rows and columns in a frequency table as points in a common low-dimensional space e.g. 2-3 (Clausen, 1998). "Correspondence analysis" permits researchers (i) to reveal the structure of a complex data matrix by replacing the raw data with a more simple data matrix without losing essential information and (ii) to present the result visually, that is, as points within a space, which facilitates interpretation.

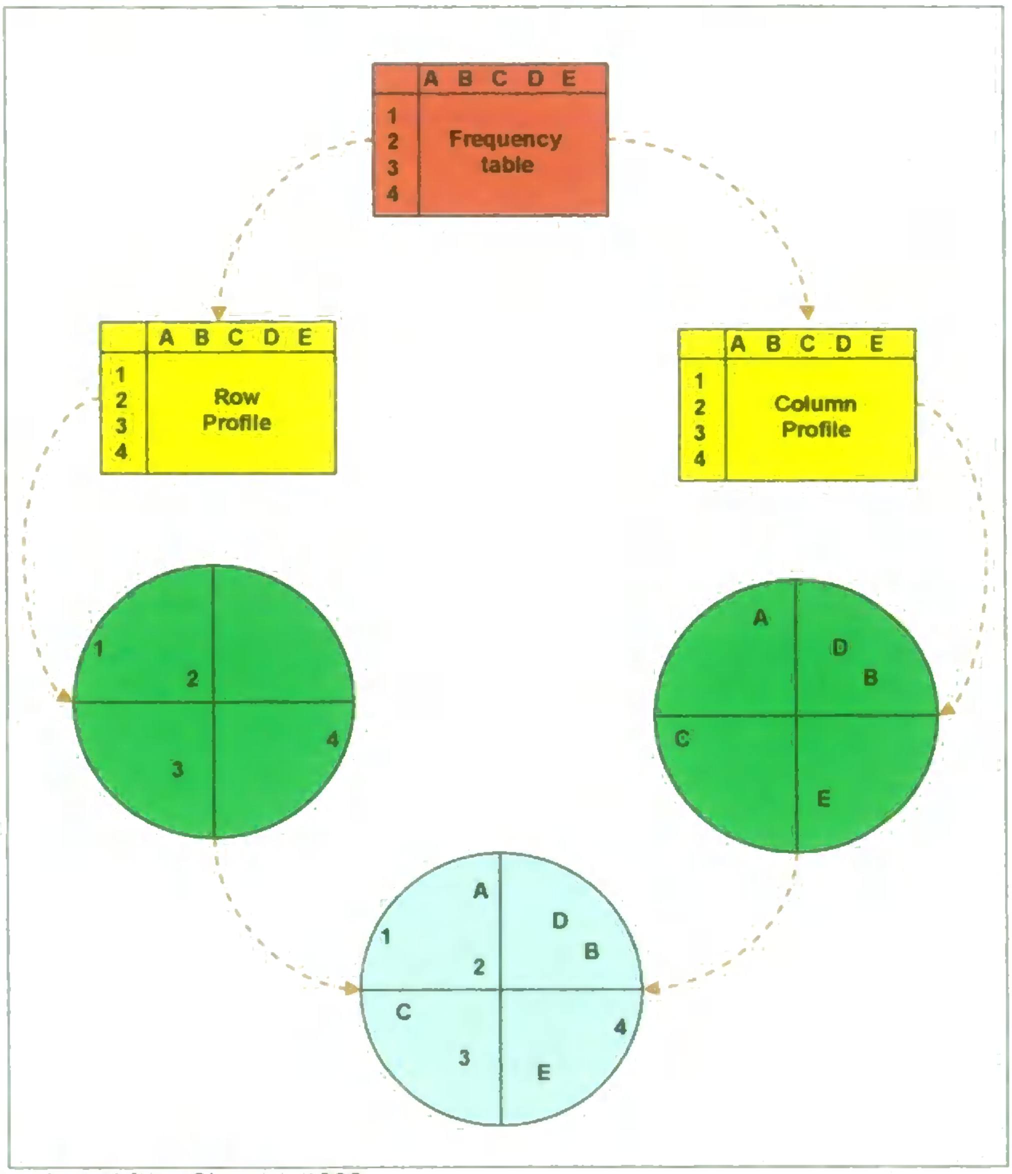
There are two main types of "correspondence analysis": the "single correspondence analysis" is a cross-tabulation of two variables in a rectangular data matrix form, and the "multiple correspondence analysis" is a multi-response table composed of several separate cross-classifications and conditional distributions that are presented in one table (Hair et al., 1995; Clausen, 1998).

Analytical process

The analytical process is performed in two stages: (i) the set of categories for one variable, and then for the set of categories for the other variable. Figure 3-4 shows that each stage is divided into three steps: (i) the analysis starts by transforming the frequencies in a cross-classification into proportions, which, as far as the rows are concerned, gives a set of so-called row profiles. Both the row and column profiles are shown in the figure below. Since each row profile is independent of the total number in the category of variables, the masses are used to provide information on this number. They can be said to be a measure of the importance of a particular profile in the analysis. The average row profile is the total of the numbers in the different columns divided by the total sum, and is the weighted average of the row profiles. This point is known as the centroid and it is placed at the origin of the principal axis (Hair et al., 1995; Clausen, 1998). (ii) Each row profile may be regarded as a mathematical vector, and a vector may be represented as a point in space where each profile element constitutes a coordinate in space. In this way, every row and column profile may be represented as points in n-dimensional space. The more similar the profiles of two rows are, the closer to each other will be the points be placed in space. On the contrary, two very different profiles will produce points lying far away from each other. The Euclidean distance is used to set these points. The chi-square distance, however, is a weighted Euclidean distance, where the weight is the inverse of the respective average profile element. This implies that the categories with few observations contribute relatively more to the interpoint distance than categories with more observations.

Thus correspondence analysis is based on this chi-square metric, and may be described as a technique for decomposing the chi-square statistic (Hair et al., 1995; Clausen, 1998).

Figure 3-4. The analytical process of correspondence analysis



Source: adapted from Clausen, 1998

(iii) When similar calculations have been carried out for the columns, the remaining problem is to find the axes in the n-dimensional space that lie closest to all the points. The problem is solved by means of principal component analysis, and the result of this analysis provides a number of useful descriptive statistics in addition to the graphical display. In correspondence analysis the variance concept is connected to the chi-square distances, therefore inertia and variance are used as synonymous terms. Total inertia is a measure of the extent to which the profile points are spread around the centroid. From this, total inertia can be systematically related to Pearson's chi-square, and in turn also related to phi-square, therefore the total inertia is decomposed into a set of eigenvalues. The number of eigenvalues that are decomposed is equal to the total number of dimensions. These eigenvalues express the relative importance of the dimensions or how large a share of the total inertia each of them explains. The shares are calculated so that the first dimension explains most, then the second and so on (Hair et al., 1995; Clausen, 1998).

Finally, in order to obtain a more complete and correct interpretation of the results of the correspondence analysis, another two sets of descriptive statistics are also used: (a) contribution of points to the inertia of dimensions refers to the proportion inertia of a particular dimension explained by the point it expresses the extent to which the point has contributed to determine the direction of the dimension concerned. Points with relatively large contributions are most important to the dimension concerned. Within each set of points, the sum of these contributions for each dimension equals 1.00. (b) Contribution of dimensions to the inertia of points explains how well each point is described by each dimension. This is expressed by the contributions of dimensions to points, which provide information on how much the inertia of a point is explained by a dimension. These contributions are often called squared correlations which are also used to avoid confusion with the contribution of the points to dimensions. The sum of the squared correlations expresses the goodness of the fit of each point's representation in the solution, and is often termed the quality of the description of each point (Hair et al., 1995; Clausen, 1998).

The interpretation of the configuration of the points is based on the chi-squares distances between points, and these distances are defined separately for each set of points. This implies that if two row-points lie close together, the profiles of these points are similar. As the profiles become more dissimilar, so the points become further apart; the same condition applies to the relation between the column-points. The marginal profiles for both sets of points lie on the origin of the axes, so that a point with a profile like the average will also lie in the centre. However, the two points positioned close together in a low-dimensional solution may lie far apart in a solution with higher dimensionality (Hair et al., 1995). Therefore, it is suggested that the number of dimensions should be kept as low as possible (the principle of scientific parsimony). Nevertheless, the solution should describe the data as fully as possible, implying that the percentage share of explained inertia should be high. Thus the solution to the problem of dimensionality implies weighing high percentage inertia, on the one hand, against low dimensionality, on the other. The latter problem is resolved by exploring the plotted eigenvalues. That is, the right dimensionality is equal to the point where the curve shows a bend (an elbow) (Claussen, 1998).

"Correspondence analysis" is basically an exploratory and descriptive technique, which uncovers and describes associations in large contingency tables. The only restriction is that the data elements must be nonnegative numbers. There are no further assumptions regarding the distribution or the nature of the data. The disadvantages of the "correspondence analysis" are that the distance between the points of different sets is not defined and it does not include significance tests for effects or interactions. It is in this connection especially that "loglinear models" are a particular useful supplement to "correspondence analysis" (Hair et al., 1995).

Empirical application

An example will clarify how "correspondence analysis" works (Clausen, 1998). Table 3-1 shows a cross-classification of leisure activities with the respondent's occupational status. By applying correspondence analysis to this table a graphical representation is obtained.

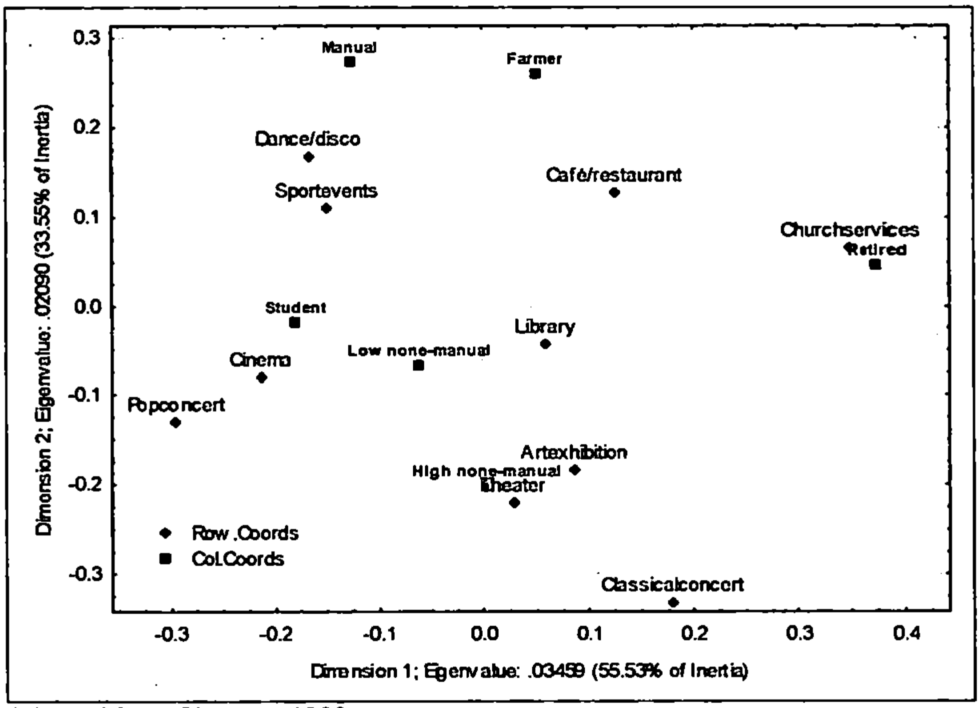
Table 3-1. A cross-classification of leisure activities with occupation

LEISURE ACTIVITIES	MANUAL	LOW NONE-MANUAL	HIGH NONE-MANUAL	FARMER	STUDENT	RETIRED
Sport events	301	497	208	50	254	187
Cinema	216	550	250	37	339	157
Dance/disco	361	534	204	59	324	216
Café/restaurant	463	766	334	72	350	601
Theatre	89	350	195	12	143	167
Classical concert	23	182	124	10	60	110
Pop concert	117	298	145	11	184	56
Art exhibition	104	379	219	21	152	213
Library	130	352	153	17	272	264
Church services	168	370	187	51	162	424

Source: Clausen, 1998

The Figure 3-5 shows a two dimensional joint space where the points represent the categories of leisure activities and occupation variables. The result is interpreted on the basis of the relative positions of these points, for example, as spatial dimensions and/or clustering. In this particular case the graphical arrangement may be interpreted as representing the association of the occupational categories with the different leisure activities.

Figure 3-5. The occupation and leisure activities are represented as points in a two-dimensional space



Source: Adapted from Clausen, 1998

The horizontal dimension separates the young (students) from the old (retired), and the vertical dimension separates cultural activities from light entertainment. The position of the points indicate that retired people are associated with church services and high status none-manual occupations are associated with art exhibitions, theatre-going, and classical concerts, whereas manual workers and farmers are situated closer to light entertainment like dancing, sports events, and café/restaurants. This example should provide an intuitive understanding of the unique property of correspondence analysis in visualising the associations between categories in contingent tables.

"Correspondence analysis" has given social scientists a very useful method of analysis. The graphical display is very beneficial for communicating complex relationships between variables/categories. The applications of this useful technique is wide and diverse, ranging from marketing, environmental studies, land use, strategic management, agricultural systems, among others, where the relationship of variables and categories of the behaviour of a person, species or productivity respectively have been analysed (Chamberlain et al., 1999; Solano et al., 2000; DeSarbo and Wu, 2001; Purvis et al., 2001; Hernandez and Valdes, 2006). Therefore, this study considers that the use of this statistics method is useful for analysing the "position" of the industries based on the different "anatomical elements" (i.e. industries, products, and interactions). The exploration of such an "industry map" leads this study to depict the changes.

The disadvantages of the method are that the distance between the points of different sets is not defined and it does not include significance tests for effects or interactions. It is in this connection especially that other analytical methods (i.e. loglinear, nonparametric) are particularly useful supplements to correspondence analysis. Calculating parameter estimates and significance tests for the interaction effects provides a measure of how strongly the different categories and variables are related. Therefore, the implementation of such analytical methods enables the researcher to obtain more information from the results of the correspondence analysis.

"Correspondence analysis" is normally employed to analyse cross-sectional datasets. This leads researchers to elucidate similarities and dissimilarities from a particular point of time (Chamberlain et al., 1999; Solano et al., 2000; DeSarbo and Wu, 2001; Purvis et al., 2001; Hernandez and Valdes, 2006). Therefore, its application to explain changes over a period of time is limited (Hernandez and Valdes, 2006).

3.1.4. Correspondence analysis and its relation to other analytical tools

The study of the anatomy of an AFS is based on the analysis of the relations between the categories (e.g. dichotomous, categorical, or continuous) of the anatomical elements (variables) of each industry which in turn permits to similarities (or dissimilarities) to be found. Therefore, other techniques such as regression analysis, cluster analysis, principal component or factor analysis were not considered in the analysis of the anatomy. The decision was based on the inherent purposes and data requirements of each of these methods.

Regression analysis

This analysis has been widely used in the research studies of social and natural sciences. In general, regression analysis enables the researcher to ask the general question "what is the best predictor of...?" The general purpose of regression analysis is to learn more about the relationship between independent or predictor variables and a dependent or criterion variable. The procedure starts by weighing each predictor variable, the weights denoting their relative contribution to the overall prediction. In calculating the weights, the regression analysis procedure ensures maximal prediction from the set of independent variables in the variate. These weights also facilitate interpretation as to the influence of each variable in making the prediction, although correlation among the independent variables complicates the interpretative process (Hair et al., 1995; Hill and Lewicki, 2006). Regression analysis is a dependence technique, therefore to apply this technique (i) the data must be metric or appropriately transformed, and (ii) the researcher must define which variable is to be dependent and which remaining variables will be independent (Hair et al., 1995).

Furthermore, there are some assumptions, limitations and practical considerations that should be taken into account. (i) The assumption of linearity which refers to the linear relationship between variables. Regression analysis is not greatly affected by minor deviations from this assumption, but as a rule it is prudent to always look at the bivariate scatterplot of the variables of interest. If curvature in the relationships is evident, one can consider either transforming the variables, or explicitly allowing for nonlinear components (Hair et al., 1995; Hill and Lewicki, 2006). (ii) Normality assumption is related to a normal distribution of the residuals (predicted minus observed values). The F-test helps to evaluate any violation of this assumption. However, before drawing final conclusions, it is important to review the distribution of the major variables of interest (i.e. histograms of residuals, normal probability plots) (Hair et al., 1995; Hill and Lewicki, 2006). (iii) The major conceptual limitation of regression analysis is that one can only ascertain relationships, but never be sure about the underlying causal mechanisms, because in real correlation research, alternative causal explanations are often not considered. (iv) Another limitation is the number of variables which should always take into consideration the number of observations (Hair et al., 1995; Hill and Lewicki, 2006). (v) Multicollinearity means that at least one of the predictor variables is completely redundant with other predictors. There are many statistical indicators of this type of redundancy (e.g. tolerances, semi-partial R), as well as some remedies (e.g. ridge regression). (vi) Outliers (i.e. extreme cases) can seriously bias the results by pulling or pushing the regression line in a particular direction, thereby leading to biased regression coefficients. Excluding just a single extreme case can yield a completely different set of results (Hair et al., 1995; Hill and Lewicki, 2006).

The anatomy approach at this level does not consider the scope of prediction. The variables that are used to analyse the anatomy of an agro-food system are categorical. The aim of the anatomical approach is to seek similarities (or dissimilarities) by analysing the relationship between the categories (e.g. dichotomous, categorical, or continuous) of the anatomical elements (variables) of each industry of the selected AFS.

Cluster analysis

Cluster analysis has been applied to a wide variety of research problems. In general, cluster analysis helps researchers to group objects based on the characteristics they possess. Cluster analysis is an interdependence technique. That is, cluster analysis is an objective methodology for quantifying the structural characteristics of a set of observations. As such, it has strong mathematical properties, but not statistical foundations. The requirements of normality, linearity, and homoscedestacity that were so important in, for instance regression analysis really have little bearing in cluster analysis (Hair et al., 1995).

Cluster analysis usually involves at least two steps. The first is the measurement of some form of similarity or association between the entities to determine how many groups really exist in the sample. Some of the distance measures available are (Hill and Lewicki, 2006): (i) Euclidean distance which is simply the geometric distance in the multidimensional space, (ii) squared Euclidean distance which permits progressively greater weight to be placed on objects that are further apart, (iii) City-block (Manhattan) distance which is simply the average differences across dimensions, so the effect of single large differences (outliers) is dampened (since they are nor squared), (iv) Chebychev distance which permits researchers to define two objects as different if they are different on any one of the dimensions, (v) power distance which permits the progressive weight that is placed on dimensions on which the respective objects are very different to be increased or decreased, and finally (vi) percent disagreement which has useful applications when data for the dimensions included in the analysis are categorical in nature.

The second step is to profile the cases or variables to determine their composition. This step may be accomplished by applying discriminant analysis to the groups identified by the cluster technique: Tree clustering, Two-way joining, and *k*-means clustering (Hair et a., 1995; Hill and Lewicki, 2006). The tree clustering considers the rule to link or amalgamate two clusters by their inherent similarities based on the distances; some of the linkage rules to cluster are: single linkage or nearest neighbour, complete linkage or furthest neighbour, un-weighted pair-group average or arithmetic averages, Ward's method, among others (Hill and Lewicki, 2006). The Two-way joining considers the circumstances when one wants to cluster both cases and variables simultaneously, because, both of them will simultaneously contribute to the uncovering of meaningful patterns of clusters. Nonetheless, the difficulty with interpreting these results may rise from the fact that the similarities between different clusters may pertain to (or be caused by) somewhat different subsets of variables (Hill and Lewicki, 2006). Finally, the *k*-means clustering is based on fixing the number of clusters that have to be analysed. This type of research question can be addressed by the *k*-means cluster algorithm. Nevertheless, the best number of clusters *k* leading to the greatest separation (distance) is not known *a priori* and must be computed from the data (Hill and Lewicki, 2006).

There are some assumptions, limitations and practical considerations that should take into account. (i) Representativeness of the sample is a critical issue because it is assumed that the sample used to perform cluster analysis represents the structure of the population. Otherwise, outliers may really be only an undersampling of divergent groups that, when discarded, introduce bias in the estimation of structure (Hair et al., 1995). Multicollinearity acts as a weighting process not apparent to the observer but affecting the analysis nonetheless. Multicollinearity is corrected by reducing the variables to equal numbers in each set or using one of the distance measures that compensates for this correlation (e.g. Mahalanobis distance).

In brief, cluster analysis refers to the sorting of different objects into groups in a way that the degree of association between two objects is maximal if they belong to the same group and minimal otherwise. This permits structures to be discovered in data without providing an explanation or interpretation. On the other hand, the anatomy analysis is not based on seeking "unknown" groups, so this technique was not considered.

Factor analysis

Factor analysis has found increased use during the past decade in all fields. In general, factor analysis can be utilised to examine the underlying patters or relationships of a large number of variables and to determine whether or not the information can be condensed or summarised in a smaller set of factors or components. Factor analysis is an interdependence technique in which all variables are simultaneously considered, each related to all others. Factor analysis still employs the concept of the variate, the linear composite of variables. These variates (factors) are formed to maximise their explanation of the entire variable set, not to predict a dependent variable(s) (Hair et al., 1995; Hill and Lewicki, 2006). There is continued debate concerning the appropriate role for factor analysis: exploratory approach, i.e. take what the data give the analyst, and confirmatory approach, i.e. asses the degree to which the data meet the expected structure of the analyst.

In most cases, principal factors and principal components usually yield very similar results i.e. combining two (or more) correlated variables into one (or more) factors. In principal components analysis, it is assumed that all variability in an item should be used in the analysis. In principal factors analysis, it is only the variability of an item that it has in common with the other items that is used. In practical terms, principal components analysis is often preferred as a method for data reduction, while principal factors analysis is often preferred when the goal of the analysis is to detect structure (Hill and Lewicki, 2006).

There are some assumptions, limitations and practical considerations that should take into account (Hair et al., 1995): (i) Correlations among variables or cases, (ii) type of variables (e.g. metric, nonmetric values). (iii) sample size (i.e. the ration between cases and variables), and (iv) statistical assumptions (i.e. departures from normality, homoscedastacity, and linearity).

In brief, principal component or factor analysis aims either to reduce the number of variables or to detect the structure in the relationships. Although, correspondence analysis employs some of the algorithms used by factor analysis, this factor analysis does not help to achieve the aim of anatomy analysis.

Chi-square Analysis

Many studies consider some ways of analysing nominal and ordinal variables and ratio variables for which the data are given as frequencies of various categories (Krishnamurty et al., 1995; Hill and Lewicki, 2006).

The unifying factor is that the values of the variables, whatever they might be, are grouped in categories and the frequency (count) or percentage of data in each category is known. The variable might be dichotomous, categorical or continuous. Hence, Chi-square is often used to test categorical data in tables.

The value of the *Chi*-square and its significance level depends on the overall number of observations and the number of cells in the table. Thus, relatively small deviations of the relative frequencies across cells from the expected pattern will prove significant if the number of observations is large. There are different tests to analyse the relationship between categorical variables (Krishnamurty et al., 1995; Hill and Lewicki, 2006): (i) maximum-likelihood *Chi*-square which is based on Maximum-Likelihood theory Bishop (1975), (ii) Yates correction which is usually applied when the table 2x2 contains only small observed frequencies, so that some expected frequencies become less than 10, (iii) Fisher exact test which is available for 2x2 tables, and computes the exact probability under the null hypothesis of obtaining the current distribution of frequencies across the current distribution of frequencies across cells, or one that is more uneven, and finally (iv) McNemar *Chi*-square which is applicable in situations where the frequencies in the 2x2 table represent dependent samples i.e. before-after design study.

The only assumption underlying the use of the *Chi*-square (other than random selection of the sample) is that the expected frequencies are not very small. The reason for this is that the *Chi*-square inherently tests the underlying probabilities in each cell; and when the expected cell frequencies fall, for instance below 5, those probabilities cannot be estimated with sufficient precision (Krishnamurty et al., 1995; Hill and Lewicki, 2006).

Therefore, this analytical tool is suitable for analysing the anatomy of an agro-food system as permits this study to examine the distribution of categories on the selected categorical variables. *Chi*-square statistic complements the results of "correspondence analysis".

3.2. The NK model

The second objective of this study is to develop an exploratory framework under a "fitness approach" that permits the identification of the "organisational configurations" of a key industry of an AFS that is the "farming industry". Thus, this section focuses on the NK-model which is the base of the "fitness approach". This section is divided into four subsections: subsection 3.2.1 discusses the pertinence of the NK-model by analysing other methods, subsection 3.2.2 focuses on the "social" application of the NK-model which has fostered the use of this method, subsection 3.2.3 provides the analytic process for the implementation of the NK-model and discusses some of the limitations of the NK-model, subsections 3.2.4 examines the use of the NK model in the social studies and subsection 3.2.5 summarises the operationalisation of the NK model in this study.

3.2.1. Models to analyse the "fitting" process

Several methods have been used to analyse the "fitting" process. Such methods are widely used in the contingency literature. Among those methods are selections, interactions, and cluster analyses using Euclidian distances. Most early studies use the selection or interaction approach for defining "fit" (Selto et al., 1995; Dooley and Van den Ven, 1999). However, Selto et al., (1995) and Jermias and Gani (2004) have criticised these methods for their inability to measure the fit of the whole system. They argued that cluster analysis with Euclidian distances uses a system approach and employs two steps to define fit: (i) cluster analysis develops the "ideal" models based on data from high performing organisations, and then (ii) cluster analysis compares the "test" organisation with the ideal models using Euclidian distance formula by calculating the absolute value of the differences between the test organisations and the ideal models along the structural dimensions of the variables.

Therefore, three main concerns are associated with this cluster analysis: First, the formulation of the ideal models is based on the structural dimensions of high performing organisations. As a consequence, the ideal models depend on the data used and the criteria selected to define the high performing organisations. Second, the causal relationship between outcome variables and "fit" variables is not well defined. This is because the ideal models are developed based on the outcome variables (high performance). In fact, it is not clear whether performance affects the selection of contingent variables or vice versa. Third, the absolute score deviations from the ideal models define the "fit" (in this case misfit). This leads to an unstable result, as any deviations from the ideal models increase the degree of misfit of the organisation. Finally, what is considered fit by this approach might be contradictory to the predicted relationship hypothesised by the theory used in these studies (e.g. contingency), because the ideal models are those used by the high performing organisations. This is very important because there are some established predictions in different theories that would be "misfit" and therefore affected by using this approach. Jermias and Gani (2004) provides an example: "if the high performing firms adopt product differentiation strategy and used a medium degree of centralization, then any product differentiation companies that used either high or low degrees of centralization would be considered misfits by using cluster analysis. This is inconsistent with the hypothesised relationship proposed by contingency-based theory which predicts that product differentiation companies should use a high degree of decentralization".

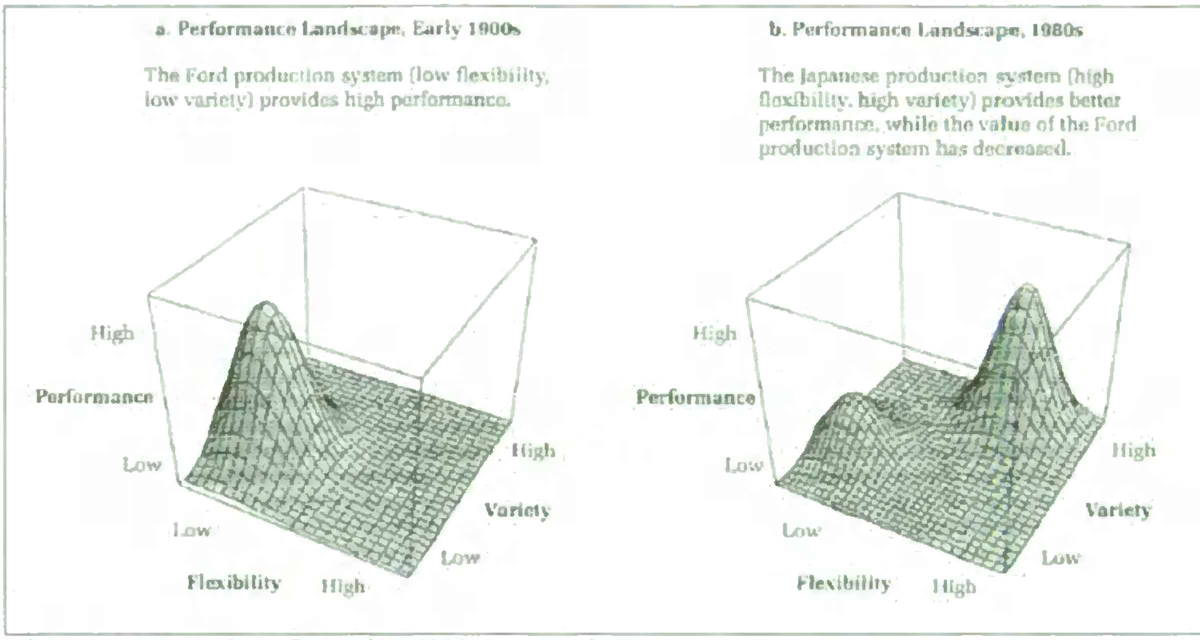
Considering the limitation of other methods, this study employs the "fitness approach" to define the analyses the relationship ("fitting" process) between the "organisational configuration" (based on the productivity management elements) and its performance indicators. As mentioned in Chapter 2, the "fitness approach" has obtained recognition for investigating the "fitting" process (Kauffman and Beinberger, 1998; Beinhocker, 1999; Dooley and Van de Ven, 1999; Levinthal and Warglien, 1999; McCarthy and Tan, 2000).

3.2.2. The notion of fitness landscape

As mention in section 2.4 "fitness" landscape developed in the realm of evolutionary biology and has found application in, for instance, studies of organisational adaptation, organisational variety, manufacturing strategies, and accounting systems. In the context of this study, the "fitness" landscape is a multidimensional space in which each dimension represents the values of a particular choice (i.e. productivity management elements) that a firm (i.e. farmers) can make and a final dimension indicating the performance indicator. For clarification, this section considers an illustration of Siggelkow (2001) that is based on a simple example in which a firm can make only two choices: the breadth of product variety and the flexibility of the production set-up. In this case the breadth of product variety is on the x-axis, the degree of flexibility is on the y-axis, and the ensuing performance is on the vertical z-axis. The performance landscape display each pair of variety and flexibility choices onto a performance value (Figure 3-6a).

Similarly for each set of N choices, the performance landscape would attach a performance value to it in an N+1 dimensional space. Performance landscapes somehow provide a way of using the concepts of internal and external fit (adaptation). External fit is represented by the height of a particular point on the landscape which is related to environmental conditions (i.e. competitors' actions, customer preferences, and available technologies). As shown in Figure 3-6a, certain combinations of flexibility and product variety lead to higher a performance than other combinations.

Figure 3-6. Performance landscape



Source: adapted from Siggelkow (2001)

The internal fit is represented by a peak in the landscape which in turn arises from the "consistency" combination of choices. This internal fit shows the match between the variables and the environment. In this case, choices refer to flexibility and variety which in turn range from low to high. In this illustration (Figure 3-6b), two examples of a consistent set of choices were highlighted (i) the Ford mass production system which is represented by low variety and low flexibility and (i) the Japanese production system which is a lean production based on high variety and high flexibility. The shape of each peak shows that the stronger the degree of interaction among a particular set of choices, the sharper the associated with peak. A misalignment is penalised by a reduction of the performance. The misalignment could stem from keeping a status quo although there are significant environmental changes (e.g. shape, number of peak changes). Looking at both graphs "a" and "b", Siggelkow (2001) tries to illustrate the influence of such environmental changes by comparing the performance landscapes between the production in the early 1900s (Figure 3-6a) and then the production by the beginning of 1980s (Figure 3-6b). In the former period (1900s), the choice of low variety and low flexibility led The Ford production system to obtain the highest level of efficiency and performance with the available technology. High variety and high flexibility were not technologically feasible. The latter period (1980s) was characterised by an improvement in technology and high variety and flexibility were feasible. The Japanese production system selected this combination (i.e. high flexibility and high variety) and in return this system achieved the highest performance. The performance value of the Ford production system declined as a consequence of the new high peak. This example was one of the starting points to use the "fitness" as an approach to study social phenomena.

The implementation of the "fitness" landscape has attracted the interest of several social scholars. The starting point then is to look at the NK model which is discussed below.

3.2.3. The Kauffman's original NK-Model

The NK-model was originally developed as a model of biological evolution. However, as shown before, its formal structure allows for applications in the domain of social sciences (e.g. management and evolutionary economics). The application permits the study of the strategy landscape in which economic agents search for instance new technological or organisational designs. Here the model and some remarks are discussed. The limitations of the model are also discussed.

McCarthy (2004) provides a critical explanation of the application of the NK-model into the social context (i.e. manufacturing strategy). This illustration is used to explain the analytical process to implement the NK-model. The NK-model is based on 4 key NK elements: N, K, A and C. Therefore, the first important step is to show the analogies between the NK elements and those of the manufacturing strategy perspective (Table 3-2). This illustration continues by setting the parameters of the NK elements (Table 3-2).

Table 3-2. NK model notation: evolutionary biology and manufacturing strategy

NK PARAMETERS	EXAMPLE	EVOLUTIONARY BIOLOGY	MANUFACTURING INDUSTRY
N	N=3 (three capabilities such as quality, flexibility and cost)	The number of elements or genes of the evolving genotype. A gene can exist in different forms or states	The number of capabilities that constitute the strategy and the resulting configuration. These could include: flexibility, facility location, technology management, degree of standardisation, process structure, approach to quality, etc.
K	K=N-1=2 (each capability will affect the other two capabilities in the strategy)	The amount of epistatic interactions (interconnectedness) among the elements or genes	The amount of interconnectedness among the capabilities. This creates trade-offs or accumulative dependencies
A	A=2 (two possible states such as the presence (1) or absence (0) of a capability)	The number of alleles (the alternative forms or states) that a gene may have	Number of possible states a capability might have. For instance, the quality capability could have four states: inspection, quality control, quality assurance, and total quality management
C		Coupledness of the genotype with other genotype	The co-evolution of one strategy with its competitors

Source: adapted from McCarthy, 2004

With these parameters the design space is $A^N = 2^3$, which provides eight possible manufacturing strategies. Each of these is allocated a random fitness value between 0 and 1 (Table 3-3). A value close to 0 indicates poor fitness, while a value close to 1 indicates good fitness. In principle, the fitness values can then be plotted as heights on a multidimensional landscape, where the peaks represent high fitness and the valleys represent low fitness.

Table 3-3. Kauffman's NK model

ELEMENTS AND STATES			FITNESS SYSTEM	FITNESS VALUE
Element 1	Element 2	Element 3	(strategy)	(assigned randomly)
absent (0)	absent (0)	absent (0)	000	0
absent (0)	absent (0)	present (1)	001	0.10
absent (0)	present (1)	absent (0)	010	0.30
present (1)	absent (0)	absent (0)	100	0.40
absent (0)	present (1)	present (1)	011	0.50
present (1)	absent (0)	present (1)	101	0.70
present (1)	present (1)	absent (0)	110	0.80
present (1)	present (1)	present (1)	111	0.60

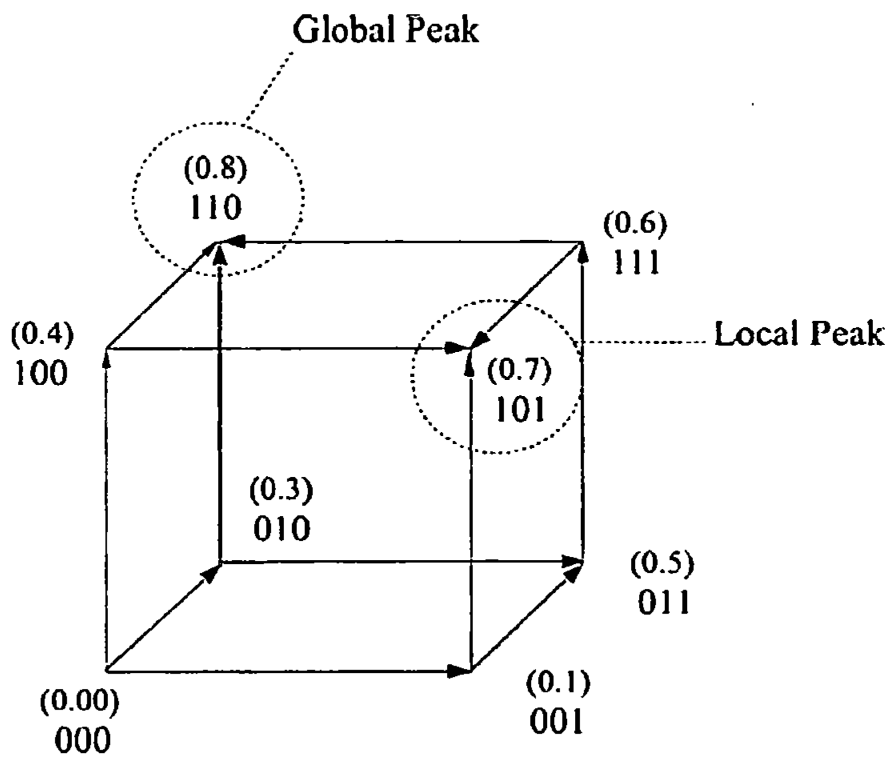
Source: adapted from McCarthy, 2004

In Kauffman's model, the fitness function $f_i(x)$ is the average of the fitness contributions, $f_i(x)$, from each element i, and is written as:

$$f_i(x) = \frac{1}{N}\sum_{i=1}^{N} f_i(x) \quad \text{Equation 1}$$

The fitness landscape of this example shows the possible combinations and their relationship to each other (Figure 3-7). Each corner point of the cube represents a manufacturing strategy and its hypothetical fitness value. Contrary to biological evolution, strategic change is assumed to be a process of moving from one strategy to another in search of an improved fitness (Siggelkow, 2001; Jermias and Gani, 2004; Frenken, 2006). This is known as the "adaptive walk". For instance, one can arbitrarily select a point on the cube (e.g. point 011) and then observe the "neighbourhood", that is points 010, 111 and 001. If point 011 has an immediate neighbour strategy with a higher fitness value then it is possible that a manufacturing firm would evolve to this fitter strategy (point 111).

Figure 3-7. A fitness landscape N=3 and K=2



Source: McCarthy, 2004

The arrows on the lines of the above Figure 3-7 represent either an uphill walk towards a greater fitness value, or a downhill walk to a smaller fitness value. A "local peak" is a strategy (e.g. point 101) from which there is no fitter point to move to in the immediate neighbourhood. A "global peak" is the fittest strategy (point 110) on the entire landscape (Siggelkow, 2001; Jermias and Gani, 2004; Frenken, 2006).

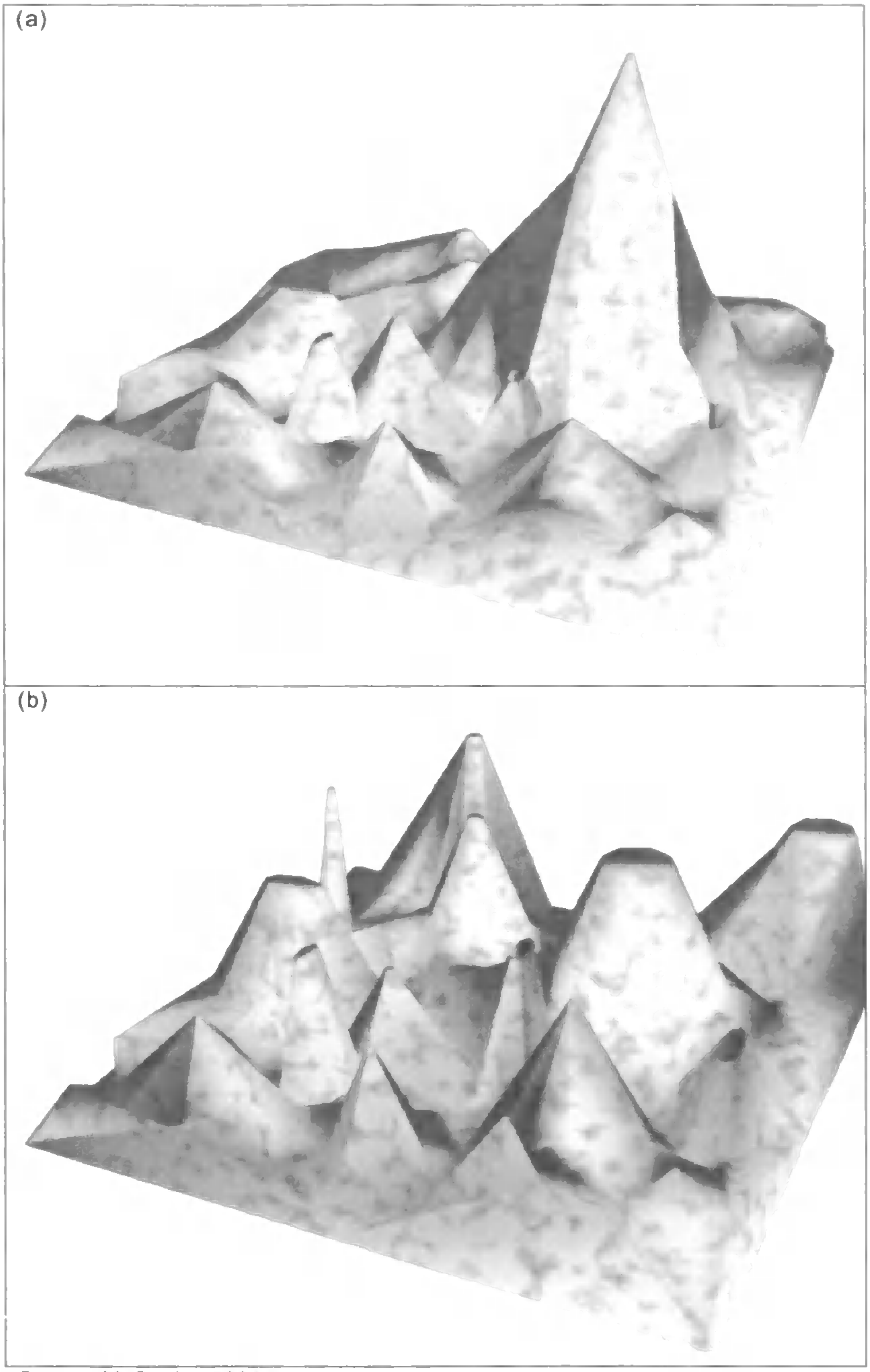
As this is a simple example consisting of three capabilities, it is relatively easy to visualise the space of strategic landscape using a wire frame cube. If the example deals with several capabilities, it then becomes harder to visualise the design space using a multi-dimensional cube. To overcome this problem a Boolean hypercube can be used to map the strategic design space (McCarthy, 2004).

The K and C parameters

As mentioned in the previous section, the K parameter is an indicator of a system's (a strategy's) connectivity. It represents the epistatic interactions between each system element (capability) and can range from K=0 to K=N-1. The former is the least complex system where each element is independent from all other elements and the latter is the most complex system where each element is connected in some way to all other elements. For K=0, the resultant landscape is relatively simple and smooth, except for one single global peak. This suggests that one single strategy dominates the competitive landscape (Figure 3-8a). As K increases from 0 towards its maximum of N=1, the fitness landscape changes to an increasingly rugged, uncorrelated, and multi-peaked landscape (Figure 3-8b).

This level of connectivity indicates frustration in the system, because it can lead to many local fitness maxima on the landscape. If the NK model is applied to the process of manufacturing strategy formulation it is assumed that the contribution of any capability to the overall fitness of a manufacturing strategy depends on the status of that capability and its influence on the status of the other capabilities in the strategy (Siggelkow, 2001; Jermias and Gani, 2004; Frenken, 2006).

Figure 3-8. Fitness landscapes: (a) K=0 and (b) K-1



Source: McCarthy, 2004

Kauffman's NK model was originally a fixed structure model, in that the system under study has not been influenced by factors outside of its system boundary. In other words, it was a closed system in a static environment. In practice, this assumption is simplistic and invalid for complex systems (Siggelkow, 2001; Jermias and Gani, 2004; Frenken, 2006). Therefore, Kauffman and Beinberger, (1989) introduced a C parameter, to indicate coupledness between the system and other systems in the environment. Coupledness means that any system will not just depend on internal factors, but also the behaviour and performance of the systems in the same environment. This notion is central to competition, because if the fitness of one firm's manufacturing strategy is increased, it is almost certain to affect the fitness of other firms' manufacturing strategies (McCarthy, 2004).

Finally, the combinatorial nature of "design space" (A^N) implies that its size increases exponentially for linear increases in N. As most social strategies (e.g. manufacturing, technological) are high-dimensional (N is large) and can be constructed in many different ways (A is large), "design space" is much vaster than firms can effectively explore. For instance, in the design space of early aircraft at the time of the Wright Brothers, it was estimated to contain nine dimensions from which almost 13,000,000 designs could be constructed by combinations of A and N (Frenken, 2006).

Fitness analysis

There are two main outputs of the NK-model: (i) the fitness value which is calculated from the equation 1, and (ii) the fitness matrix which is calculated from the different combinations of variables and their respondents (NK combinations). As mentioned before, this model was brought to the organisational arena a few years ago, so the empirical studies only include correlation and hypothesis test analysis. Correlation analysis is based on the relationship between fitness value and standard organisational performances which in turn checks that an internal configuration matches the environmental influence. Such relationships can be tested by either two tails or one tail depending on the set of hypotheses given (Jermias and Gani, 2004). Another type of analysis is to scrutinise the matrix combination and its particular cases (e.g. the fittest case) which in turn permits the identification of the "organisational configuration" and its key elements (McCarthy and Tan, 2002; McCarthy, 2004).

3.2.4. NK model in social studies

As mentioned in previous sections, the "fitness approach" has been considered in the study of social phenomena. This section discusses the advantages and disadvantages of the implementation of the "fitness approach" outside its original setting in evolutionary biology, and the discussion of the core parameters that influence the NK model.

Advantages

As mentioned in sections 2.1 and 2.2, organisations have to deal with a challenging and more competitive environment, so this leads to them having varying levels of unpredictability. The use of forecasting and optimisation techniques at all levels (strategic and operational) has served to cope with such unpredictability (section 2.3), nonetheless, with business and customer demands intensifying, the levels of unpredictability have been increasing and the confidence in such techniques is reducing. Therefore, in order to satisfy customers and remain competitive, McCarthy (1995; 2003, 2004) argues that organisations should learn from their environment and develop decisions, which rely less on inaccurate forecasts and more on the ability to sense and respond (adapt). Adaptation, then concentrates on the process of making strategic decisions and the resulting organisational forms. As reviewed in section 2.4, "Fitness" theory treats the organisational system and its decisional situation as a complex adaptive system, which is continually coevolving with its environment, whilst searching for solutions and making decisions (McCarthy and Tan, 2000). Additionally, the NK model has helped to explore this consideration by providing a tool to develop interesting theoretical and empirical results.

The first advantage provided by the consideration of the NK model is to refer the procedure of decision taken to an adaptive process. Thus, the former studies try to assimilate the idea of "fitting into the environment" by considering a complex system perspective (Drazin and Van de Ven, 1985; Van de Ven and Drazin, 1985; Gresov, 1989). Later, the influential work of Kauffman and Weinberger (1989) permitted the introduction of empirical analytical models and brought important concepts to explain "fitness" such as landscape, local and global position, interaction (Abemethy and Stoelwinder, 1991; McCarthy, 1995; Beinhocker, 1999; Dooley and Van den Ven, 1999; Levinthal and Warglien, 1999). McCarthy and Tan (2000), McCarthy et al. (2000) and Siggelkow (2001) attempted to systematise core definitions and propose that "NK model" could be a useful tool to analyse performance and to identify the set of arrangements which lead to such higher levels of performance.

The second advantage of the NK model concentrates mainly on simulations. This is the NK model is used to deal with the construction of a solution landscape. This landscape permits the analysis of different degrees of interactions (i.e. epistasis), number of solutions (based on variables) and different landscapes across time (i.e. generations). Some of the variables used to construct landscape are: cognitive and experiential research (Gavetti and Levinthal, 2000), centralised, decentralised and reintegrated structures (Siggelkow and Levinthal, 2003), team player (Solow et al., 2002), selectionism and learning (Sommer and Loch, 2004; Susuki and Arita, 2007), technological innovation (Ma and Nakamori, 2005), modularity and vertical integration (Frenken, 2006). The simulation framework has permitted researchers to broaden their perspective into the complex nature of the world, and as Ma and Nakamori (2005) proposed, simulation modelling is used to aid intuition.

The last advantage focuses on the empirical applications of the NK model. These studies have concentrated on implementing the NK model in empirical applications (non simulation) which in turn shed light on how to operationalise all elements required in the NK model. The NK model helps to identify the main factors that drive performance, to test some of the theoretical assumptions regarding the business strategy by using the "fitness" value, and to consider these findings as a complex system that is changing and evolving (Jermias and Gani, 2004, 2005). These studies are pioneering and therefore can be perfected. Thus, there is a huge potential to contribute to this direction, so more empirical applications are needed to overcome operationalisation and interpretation issues.

Disadvantages

Nevertheless, the NK model has some disadvantages. It is accepted in most of the simulation studies that more empirical research should be taken into consideration in order to gain insight to find patterns in data or find the consequence of assumptions in the real world. Otherwise, as other scholars argue, simulation would be only highly speculative, so must not be pushed too far (Anderson, 1999; Sinha and Van de Ven, 2005). Most of the scholars foster the use of the NK model as the best tool to construct landscapes (McCarthy, 2004). However, it was found in the literature review that the empirical applications of landscapes are rather rare in social science. Two empirical studies were found (Jermias and Gani, 2004, 2005). These studies are unique and concentrate on business strategy.

Parameter values and fitness value

As mentioned in the previous subsection, three assumptions are core in the implementation of the NK model: (i) the consideration of interaction or non-interaction between variables (epistasis) K=0, (ii) the assumption that there must be a single fittest value, and finally (iii) the selected set of variables are sufficient to construct a robust fitness landscape.

The interaction between variables is the main contribution of the NK model and is widely considered in most of the biological studies (Kauffman and Weinberger, 1989; Louzano et al., 2006; Fath and Grant, 2007). Although, social studies also recognise the important role of this parameter (Solow et al., 2002; Siggelkow and Levinthal, 2003; McCarthy, 2004; Sommer and Loch, 2004; Ma and Nakamori, 2005; Frenken, 2006; Susuki and Arita, 2007), there is little known about the operationalisation of this parameter in the social context. Thus, empirical studies considered to fixing K=0 in order to gain more insight into the basic implementation of the NK model (Jermias and Gani, 2004, 2005). This parameter fixes the number of "fittest" in the landscape, K=0 implies that there is one "fittest" position (McCarthy, 2004).

The simple NK model is based on the assumption that fitness values are given randomly. From this starting point it is possible to calculate the total fitness value of each system, and to identify which has the highest value. This procedure was used in most of the modelling and theoretical studies (Siggelkow and Levinthal, 2003; McCarthy, 2004; Sommer and Loch, 2004; Ma and Nakamori, 2005; Frenken, 2006; Susuki and Arita, 2007). Nevertheless, for empirical studies this assumption has little benefit, so empirical studies proposed to the calculation of the fitness value by taking into account theoretical considerations rather than purely stochastic ones (Jermias and Gani, 2004, 2005).

Finally, since the NK model tries to emulate the evolutionary process of living organisms, the number of combinations is increasing in each generation and recombination (Kauffman and Weinberger, 1989). The same could be applied to social systems. However, the selection of the variables is more limited, and researchers only concentrate on a small part of them (Siggelkow and Levinthal, 2003; McCarthy, 2004; Sommer and Loch, 2004). This constraint is also reflected in the empirical studies (Jermias and Gani 2004, 2005).

In brief, the NK model is a robust method for evaluating the performance of a system by considering its internal configuration. The main advantage of NK model is the possibility of expanding our understanding of complex systems such as economic organisations. The NK model is also very useful and provides a reliable framework to be used in other realms outside of its original setting in evolutionary sciences. The parameters are very flexible and permit a study of different levels of approach i.e. conceptual, modelling, and empirical. For all these reasons, this study uses the NK model to examine the relationship between the organisational configurations and relevant performance indicators in the "farming" industry of CAFS, Tabasco, Mexico.

3.2.5. NK model: operationalisation

Under this framework, it is possible to conduct empirical studies that look for relationships between a mosaic of strategic configurations and performance (fitness) without sacrificing flexibility (all options are possible) and giving up on causality (McCarthy, 2004: 146; Jermias and Gani, 2004: 181). This section focuses on the operationalisation of the NK model which in turns explains how the Fitness Appraisal Instrument (FAI) is constructed and analysed. The construction and analysis of FAI take into consideration the empirical studies discussed in the previous section and its subsections.

Following the empirical work of Jermias and Gani (2004), McCarthy and Tan (2000), and McCarthy (2004), there are a number of steps to be taken in the construction of the "fitness" value and in the analysis of a particular theory. The construction of the FAI considers two main steps: (1) variable relationship and (2) "fitness": scale, landscape and value. Each step has specific activities which should be carried out systematically. As mentioned, there are two ways of analysing the empirical implementation of "fitness": (1) correlation analysis, and (2) landscape analysis.

The first step considers the selection of the key variables to create a set of "organisational configurations". Two "organisational configurations" are proposed in this study: "factor's organisational configuration" and "aspect's organisational configuration". They are discussed fully in section 6.2. The "fitting" process is tested by the relationship between the "fitness" value of such "organisational configurations" and key "performance indicators". This is also discussed in section 6.2.

The implementation of the NK-model requires three key steps to be taken in order to calculate the fitness value of a strategy (which from here is known as "organisational configuration"). First, the "fitness" scale look at the homogeneity of the variables. This implies having only categorical variables, to fix the number of categories or responses and to assign a number from 0 to 1 which can be computed from the assigned value of the responses. Second, the "fitness" landscape provides the design space which from here is regarded as "organisational configuration" and is calculated from the formula A^N, where A refers to the number of responses (or categories) and N refers to the number of variables. This study has considered analysing two main "organisational configurations" which are based on different NK parameters: (i) "factor's organisational configuration" (i.e. N=3, A=5), and "aspect's organisational configuration" (i.e. N=7, A=2). Both fitness landscapes are discussed in detail in section 6.1. The fitness value is calculated by using the above equation 1. If there are compound variables it is suggested using the weighted sum of the selected variables that belong to such compound variables. This is fully discussed in section 6.2. Finally, a set of hypotheses are established in order to test the "relationship" between the fitness values of each "organisational configuration" and "performance indicators", indicating their expected sign.

The analysis of the "Fitness Appraisal Instrument" is discussed in Chapter 6. Two systematic procedures were used to analyse this empirical implementation of the "fitness approach". First, the correlation analysis was used to test the relationship between the "fitness" value of proposed "organisational configurations" and key "performance indicators". Additionally, this analysis also tested the relationship between all selected "productivity management elements" and key "performance indicators". This provides more information about what factor (i.e. technology, competence, and operational climate) is influencing the "fitness" value. Sensitive analysis is employed to test the reliability of the findings. Second, the landscape analysis refers to the exploration of the "fitness" value of significant "organisational configurations" and the graphical scouting of the "productivity management elements" and their influence on "performance indicators". The discussion of the findings is placed in Chapter 8.

3.3. Sampling and data collection

The "cacao agro-food system" in Tabasco (Mexico) was selected as the research field. Sampling and data collection consisted on three main tasks:

The first task was to construct a database of current populations of the four selected industries: "farming", "curing", "wholesaling" and "chocolate". The information to construct this database was provided by two main sources (i) reports of government, universities, and farmer associations, and the literature review, and (ii) interviews with key organisations of each industry. Then, this database was checked and corrected by eliminating double, false and irrelevant information on the number of organisations, their location and strata variable in each industry.

The second task was the determination of the sample target for each industry of the CAFS by considering the purposes of each analytical instrument (Table 3-4), i.e. Quick anatomical Assessment (QAA) and Fitness Appraisal Instrument (FAI). The sample size of the chocolate and wholesaling industry considered the whole population respectively. The sample size of the curing industry took into consideration half of the total population and was divided into three strata groups. The strata division of the "curing" industry took into consideration the quantity of cured cacao proposed by Cordova (2001).

This study considered 400 cases in the target sample of the "farming" industry by taking into account two main recommendations: (i) the sample size for the cacao farming industry in Tabasco, Mexico, was determined by using FAO methodology, i.e. a simple random sample with a confidence level of 95% and a confidence interval of 5 (SAGARPA, 2001) and (ii) the sample was divided into 5 strata groups by considering the number of hectares as a strata variable proposed in the studies of Ramirez (1997) and Cordova (2001) studies. The QQA was applied to half of the total sample of "farming" industry randomly (Table 3-4).

Table 3-4. Population of CAFS, target sample and strata variable

CAFS INDUSTRY	POPULATION	SAMPLE QAA	SAMPLE FAI	STRATA
Farming	32902	200 (50% of FAI)	400	(i) 0-1 Ha – 45% (ii) 1.1-3 Ha – 30% (iii) 3.1-6 Ha– 15% (iv) 6.1-9 Ha – 8% (v) >9.1 Ha – 4%
Curing	100	50		(i) 0-250 Ton– 55% (ii) 251-500 Ton – 35% (iii) >500 Ton– 10%
Wholesaling	9	9		-
Chocolate	10	10		-

The third task focused on the process of collecting, recording and verifying data. The data were collected in two sessions. The QAA was implemented in the first session in December 2004. The QAA is an open structured interview (Appendix A). The FAI was implemented in the second session in November 2005. The FAI is a structured questionnaire (Appendix C). The collection of data was based on personal visiting in field. Two students were trained and then helped to collect data. Some of the questionnaires were incomplete and therefore omitted from the analysis; some of the organisations in the "chocolate", "wholesaling" and "curing" industry did not want to participate in the study, so the sample target was also reduced. The final and usable data set is as follows. QAA: "farming" (176 cases), "curing" (37 cases), "wholesaling" (6 cases), and "chocolate" (7 cases). FAI: "farming" (356 cases). Data were recorded and analysed by using Excel® and Statistica® software.

The dataset is characterised as a cross-sectional sample which in turn permits this study to identify similarities and dissimilarities of the data at a specific point of time. The inclusion of secondary data also allows the comparison of a situation over a period of time. This study is therefore able to discuss the current or potential changes of these particular situations.

4. Cacao production in Mexico

This chapter discusses the importance of cacao production at international, national and local level by exploring the different dimensions (i.e. economic, social, and environmental) of cacao production. Such discussion explains in detail the context of this study and provides the justification for this research setting by considering the international, national and local context of cacao production. This chapter is divided into two main sections: section 4.1 discusses the international context of cacao production and section 4.2 concentrates on the examination of the research setting by considering the national (Mexico) and local (Tabasco) context of cacao production.

4.1. The International context

This section discusses the importance of cacao production and consumption at international level. The section is divided into three main subsections: subsection 4.1.1 provides key information about the production and consumption pattern of cacao and chocolate; subsection 4.1.2 examines the industry interaction and its effects on cacao production and subsection 4.1.3 discusses the competitive strategies that need to be developed in order to survive in the cacao business.

4.1.1. Production and consumption

Cacao is a tropical perennial crop whose particular attributes gave it the legendary title of "Food of Gods" by different Pre-Columbian cultures in

Mexico (i.e. Aztecs, Mayas, and Olmecas) more than 500 hundred years ago (Wood and Lass, 1985). However, it is in Europe where this acknowledgment was fully developed with the mass production and consumption of chocolate (Minifie, 1970; Beckett, 1988; Coe and Coe, 1996; Knight, 1999). This chocolate industry is particularly interesting for two reasons: (i) On the one hand the main raw material of chocolate is cacao and cacao production is largely located in tropical areas; (ii) on the other hand, chocolate is classified as a candy, and its consumption is largely concentrated in temperate regions (Flood and Murphy, 2004). Understanding such a dual relationship permits us to shed light on the forces that enhance or inhibit the production and consumption of cacao and chocolate, respectively (Table 4-1).

Cacao and chocolate, as industries, have opportunities and threats that are common pressures for all industries and thus managing them is part of the daily task of running a business. Table 4-1 shows that the consumption of chocolate drives the production of cacao and such consumption is highly concentrated in two regions: the European Union and the United States of America. Cacao production is also highly concentrated in 6 countries (Nigeria, Ghana, Ivory Coast, Malaysia, Cameroon and Brazil), which supply more than 90% of the global production (Flood and Murphy, 2004; ICCO, 2005). It is expected that an increase in chocolate consumption will record as other regions become wealthier (i.e. China, India and Russia). Therefore, cacao production will need to be increased.

Table 4-1. Characteristics of cacao and chocolate industry

CHARACTERISTICS	CACAO	CHOCOLATE
Production regions	Tropical humid regions (i.e. Africa, South America, and Pacific Asia)	Temperate and cold regions (i.e. European Union and USA)
Production concentration	Highly concentrated, 6 countries control 90% per cent of the global production which comes from Africa (3453 millions of tons)	Europe and America produce around 69% of the world grinding of cacao beans (1134 millions of tons).
Price formation	London or New York Cacao Markets	Competition
Price regulation	Government, or stock balance	Competition
Potential of growth production	Increment of yields per hectare, transforming primary forest, or moving to arid zones. It is expected that 500,000 tones would be needed by 2012/13 (i.e. annual growth rate of 1.5%)	Emerging economies (i.e. China, India, Russia, Brasil).
Internal industry division	Farmer carry out production and curing activities	Pressing and chocolate industry
Employment	10 millions cacao producers	100,000 employments are related to chocolate production and semi-elaborated cacao products
Main use	Raw material: beans	Candy: chocolate bar, more than 3000 types of chocolate presentations
Quality	Fermented bean, organic, fine or aromatic, fair trade	Mass, organic, fair trade, luxury, functional
Semi-elaborated products	Juice, soap, marmalade, pectin	Liquor, butter, and powder
By-products	Pod husk, seed pulp, cacao shell	Cacao shell

Characteristics of cacao and chocolate industry (continued)

CHARACTERISTICS	CACAO	CHOCOLATE
Technical threats	Pests and diseases cause the global loss of some 30% of annual cacao production	-
Economic threats	Price at farm gate is low, as cacao is still heavily taxed Liberalisation process does not lead to an increase in price	Increasing of substitutes European and US chocolate industry consumes high price European milk and sugar Chocolate is not considered as food so it is levied with a value added tax (VAT)
Social threats	Child labour is a problem in many cacao areas Cacao pioneers and land tenure dispute	Lack of corporate social responsibility in the supply chain
Environmental threats	Loss of primary forest Climate global change	Consumption of Eco-label products
Health threats	Chemical product effects on farmers HIV/AIDS in West Africa has risen rapidly in recent years	Obesity Presence of undesirable constituents in chocolate and cacao-based products

Adapted from Coe and Coe, 1996; ITC, 2001; Flood and Murphy, 2004; Leiter and Harding, 2004; ICCO, 2005

There has been a visible change in chocolate consumption patterns. Currently, consumers are drawn to particular chocolate products which are either characterised by higher standards of quality, or by social responsibility and sustainable production (Flood and Murphy, 2004; ICCO, 2005).

Finally, cacao and chocolate industries are facing different threats ranging from technological to environmental factors. Some of these threats have been controlled by an active collaboration between producers and consumers. However, there are other threats that are beyond the control of both industries, therefore the participation or intervention of government is likely to be considered again (Flood and Murphy, 2004; ICCO, 2005). The participation (or withdrawal) of government is discussed in detail in the next section.

4.1.2. Industry interaction

This subsection discusses one of the main changes in the relationship between cacao producers (i.e. farming industry) and cacao consumers (i.e. grinding and chocolate industry): the introduction of the free market interaction. This discussion concentrates on the production side in order to address the objectives of the study. This subsection is divided into two main parts: (i) the first describes different types of marketing structures of cacao producer countries, and (ii) the second focuses on the current free market interaction.

After gaining their independence, many cacao producing countries developed different systems by which cacao is brought from the farm gate to the point of export and the method by which cacao is sold into the world market (Leiter and Harding, 2004). These marketing structures differ by taking into account the geographical location and the colonial heritage of the cacao producing countries (ITC, 2001). The types of marketing structures are: "marketing board" "stabilisation fund", "cooperative monopolies" and "free market route". (i) a "marketing board" is statutory bodies which purchased the cacao from farmers at a fixed price for the season, and acted as principal sellers and exporters to the world market under one name (e.g. Ghana, Nigeria, Sierra Leone, and some countries in the Caribbean and the Pacific); (ii) "stabilisation fund" (*caisse de stabilisation*) allowed independent intermediaries (*traitants*) to purchase cacao from farmers at a fixed price during the season (e.g. Ivory Coast and Cameroon). After receiving permission from the fund, private exporting companies sell the cacao into the world market under their own names and brands; (iii) in Latin America, "cooperative monopolies" or "marketing boards" also were implemented to control over sales, but different levels of control were found. These vary from maximum (e.g. Mexico, Venezuela) to minimum control (e.g. Brazil), and (iv) finally other countries have relied on a "free market route" (e.g. Dominican Republic, Indonesia, Malaysia).

The current free market interaction has been possible due to an intensive implementation of neo-liberal agricultural policies which recommend complete governmental withdrawal from agricultural production. It is expected that organisations would interact freely in order to achieve high levels of efficiency, and this should lead to a better distribution of wealth. Such a liberalisation process has been implemented in many countries. That is, exporters are now free to purchase directly from the farmer. The need for government approval before export has also been scrapped (Flood and Murphy, 2004).

The effects of this process are controversial for a number of reasons. First, world market prices were significantly above the costs of growing cacao and this was the case for almost every crop year up to 1998. Therefore, cacao bean prices started to decline and eventually dropped below the farm gate price (ITC, 2001; Flood and Murphy, 2004). Second, some governments still tax production, so a farmer does not receive a substantial increase in farm gate prices (Gilbert, 1997; De Lattre et al., 1998). Third, government had the necessary infrastructure to be informed about the international cacao price. Farmers under a liberalised marked are at disadvantage as they lack accurate, economic and timely price information. In fact, they are under great pressure as the daily price they get for their beans is now more of a reflection of the world market price which would eventually lead to a significant level of speculation (Flood and Murphy, 2004). Finally, it was expected that intermediaries of grinding and chocolate industries or farm cooperatives would not only take care of the purchasing activities (i.e. gathering, transporting, storing), but also of the farming support services (i.e. technical assistance, credit). These farming support services are very important to achieve a sustainable production. However, the intermediaries do not include farming support services in their actions. Furthermore, a decoupling between technology generation and a technology transfer would have a negative effect on public research and development institutions. This gap, then, would be filled in the near future by private companies (i.e. Monsanto, Bayer, Du-point) in order to face the technical threats mentioned in the previous subsection, but no timetable has yet been set (Flood and Murphy, 2004).

These structural changes are influencing the cacao production all over the world, and some reactions have already occurred. These reactions will be discussed in the following subsection.

4.1.3. Competitive strategies

This subsection discusses some of the strategies that the cacao farming industry is developing in order to adapt to a challenging and more competitive cacao environment. Two groups of strategies are discussed: The strategies built around supply chain and strategies built around the cacao system, its by-products and its uses.

The first group of strategies takes place in the cacao supply chain. (i) one strategy is to differentiate cacao production. Therefore there are farmers whose cacao production is differentiated through a particular certificate. This certificate allows them to obtain premium prices, and also to gain the loyalty of consumers (CCI, 1991). This certificate has a cost. So, further investigation is needed in order to fully assess the cost/benefit of such particular products. The certification covers different attributes ranging from quality (i.e. fine or flavour cacao) through environmental (i.e. carbon capture, rain forest, bird watching, wild life) as well as social attributes (i.e. fair trade) (Radi, 2005). Such certification initiatives are developed and managed by cacao consumer countries, which eventually lead to awareness of cacao producer countries about the necessity to make more effort to fill this market research gap.

(ii) Another strategy is to add value to cacao production. That is the farming industry should participate in the grinding process as suggested by several international organisations (i.e. FAO, ICCO). There are several obstacles that have to be managed to do this. But in the long term it would bring competitive advantage to the cacao producing countries.

(iii) Another strategy suggested in different cacao meetings is the enhancement of internal consumption in cacao producing countries. This would lead the development of an internal storage capacity which in turn could transfer some of the stocking power exerted by the cacao consumer countries to the producer countries. However, this seems to be a long term objective (ITC, 2001).

(iv) Finally, a traditional strategy considers increasing the yield of cacao per hectare which "ceteris paribus" should result in higher returns. This strategy is very important as it helps in the rejuvenation and replanting of older plantation areas, rather than using virgin tropical rain forest, and in turn meets a sustainable cacao production system requirement. However, there are still many limitations to this strategy. These limitations arise from the evidence that private organisations have not carried out all the functions that were traditionally controlled by public institutions in the past. In fact, they only limit their actions which are linked to profits (Flood and Murphy, 2004). This limitation is also exacerbated by other conditions such as: (i) ageing of the farmers who at the beginning of the cacao plantation were fully supported by the government, but now, have to face this new environment at an old age, (ii) aversion by young generations towards cacao production, who prefer to leave from rural areas, and (iii) insignificant public investment in rural areas (i.e. communication and transport infrastructure, public services) (Ramirez, 1997).

The second group of strategies takes place on the surroundings of the cacao environment, by-products and uses of cacao. The first strategy is based on the concept of agricultural diversification which in turn should (i) allow farmers to diversify their income by incorporating more products associated to cacao agro-ecological system; (ii) contribute to food security; (iii) break the seasonality of cacao income; and (iv) spread the risk of trading losses between different agricultural products (or services). This strategy should also offer opportunities for expanded employment and efficient use of capital, land and human resources (Rice and Greenberg, 2000; Flood and Murphy, 2004). Such diversification promotion requires strong external support and time for learning. Diversification strategy should fit into a market economy. Avoiding the idea of incorporating this strategy in cacao-based systems would lead to the closure of a sustainable option for the next generations (Rice and Greenberg, 2000).

The second strategy is based on the use of cacao by-products. This strategy was suggested a long time ago (Greenwood, 1965). It has not expanded rapidly, as many products require a process of incubation, growth, and renovation. For instance, in Brazil, cacao pulp juice (sweetening) is used to produce a cacao juice, and various mixtures in ice creams. It has already become so popular that it is available in many supermarkets. It is argued that this by-product provides more revenue to the farmer than the processed beans (Flood and Murphy, 2004). There is also innovative research based on cacao by-products which range from chemical applications (i.e. pectin), through medical uses (i.e. HIV/AIDS and malaria inhibitor) to agricultural purpose (i.e. feeding, soil substrates). The investment in such line of research may be one way of generating more income from domestic and export markets (Figueira et al., 1993).

Finally, there is another strategy which considers the importance of cacao as food rather than as a candy. Mexico is recognised as the centre of the domestication of several crops (i.e. maize, tomato, and chilli) including cacao. The domestication process and the mixing of cultures in the last 500 hundred years resulted in the development of a unique cuisine (Gonzalez and Amaya, 2005). This food heritage would extend cacao consumption where, at present, chocolate bars are limited by tropical weather, spicy food, and a weak snack culture, especially in the newly emerging rich countries (i.e. China and India).

4.2. Cacao agro-food system in Tabasco (Mexico)

This section discusses some of the characteristics of the setting of this study. This section is divided into two main subsections: subsection 4.2.1

the national context, Mexican cacao, which refers to the general information of the cacao production in Mexico, and subsection 4.2.2 which discusses the importance and performance of this agro-food system in Tabasco, Mexico.

4.2.1. Mexican cacao: the national context

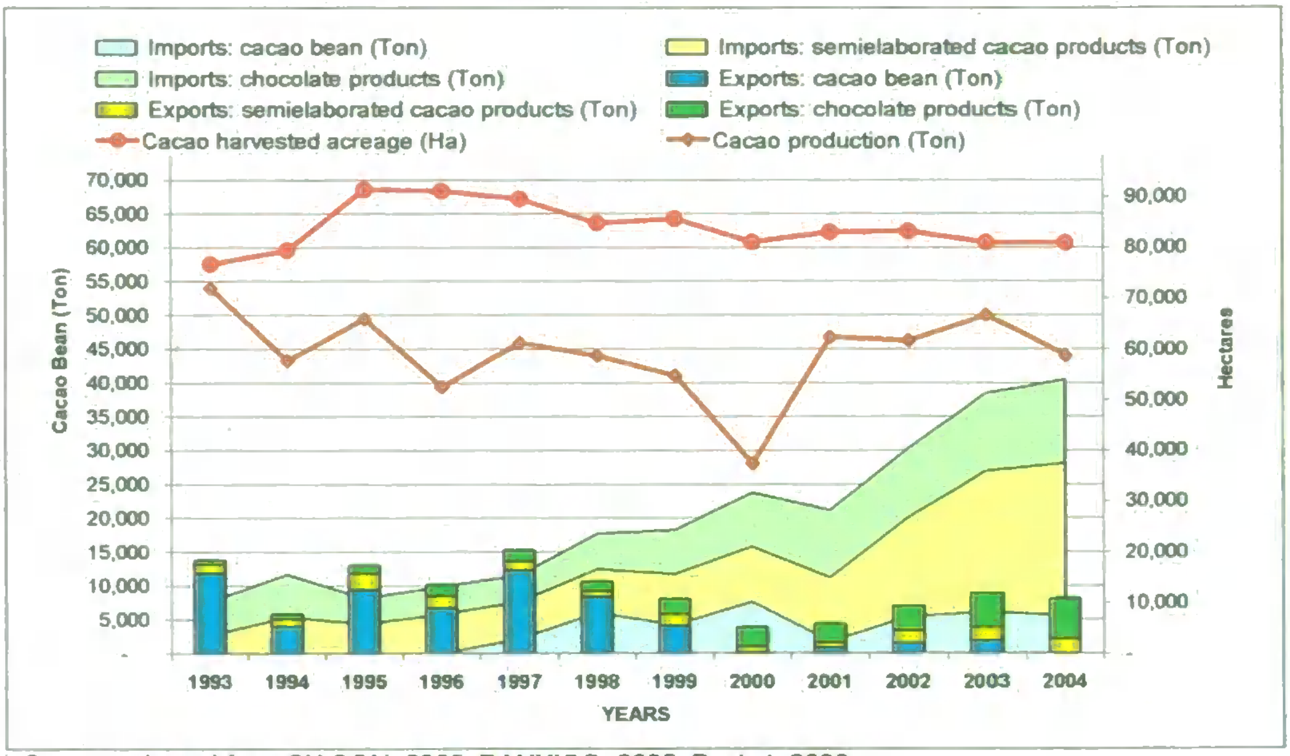
This subsection concentrates on the discussion of three main aspects which describe the national context of the Mexican cacao production and consumption: free market economy, coöperative system, and agro-ecological system.

Market economy

Mexico opened its domestic market to international competition in 1987, and accelerated this process by signing several agreements with different partners (i.e. NAFTA, EU, South America, and Pacific Asia) over the past 2 decades. As mentioned before, a market economy should permit a higher level of efficiency and profitability to be reached and a better distribution of wealth and a sustainable improvement in the quality of life to be achieved. For the cacao industry, this would be a great opportunity to develop its comparative advantages which are based on the geographical position, good quality of cacao bean, and a well developed cooperative structure. However, these comparative advantages are not visible in the national statistics.

Figure 4-1 shows the "cacao bean unit" of three commodity categories (i.e. "cacao bean", "semi-elaborated cacao products", and "chocolate products"). Technical conversion factors were employed to transform both export and import values of such three commodity categories into their respective "cacao bean" units. Cacao bean production and harvested acreage (Ha) are also shown. Internally, it is observed that the demand of these three commodity categories has increased in Mexico, and such demand is satisfied by imported products.

Figure 4-1. Mexican cacao trends in acreage, production, export and import (cacao bean units)



Source: adapted from SIACON, 2005; BANXICO, 2005; Becket, 2000

Externally, Mexico has moved from the export of raw materials to value added products. Considering national cacao production, the farming industry has not grown. In fact, imported products represented almost half of national cacao production in 2004. If one considers that national production is supplied by 40,000 farmers, then it seems that each of them did not received the value of around 1000 kilograms of cacao in 2004. The yield per hectare obtained in the national agricultural research institution (INIFAP) is around 1200-1500 $Kg \cdot ha^{-1}$ (SE, 2002), which means that the cacao import can be substituted internally. Furthermore, the farming industry shows a negative tendency by reducing the cacao acreage.

This is quite alarming as cacao production is based on a particular agro-ecological system which supports a variety of plants and wildlife (Rice and Greenberg, 2000; Donald, 2004). So the loss of 80 thousand hectares over the next decade is not a welcome result.

The situation in the chocolate industry is also difficult. There is a contraction of around 50% from 589 production units in 1989 to 301 in 2003. The chocolate industry claims that having a "cacao coupons law" which forces it to buy the nationally produced cacao before it can buy cacao beans from international markets puts it in a cost disadvantage. It is also argued that many chocolate products, which come from NAFTA area, have a distorted price because their ingredients such as milk and sugar are heavily subsidised (Gonzalez and Amaya, 2005).

Finally, the retailing industry is seen as the real winner from such neo-liberal policies, as it can import final cacao products at a tax rate of 0. Furthermore, this industry benefits from international chocolate firms which have spent heavily on promotion in the last decade. Such a marketing strategy has already influenced the higher income deciles of the Mexican population situated in the mega-cities who are more likely to consume "chocolate bar" style cacao. Therefore, the national chocolate industry has failed to attract the value of the buying-power of this particular segment of the market.

Although neo-liberal policies will be fully implemented in 2008, most of the import tariffs have already been reduced. Therefore, all the organisations of the industries in the national cacao-agro food systems need to work together if they want to survive and succeed.

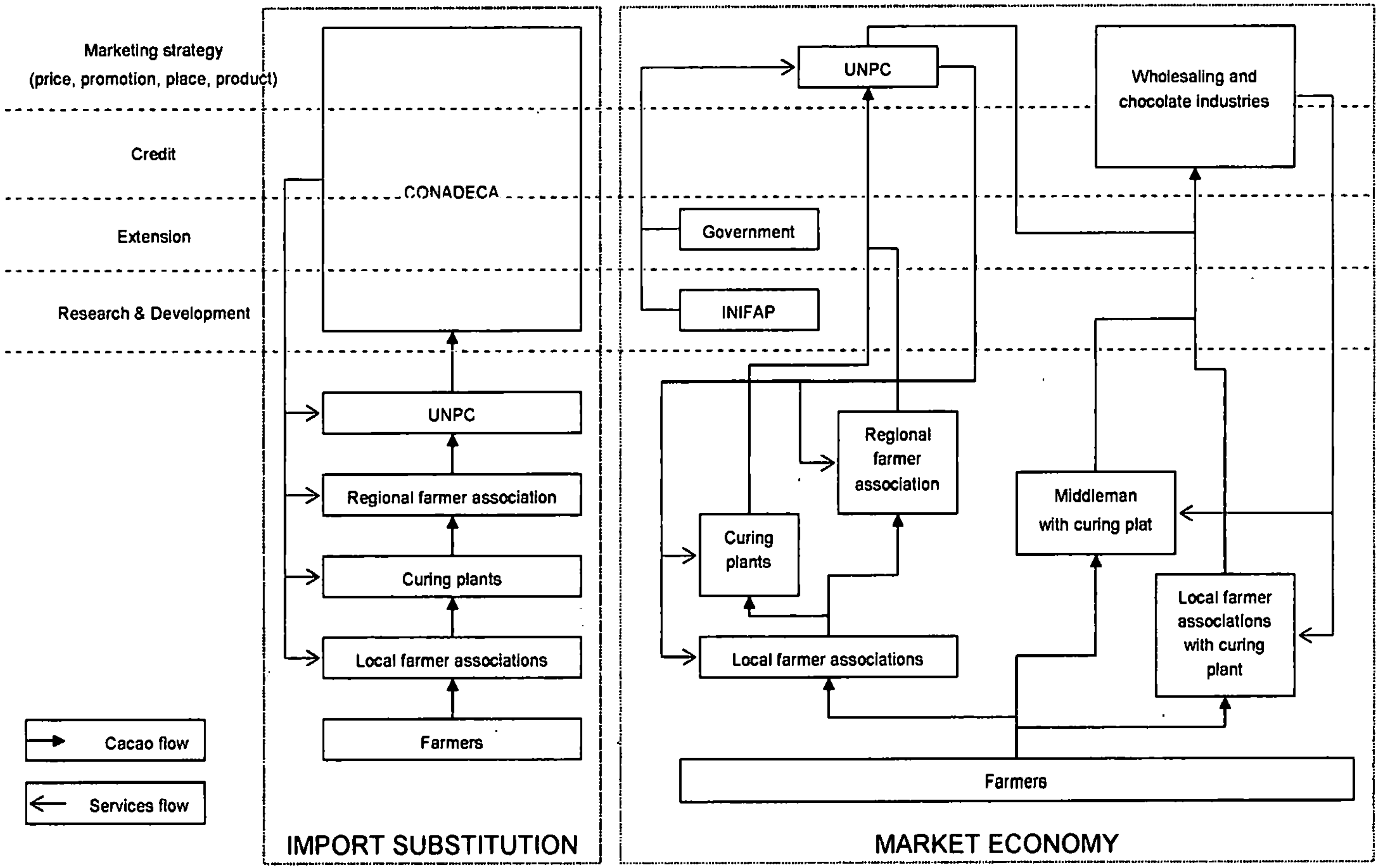
Cooperative system

There is a long tradition in producing cacao in Mexico (Wood and Lass, 1985; Ramirez, 1997; Cordova, 2001), from the "Mesoamerican" period (1200 AD) through the "pre- and post-revolutionary" (1910 AD) and the "import substitution" (1940-1983) to the "market economy" period (1984-to date). Each period has provided key elements to the cacao production. However, the last two periods have played an important role in the construction of the current structure of the national cacao agro-food system. During the "import substitution" period, cacao acreage increased dramatically as many primary forest areas were transformed into arable lands. A cacao board (CONADECA) was installed to control the cacao cooperative system where farmers deliver their produce (ASERCA, 1991). This cacao board was also in charge of many of the strategic functions (i.e. research, extension, credit, and marketing). The cacao cooperative system gathered around 40,000 farmers. Figure 4-2 shows that this cooperative system was organised into 31 curing plants, 26 farmer associations, 3 regional farmer associations and one national farmer union (UNPC, 1990).

This organisation was oriented to supply cacao beans both to national (55%) and international (45%) markets. Under this system, farmers had to supply their produce as "fresh bean". So curing plants prepared larger amounts of cacao which in turn resulted in a higher quality of cacao bean (ASERCA, 1991). The UNPC also had a grinding infrastructure where some of the cacao production was processed to obtain both semi-elaborated (i.e. liquor, butter, and powder) and final cacao products (i.e. chocolate) (ASERCA, 1991). A combination of a higher cacao international price and strong support from the government permitted to higher levels of productivity to be maintained, the cacao acreage to be increased, and somehow stability to be offered at farm level. However, it is also accepted that this structure became more political, so it could never be professionalised. This weakness was reflected once the UNPC had to consider a future without any public support.

The period of "market economy" was marked when CONADECA vanished in 1989. This led to a division of the cacao supply chain into two main groups: union of farmers (UNPC), and private middleman. UNPC faced a vandalism situation which affected their assets considerably (i.e. trucks, airplanes, warehousing, and curing plants). In fact, the grinding and chocolate industry owned by the UNPC is still under embargo (Ramirez, 1997). This situation also coincided with the falling international cacao prices which dropped to their lowest level in 1999. This led to stopping the harvesting of cacao and production was reduced by almost 50 per cent (Figure 4-2). Government policies were more flexible about the cacao situation and considered a series of programs oriented to reverse this negative situation in 2000 (SAGARPA, 2001, 2002).

Figure 4-2. Changes in the CAFS: from "import substitution" (1940-1983) to "market economy" period (1984-)



Source: after ASERCA, 1991; Cordova, 2001.

The UNPC has benefited from such cacao programs but this has not been enough and some members have separated themselves from such cooperative structure in order to avoid suffering from the lack of leadership in cooperatives (Cordova, 2001).

On the other hand, international wholesaling and grinding firms increased their participation during this unstable period, and now they gather more than a half of the cacao production by employing a network of middlemen. They also train these middlemen to carry out the curing process in order to secure higher quality levels. Wholesaling and chocolate industries provide credit and training to the curing process (Gonzalez and Amaya, 2005).

Furthermore, significant changes have been made in this period. One change was the elimination of tax tariffs on chocolate products in 2002 (Gonzalez and Amaya, 2005). As mentioned before, this accounts for a doubling of the value of imports which would be equivalent to around 30,000 tons of cacao. Another change is the confirmation that frosty pod rot, a fungus disease that has reduced cacao production by up to 80% in Latin America, has reached Mexican cacao areas (Phillips et al., 2006). Under this scenario, it is considered that cacao cannot be abandoned as in 1999/00. There have been a series of actions carried out by the government in order to face these challenges. At the beginning of 2000, a program based on an increase of yield per hectare was implemented, which "ceteris paribus" should result in higher returns and better standard of life. However, such cacao programs have been insufficient.

This is confirmed by a lack of strategic services to the farming industry mainly extension, credit, and marketing (Cordova, 2001).

Agro-ecological system

Cacao is a tropical crop which is widely distributed in many regions of Mexico. However, the production is concentrated in 6 states of Mexico of which two supply 99% of the national cacao production: Tabasco (70%), and Chiapas (29%) (SIACON, 2005). This main region of cacao production is located in the southeast of Mexico (Figure 4-3). Whilst Tabasco is a flat and flooded area, Chiapas is a very hilly zone. Thus, agro-ecological systems differ in many aspects (SIACON, 2005).

Figure 4-3. Cacao production in Mexico

Source: elaborated from data of SIACON, 2005

Cacao orchards never reached a plantation status where all primary forest is cut down in order to have 100 percent solar radiation. Therefore, Mexican cacao is a very rich agro-ecological system, as it conserves the primary and secondary canopies. There are many native species of animals and plants that share a space in this canopy (Rice and Greenberg, 2000; Donald, 2004). Traditional farmers have learnt to get several benefits from such particular outcomes (i.e. timber, honey made by endemic bees, medicinal and food plants, bushmeat of reptiles and mammals). The potential to obtain the best of such diversified agro-ecological system has not been reached (Flood and Murphy, 2004). The likelihood of losing a learning opportunity about this natural relationship is getting much closer.

One strategy to be successful in a competitive environment is by attracting value from the market. Diversification could be a solution. However, it is necessary to have a new insight into opportunities and threats at both an internal and external level.

4.2.2. Mexican Cacao: the local context (Tabasco)

This subsection concentrates on the discussion of general information and performance indicators. This information describes the Cacao agro-food system in Tabasco (Mexico) –CAFS.

Tabasco: General information

Tabasco is located in southeast Mexico (North 18°39' and South 17°15' at North latitude, East 91°00' and West 94°07' at West longitude), and represents 1.3% of the national surface (25,470.224 Km^2). The geography of Tabasco is mainly low lying. Climate is largely humid with abundant rainfall in summer. The average annual rainfall is 2000mm, and the average temperature is 26º C (INEGI, 2005).

Tabasco consists of a complex hydrological network which is the most important in Mexico. This hydrological feature leads Tabasco being divided into 2 regions (i.e. Grijalva and Usumacinta) and 5 subregions (i.e. Chontalpa, Centro, Sierra, Pantanos, and Rios), where its 17 municipalities are distributed (Figure 4-4).

Figure 4-4. Regions, subregions and municipality division of Tabasco

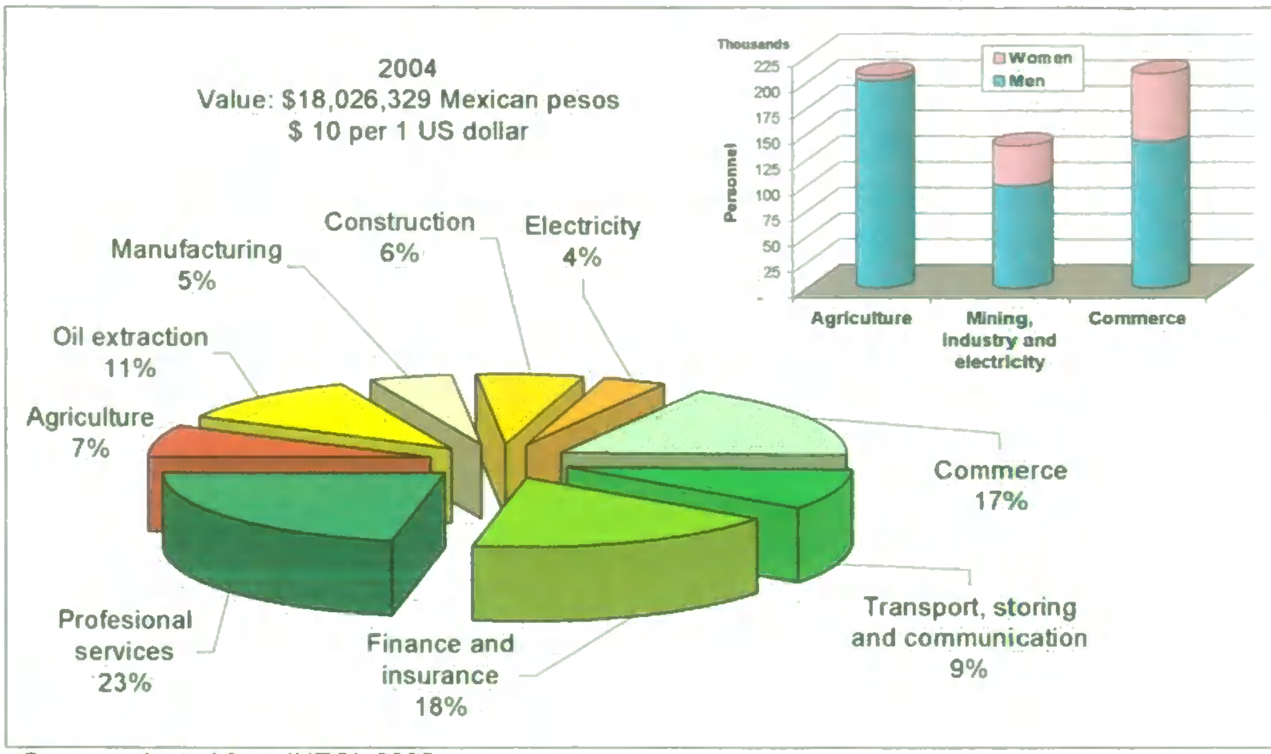
Source: After INEGI, 2005

The "Grijalva" region accounts for 47% of the surface (12,069.34 Km^2) and consists of 3 subregions: (i) "Chontalpa" which includes the municipalities of Cardenas, Comalcalco, Cunduacan, Huimanguillo, and Paraiso; (ii) "Centro" which includes the municipalities of Centro, Jalpa de Mendez, and Nacajuca; and (iii) Sierra which includes the municipalities of Jalapa, Tacotalpa, and Teapa. This region is characterised by a high concentration of population (1,185,432 inhabitants of which 48% are placed in rural areas), a decreasing oil industry activity, and high levels of contamination. The "Usumacinta region" accounts for 51% of the Tabasco surface (12,591.66 Km^2) and consists of 2 subregions: (i) Pantanos which includes the municipalities of Centla, Jonuta, and Macuspana; and (ii) Rios which includes the municipalities of Balancán, Emiliano Zapata, and Tenosique. This region is characterised by a low concentration of population (316,312 inhabitants, of which 60% are located in rural areas), the location of the largest swamp area of Mexico, and predominant economic activities of oil, fishery and forestry (INEGI, 2005).

The vegetation and its uses in Tabasco is divided into four main categories: agriculture –*Theobroma cacao*, *Musa paradisiacal*, *Saccharum offinarum*, *Cocos nicifera*, *Zea mays* (26%), pasture – *Cynodon plectostachyus*, *Pennisetum purpureum*, *Echinochloa polystachya*, *Hyparrhenhia rufa*, *Paspalum sp.* (31%), forestry – *Terminalia amazonia*, *Nectandra sp.*, *Manilkara zapota*, *Bursera simaruba* (16%) and swamp –*Typha sp.*, *Cyperus sp.*, *Thalia geniculata*, *Avicennia germinans*, *Rhizophora mangle*, *Laguncularia racemosa* (26%) (INEGI, 2005).

In 2005, the total population of Tabasco was 1,989,969 which accounted for 1.9% of the national population. Figure 4-5 shows the value of the different economic activities performed in Tabasco; agriculture accounted for 7% of the total value in 2004 and gave employment to 25% of the total labour force (202,000 people). Agriculture activities are performed mainly by men.

Figure 4-5. Key economic activities and employment in Tabasco



Source: adapted from INEGI, 2005

Agriculture is based on livestock and crop production. Crop production is divided into two main categories: annual and perennial crops. Considering the acreage, cultivated maize (108,125 Ha) and cacao (60,612 Ha) are the main crops in Tabasco. Cacao is located mainly in the "Chontalpa" subregion. Considering acreage and the number of farmers, the main municipalities where cacao is produced are (in order of importance): Comalcalco, Cardenas, Cunduacan, Huimanguillo, Jalpa and Paraiso. Cacao is also produced in the subregion of "Centro" and Sierra" but this accounts for about 1 per cent of the total production. The Subregion of Chontalpa is also divided into two main areas (INEGI, 2005). The first area was established by the Mexican government in 1960. This government program was located in Cardenas and Huimanguillo and consisted of the incorporation of a vast surface of agricultural land by cutting down the rainforest area and installing a series of agricultural (i.e. drainage) and rural infrastructure (i.e. houses, schools, hospital) (Murillo, 2004). The second area consists of a set of native communities which were created after the "latifundio" was dissolved by the Mexican revolution in 1920. This area includes the municipalities of Comalcalco, Cunduacan, and Paraiso (Murillo, 2004; Cordova et al., 2001). The cacao production is located in the Grijalva region (Chontalpa, Centro and Sierra subregions). Figure 4-6 shows the main municipalities that produce cacao in Tabasco. Cardenas, Comalcalco and Cunduacan, highlighted in green, have 70% of the acreage and 66% of farmers dedicated to cacao production.

Figure 4-6. Cacao in Tabasco: acreage and number of farmers

Source: After SE, 2002

CAFS: socio-economic importance and technical indicators

As mentioned above, Tabasco produces around 70% of the national cacao production. Therefore, the main structure of national cacao agro-food system is located in this state. Two main features of the subsystems of the cacao agro-food system in Tabasco (CAFS) are reviewed: (i) socio-economic importance and (ii) technical performance indicators. Table 4-2 shows four industries of the CAFS: farming, curing, wholesaling and chocolate. The farming industry consists of about 30,000 farmers who have an average yield of 750 per hectare, with an average acreage of 2.4 Ha and an average age of cacao orchard of 27 years. The profitability of this cacao area is around 20%, and this implies an income of around 2.00 US dollars per day (Cordova, 2001; Cordova et al., 2001). This income is complemented with both other agricultural and non-farm activities.

The curing industry has two forms of organisation: social and private. The first refers to a series of farmer associations which own curing plants. There are 27 curing plants with a capacity to gather up to 50% of the fresh bean production. However, many curing plants are closing because of their managerial problems. The average curing capacity is 250 tons of cacao bean per year. These plants do not have any activity during 2-4 months of the year. So farmers either close them or use this period to carry out maintenance activities (Cordova, 2001). The second form of organisation refers to a series of about 70 middlemen. They gather the other 50% of the cacao production. There is little information about their performance indicators. As mentioned before they are supported by firms of chocolate or wholesaling industries (Gonzalez and Amaya, 2004).

The wholesaling industry comprises of 14 organisations of which the UNPC is one of main organisations as it commercialises up to 40% of the total cacao production (ITESM, 2001). The remaining organisations include national and international wholesalers, and manufacturing firms. The chocolate industry processes less than 3% of the total cacao production and consists of 11 small firms (ITESM, 2001). The union of farmers also own a chocolate industry, INCATBSA, which operates at 5% of its capacity, is technologically obsolete and is under embargo (Ramirez, 1997; ITESM, 2001).

The challenge of the CAFS is to establish a set of strategies that take advantage of the technological, geographical, climatic and cultural conditions. Domestic and international markets are increasing and demanding diverse products. There are two levels of influence in Tabasco: cacao producers and consumers. At producers' level, it is necessary to develop strategies that permit (i) the rehabilitation of cacao orchards in the short term, (ii) the improvement of skills and competences of farming industry in order to create more value and to attract value from the market which in turn would imply horizontal and vertical diversification, and (iii) the development of a win-win strategy with cacao consumers. Deferring this alliance would lead to a conflict of interest in the medium term. At the consumer level, wholesaling and chocolate industries have started to develop the supply network, to provide the curing plants with credit and training, to participate in the initiatives proposed by government to organise the CAFS. All these new interactions are changing the internal configuration of each industry, and this study examines such features mainly in the farming industry.

Table 4-2. The CAFS: industries, type of organisation, number of production units and performance indicators

SUBSYSTEMS	ORGANISATIONS	PRODUCTION UNITS	PRODUCTION VOLUME PER YEAR	INDICATORS (AVERAGE)
Farming industry	Farmer	30,000	31,860 ton of cacao bean	Yield per hectare 750 Kg Ha^{-1} Acreage per farmer: 2.4 Ha Age of cacao orchards: 27 years
Curing industry	Farmer associations	30	50 % of total production	Recovery factor: - Curing capacity per year: 241 Ton
	Middlemen	70	50 % of total production	Recovery factor: Curing capacity per year: -
Wholesaling industry	Union of framers	1	13,000 ton of cacao bean	Exports: 0%
	Private	15	21,860 ton of cacao beans	Exports: -
Chocolate industry	Union of Farmers	1	15,000 ton (5-10% capacity)	-
	Private	10	-	-

Source: After Ramirez, 1997; Cordova, 2001; SE, 2004

5. Anatomy of the cacao agro-food system (CAFS) in Tabasco, Mexico

This section concentrates on a discussion about the analysis of the CAFS. An exploratory assessment instrument was designed to analyse the key industries (i.e. farming, curing, wholesaling, and chocolate) of the CAFS, its products and interactions. The chapter is divided into 3 sections: section 5.1 refers to the discussion of the anatomical elements, section 5.2 discusses the visualisation of the CAFS and section 5.3 concentrates on the changes of the industries of the CAFS.

5.1. Quick anatomical assessment

This section discusses the key elements used to analyse the structure of the CAFS. This section is divided into four subsections: the operationalisation of the "anatomical elements" takes place in the first three subsections, subsection 5.1.1 analyses the industry, subsection 5.1.2 the products and subsection 5.1.3 the interactions. The last subsection 5.1.4 discusses the expected changes in the anatomy of CAFS.

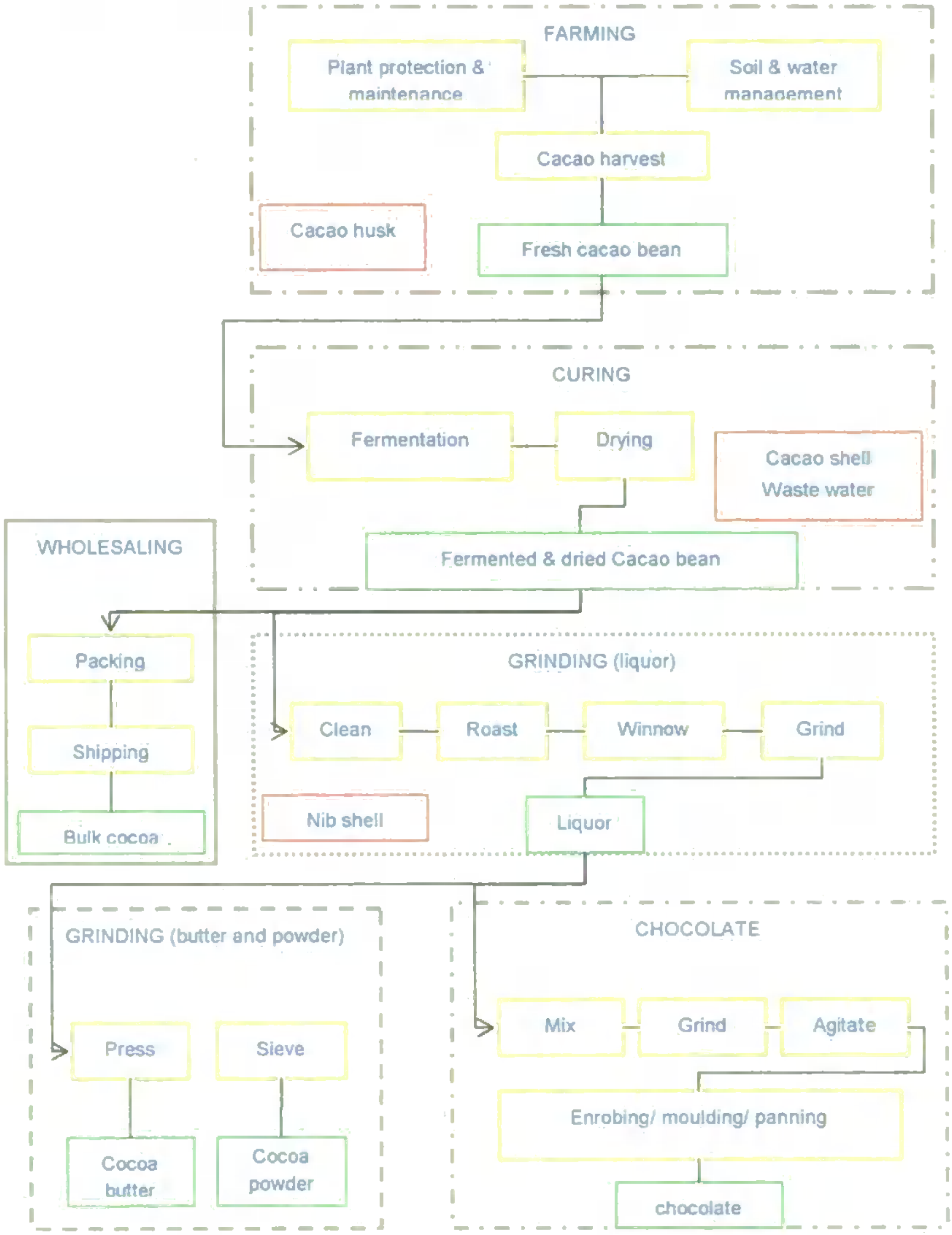
5.1.1. Industry

Chapter 4 provided a general and particular outlook related to the key industries (i.e. farming, curing, wholesaling, grinding and chocolate) that comprise a cacao agro-food system. However, the industries of CAFS have not been defined yet. This is the first task in this subsection. Strack and Morgan (1995) highlight that any establishment (e.g. farmer, organisation or firm) can be classified. To classify each establishment, it is necessary to consider the main activities and products of the establishment. Figure 5-1 shows the main processes of a cacao agro-food system. From this figure, it is possible to appreciate 5 core processes: farming, curing, grinding, wholesaling, chocolate manufacturing. Each process shows its main activities (yellow lines), products (green lines), and by-products (red lines).

“Farming” is defined as the process through which fresh cacao beans (seeds) are obtained by carrying out different activities ranging from plant protection & maintenance, soil and water management, and harvesting. The cacao husk is the main by-products resulted from this farming process (Wood and Lass, 1985; Ramirez, 1997; SE 2002). “Curing” is characterised as the process where fresh cacao is changed into cacao beans and two main activities are necessary to achieve this particular bean: fermenting and drying. Cacao shell and waste water are the main by-products obtained from this “curing” process (Wood and Lass, 1985; Ramirez, 1997; SE 2002). Once cacao beans are fermented and dried, they can be distributed or used to produce further processed products. The “wholesaling” process is regarded as the gathering, packing and distribution of cacao beans. The product is referred to as bulk cacao (ITC, 2001).

The next process is “grinding”. Several authors emphasise two main “grinding” phases (Minifie, 1970; Beckett, 1988; 2000; Coe and Coe, 1996; Knight, 1999). The first refers to the “grinding” of the cacao bean in order to obtain the "liquor", and comprises of clean, roast, winnow and grind activities. The second refers to the "pressing" of the "liquor" in order to obtain the "butter" and "powder". Nib shells are the main by-product of the "grinding" process.

Figure 5-1. The cacao agro-food system: main processes



Source: After Minifie, 1970; Beckett, 1988, 2000; Mossu and Coste, 1992; La-Gra, 1993; Coe and Coe, 1996; Ramirez, 1997; Knight, 1999.

Finally, the "chocolate" process consists of different activities such as mixing, grinding, agitating, enrobing, moulding and panning. Chocolate is one of the main products obtained in this process (Minifie, 1970; Beckett, 1988; 2000; Coe and Coe, 1996; Knight, 1999).

This process examination is also supported by the North American industry classification system –NAICS which classify each establishment systemically into different aggregate levels from industry (i.e. cacao farming) through a group of industries (perennial crop) to sectors (i.e. agriculture). This classification is also based on the main activities and the expected products that such an establishment under a specific industry level should carry out (INEGI, 2002).

The examination of the main processes of the cacao agro-food system permits to refine the findings of section 4.2. Table 5-1 shows the industries in a cacao agro-food system, their main activities, products and by-products. This table is the first element required in order to analyse the anatomy of the cacao agro-food system in Tabasco, Mexico. The presence or absence of any industry will provide useful information about its current structure and its main characteristics. Therefore, this element consists of five categories: the "farming" industry (FR), the "curing" industry (CR), the "wholesaling" industry (WS), the "chocolate" industry (CH) and the "grinding" industry (GR).

Table 5-1. Cacao agro-food system: industries, activities, products and by-products

INDUSTRY	ACTIVITY	PRODUCTS	BY-PRODUCTS
Farming	Production of fresh cacao bean	Fresh cacao bean	Cacao husk
Curing	Fermenting and drying	Fermented and dried cacao bean (which from here only refers as cacao bean)	Cacao shell and waste water
Wholesaling	Gathering and distribution	Cacao bean	-
Grinding	Grinding and pressing	Liquor, butter and powder	Nib shell
Chocolate	Manufacturing of chocolate	Chocolate	-

Source: After Minifie, 1970; Beckett, 1988, 2000; Mossu and Coste, 1992; La-Gra, 1993; Coe and Coe, 1996; Ramirez, 1997; Knight, 1999.

5.1.2. Products

As mentioned in other sections and subsections (i.e. 4.1, 4.2 and 5.1.1), there are standard "products" and "by-products" which are obtained in each core process throughout 4the cacao agro-food system. Some authors propose an analysis of the changes of an agro-food system by looking at the different variables of the products, for instance value-added, standard classification, quality, and destination. These aspects are discussed and defined below.

Cacao products

The above subsection shows the different "products" that are obtained by each industry in the cacao agro-food system. Kaplinsky and Morris (2000) highlight the importance of differentiating the AFS by analysing the "value added" of the products. Therefore, four categories are considered with regard to this "value added" aspect (i) "raw" products refers to production of fresh cacao beans, fermented and non-fermented cacao beans, (ii) "intermediate" consists of liquor, butter and powder, and (iii) "final" refers to the production of chocolate.

Cacao is the main product in the agro-food system. However, cacao can be classified by considering other aspects which stem from the different attributes (i.e. quality, variety of cacao tree, organic production). The analysis of the changes of these cacao products leads an understanding of the changes in a particular industry of a cacao agro-food system (Ramirez, 1997; SE, 2002). Two main aspects are used in this study in the classification of cacao beans (Table 5-2). (i) The type of cacao beans which consists of four categories: fresh cacao, non-fermented cacao, fermented cacao, and combination (which refers to the presence of both fermented and non-fermented cacao) and (ii) the type of quality which consists of three categories: bulk (or commodity quality), fine (related to flavour of beans due to a special variety of trees), and organic (which refers to a particular production practice based on organic philosophy).

Table 5-2. Cacao: type of bean and type of quality

ASPECTS	CATEGORIES	DEFINITION
Type of bean	Fresh	Seeds which are embedded in a mass of white, pinkish or brownish, acid to sweet, aromatic pulp.
	None-fermented	Cacao beans which have a characteristic slaty-colour of the cotyledons, a cheesy texture, and unpleasant flavour
	Fermented	Cacao beans which have been fermented and dried properly
Type of quality	Bulk	Cacao beans which do not have any particular attribute
	Organic	Cacao beans which have been obtained under an organic production system
	Fine	Cacao beans which come from the "criollo" or "trinitario" variety of cacao

Source: After Wood and Lass, 1985; CCI, 1991; Ramirez, 1997; Motamayor et al., 2002; Ayenor et al., 2004; Radi, 2005

Table 5-2 shows the different type of products that a cacao agro-food system normally manages. Organic production has increased in the last 20 years. Many ONGs and also agricultural programs of cacao producing countries have drawn attention to this particular production (Raynolds, 2004). Therefore, this study also considers ascertaining whether industries in the CAFS are participating in this alternative production system. This aspect of the production is examined by asking whether the establishment is participating in an organic cacao program. Three categories are considered: non-participation in organic programs, certification in progress (i.e. 1-3 years), and already certified (normally at 4^{th} year).

By-products, agro-products and services

Recently, it has been accepted that tropical perennial crops can be seen as integrated systems from which not only a main commodity is obtained (e.g. cacao bean), but also other outcomes (products and services). These outcomes are studied by different disciplines, ranging from technological and environmental to economics (Rice and Greenberg, 2000; Flood and Murphy, 2004). This extended function of the cacao agro-food system was considered by asking whether the farmer uses (produce or commercialise) the following by-products, agro-products, and services (Table 5-3).

Destination of production

Another important aspect is the destination of the product (Gilbert, 1997; Ruf and Yoddang, 1998; ITC, 2001). A variable with four categories was used to establish the destination of the production.

Table 5-3. By-products, agro-products and services: categories and uses

TYPE	CATEGORY	USES
By-products	Cacao husk	To prepare compost, to feed livestock
	Cacao pulp	To prepare jam
	Cacao sweating	To prepare juices and, refreshments, to extract pectin
	Cacao nib	To use in poultry production
	Cacao shell	To use in cigarette production
Agro-products	Food crop	To complement the diet of the household
	Medicinal plant	To cure some health problems
	Ornamental	To diversify production
	Timber	For domestic use
	Honey	For domestic use
	Bush-meat	To complement the diet of the household
Services	Tourism	To diversify the income of farmer

Source: after Greenwood, 1965; Figueira et al., 1993; Flood and Murphy, 2004; Gonzalez and Amaya, 2005

The categories used were: (i) the local market which refers to the State of Tabasco, (ii) the national market which includes all the States of Mexico, (iii) the international market which refers to sending the production abroad, and (iv) a combination of the local and the national market was also considered.

5.1.3. Interactions

The first interaction takes place in the establishment. This internal interaction is related to the degree of association. This is very important as several production systems in Mexico were created on a monopoly cooperative basis (Torres et al., 1996). This variable considers whether the establishment is: (i) "business" which refers to discrete relationship between buyer and seller or (ii) "social" which is the relational exchange between buyer and seller.

The second interaction refers to the link of the firm to a supply structure. As discussed in subsection 4.2.2, the cacao agro-food system has a dual supply structure which stems from the participation of private firms and the farmers union in the gathering and commercialisation of cacao production (Cordova, 2001). Thus, this variable consists of three categories: (i) "union" which refers to the establishment of who supplies their product to the UNPC, (ii) "private" which addresses the new supply structure supported by private firms, and (iii) "union+private" that considers the use of both supply structures mentioned before.

In section 4.2.2, it was stressed that supporting services were highly affected in neo-liberalised period. Therefore, it is expected that a "supportive" interaction would be implemented (Cordova, 2001). Three categories were used in this type of interaction: (i) "non support" which implies an interaction based on a purely business exchange basis, (ii) "production support" which consists of providing some strategic inputs to help transactions between buyer and seller, the buyer is the one who provides the support, and (iii) "infrastructure support" refers to the supply seller with some funds (or credits) to improve the infrastructure.

Finally, interactions are subject to change (Storer and Taylor, 2006). Therefore, it is very important to know whether a contract is considered to improve the interaction. This variable consists of three categories: (i) "non contract" which implies the most unstable interaction, (ii) "short-term contract" which considers a seasonal agreement between seller and buyer, and (iii) "long-term contract" which implies a strategic importance of the interaction.

5.1.4. Anatomy of the CAFS: main features

This subsection discusses the main features of the anatomy of CAFS which in turn permit the verification of the conclusions in last section of this chapter. As discussed before in Figure 4-2, under the "import substitution" period (1940-1983) farming, curing, wholesaling, grinding and chocolate industries were quite delimited in the CAFS. Then, after the implementation of structural reforms, it seems that the CAFS has changed. But this change seems to be only reflected in the control of gathering and distribution which were transferred from union of farmers to private firms. What other changes are expected? Figure 5-2 shows some key expected changes that should occur in the CAFS. The result of these assumptions will be discussed in the last section of this chapter. The main assumption is to observe a more diverse anatomy of CAFS. This implies a separation of the traditional and theoretical assumption which is drawn at the top of this figure.

As mentioned before, there is a "union of farmers" which controls two main industries "farming" and "curing". Therefore, it is expected that they could strengthen other functions such as wholesaling (i.e. export), grinding and chocolate manufacturing. The "curing industry" is also an important player in the CAFS. There are new participants in this industry, the network of middlemen. Therefore, it would be expected to have an upward movement. This implies that "curing industries" would sell their cacao beans in the national and international markets or would start to transform their cacao beans. The "wholesaling industry" has been changed dramatically. The participation of new firms in this activity has diminished the monopoly of the UNPC. It is expected that they would explore both downward and upward industries (i.e. curing and chocolate). Finally, it is expected that the chocolate industry will seek opportunities downward of the CAFS which in turn implies the control of "curing" and "farming" activities.

Figure 5-2. CAFS's industries: upwards and downwards movements

Theoretical assumption	FARMING INDUSTRY	CURING INDUSTRY	WHOLESALING INDUSTRY	CHOCOLATE INDUSTRY
Expected dynamic after anatomy analysis	Farming			
	Farming	→		
	Farming	→	→	
	Farming	→	→	→
		Curing		
		Curing	→	
		Curing	→	→
			Wholesaling	
		←	Wholesaling	→
		←	←	Chocolate

→ Indicates an upward movement, which covers the functions of the respective industry where the arrow is placed

← Indicates a downward movement, which covers the functions of the respective industry where the arrow is placed

5.2. Visualisation of the CAFS

This section shows the findings of the exploratory visualisation of the anatomy of CAFS. This section is divided into three subsections. Subsection 5.2.1 discusses the spatial structure of the products of the CAFS, subsection 5.2.2 examines the spatial structure of the by-products and agro-products of the CAFS and finally subsection 5.2.3 discusses the spatial structure of the interactions of the CAFS and 5.2.4 summarises the main remarks of the CAFS.

The visualisation of the anatomy is based on the spatial maps obtained by "correspondence analysis". Therefore, the explanation of the anatomy concentrates on looking at the clusters between industries (rows) and anatomical elements (columns). The clustering process starts with the dimension that explains most of the differences (or similarities) between spatial patterns of row points and column points i.e. points are concentrated or dispersed. Whilst concentrated points at the origin of the axes indicate a higher number of observations of those points, dispersed points show the opposite. Subsequently the second dimension is used to explain other difference (or similarities) and so on. It is assumed that row and column points should match in some positions. This matching is caused by the number of observations related to the "most important" category. The mismatch, then and in this particular study, means that an "industry" also has frequency values in other "less important" categories. The larger the frequency values of these "less important" categories, the more separation will be observed between the "most important" category and the selected industry point. This effect will be called as pull/push and can be down/up or left/right or a combination of any them. The analysis of each "anatomical element" starts with a description of the statistics of the "anatomical map" based on the "correspondence analysis". Then, the identification of the clusters is explained. Finally, a discussion about the findings of such an "anatomical map" is given.

"Correspondence analysis" is an exploratory tool, so the number of dimension was selected considering the "best" visualisation to find patterns. From the beginning, it was decided to start the analysis with a default dimension of "2" proposed by the statistical program. This dimension space or solution, in most of the cases, explained more than 80% of the distribution and other cases require only one dimension. Finally, there was only one case (i.e. cacao by-product) whose solution was based on 3 dimensions. The higher the number of dimensions, the better a solution is obtained (Clausen, 1998).

5.2.1. Products of CAFS

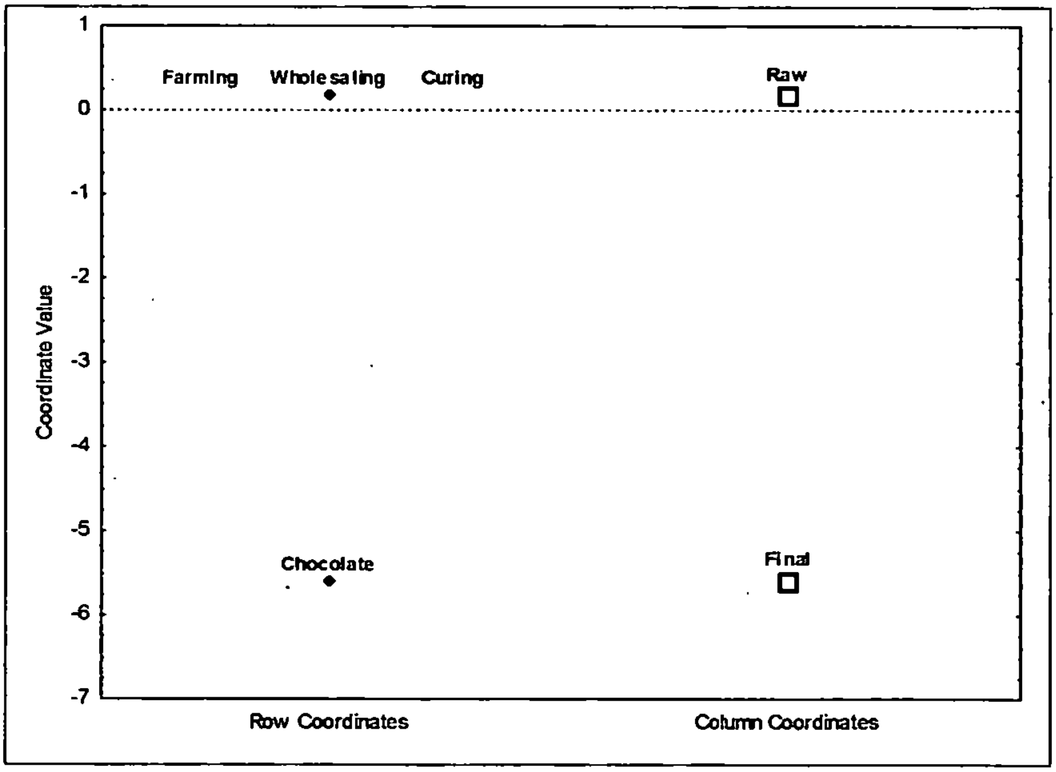
This subsection discusses the "anatomical element" related to products commercialised by CAFS's industries. Five variables were considered in order to analyse the anatomy of the CAFS: (i) value added product (ii) type of cacao bean, (iii) quality of cacao bean, (iv) participation in organic cacao program and (v) destination (or market) of the products.

Value added product

The analysis of the value added product is discussed below. Figure 5-3 shows the anatomical map of the CAFS's industries and the type of value added products i.e. "raw" (bean), "intermediate" (powder, butter, and liquor), and "final" (chocolate). The anatomical map was constructed from a 1-dimensional solution by employing correspondence analysis (Eigenvalues: 1.000; total Inertia=1.0000, Chi^2=226.00, df=3, $p<0.001$). This solution explains 100% of the inertia and suggests that the distributions of the categories of the "value added product" are not the same for all categories of industries. Dimension 1 (horizontal axis) accounts for 100% of the inertia. Both row and column coordinates are represented quite well in the 1-dimensional solution; the quality for all points is 1.0 (which is the highest value). The row point that contributes most to the overall inertia is that representing the "chocolate" industry and the column point that contributes most is that representing the "final" products (Appendix B).

The analysis of this anatomical map is as follows. The map can be divided into 2 clusters (Figure 5-3). The first cluster is located above the horizontal axis and consists of "raw" products, and "wholesaling", "curing" and "farming" industries. The second cluster is located below the horizontal axis and is characterised by "final" products and "chocolate" industry. The first cluster suggests that "wholesaling", "curing" and "farming" industries are dedicated mainly to the production of raw products i.e. cacao bean. This accounts for 100 % of the observations respectively. The second cluster suggests that "chocolate" industry mainly focuses its production on final products mainly (i.e. chocolate) which in turn reflects 100% of the observations. .

Figure 5-3. Anatomy of CAFS's industries: value added product



This result confirms that the CAFS is mainly based on the production of raw products which in this case is the cacao bean. Furthermore, the importance of "chocolate" industry is described as very low (ITESM, 2001). There is no industry dedicated exclusively to the production of intermediate products. Although some chocolate industries produce "intermediate" products, the core production is based on "final" products. Therefore, if the CAFS wants to add value to its products by producing intermediate products, it needs to look for strategies to either reactivate the "grinding" industry owned by the UNPC or support new initiatives carried out by other organisations of the CAFS such as farmers producing chocolate or curing industries producing intermediate products.

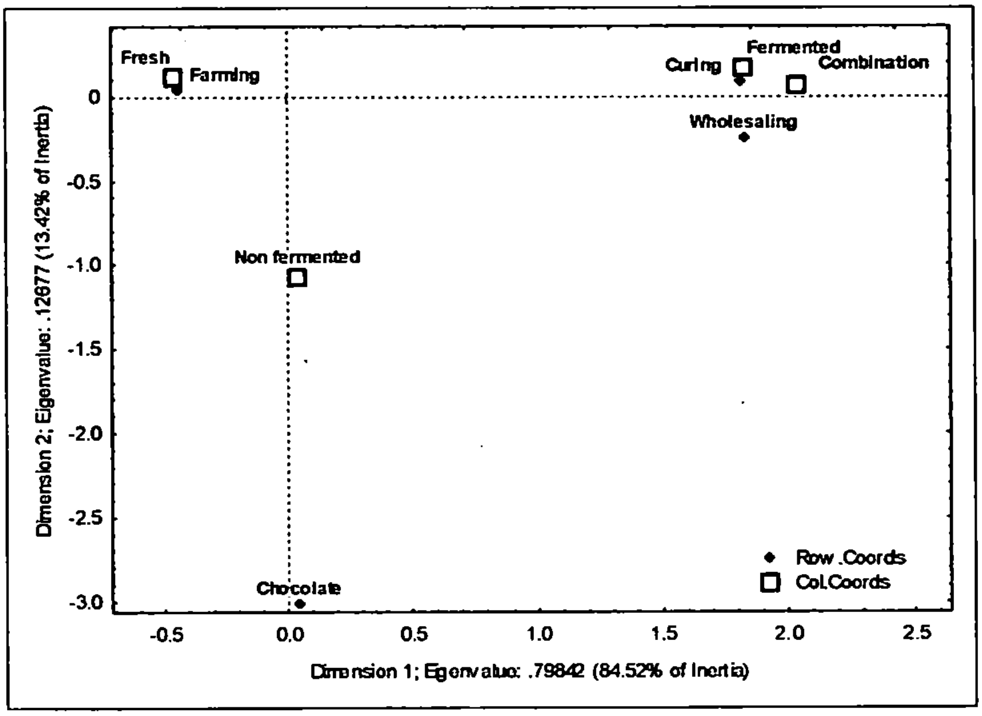
Type of cacao bean

The analysis of type of cacao bean is discussed below. Figure 5-4 shows the anatomical map of the industries and the type of cacao beans i.e. "fresh", "fermented", "non-fermented" and "combination" (i.e. fermented + non-fermented). The anatomical map was constructed from a 2-dimensional solution by employing "correspondence analysis" (Eigenvalues: .7984, and .1268; total chi-square=209.70, df=9, $p<0.001$). This solution explains the 97.9% of the inertia and implies that the distributions of the categories of "type of cacao bean" are not the same for all categories of industries. Dimension 1 (horizontal axis) accounts for 84.5% of the inertia. Dimension 2 (vertical axis) accounts for 13.4% of the inertia. Therefore, dimension 1 is the most important axis, explaining most of the differences between spatial patterns of row points and column points. Both row and column coordinates are represented quite well in the 2-dimensional solution. The quality for all points is above 0.95 (highest value 1), but “wholesaling” has a value of 0.85. The row point that contributes most to the overall inertia is that representing the “curing” and “farming” industries (0.59% and 17% respectively) and the column points that contribute most are those representing the “fermented” and “combination” beans (39% and 31% respectively) (Appendix B).

The analysis of this anatomical map is as follows. The map can be divided into 2 main clusters by considering the importance of dimension 1. The first cluster is located at the left side of the horizontal axis. This cluster consists of “fresh” beans and “farming” industry. Both points are near the origin. The second cluster refers to the points that are on the right of the horizontal axis. However, two main remarks can be made: (i) “non-fermented”, “fermented” and “combination” beans, and “curing”, wholesaling” and “chocolate” industry are located far at the right side of the horizontal axis, and the “non-fermented” bean and “chocolate” industry are much closer to vertical axis. Therefore, a third cluster is identified by looking at the vertical axis and dimension 2 explains this dispersed vertical association.

This first cluster suggests that the “farming” industry is related mostly to the production of “fresh” cacao beans (90% of the observations). However, the presence of “non- fermented” cacao beans in the “farming” industry pushes it slightly down (9% of the observations). The second cluster suggests that “curing” and “wholesaling” industries are dedicated mainly to “fermented” and “combination” cacao beans (around 80% of the observations). Both industries are also pulled down due to the presence of firms that commercialise only "non-fermented" cacao beans. Finally, the third cluster implies that "chocolate" industry commercialises only "non-fermented" cacao beans (100% of the observations). Therefore, it is located further down this point.

Figure 5-4. Anatomy of CAFS's industries: bean



This "anatomical map" confirms that each of the CAFS's industries carries out specialised activities. That is, the "farming" industry focuses on production of "fresh" cacao (raw material) and supplies to the "curing" industry which in turn produces the "fermented" cacao bean and supplies to the "wholesaling" industry. The pattern that CONADECA set more than 20 years ago is still valid without significant changes (ASERCA, 1991). However, an especial remark arises from this analysis. "Curing" and "wholesaling" industries commercialised both types of cacao bean: "fermented" and non-fermented". The fact that "curing" industry commercialises both types of cacao is surprising. This confirms the existence of farmers who produce "non-fermented" cacao as well but these particular farmers have not been reflected in the number of observations in the farming industry. The fact that the "wholesaling" industry manages both types of cacao beans would suggest that there are especial niches for both types of cacao in the Mexican market. However, the presence of "non-fermented" cacao bean means that the highest level of cacao quality is not fully achieved.

Finally, "chocolate" organisations indicate that they prepare their products with "non-fermented" cacao beans. This particular remark characterises the chocolate industry as an artisanal production. The fact that some "chocolate" industries commercialise "non-fermented" cacao confirms that their internal cacao production cannot be totally transformed. Therefore, they introduce "non-fermented" cacao production in the domestic supply chain.

Quality of cacao bean

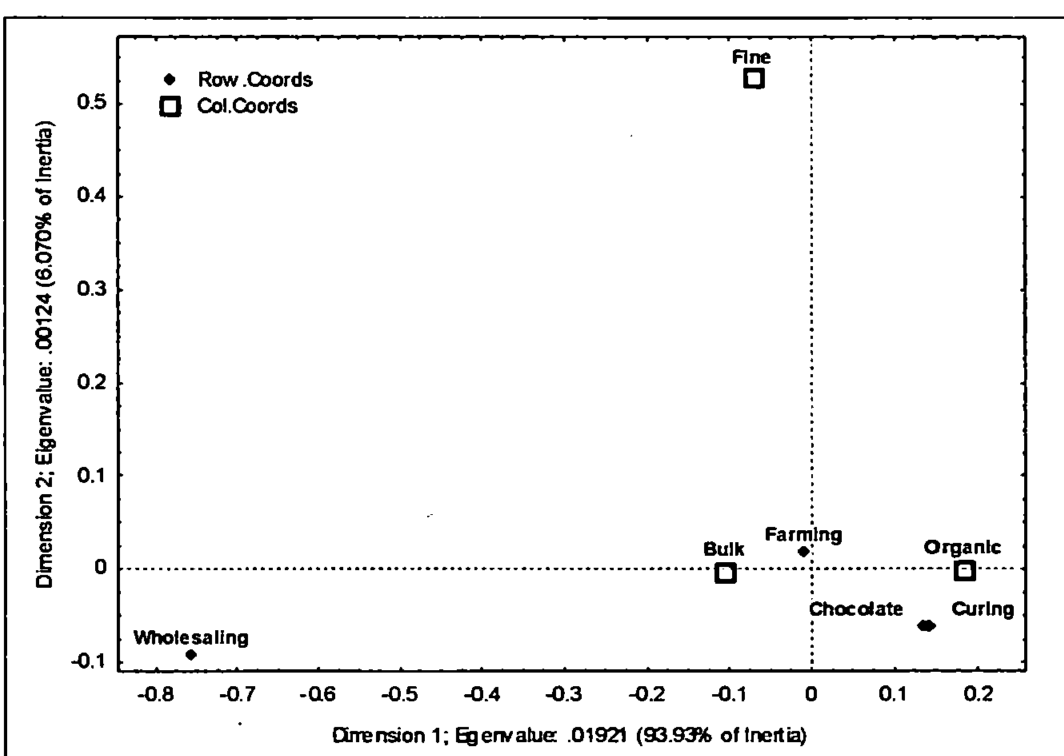
The quality of cacao bean is discussed below. Figure 5-5 shows the anatomical map of the industries and the quality of cacao beans: bulk, organic and fine. The anatomical map was constructed from a 2-dimensional solution by employing "correspondence analysis" (Eigenvalues: .0192 and .0012; total chi-square=4.62, df=6, p=.59). This solution explains 100% of the inertia and leads to the conclusion that distributions of the categories of "quality of cacao bean" are the same for all categories of industries. Dimension 1 (horizontal axis) accounts for 94% of the inertia. Dimension 2 (vertical axis) accounts for 6% of the inertia. Therefore, dimension 1 is the most important axis, explaining most of the differences between spatial patterns of row points and column points. Both row and column coordinates are represented quite well in the 2-dimensional solution; that is the quality for all points is 1 (the highest value). The row points that contribute most to the overall inertia are those representing the "wholesaling" and "curing" industries (0.75% and 19% respectively) and the column points that contribute most are those representing the "organic" and "bulk" cacao beans (60% and 34% respectively) (Appendix B).

The analysis of this anatomical map is as follows (Figure 5-5). The map can be divided into 2 clusters by considering the importance of dimension 1. The first cluster is located at the left side of the vertical axis. This cluster consists of "bulk" quality and the "farming" industry. The second cluster is located at the left side of the vertical axis. This cluster consists of "organic" quality, "curing" and the "chocolate" industry. Furthermore, the "wholesaling" industry, is located farthest left of the horizontal axis. By considering the dimension 2 (vertical axis), "fine" quality is located farthest up of the vertical axis.

This first cluster suggests that the "farming" industry is related to "bulk" quality. However, the presence of organic farmers pulls this point to the right (64% and 35% of the observations respectively). Furthermore, the "farming" industry also is slightly pulled up by the presence of a farmer who has "fine" quality cacao (1% of the observations). The second cluster suggests that the "curing" and "chocolate" industries are related to "bulk" and "organic" quality (57% and 43% of the observations). The absence of any "fine" quality cacao pushed both industries down. Finally, the position of the "wholesaling" industry suggests a remarkable difference between it and other industries. Such a difference is based on the presence of only "bulk" quality cacao (100% of the observations).

This anatomical map confirms all industries manage "bulk" quality. However, although the "farming" industry concentrates mainly on "bulk" quality production, it also manages "organic" quality beans. Furthermore, one farmer produces "fine" cacao. In brief, the "farming" industry has two strategies to improve quality by producing both "organic" and "fine" cacao. Both strategies seem to be appropriate to increase the income of farmers, and to improve their managerial capabilities. Further studies would be needed to corroborate the influence of "quality". The "chocolate" and "curing" industries also manage "bulk" quality and "organic" quality (57% and 43% of the observations respectively). None of these industries manage "fine" cacao.

Figure 5-5. Anatomy of CAFS's industries: quality



It is important to mention that the "organic" quality position stems from the "organic" programs implemented by NGOs and government in the last four years. By the time this research was carried out, none of the farmers had placed cacao beans in the "organic" market. Therefore, their production had been paid as "bulk". However, in 2006, some farmers started to sell "organic" cacao beans in the European market, especially Germany.

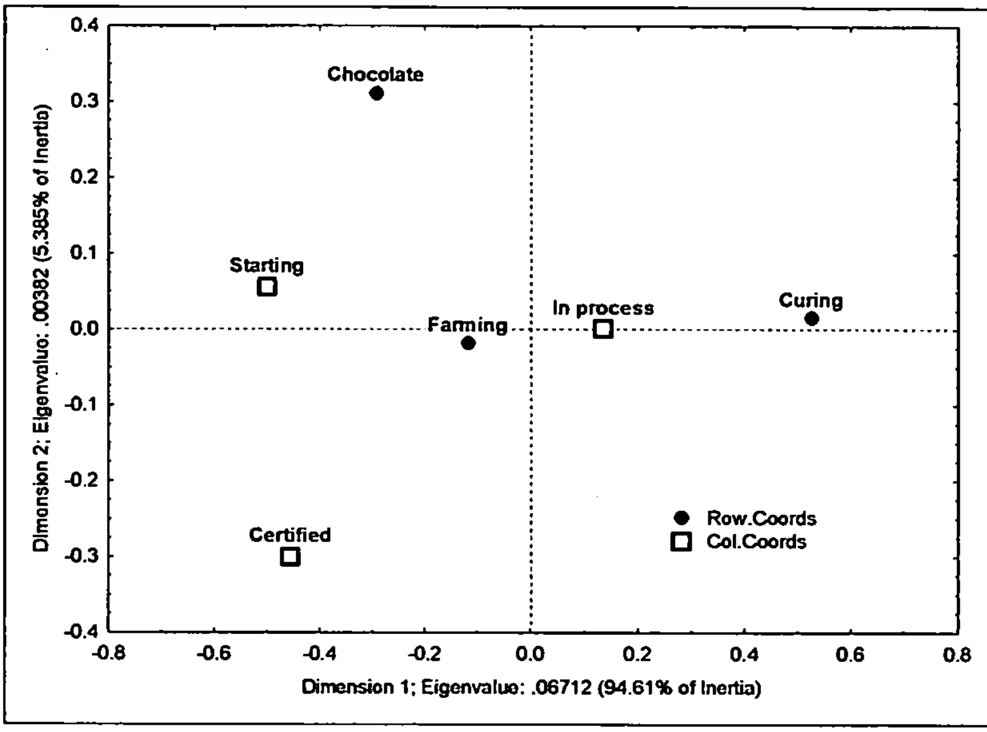
Finally, the position of the "wholesaling" industry shows that it concentrates exclusively on "bulk" quality (100% of the observations). Quality is based on fermentation which is a "commodity" standard. By the time this study was carried out, this industry seemed not to be interested in "organic" cacao at all. This attitude will change in the future, so a further investigation will be needed.

Participation in organic cacao program

The farmer's participation in the organic cacao program is discussed below. Figure 5-6 shows the anatomical map of "farming", "curing" and "chocolate" industries and the participation in the "organic" cacao program: "starting" (1 year), "in process" (2-3 years), and "certified" on organic production. The anatomical map was constructed from a 2-dimensional solution by employing "correspondence analysis" (Eigenvalues: .0671 .0038; total chi-square=5.88, df=4 p=.2077). This solution explains the 100% of the inertia and suggests that distributions of the categories of "participation in organic cacao program" are the same for all categories of industries. Dimension 1 (horizontal axis) accounts for 94.6% of the inertia. Dimension 2 (vertical axis) accounts for 5.4% of the inertia. Therefore, dimension 1 is the most important axis, explaining most of the differences between the spatial patterns of row points and column points. Both row and column coordinates are represented quite well in the 2-dimensional solution; that is, the quality for all points is 1 (the highest value). The row points that contribute most to the overall inertia are those representing the "curing" and "farming" industries (0.75% and 15% respectively) and the column points that contribute most are those representing the "starting" and "in process" (64% and 21% respectively) (Appendix B).

The analysis of this anatomical map is as follows (Figure 5-6). The map can be divided into 2 clusters by considering the importance of dimension 1. The first cluster is located at the right side of horizontal axis and near the origin. This cluster consists of "in process" participation and "curing" industry. The second cluster is located at the right side of the horizontal axis. This cluster is characterised by the points "starting" and "certified" participations and "farming" and "chocolate" industries. By considering the dimension 2 (vertical axis), it seems that the "chocolate" industry and "certified" participation are moved farther from the horizontal axis. All this suggests that "farming" is inside a triangle which consists of all categories of participation "starting", "in process", and "certified" (22%, 73%, 5% of the observations respectively), the "curing" industry has only "in process" participation (100% of the observations) and chocolate has both "starting" and "process" participation (33% and 67% of observations).

Figure 5-6. Anatomy of CAFS's industries: participation in the organic cacao program



This anatomical map confirms that most of the organisations of the industries in the organic cacao program are in the process of reaching the certification (in process). However, now it is clear that the process of certification is slightly variable particularly in the farming industry, so a full certification will be achieved in different periods.

On the other hand, the "curing" industry is homogenous, so it seems that all these plants will be certificated at the same time. Whilst the government is supporting some "curing" plants to adapt their facilities into "organic" standards, NGOs are also doing the same. The government initiative has been implemented in the mentioned monopoly cooperative structure (UNPC), and the NGO initiative looks at special farmer targets (SAGARPA, 2002; Gonzalez, 2004). There are many "curing" plants under the middleman network that are not participating in the organic cacao program. Therefore, a change in this network is to be expected, once the organic production flows to the market.

Finally, there are some organisations in the "chocolate" industry which are participating in the organic cacao program. This also confirms the especial interaction between farming and agro-industrial activities of this particular industry.

Destination

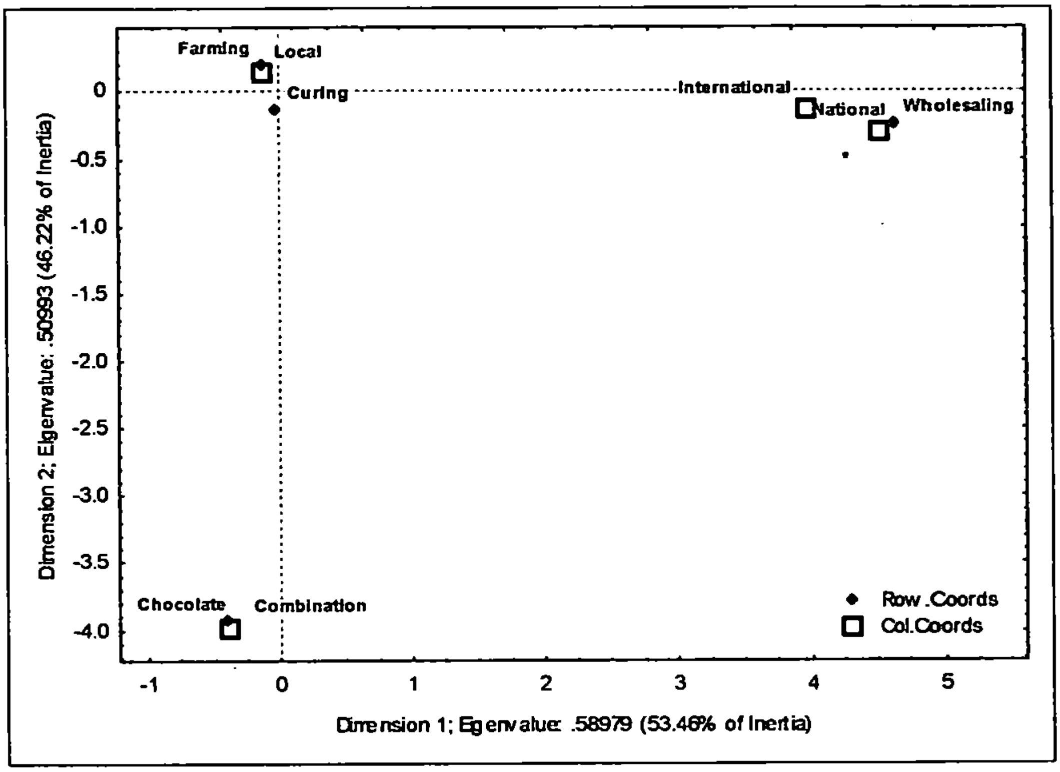
The destination of cacao products is discussed below. Figure 5-7 shows the anatomical map of the CAFS's industries and the destination of cacao products i.e. "local", "national", "international" and "combination" (local and national). The anatomical map was constructed from a 2-dimensional solution by employing a "correspondence analysis" (Eigenvalues: .5898, .5099 and .0034; total chi-square=249.314, df=9, $p<0.001$). This solution explains the 99.69% of the inertia and implies that distributions of the categories of "destination" are not the same for all categories of industries. Dimension 1 (horizontal axis) accounts for 53% of the inertia. Dimension 2 (vertical axis) accounts for 46% of the inertia. Therefore, the differences between spatial patterns of row points and column points are explained by both dimensions. Both row and column coordinates are represented quite well in the 2-dimensional solution; that is the quality for most points are above 0.9 (the highest value is 1). However, the "curing" industry has the lowest value, 0.51. The row points that contribute most to the overall inertia are those representing the "wholesaling" and "chocolate" industries (52% and 44% respectively) and the column points that contribute most are those representing the "combination", "national" and "international" destinations (45%, 33% and 19% respectively) (Appendix B).

The analysis of this anatomical map is as follows (Figure 5-7). The map can be divided into 3 clusters by considering the importance of both dimensions. By considering dimension 1, the first cluster is located at the origin of the axis. This cluster consists of "local" destination and "farming" and "curing" industries. The second cluster refers to the points that are farthest to the right side of horizontal axis i.e. "international" and "national" destinations and "wholesaling" industry. By considering the dimension 2, the last cluster refers to the points that are farthest to the bottom of the vertical axis i.e. "combination" destination and "chocolate" industry.

The first cluster suggests that the "farming" and "curing" industries are mainly addressing the "local" destinations which account for 99% and 92% of total observations. The "curing" industry seems to be pulled down by the "combination" destination and pulled right by the "national" destination (5% and 3% of the total observations respectively). On the other hand, there is a minimal mismatch between the "farming" industry and the "local" destination, so this is explained by the presence of a farmer who exports his cacao beans. This is discussed later.

The second cluster suggests a clear separation of the "wholesaling" industry which commercialises cacao beans at both "national" and "international" destinations (50% and 33% of the total observations respectively). The last cluster suggests that the "chocolate" industry mainly allocates its production at both "local" and "combination" destinations (29% and 71% of the total observations respectively).

Figure 5-7. Anatomy of CAFS's industries: destination of production



This anatomical map confirms that all categories of industries have different destinations for the allocation of their products. Therefore, the "farming" industry mainly placed its production at "local" destination. Nevertheless, there was a single case which exports its cacao beans to the European market and in turn produces a particular cacao bean: fine. The features of this particular farmer are discussed in the next section. The "curing" industry also largely allocates its product at "local" destination. However, there are some slight differences and some organisations have succeeded in allocating their products in national markets. This phenomenon is particular interesting because it would imply a positive change which shows more participation in the development of a strategy to attract value from the market.

The "wholesaling" industry is also relevant in this new arrangement. The UNPC cannot export its cacao beans because it does not have the economic capacity to deal with this activity. Some reasons have already been discussed in section 4.2.2. In fact, the UNPC allocates its products locally in Tabasco. Therefore, "private" wholesalers are those who control the distribution at national and international markets. Furthermore, some of these wholesalers are, in fact, grinding industries located in Veracruz (a port regulated by NAFTA). These "grinding" industries process the cacao and introduce their intermediate products as follow cacao powder to the national market and cacao butter to the international market. This finding is very interesting because it leads to questions about the quality of Mexican cacao and the operational gap between production and consumption in Mexico which was discussed in subsection 4.2.1 and is highlighted here too.

The "chocolate" industry firstly concentrates on "local" and then on "national" markets. As mentioned before, its products are considered artisanal, and in most of the cases these products are offered as "souvenirs". From this product perspective, it is possible to understand why the local market is more attractive for these small family firms.

5.2.2. By-products and agro-products

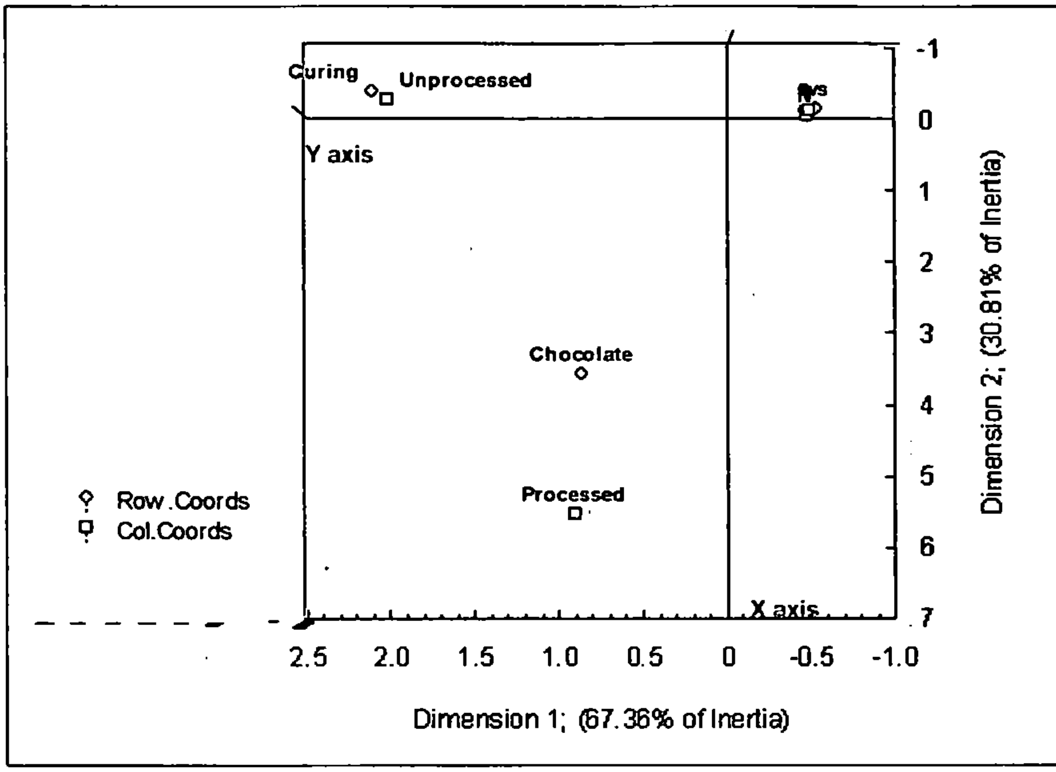
This subsection discusses the "anatomical element" related to the by-products of cacao used or commercialised by the CAFS's industries. Two variables were considered to analyse the anatomy of the CAFS: (i) cacao by products and (ii) agro-products.

Cacao by-products

The analysis of cacao by-products is discussed below. Figure 5-8 and Figure 5-9 show the anatomical map of the CAFS's industries and the level of application of cacao "by-products" i.e. "none"-application, "internal" application (domestic use), sold as "unprocessed" product sand sold as "processed" product. The anatomical map was constructed from a 3-dimensional solution by employing "correspondence analysis" (Eigenvalues: .91, .41 and .03; total chi-square=306.03, df=9 $p<0.001$). This solution explains the 100% of the inertia and that distributions of the categories of "by-products" are not the same for all categories of industries. Dimension 1 (Y axis) accounts for 67.3% of the inertia. Dimension 2 (X axis) accounts for 30.8% of the inertia. Dimension 3 (Z axis) accounts for 1.8% of the inertia. Therefore, the differences between spatial patterns of row points and column points are explained by dimensions 1, 2 and 3. That is, the quality for all points is 1 (i.e. the highest value). The row points that contribute most to the overall inertia are those representing the "curing", "chocolate" and "farming" industries (55%, 31% and 12% respectively) and the column points that contribute most are those representing the "unprocessed", and "processed" applications (54% and 31% respectively) (Appendix B).

The analysis of this anatomical map is as follows (Figure 5-8). The map can be divided into 3 clusters by considering the importance of dimensions 1 and 2.

Figure 5-8. Anatomy of CAFS's: applications of cacao by-products (X-Y axis)



The first cluster refers to the points that are farthest to the positive values of Y axis i.e. "unprocessed" application and the "curing" industry. The second cluster refers to the points that are farthest to the positive values of X axis i.e. "chocolate" industry and "processed" application. The points that belong to the third cluster are located near to the origin of X-Y axes and almost share the same negative coordinates at X and Y axes (Figure 5-8). As shown, the visualisation of the points of clusters 3 on the X-Y plane is poor. It is necessary to look at the Z axis to distinguish cluster 3 (Figure 5-9). Considering the Z axis, it is possible to see that the third cluster consists of "none" and "internal" applications and the "farming" industry. All these points are closer to the "0" value of Z. Furthermore, an isolated point is also shown i.e. "wholesaling" industry that is farthest to the top of the Z axis (Figure 5-9). Dimension 3 explains this particular position of the "wholesaling" industry.

Figure 5-9. Anatomy of CAFS's: applications of cacao by-products (Z axis)

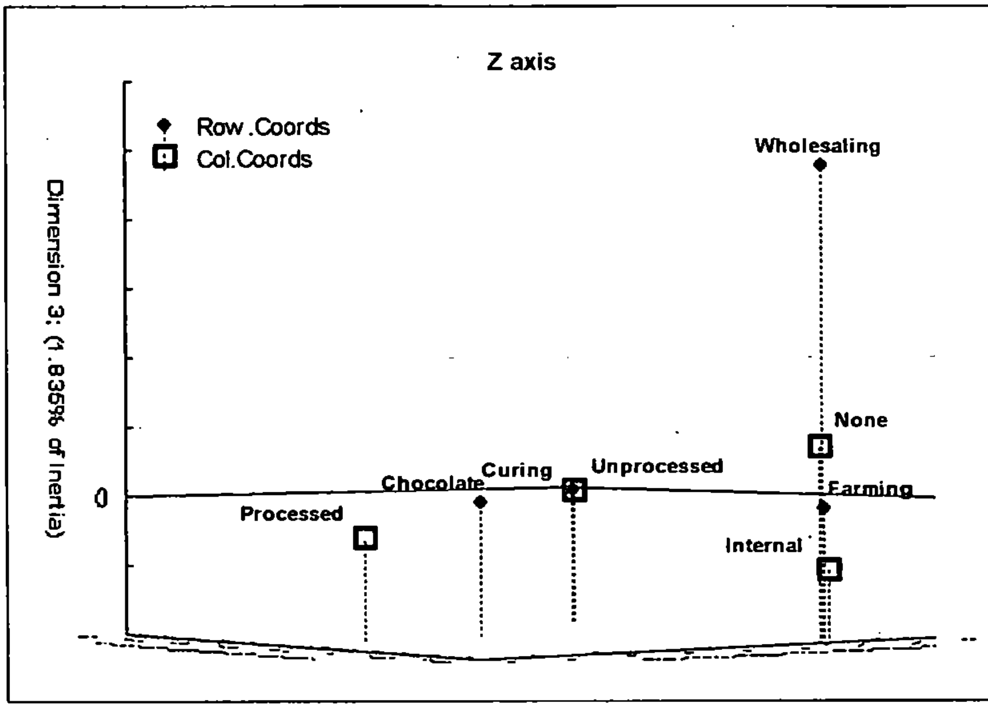
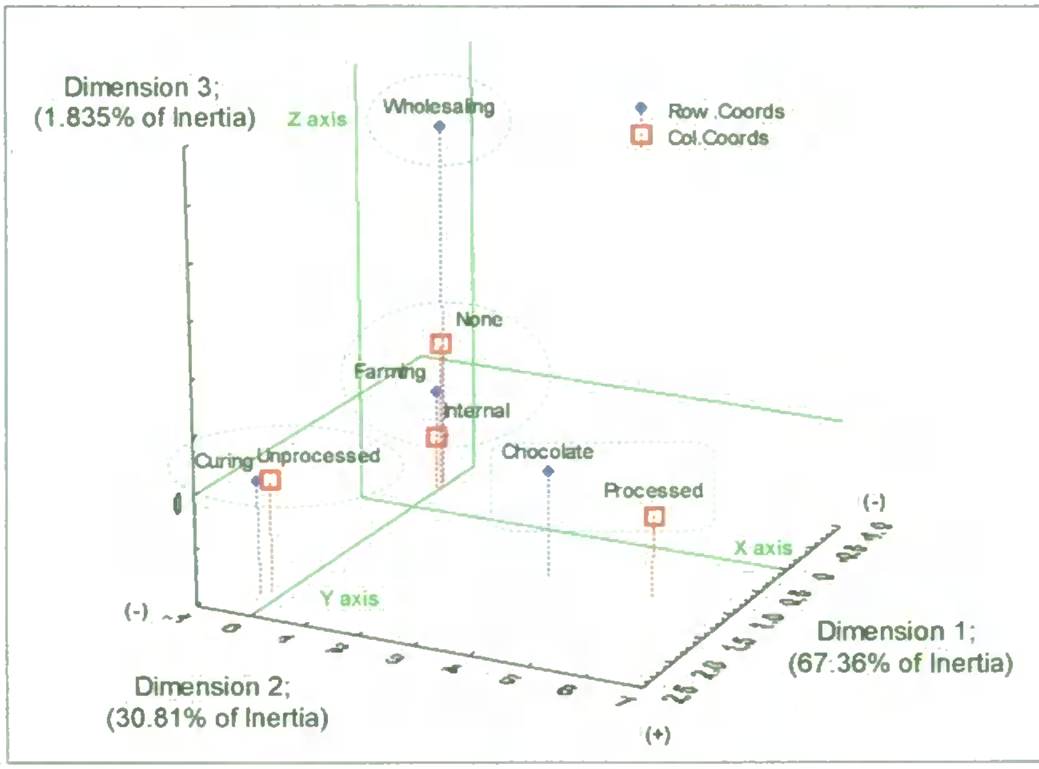


Figure 5-10 shows the solution on a 3D-graph. The first cluster suggests that the "chocolate" industry mainly processes and commercialises cacao by- products (43% of the total observations). The nature of these products is explained later. The second cluster suggests that the "curing" industry largely commercialises "unprocessed" cacao by-products (100% of the observations), so these products are sold as raw materials. The nature of such by-products is discussed later. The third cluster shows that the "farming" industry has both types of applications: "none" and "internal" (56% and 43% of total observations respectively). Finally, the extreme position of the "wholesaling" industry suggests that this industry does not have any application of cacao by-products (100% of the total observations). Therefore, it is pushed further up the Z axis.

This anatomical map confirms that each firm caries out different activities dedicated to the use of cacao by-products. Therefore, there is a potential to incorporate the production, processing and commercialisations of more by-products in each industry of CAFS.

Figure 5-10. Anatomy of CAFS's industries: applications of cacao by-products (X-Y-Z axis)



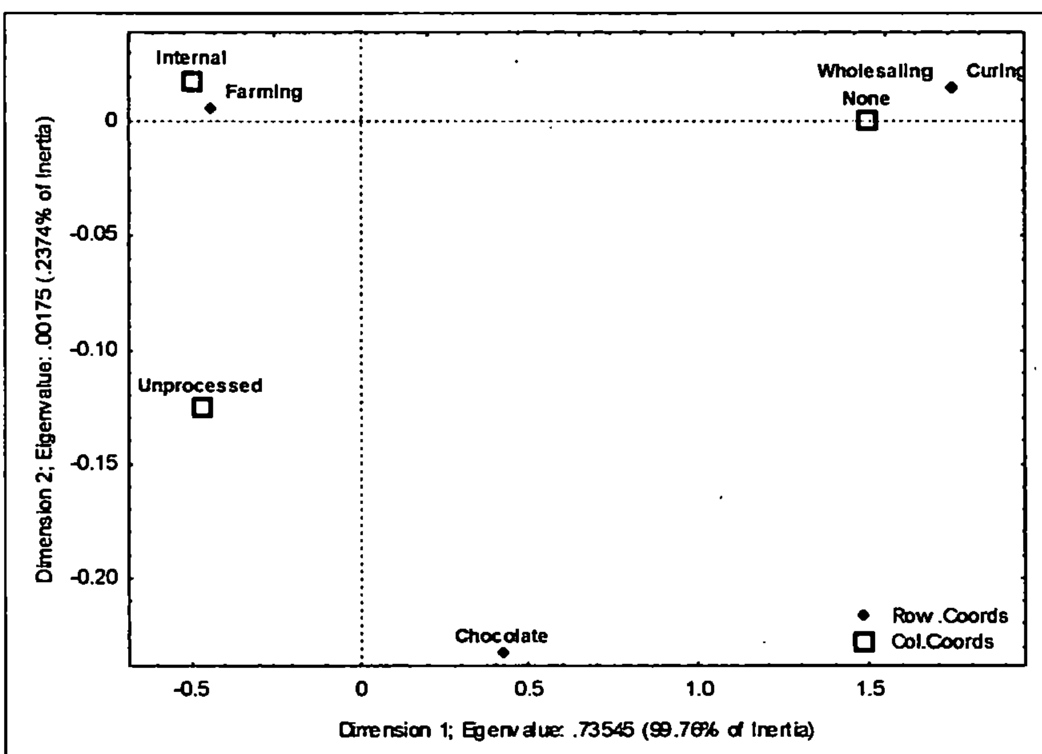
It is important to highlight that each industry has its own by-products. For instance, the cacao pod is the main by-product in the "farming" industry and is used by farmers as an ingredient to produce compost for organic production and to feed livestock. Cacao nib and sweating are the main by-products of the "curing" industry. Cacao nib is sold to either local "chocolate" firms or "pozolerias" (small business which prepare a traditional beverage made of cacao and maize). Sweating does not have any use, so it is discharged from the "curing" plant. The "chocolate" industry has developed knowledge of sweating, so the potential for it being processed is high. Other important "by-products" in chocolate industry are broken nib and shell, which are sold to the cigarette and poultry industries. The potential to increase the use of such by-products is low, because of the size of the "chocolate" industry. Finally, the pulp of cacao has been used by the "chocolate" industry to prepare some jams. They still need to be improved, but the local people already consume this particular processed by-product.

Agro-products

The level of utilisation of cacao "agro-products" is discussed below. Figure 5-11 shows the anatomical map of the CAFS's industries and the level of utilisation of cacao "agro-products" i.e. "none" utilisation, "internal" utilisation (domestic use), sold as "unprocessed" products and sold as "processed" products. The anatomical map was based on a 2-dimensional solution employing "correspondence analysis" (Eigenvalues: .73 and .0018; total chi-square=166.60, df=6, $p<0.001$). This solution explains the 100% of the inertia and that distributions of the categories of "agro-products" are not the same for all categories of industries. Dimension 1 (horizontal axis) accounts for 99.8% of the inertia. Dimension 2 (vertical axis) accounts for 0.2% of the inertia. Therefore, dimension 1 is the most important axis, explaining most of the differences between spatial patterns of row points and column points. Both row and column coordinates are represented quite well in the 2-dimensional solution; that is the quality for all points is 1 (i.e. the highest value). The row points that contribute most to the overall inertia are those representing the "curing", "farming", and "wholesaling" industries (67%, 21% and 11% respectively) and the column points that contribute most are those representing the "none", and "internal" utilisations (75% and 22% respectively) (Appendix B).

The analysis of this anatomical map is as follows (Figure 5-11). The map can be divided into 2 clusters by considering the importance of dimension 1. The first cluster is located at the left side of horizontal axis. This cluster consists of "internal" agro-products and the "farming" industry. The second cluster refers to the points that are farthest to the right on the horizontal axis. This cluster is characterised by "none" agro-products, and the "curing" and "wholesaling" industries. By considering dimension 2, a third cluster is highlighted and refers to the points that are farthest down on the vertical axis. This cluster consists of the "chocolate" industry and "unprocessed" agro-products.

Figure 5-11. Anatomy of CAFS's industries: utilisation of agro-products



This first cluster suggests that the "farming" industry produces mainly agro-products for "internal" consumption (86% of the total observations). However, it was also observed that some farmer sell these agro-products as raw materials (12% of the total observations). The second cluster suggests that the "curing" and "wholesaling" industries are not producing or commercialising any agro-product (100% of the total observations respectively). The last cluster suggests that the "chocolate" industry produces and commercialises agro-products (75% of the total observations). However, these agro-products are mainly "unprocessed" (14% of the total observations). There are some "chocolate" firms that do not produce any agro-products (43% of the total observations).

This result confirms that production and commercialisation of agro-products are carried out in two industries: "farming" and "chocolate".

Farmers normally carry out activities oriented to utilise the agro-ecological diversity of cacao. The level of utilisation, however, is mainly "internal". The agro-products in the "farming" industry include fruit crops, medicinal plants, timber, honey, and bushmeat. The biological species related to these agro-products are mentioned in the next section. Ornamental plants were not identified. This result confirms the findings by some authors, who have identified several ornamental plants (mainly orchids), but the farmer does not realise their value. In brief, there is a potential to diversify the cacao system by considering the empirical knowledge of farmer. Therefore, projects based on farmer and scientific participation would be very fruitful. This study has some interesting cases that can be used for this purpose.

As mentioned before, there is a high participation of the "chocolate" industry in the utilisation of agro-products. There are two reasons for this: (i) the nearness of such firms to urban populations and (ii) the close interaction with customers who ask for new products. The agro-products include honey, ornamental plants, and tourism services. The latest is quite an innovative product: cacao-chocolate tourism. The government has fostered this new "product", and some "chocolate" firms have been benefited. However, it is needed a full evaluation about its effects.

Finally, the "wholesaling" and "curing" industry has not realised the potential of the cacao system. They concentrate on cacao beans. However, they would be the cornerstone that would connect the market and agro-products. This would help them to fully employ their facilities and resources which have idle periods due to the inherent seasonal production of cacao. Some private organisations manage different products. For instance, cacao and pepper are very compatible because they have different harvesting seasons. Middlemen combine "curing" activities with other activities such as aquaculture, sugar cane production, livestock, etc. Therefore, the potential to diversify agro-products based on the cacao system is feasible.

In brief, the identification of these differences would help researchers and potential users to know more about these products. The information about quantities and qualities of such products is still unclear. Each "industry" has different ways of diversifying production, so a sharing process would serve as a starting point and lead to increased awareness.

5.2.3. Interaction between CAFS's industries

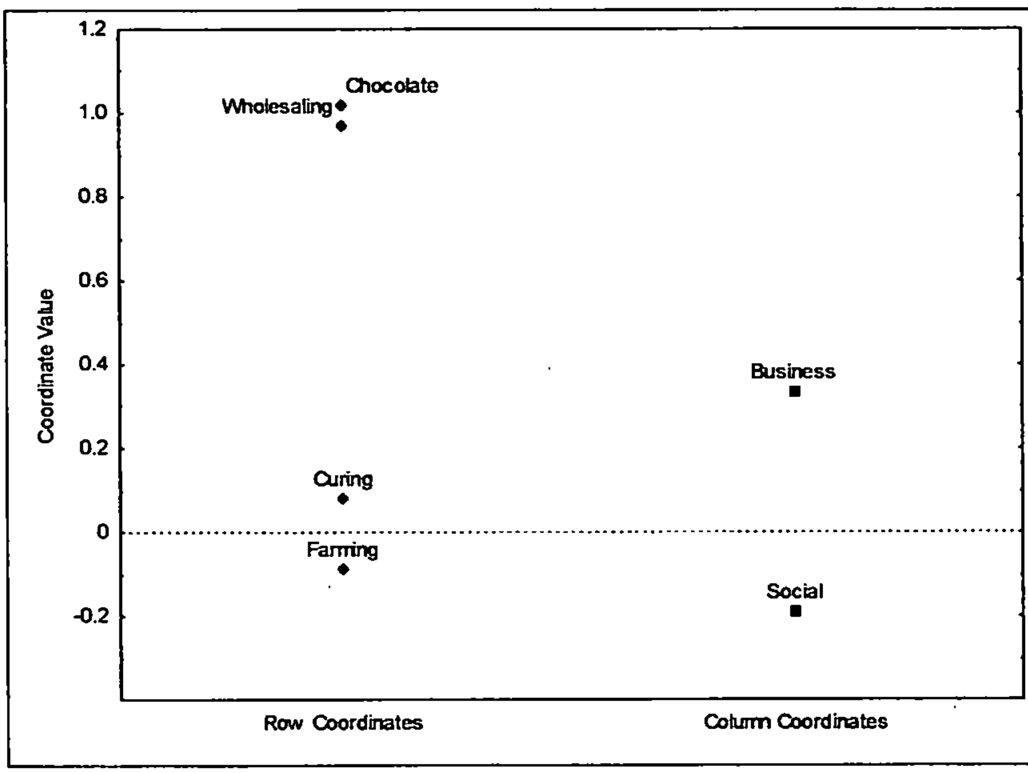
This subsection discusses the "anatomical element" related to the interactions between CAFS's industries. Four variables were considered in the analysis of the anatomy of the CAFS: (i) type of association (ii) type of commercialisation structure, (iii) type of contract and, (iv) type of supporting activities.

Association

The analysis of type of association between the CAFS's industries is discussed below. Figure 5-12 shows the anatomical map of the CAFS's industries and the type of association. Two categories have been used in this variable: "social" association and "business" association. The anatomical map was constructed from a 1-dimensional solution by employing "correspondence analysis" (Eigenvalues: .06; total chi-square=14.49, df=3, p<.01). This solution explains the 100% of the inertia and elucidates that distributions of the categories of "association" are not the same for all categories of industries. Dimension 1 (horizontal axis) accounts for 100% of the inertia. Therefore, dimension 1 is the most important axis, explaining most of the differences between the spatial patterns of row points and column points. Both row and column coordinates are represented quite well in the 1-dimensional solution; that is the quality for all points is 1 (i.e. the highest value). The row points that contribute most to the overall inertia are that representing the "chocolate", "wholesaling" and "farming" industries (50%, 39% and 10% respectively) and the column points that contribute most are that representing the "business", and "social" association (63% and 37% respectively) (Appendix B).

The analysis of this anatomical map is as follows (Figure 5-12). The map can be divided into 2 clusters by considering the importance of dimension 1. The first cluster is located above the horizontal axis. This cluster consists of "business" association, and the "chocolate", "wholesaling" and "curing" industries.

Figure 5-12. Anatomy of CAFS's industries: type of association



The second cluster refers to points that are located below the horizontal axis. This cluster is characterised by "social" association and the "farming" industry. The first cluster suggests that the "curing", "wholesaling" and "chocolate" industries are mainly based on "business" association (41%, 83 % and 86% of the total observations respectively). The second cluster suggests that the "farming" industry is mainly based on a "social" association (68% of total observations). However, since

59% of the total observations of the "curing" industry are related to "social" association, this industry seems to be also pulled down and is near to the axis.

This result confirms that whilst the "farming" and "curing" industries share a "social" association, the "wholesaling" and "chocolate" industries are related mainly to a "business" association.

The "farming" industry has a "social" relationship with its upward linkage i.e. the "curing" industry. Cordova (2001) highlights that this association relies on a "cooperative" philosophy promoted in the 40's and 60's by the government. Nevertheless, it is also clear that the "business" association is pulling the "farming" industry up. This is explained by the number of farmers that bring their cacao to such curing plants when the transaction conditions are more favourable. The "curing" plants managed by farmers are failing to provide the best transaction conditions. Defaulting is the main cause for such attitude. The "social" association is permuted for a more practical and discrete relationship.

As mentioned in section 4.2.2, the "curing" industry has been affected by the new wholesalers and the weak position of the UNPC. Therefore, the "curing" industry is higher up the horizontal axis. A "business" association is more predominant in this industry. This effect will tend to increase in the long term if the UNPC does not professionalise the "curing" plants. Management training is considered by many authors as the best solution to this phenomenon of defaulting (Ramirez, 1997; Cordova, 2001).

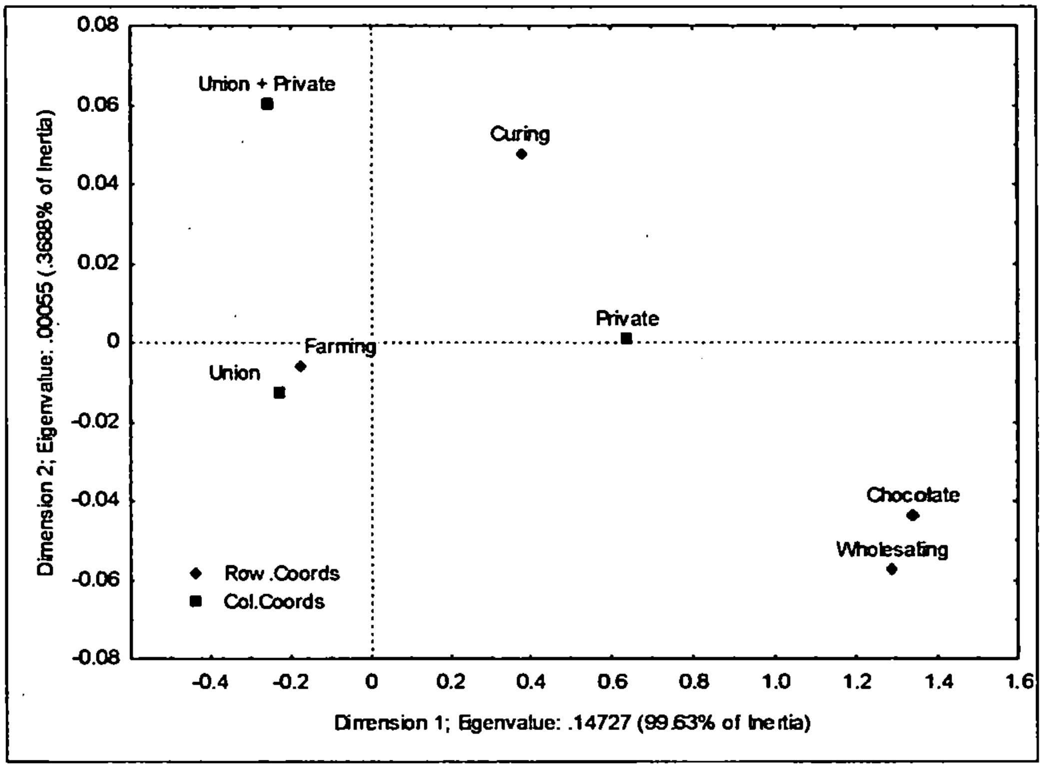
Finally, the "wholesaling" and "chocolate" industries have only "business" associations with their upward linkages. Therefore, the "wholesaling" industry dramatically influences the whole CAFS. In contrast, "chocolate" industry does not have such power, and still struggles with the "business" association between them and the customer.

Structure

The structure of commercialisation is discussed below. Figure 5-13 shows the anatomical map of the industries and the structure of commercialisation i.e. "union" structure, "private" structure and "union+private" structure. The anatomical map was constructed from a 2-dimensional solution by employing "correspondence analysis" (Eigenvalues: .14 and .0005; total chi-square=33.40, df=6, p<0.001). This solution explains the 100% of the inertia and leads to consider that distributions of the categories of "structures" are not the same for all categories of industries. Dimension 1 (horizontal axis) accounts for 99.6% of the inertia. Dimension 2 (vertical axis) accounts for 0.4% of the inertia. Therefore, dimension 1 is the most important axis, explaining most of the differences between the spatial patterns of row points and column points. Both row and column coordinates are represented quite well in the 2-dimensional solution; that is the quality for all points is 1 (i.e. the highest value). The row points that contribute most to the overall inertia are those representing the "chocolate" and "wholesaling" industries (38% and 30% respectively) and the column points those contribute most are that representing the "private" and "union" structures (73% and 21% respectively) (Appendix B).

The analysis of this anatomical map is as follows (Figure 5-13). The map can be divided into 2 clusters by considering the importance of dimension 1. The first cluster is located at the left side of the horizontal axis. This cluster consists of ""union" and "union+private" structures and the "farming" industry. The second cluster is located at the right side of the horizontal axis. This cluster consists of "private" structure and the "curing" "chocolate" and "wholesaling" industries. Dimension 2 explains the vertical position of "union+private" structure and the "curing" industry.

Figure 5-13. Anatomy of CAFS's industries: structure of commercialisation



This first cluster suggests that the "farming" industry is highly related to the "union" structure (68% of the total observations). However, it is possible to observe that "farming" is pulled up to "union+private" which accounts for 19% of the total observations. The second cluster suggests that the "curing" industry has both types of structures: "union+private" and "private" (46% and 43% of the total observations respectively).

Finally, the third cluster suggests that the "wholesaling" and "chocolate" industries are mainly based on "private" structures (83% and 86% of the total observations respectively).

This anatomical map confirms that each industry uses different structures to distribute their production. Therefore, the "farming" industry concentrates on "union" structure and nowadays is using the structure "private" or its combination with "union". This would be explained by the managerial problems that the UNPC still has and such problems have led farmers to seek private alternatives. An additional explanation about this phenomenon is further discussed in section 7.2.

The "curing" industry has transformed itself and now "private" structure covers the same proportion of "union" structure. For instance, some "curing" plants that belong to UNPC are combining sales between the UNPC and the "private" structure. However, one question arises from all this, why does UNPC still have control of 30% of the cacao production. This is discussed in the next analysis.

Finally, the "chocolate" and "wholesaling" industries uses the "private" structure to distribute their products.

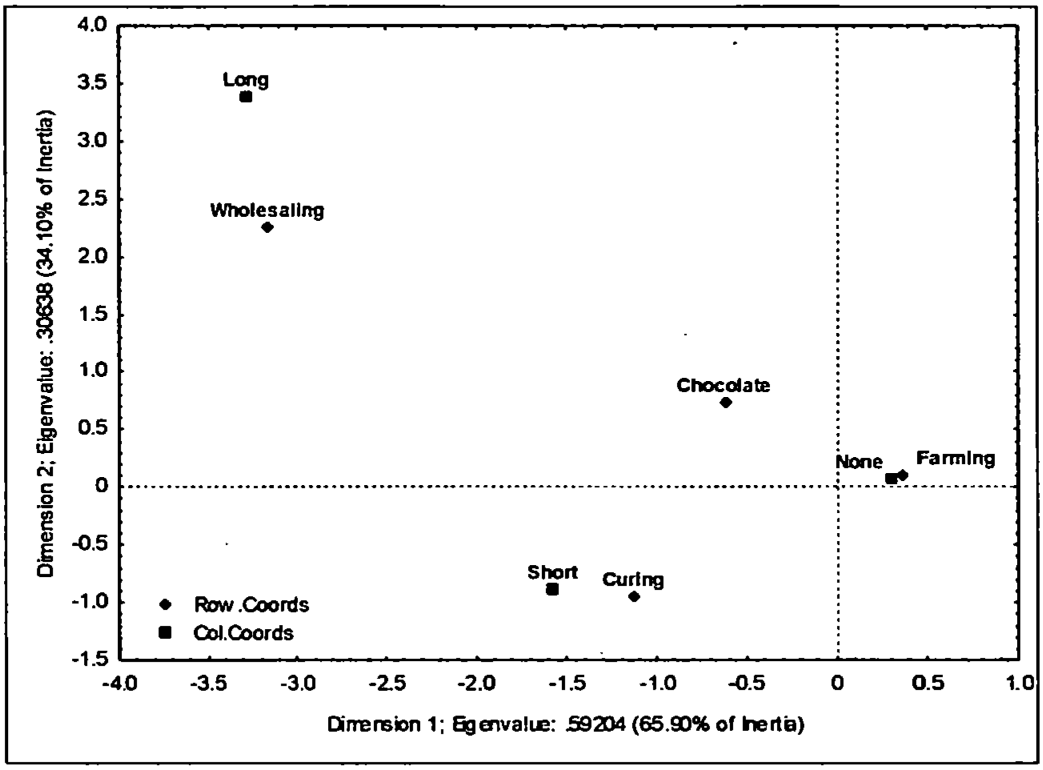
Contract

The type of contract between buyer and supplier is discussed below. Figure 5-14 shows the anatomical map of the CAFS's industries and the type of contract between buyer and supplier i.e. "none" contract, "short" contract and "long" contract. The anatomical map was constructed from a 2-dimensional solution by employing "correspondence analysis"

(Eigenvalues: .59 and .30; total chi-square=203.04, df=6, p<0.001). This solution explains the 100% of the inertia and implies that distributions of the categories of "contract" are not the same for all categories of industries. Dimension 1 (horizontal axis) accounts for 65.9% of the inertia. Dimension 2 (vertical axis) accounts for 34.1% of the inertia. Therefore, both dimensions are the most important axes, explaining most of the differences between the spatial patterns of row points and column points. Both row and column coordinates are represented quite well in the 2-dimensional solution; that is the quality for all points is 1 (i.e. the highest value). The row points that contribute most to the overall inertia are those representing the "wholesaling" and "curing" industries (45% and 40% respectively) and the column points that contribute most are those representing the "short" and "long" contracts (47% and 44% respectively) (Appendix B).

The analysis of this anatomical map is as follows (Figure 5-14). The map can be divided into 2 clusters by considering the importance of both dimensions. The first cluster is located closer to the origin of both axes. This cluster consists of "none" contract, and the "farming" industry. The second cluster refers to the remaining points that are at the left side of the horizontal axis. By considering the dimension 2, it is possible to differentiate between the "curing" and "wholesaling" industries. The first cluster suggests that "farming" industry is mainly related to "none" contract (99% of the total observations). Although, the "chocolate" industry is related to "long" and "short" contracts (14% and 14% of the total observation respectively), its relative nearness to the "none" point shows that it is also influenced by this type of contract category (71% of the total observations).

Figure 5-14. Anatomy of CAFS's industries: type of contract



The second cluster suggests that the other industries are related to "short" and "long" contracts. Dimension 2 helps to differentiate the "curing" industry (which is related mainly with "short" contract, 62% of the observations) and the "wholesaling" industry (which is related to both contracts, 50% of the observations respectively).

This anatomical map confirms that each industry uses different types of contracts to commercialise its products.

There is an informal relationship between the "farming" industry and the other CAFS's industries. This informal relationship can be seen also in both supply structures "union" and "private". Therefore, it is suggested that farmers depend largely on the good practices of their buyers. That was one of the reasons to create and foster a union of farmers, however it seems that this strategy needs to be examined and improved.

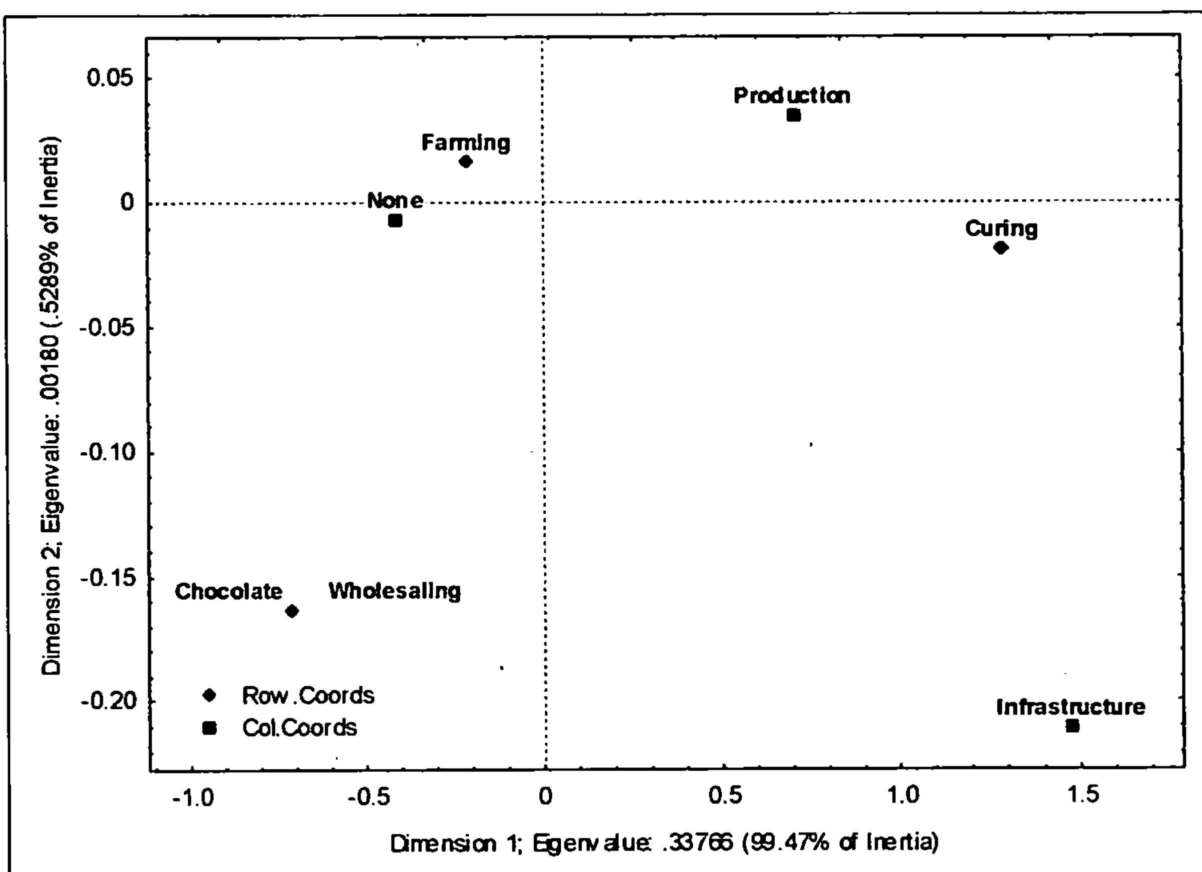
The "curing" industry has contracts because of the volume of production. "Short" contracts are the most preferred and are given by the "wholesaling" industry of the "private" structure of commercialisation. This type of contracts helps the "curing" industry to operate during a production cycle. The UNPC works differently because of the legal configuration. The "contract" is based on the legal terms of the association. Therefore, this type of "curing" plant is forced to sell products to the UNPC.

The "wholesaling" industry has established "long" term contracts with their customers. Therefore, this industry can design and control its production on a long term basis. The same pattern is seen in the "chocolate" industry. However, there are also a number of firms that do not have any contracts with their buyers.

Support

The type of support between buyer and supplier is discussed below. Figure 5-15 shows the anatomical map of the CAFS's industries and the type of support between buyer and supplier i.e. "none" support, "production" support and "infrastructure" support. The anatomical map was constructed on a 2-dimensional solution by employing "correspondence analysis" (Eigenvalues: .33 and .0018; total chi-square=76.71, df=6, p<0.001). This solution explains the 100% of the inertia and suggests that distributions of the categories of "support" are not the same for all categories of industries. Dimension 1 (horizontal axis) accounts for 99.4% of the inertia. Dimension 2 (vertical axis) accounts for 0.6% of the inertia. Therefore, dimension 1 is the most important axis, explaining most of the differences between the spatial patterns of row points and column points. Both row and column coordinates are represented quite well in the 2-dimensional solution; that is the quality for all points is 1 (i.e. the highest value). The row points that contribute most to the overall inertia are those representing the "curing" and "farming" industries (80% and 11% respectively) and the column points that contribute most are those representing the "production" and "none" supports (47% and 33% respectively) (Appendix B).

Figure 5-15. Anatomy of CAFS's industries: type of support



The analysis of this anatomical map is as follows (Figure 5-15). The map can be divided into 2 clusters by considering the importance of dimension 1. The first cluster is located to the left side of the horizontal axis. This cluster consists of "none" support, and the "farming", "chocolate" and "wholesaling" industries. The second cluster refers to the points that are to the right of the horizontal axis i.e. the "chocolate" and "wholesaling" industries, and "production" and "infrastructure" support.

The first cluster suggests that the "farming", "wholesaling" and "chocolate" industries are related to "none" support (75%, 100% and 100% of the total observations respectively). However, the presence of farmers with "production" support also influences this industry (24% of the total observations). The second cluster suggests that the "curing" industry has both types of support: "production" and "infrastructure" (81% and 14% of the total observations).

This anatomical position confirms that whilst the "farming", wholesaling" and chocolate" industries do not receive any support from their buyers, the "wholesaling" industry does.

Farmers in general, do not receive any support from upper level links. The few supporting activities that are provided for the farmers have two main characteristics: (i) the UNPC has high control of the public funding. Therefore, UNPC distribute discretionally the supporting to their members. (ii) Supporting activities are designed by the government.

The "curing" industries have received more support from the "wholesaling" industry because of the volume of cacao that these "curing" plants gather. The support has concentrated on the operation (i.e. gathering, fermentation and drying of cacao). On the other hand, the UNPC has benefit from public funds and have allocated this public fund to improve some of its "curing" plants. However, the rehabilitation of these "curing" plants will conclude in two years, so the impact of such public support needs to be analysed.

Although, "chocolate" and "wholesaling" do not receive any support from their buyers (or next link). There are public programs which permit them to develop their own supply chain.

5.2.4. Main remarks about "correspondence analysis"

The "correspondence analysis" helps this study to analyse the spatial distribution of different anatomical elements on each industry of the CAFS. There are two advantages of using such a technique for this analysis: (i) there is an explicit description of the dimensions of perceptual space between the objects and their attributes which in turn permits to an examination of the main characteristic of each industry, and (ii) as this technique provides a direct method of representing both attributes and objects on a single map (with several tools providing the additional positioning of respondent group), this information would provide a unique insight into the CAFS anatomy. On the other hand, there are also some limitations: (i) the similarity assumption between objects is limited to only the attributes rated by the respondents, and (ii) the data collection effort is substantial, especially as the number of choice objects increase (Hair et al., 1995).

"Correspondence analysis" is an exploratory tool. However, this particularity gives additional tasks to researchers. One of these tasks was to decide the number of dimensions which showed the similarities (or dissimilarities) between each industry. This study sought the best visualisation i.e. highest number of dimension, but only one graph was plotted using three dimensions. A solution based on a lower number of dimensions would mislead the results. For instance, cacao "by-product" has a solution of 3 dimensions. From this solution, it is clear that each industry has different distributions of the "by-product" category. However, if one took a solution with 2 dimensions, then "wholesaling" and "farming" share the same position of the row points "none" and "internal". This result would be misleading as it suggests that an "internal" application of by-products is also carried out by the "wholesaling" industry which is not the case.

According to some authors (Clausen, 1998 and Hill and Lewicki, 2006), "correspondence analysis" could be complemented with other analytical techniques such as Loglinear and Nonparametric (*Chi*-square). Therefore, this "correspondence analysis" was complemented with *Chi*-square analysis (Appendix B). The *Chi*-square values were very useful for confirming most of the positions of the industries and the categories of the anatomical elements resulting from "correspondence analysis". Whilst the main similarities were found in the following anatomical elements: "product", "quality", "organic", the dissimilarities were found in the remaining anatomical elements (Appendix B and Table 5-4). On the other hand, it was necessary to group the "wholesaling" and "chocolate" industries in order to meet *Chi*-square rule: the number of expected frequencies should be more than 5. By using this aggregated group, two analyses were performed: (i) "farming" and the group of "wholesaling" and "chocolate", and (ii) "curing" and the group of "wholesaling" and "chocolate". The aggregation of both categories led to a conversion of some of the similarities found in the "correspondence analysis" into dissimilarities. This situation led this study to keep the results of the "correspondence analysis" where such disagreements were found.

In brief, the *Chi*-square test is a useful complementary analysis which confirmed most of the positions between industries and anatomical elements which in turn permitted the identification the main features of the CAFS and its industries. Some *Chi*-square tests would not be useful because it is necessary to increase the sample size of the "wholesaling" and "chocolate" industries. However, this is very difficult to achieve because the size of population of both industries is quite low being less than 20.

5.3. Industrial features

This section concentrates on the discussion of the particularities found at each industry of the CAFS. The particularities consider the three anatomical elements: products, by-products and interactions. Some of these particular features provide useful information for pinpointing changes which compared with the literature review and between the industries of CAFS led this research to explain the active process or some tendencies (dynamic) of the whole CAFS. Nevertheless, this study acknowledges that it is necessary to examine data from different years to confirm such movement.

This section is divided into 4 subsections: subsection 5.3.1 refers to three particular features found in the "farming" industry (i.e. dry bean, organic production, fine bean, and diversification); subsection 5.3.2 focuses on two major features in the "curing" industry (i.e. general characteristics and value added); subsection 5.3.3 concentrates on one feature used by the "wholesaling" industry"; subsection 5.3.4 refers to two main features seen in the "chocolate" industry (i.e. value added and diversification); finally subsection 5.3.5 examines some of the main changes found in the CAFS.

5.3.1. Farming industry

"Farming" is the most important industry in the CAFS due to the number of people involved. Some of the results showed in the above section are to be discussed below. The discussion is divided into its three anatomical elements (i.e. product, by-product, and interactions) and helps to highlight the main features of this industry, its weaknesses and strengths.

Product

The product of the "farming" industry is characterised as "raw" "fresh + non-fermented", "bulk + organic", and "local". That is, farmers focus on producing fresh cacao beans. Whilst, it can be argued that this limit the creation of value, farmers point out that carrying out the "curing" activity themselves requires critical inputs (i.e. technological, infrastructure, economic). The lack of "curing" plants near cacao orchards forces some farmers to take a risk, and to carry out two particular activities "wash" and "sun-dry". From this activity, non-fermented cacao is obtained. This particular type of cacao is named as "lavado" or "beneficiado". Although, the quality of such cacao would be sanctioned in the international markets, this cacao is appreciated in the domestic market. In fact, it accounts for about one third of total production. It was found that a certain group of farmers supply such non-fermented cacao to national markets. Thus, farmers need to be aware about customer needs.

The farming system is moving to a different type of production: organic farming. According to governmental figures, organic production covered 10,000 hectares in 2005 which represented around 16% percent of the total cacao acreage in Tabasco. The organic cacao program started in 2003 under the title "productive conversion program". This program consisted of giving financial support for the acquisition (or production) of "organic inputs", and technical advice on organic production. Before this public program, a group of NGOs started a series of initiatives with the same production purpose in 2000. However, the NGOs initiative differs from the public one. Whilst the organic public program has not contemplated a market strategy, the NGO initiative receives funds from organic buyers. Thus, the NGOs have certified cacao orchards and a guaranteed market, so this gives them a relative advantage over the public strategy. In brief, an international market provides new niches to be explored and met, and private or public institutions are participating in this exploration.

Another aspect is the process of certification. It has been observed that there is no a homogeneous progress in the certification process. That is, there are farmers who are in the first year of certification, others in the second and third year, respectively. This variation would be explained by an increment of public or private funds to this program. A major concern is that under a new governmental period, this public program would be changed without considering the results of such an organic program. The last feature refers to the impact of the "organic" concept into the production. Some farmers observed a reduction of production. However, other farmers mentioned that an increase in production was observed. The increase in production is discussed in section 7.2.

In Latin-America, there is an increasing interest in supplying fine cacao to international markets. This study found only one case in Tabasco, which produces and exports "fine cacao". An important feature is the recognition of "fine" cacao beans. Although, there is no accepted norm for distinguishing "fine" cacao from "bulk" cacao, luxury chocolate firms in Europe have developed some expertise in recognising "fine" cacao. Considering this gourmet skill, a European chocolate firm, "Pierre Marcolini", came to Tabasco and visited Ms. Clara Echeverria at "Finca la Joya". The visit from this chocolate firm confirmed that the Finca la Joya cacao beans can be classified as "fine". So this firm established a business relationship to supply these particular cacao beans. At national level, there is no institution to provide certification of fine cacao production. Thus, the existence of "fine" cacao beans is by the agreement between the buyer and the seller. The finest of this cacao is obtained from the "criollo" variety. Another feature is the value of this particular product. It was found that the chocolate firm paid $34 Mexican pesos for this bean, the equivalent of 2 times the value of "bulk" quality beans in 2004.

The logistics for this particular cacao is also different. The bean must be fermented and dried by the producer. Then the cacao beans are transported to Cancun where they are shipped to Europe by air. The last feature is related to the origin of such a particular cacao variety. Ms Echeverria's father was one of the co-founders of the UNPC. During the CONADECA period, he travelled around the world to assist CONADECA in the introduction of new cacao varieties to farmers. This particular position gave him the opportunity to establish his own cacao nursery. According to Ms Echeverria, he established 50 hectare of this particular cacao variety. However, after he died, his oldest son cut down all the cacao trees to farm sugar cane and livestock. Ms. Echeverria was able to rescue some of the cacao material and establish two plantations (the first is 8 years old and the second is 4 years old). Her cacao production is characterised as intensive, since mechanisation and irrigation have been incorporated. However, in the last three years, she also followed the organic philosophy which in turn could give an extra value to her production.

By-products

The farming industry still has a huge potential to diversify its production. This diversification is observed in both categories: cacao by-products and agro-products. Several authors point out the need to review and improve upon strategies for diversification in order to reduce farmers' economic dependence on cacao due to several changes considered in section 4.1. This study found some examples of these strategies.

One activity regarding such diversification is the use of cacao by-products. Under an organic philosophy, farmers are using home supplied inputs to use in their cacao fields. Cacao husk is one of the main ingredients in this activity. However, the incorporation of organic compost requires more time. So farmers are not totally convinced to about carrying out this activity. Some farmers also use the pulp to prepare traditional food. However, this production is highly seasonal and few examples of this use were found. Farmers with livestock activities are more likely to use cacao husk as a feed product. However, this is also highly seasonal.

Another activity is agricultural diversification into the cacao agro-ecological system. Farmers have intercropped some food crops into the cacao orchards, especially fruit trees (*Citrus sinensis* L., *Cocos nucifera* L., *Chrysophyllum cainito* l., *Byrsonima crassifolia* L., *Carica mexicana*, *Musa balbisiana*). This production is normally consumed internally. However, there are other fruit trees which are good value, so the product is sold to intermediates (*Persea americana* L., *Magnifera indica* L., *Mammea americana* L., *Manilkara zapota* L. Royen, *Talisia olivaformis*). Timber production is also another source for the diversification of cacao production. There are farmers who have employed fine varieties of timber as shade cover. Other farmers have kept original timber trees from the primary forest, and sometimes they use them for domestic consumption (*Swietenia macrophylla, Cedrella odorata, Colubrina* sp).

However, in general, there is a lack of knowledge on how to manage both systems, and more importantly, how this timber production could be planned to become a business opportunity. Farmers do not recognise any ornamental plants as a source of diversification.

The last activity refers to the use of fauna from cacao orchards. It was found that farmers point out the presence of wild animals from birds, reptiles, and mammals and recognise some of the opportunities or threats of such wild animals. For instance, one of the main types of bushmeat consumed by farmers is: iguana (*Iguana iguana*). Although, there are some projects related to the production of wildlife, farmers do not have any knowledge of how to manage these natural resources. Honey production was also found in this study. The honey comes from a particular bee species which does not have a poisonous sting (Hymenoptera: Apidae: Meliponinae).

Interactions

The interactions of the "farming" industry is characterised by "social", "union", "none-contract", and "none support + production support". These categories lead this study to assume that "farming" industry depends largely on the upper layers or links. Nevertheless, the cooperative system is weak and cannot respond to its members without the intervention of public assistance which is very limited. There has been a change in the way cacao is gathered and private middleman network has become more important. This would lead to a review of the agricultural policies and a search for an integral solution which includes both structures "private" and "union".

Conclusion

In conclusion, the QAA examines the "farming" industry by looking at its anatomical elements i.e. production, by-products and interactions. Some weaknesses were discovered. This industry has not been able to create more value, so its products are mainly raw, fresh, bulk and local. It has not diversified its production, and is very vulnerable to the decisions of its upper linkages. This situation seems to be similar from previous periods. The implementation of neo-liberal policies has had little effect on this industry after 25 years. Nevertheless, the current situation would not be able to cope with new challenges (e.g. new lethal diseases, falling prices, full market liberalisation), so a new strategy is more likely to be required. However, some strength were also pinpointed that this industry is improving its products by considering the customer preference, so customised products would be a solution (i.e. organic, fine). Several by-products have been identified that have the potential to diversify the income of farmers. Inter- and trans-disciplinary actions are needed to achieve this diversification objective. Finally, the cooperation between farmers can be reinforced in order to cope with new challenges, but such collaboration should also increase self-determination. This in turn would imply a new reconfiguration which is not considered in the current legal system of cooperatives and public programs.

5.3.2. Curing industry

The "curing" industry plays a fundamental role in achieving higher levels of bean quality. This section concentrates on the discussion of three anatomical elements (i.e. product, by-product, and interactions) and sheds light on the main features of this industry, its weaknesses and strengths.

Products

Although the products of the "curing" industry are characterised as "raw", one curing plant was found that was able to produce an intermediate cacao product (i.e. cacao liquor). This "curing" plant is social in nature but independent from the UNPC. This project is financed by the government. So the success of this initiative could open the opportunity for other "curing" plants to be established. It was found that the network of middlemen has had access to these public funds. This would lead to a change in the structure of the CAFS.

The function of the "curing" industry is to ferment and dry the cacao bean. It was found that some "curing" plants also manage "non-fermented" cacao. This shows that the commercialisation of non-fermented beans is important and this will be also confirmed later by analysing the products of the "wholesaling" industry. This phenomenon has been observed in other cacao regions as well (Wood and Lass, 1985; Gilbert, 1997; Lattre et al., 1998; Ruf and Yoddang, 1998; Flood and Murphy, 2004). There are different reasons for the production of "non-fermented" beans (i.e. low international price, lack of knowledge and infrastructure, economic household conditions), but in the CAFS, "curing" plants emphasise two main issues (i) an increase in input price, mainly gas, and (ii) a lack of professional personnel who is responsible for the management of the "curing" plant. The latter problem has been highlighted specially in those plants managed by the UNPC. Another possible explanation is the demand, albeit, low for "non-fermented" beans. This particular bean is used to produce "Mexican" chocolate style by using traditional ingredients and production techniques.

There are three quality categories: "bulk", "organic" and "fine". The "curing" industry manages mainly "bulk" quality, but some plants have facilities to cure "organic" beans as well. According to some authors, "organic" production has been the solution for increasing the income of farmers in many agricultural regions (Ayenor et al., 2004; Flood and Murphy, 2004; Raynolds, 2004). Therefore, such "curing" plants have the potential to diversify their marketing channels and the opportunity to increase income. However, at the time this research was carried out, these plants were still trading their whole production as "bulk". So, further research needs to be done.

The "curing" industry allocates its production locally. This characteristic has not changed in the last 20 years (Ramirez, 1997). However, some "curing" plants are looking for customers who are located in other regions of Mexico. Additionally, organic cacao production also would lead to a change in this pattern.

By-products

Two main cacao by-products have been identified in the "curing" industry: sweetening and broken nibs. Sweetening is normally discharged and has never been used by the "curing" industry. Broken nibs are normally collected during the curing season and sold them to different users such as chocolate plants and posolerias. However, sweetening is the cacao by-product which has the highest potential to be processed and commercialised (Greenwood, 1965; Figueira et al., 1993; Flood and Murphy, 2004; ICCO, 2005). In fact, as will be discussed later, "chocolate" industry has the knowledge to produce value added products such as wine, liquor, refreshments, vinegar.

Cacao production is seasonal, so most of the "curing" plants have idle periods. It was found that the "curing" industry only concentrates on cacao beans, so it ignores other agro-products which are normally produced in the cacao orchard as well. Some authors emphasise the importance of diversifying the production in the cacao system (Wood and Lass, 1985; Flood and Murphy, 2004, ICCO, 2005). Considering that it was found farmers produce agro-products in their cacao orchards, it is possible to think of using curing plants to gather agro-products (including differentiating those products from organic production systems) and even processing some of them. Some examples were discovered during this research for instance private "curing" plants owned by middlemen normally carry out different activities in their facilities (e.g. production of poultry, selling of fish, gathering of pepper). The capacity for such utilisation is increased by considering agro-products, but further investigation is needed.

Interactions

According to Ramirez (1997), the "curing" industry was dominated by a monopoly cooperative structure. This study shows that this structure has changed and the "curing" industry has moved from a monopoly cooperative to a network of middlemen. Whilst the former is characterised by social and cooperative principles, the latter is founded on business and private principles. This process is interesting because of two issues: (i) all "curing" plants share common challenges and problems, but (ii) those "curing" plants which offer more benefit to farmers are more likely to succeed. There is a real competition between both types of associations (social and business), and it was found that "social" associations are more likely to be reduced. Such a situation is also found in other cacao regions (Lattre et al., 1998; Flood and Murphy, 2004). A lack of professional management, defaulting managerial situations, and low cacao prices are some of the reasons to explain this tendency. On the other hand, the middleman network is growing and consolidating its geographical positions. Surprisingly, there are public programs which foster both private and social "curing" plants. These public programs have paid more attention to social "curing" plants.

The main structure for the curing of cacao is still controlled by the UNPC. However, there are new findings. First, more "curing" plants which were in the "union" structure have changed to "private" structure. Political issues and economic problems explained such a division. Additionally, other "curing" plants also trade with "private" structure because sometimes the UNPC cannot help them to carry out their activities properly. Second, the "curing" capacity of the network of middlemen has increased in the last decade. It is supported financially and technologically by wholesalers. This permits middlemen to carry out their activities properly. Finally, some middlemen have improved their economic situation by addressing their products to new customers and niche markets, so their wholesalers are other customers. In brief, the structure of the "curing" industry is changing dramatically, but as mentioned before, only those plants that take care of their suppliers (i.e. farmers) and customers (i.e. wholesaler or industry) have an increase chance of survival.

From above, it is clear that there are different transaction exchange patterns. Most of the "curing" plants have contracts with private wholesalers. On the other hand, "curing" industries controlled by the UNPC do not need a contract. The legal organisation between them suggests that "curing" plants are obliged to sell all their products to the UNPC, but in fact, as mentioned above, this is not the case.

It was highlighted that private "curing" plants are fully supported by private wholesalers, and social "curing" plants are partially supported by the UNPC which received most of the public funds. For instance, about 5 of the 37 curing plants interviewed have participated in a modernisation program of their "curing" facilities. This program aimed to rebuild the "curing" capacity of the UNPC (the last target was 11of 27), reduce the cost of production by incorporating new technology in the "curing" process, and add a cacao gathering capacity for massive organic production.

Conclusions

In conclusion, the QAA provides a characterisation of the anatomy of the "curing" industry. Three elements i.e. production, by-products and interactions were employed in the anatomical analysis. Some weaknesses were discovered. Although, this industry provides cacao with an extraordinary attribute "curing" (i.e. fermentation and drying) to extend the life span of the bean, its products are mainly raw, bulk and local. It has not diversified its production, and is still very vulnerable to the decisions of wholesalers. The implementation of neo-liberal policies has had a great effect on this industry. It was found that "curing" industry is divided into two main structures: a social and cooperative structure, and a private and business one. Both structures will have to cope with new challenges (e.g. new lethal diseases, falling prices, and full market liberalisation). Whether a further division is still a valid strategy for this industry is one of the main questions which arises from this study. Nevertheless, this industry has some strengths as well. The "curing" industry is improving its products by considering the customer preference, so customised products would be a solution (i.e. organic). Additionally, grinding is an activity which can add more value. Several by-products and agro-products have been identified that permit "curing" plants to have the potential to diversify their income and achieve full use of their facilities. A closer cooperation with farmers is, therefore, fundamental for the survival of "curing" plants. Both structures have to work in the improvement of this relationship in order to develop an efficient cacao supply system.

5.3.3. Wholesaling industry

The distribution of cacao is carried out by the "wholesaling" industry. This subsection discusses some of the main features, weaknesses and strengths of this industry. The discussion considers the results of the correspondence analysis of anatomical elements i.e. products, by-products, and interactions.

Products

The “wholesaling” industry is characterised by trading “raw” and “bulk” cacao beans. This trading was expected and has not changed for the last 4 decades (Ramirez, 1997). However, three interesting issues have been noted. (i) The “wholesaling” industry focuses mainly on raw products. However, it was found that 2 of the 5 main wholesalers are in fact “grinding” firms. These “grinding” firms are located in another state i.e. Veracruz, and transform around 50% of the national cacao production into intermediate products (e.g. butter, powder, cake). (ii) The “wholesaling” industry trades less fermented beans. Ten years ago, such beans were sold at a very low price, but now the price of this type of cacao is almost similar to that of “fermented”. There are two possible explanations; on the one hand there is a restriction for importing cacao beans, so the increasing domestic demand pushes prices up, on the other hand “non-fermented” cacao beans are also preferred because these beans are the main ingredient to prepare the Mexican chocolate. Both situations are possible but cannot be tested further here. (iii) “Wholesaling” industry was not interested in other cacao beans such as organic and fine. Wholesalers replied that the “organic” market is situated abroad, is small, and requires some investment. Additionally, it realised that the supply of organic cacao is still very variable. Furthermore, “fine” cacao is not recognised by any “curing” industry.

The "curing" industry has domestic and overseas customers. The industry supplies the national "chocolate" industry and also exports some products to the NAFTA area. According to Ramirez (1997), the UNPC used to trade most of the cacao beans abroad, but nowadays private wholesalers are in charge of exports. Farmers have lost their export competences and the current managerial problems at the UNPC are a real limitation to overcoming this situation.

By-products

As mentioned in the previous section, the "wholesaling" industry does not have participation either on cacao by-products or agro-products. Nevertheless, some wholesalers trade different agricultural products for instance, pepper, vanilla, coffee, annatto. This is again an example of how organisations deal with capacity and idle periods. This finding would help in the proposal of new ways to increase and diversify the capacity of "curing" and "farming" industries.

Interactions

As discussed before, the "farming" and "curing" industries are moving from a monopoly cooperative structure to a "private" structure. The anatomy analysis suggested that the "wholesaling" activity has led to this change. The division of the CAFS started once the UNPC had critical managerial problems, the supporting institutions controlled by CONADECA (i.e. cacao board) disappeared, and private "wholesaling" companies decided to begin the commercialisation of cacao. It is not clear what issue mentioned above played the most important role. But the effect was discussed by some scholars (Ramirez, 1997; Cordova, 2001). Thus, the division of CAFS is also confirmed in this study. The main division arises from two types of association: social and private. Many scholars still claim that either cooperative or private are the best strategies (Gilbert, 1997; Lattre et al., 1998; Ruf and Yoddang, 1998; Flood and Murphy, 2004). However, this new configuration provides a good opportunity to test both different points of view. Thus, further research needs to be considered.

The UNPC controls the commercialisation of cacao, but its power of commercialisation is quite limited. The UNPC cannot export because of its legal problems. Therefore, it sells cacao beans to both chocolate industries located in other states of Mexico and other “wholesalers” located in Tabasco. Most of the private “wholesalers” do not have contracts because, as mentioned before, they are an extension of other firms (i.e. grinding and chocolate).

The UNPC is the unique “wholesaler” which receives support from public programs. This situation is seen as a weakness, because it means that the stable operation and its profitability are set artificially. On the other hand, private wholesalers consider that they have a more independent position which permits them to cope with different scenarios.

Conclusions

In brief, “wholesaling” industry is split into two structures which compete for the control of the CAFS. It was suggested that such a competitive environment would help to increase efficiency throughout the CAFS. Fermented-bulk cacao is still asked for by wholesalers. Wholesalers distribute products in both markets domestic and abroad. Some wholesalers are in fact and extension of the "grinding" industries. Some of them have diversified their activities in order to fully use their facilities. However, there are some disadvantages under such a division. There is a lack of interest in supporting the rehabilitation of cacao orchards. This means that the "wholesaling" industry plays as a gatherer rather than as a producer (Cordova, 2001). This issue is particularly critical because of the presence of a lethal disease, Monilia palmivora, which will diminish up to 80% the cacao production in the coming years (Phillips et al., 2006). It is difficult to see a radical change, because the "wholesaling" industry also realises that the importation of cacao products (from bean to chocolate) will have been completely liberalised in 2008.

5.3.4. Chocolate industry

In chapter 4, it was argued that the "chocolate" industry of CAFS is very small and its participation remains local. This subsection discusses the results of the analysis of three anatomical elements: products, by-products, and interactions. The discussion concentrates on the main features, weaknesses and strengths of this industry.

Products

The first attempt to add value to the production of cacao in Tabasco was made by union of farmers. The UNPC created a firm, INCATBSA, which is responsible for the production of chocolate and semi-elaborated cacao products (butter, powder, and cake). This firm was able to achieve 100% of its capacity in 1989. However, since then, its production capacity has been decreasing and now it only works at 5% of its capacity. The second attempt to add value came from small chocolate firms in Tabasco. They were highly supported by the oil union leaders. That is, their production was fully absorbed by this particular customer during the 70's and 80's. However, once the oil union lost power, they had to face fierce competition with national and international chocolate firms. As a consequence, their participation in the market is very limited.

The "chocolate" industry mainly uses non-fermented cacao beans. The use of this bean is for two reasons: (i) it permits elaboration of the traditional table chocolate which is used to prepare a beverage, rather than to prepare a candy (i.e. chocolate bar). (ii) It is more efficient because it produces more chocolate than a "fermented" bean. A non-fermented cacao bean weights 5-10% more than a "fermented" bean. Nevertheless, some "chocolate" firms use "fermented" cacao in order to elaborate chocolate bars.

As mentioned before, "chocolate" firms owned their own cacao orchards. This position facilitated the participation in the "organic" cacao program promoted by NGOs or public programs. A third of the firms were not interested in this process of certification.

As mentioned above, the "chocolate" industry allocates is production in the local and national market. The local market is very important because this chocolate is seen as a souvenir. However, other industries have focused on reaching new niche markets and offered their products in some superstores which have a large network distribution across the country.

By-products

As mentioned before, the "chocolate" industry has developed different products from cacao by-products. These products have been accepted by the customers in the local market. There are two chocolate firms that have developed technology to transform the cacao sweetening into cacao wine, and the pulp of cacao into cacao jam. Another firm produces compost of the cacao husk and uses it in its cacao orchard or sells it as compost. There have been a number of interactions between universities and these firms in order to improve the quality of the products and the efficiency of the production process. Some results are very interesting and others need to be changed. A similar project was conducted by ICCO (2005) in Ghana. Thus, there are still a number of products to be designed, evaluated and marketed. The main contribution is the dispersion of this knowledge to other industries (i.e. curing and farming) which have a huge potential to utilise these cacao by-products.

The "chocolate" industry also commercialises agro-products. One of the most innovative is tourism services. Four of the 7 chocolate firms have included tourism services. They are pioneers in this new rural business. This tourism activity has been supported by the government. The "chocolate" industry normally transforms some agro-products such as mango, annatto, vanilla, and guava. Again, this industry has become the leader in processing and marketing agro-products. This experience could be transmitted to other industries of the CAFS.

Interactions

The competition between INCATABSA and the private small chocolate firms only has a local impact, not a national one. Since few firms place their products nationally, the number of contracts is very low.

The ICATABSA has tried to obtain public funds to rebuild its "grinding" facility. However, all attempts have failed. The public support for the UNPC has only permitted a limited reactivation of a small fraction of the whole facility. Some "chocolate" firms, however, have collaborated to create a new private "grinding" industry. The project has not yet been concluded.

Conclusions

The "chocolate" industry has a little impact on the national market. However, they have created a particular knowledge that could be used to create new products and processes within the CAFS. Furthermore, other rural services (carbon fixing, bio-conservation, bird-watching) can be incorporated, but this time reaching the "farming" industry. They could also play an important role in the installation of the new "grinding" industry. However, this industry has some weaknesses such as: the division between social and business associations, the age of the owners and the business transition to the next generation, and the small size of the firms.

5.3.5. Changes in CAFS

This subsection discusses the main features of the CAFS and sheds light on some changes in the anatomy of the CAFS.

The "correspondence" analysis and *Chi*-square analysis permitted this study to identify the main features of the industries of the CAFS by evaluating the distributions of different categories of 11 aspects of three anatomical elements (Table 5-4). This analysis has been complemented by contrasting these findings with information from the literature review. All this sheds light on the discussion of some changes in each industry and the CAFS as whole.

Table 5-4. Main features of CAFS industries by 11 anatomical elements

ASPECTS	ANATOMICAL ERLEMENTS	ORGANISATIONS			
		FARMING	CURING	WHOLESALING	CHOCOLATE
PRODUCT	Product	Raw	Raw	Raw	Final
	Bean	Fresh	Fermented	Combination	Non-fermented
	Quality	Bulk	Bulk	Bulk	Bulk
	Organic	In process	In process	-	In process
	Location	Local	Local	National+ International	Local+National
BY-PRODUCT	Cacao by-product	None +internal	Raw	None	Raw+ Processed
	Agro-product	Internal	None	None	Internal+Raw
INTERACTION	Association	Social	Social	Business	Business
	Structure	Union	Union+ Private	Private	Private
	Contract	None	Short	Long+ Short	None
	Support	None	Production	None	None

The anatomy of CAFS has changed slightly in the last two decades after the implementation of a neo-liberal agricultural policy. As a whole, the CAFS is characterised as a system oriented to produce raw and bulk products. The absence of a "grinding" industry is one of the main limitations of the CAFS. The production, processing and commercialisation of cacao by-products and agro-products are important in the CAFS. There are different experiences and successful products and services. However, the potential has not been fulfilled. The CAFS has been divided into two main supply cacao chains: private and union.

This division fosters competition which in turn permits an increase in efficiency. Nevertheless, much time has been wasted, and a huge challenge awaits both groups. A lethal fungal disease, frosty pod rot (FPR), will reduce the production of cacao by up to 80%. Another important challenge is the full liberalisation of cacao products in 2008. This will permit different organisations to import cacao products (e.g. chocolate, powder, butter, bean) to supply the domestic demand. Collaboration is needed to cope with both new challenges. Public programs play an important role in the design and implementation of such strategy of collaboration.

It was found that the "farming" industry has generally stagnated. By analysing its anatomical elements and contrasting this information with the literature, it would seem that farmers still focus mainly on the production of raw materials rather than value added products. Nevertheless, some particularities have been identified and these need more discussion because they could lead to interesting outcomes. Farmers need to differentiate their products, and an organic production is one of the ways of achieving this. Organic production would give farmers the opportunity to stay in the market. Fine cacao is also very valuable in international markets, so producing this is another way to stay in the market. However, as was found, both products need to be cured. This requirement could be a limitation, but it is possible to solve this in the short term. Farmers also need to diversify their production. Most farmers take advantage of the cacao agro-ecological system and produce complementary products which can make a difference in the future. However, it has been identified that to optimise this effort closer interaction between farmers and, as discussed before, the "curing" plant is necessary. Finally, farmers need to strengthen their interactions either private or union structures. This is very important because they are at the end of the supply chain and their knowledge about the demand and preference of their products is very limited. A closer interaction will provide more efficient mechanisms to work (e.g. contracts, funding, and training). In brief, there is a small group of farmers who are changing and adapting to the current competitive environment. Therefore, these small differences could help to boost the potential of other farmers. Since public programs have limited resources, this is a good starting point to seek successful strategies. The aim of these strategies is to make the "farming" industry less dependent, a situation that makes it very vulnerable. A study of these differences is investigated further in next chapters by analysing this industry under the "fitness" approach.

The "curing" industry is a key player in the CAFS and therefore, it has been under high pressure because of, for instance, the high level of trading defaults, the limitation of funding to operate, and the inherent seasonal production of cacao. The analysis of its anatomical elements and the comparison between this information and literature review reveals an industry which is changing rapidly. This dynamic is led mainly by the participation of union (the UNPC) and private structures (the network of middlemen). The structure that controls the "curing" plants controls the CAFS. Therefore, the "curing" plants have been awarded with different public and private programs. For instance, whilst the UNPC attempted to rebuild all its "curing" plants, private wholesalers provided credit and training to the network of middlemen. In general, it is accepted that most of the "curing" plants depend heavily on wholesalers. However, during this disputation process two main remarks can be highlighted. First, some "curing" plants are more independent. That is, the "curing" industry takes care of its produce, looks for new customer and markets, and applies for funding to implement their new projects. Second, the "curing" industry can learn more things from the exchange of knowledge with other industries. This would lead it to grow vertically or horizontally. For instance, "curing" plants can increase their capacity by considering other products (e.g. by-products and agro-products). In brief, although the "curing" industry depends largely on the "wholesaling" industry, this situation does not limit the possibility of exploring new projects and developing some strategies to success in the current competitive environment. On the other hand, "curing" plants are the main players in the solution of the FPR problem, so both structures will need to cooperate in order to cope with this new threat.

The "wholesaling" industry has been the source of most of the changes discussed above. The analysis of its anatomical elements and the comparison between this information and the literature review confirms this. The main characteristic of this industry is the division between union and private structure. Some of the features of each structure have been discussed in previous sections. Thus, only two issues are highlighted here: (i) the CAFS needs to renovate its cacao acreage otherwise the yield will dramatically reduce because of the age of the cacao trees and the FPR disease. As mentioned above, both structures need to cooperate in order to cope with this current situation. However, it is not clear how to deal with the new territorialisation of cacao production, and this is a huge challenge. (ii) The "wholesaling" industry dramatically influences the CAFS. Therefore, it is necessary to introduce a framework where this industry has a wide and proactive role. As discussed before, there are many supporting activities which have not been linked to production or reached "farming" industries such as research and development and extension and training. Thus, all wholesalers need to share responsibility for this to be done.

Although the "chocolate" industry has a relatively small impact on the CAFS, it can provide a set of different ideas to increase the capacity of the CAFS. The analysis of its anatomical elements and the comparison between this information and that provided in the literature review results in an industry which is changing albeit unevenly. As mentioned above, some particular farmers integrated a small chocolate plant in their plots. This new activity permitted them to increase their knowledge about cacao and by-products and also to be closer to the customer needs. Some of them have also attempted to use their knowledge in order to set up a new grinding industry. All this is very valuable and needs to be shared.

Production, supply and consumption of food

The production and consumption of food is changing rapidly. As discussed in chapter 2, production is influenced by the products and their attributes, and the way these products are supplied to consumers. Thus, organisations need to add value, to differentiate and to diversify their products, if they want to stay in more competitive markets (Porter, 1985, 1990; Solleiro and Valle, 1996; Cuevas, 2004; Scherr, 2004). The study of the anatomy of an agro-food system permits those features to be emphasised that are limiting the linking of the agro-food system and the development of each industry of the agro-food system. From this approach, it was found that the CAFS present a different picture so that above, so its future is more likely to be at risk.

The supply of cacao is characterised by a dual structure which consists of two main groups: private and union of farmers. This phenomenon is also observed in many agro-food systems (Kaplinsky and Morris, 2000; Trienekens and Zuurbier, 2000; Eastham et al., 2001; Zylbersztajn and Pinheiro, 2003). The dual structure of CAFS is relative young, and requires more time to define the final configuration (e.g. winner and loser). However, as mentioned before, a new lethal fungal disease (FRP) is threatening the cacao production and forcing the dual structure to cooperate for a while if both of them want to gather cacao in the immediate future. The selection of the consumer also plays an important role, because organisations are encouraged to acquire new capabilities which in turn permit them to develop sustainably (Scherr, 2004). The anatomy of the CAFS shows that consumers are placed in domestic markets. This feature contrasts with the main cacao producers in the world which produce cacao as a cash crop strategy and, therefore, the consumption of cacao is very low (ASERCA, 1991; Ramirez, 1997). Within a free trade agreement, Mexican consumers could get cacao products from abroad, so under this particular scenario, the CAFS would not be necessary. Therefore, the domestic market plays an important role in the consumption of cacao and the CAFS needs to understand this situation.

6. The Fitness Appraisal Instrument (FAI)

This section concentrates on the development of the "Fitness Appraisal Instrument" which was implemented in the cacao agro-food system in Tabasco (Mexico) in order to analyse the "organisational configuration" of the cacao farming industry based on three main driving factors "technology", "competences" and "operational climate". This chapter is divided into three main sections. Section 6.1 focuses on the construction of the theoretical "organisational configuration" by employing the "productivity management" perspective, section 6.2 discusses the operationalisation of the "fitness approach" by discussing its scale, landscape and value, and section 6.3 provides the hypotheses to test the implementation of the "Fitness Appraisal Instrument" in the Cacao Agro-food System in Tabasco (Mexico).

6.1. The productivity management model

As mentioned in section 3.3, there are a number of steps in the construction of the "fitness" value and in the analysis of a particular theory. The construction of "Fitness Appraisal Instrument" (FAI) considers two main steps: (1) variable relationship and (2) "fitness": scale, landscape and value. This section aims to achieve the first step of constructing the "Fitness Appraisal Instrument"

"Productivity management" perspective provides three key factors (i.e. technology, competences and operational climate) in the development of the "organisational configuration" of a system (e.g. firm, organisation). It was also discussed that such "productivity management" factors influence positively the performance of an organisation and respond, to a large extent, to the uncertainty with which the organisation must cope.

This section is divided into 6 subsections. Subsection 6.1.1 examines the concept of organisational configuration and its link to the FAI, subsection 6.1.2 briefly introduces the relationship between factors, aspects and performance. Subsection 6.1.3 discusses the "technology" factor, its aspects (i.e. innovation, diffusion and labour) and its 8 "productivity management" elements. Subsection 6.1.4 examines the "competence" factor, its aspects (i.e. skills and "complementarity") and its 5 "productivity management" elements. Subsection 6.1.5 discusses the "operational climate" factor, its aspects (i.e. vertical integration and diversification) and its 7 "productivity management" elements. Finally, subsection 6.1.6 examines the selected performance indicators based on traditional and alternative perspectives.

6.1.1. Linking organisational configuration

Organisational configuration is a mean of categorisation, which enables researchers to organise reality from a point of view relevant to the objectives of the study being undertaken. Organisational configuration seeks coherence within data in order to study and represent organisational complexity from different points of view (Miller, 1987). There is no universal formula for elaborating organisational configuration, as far as the selection of variables and determination of their hierarchy is concerned, as these should be adapted to the questions guiding the researcher. However, two theoretical concepts would apply: (i) resource endowment and (ii) strategy

Resource endowment comes from the realm of economics and refers to the given natural resource of an area. Three main issues are considered with this concept: (i) the quantification of such resources, (ii) the terms of resource use and (iii) the outcomes deriving from such utilisation. All this has permitted researchers to shed light on different patterns of growth and development among other economic research questions (Rae and Josling, 2003; Wen and King, 2004; Ding and Field, 2005). Under this traditional approach, different studies have been carried out to explain some of the differences found in the performance of agricultural systems (Temu and Due, 2000; Kebbeh and Miezan, 2003; Tschackert, 2004; Dogliotti et al., 2005) to model the impacts of the effect of a set of strategies (e.g. agronomical, political, and economic) on the different resource endowment groups (Shepherd and Soule, 1998; Tittonell et al., 2005), and to characterise the farm typology (Duvernoy, 2000; Daskalopoulou and Petrou, 2002; Andersen et al., 2007).

One of the main outcomes of these studies is the realisation that resource endowment of agricultural systems is normally variable but some cluster and relationships can be obtained. Furthermore, if one ignores the important differences in resource endowment that exist among rural stakeholders, then a one-size-fits-all solution does risk widening, rather than reducing, the poverty gap. Thus, this theoretical concept helps to guide the construction of an organisational configuration.

Nevertheless, in order to survive and prosper, every organisation must develop and maintain an acceptable relationship with its environment. Such endeavour is limited under resource endowment, so management theory proposes strategy as the mechanism that guides environmental relationship and provides integration for organisational configurations (Forsman, 2004). As mentioned, the basic premise of thinking about strategy concerns the inseparability of organisation and environment. The organisation uses strategy to deal with changing environments. Because change brings novel combinations of circumstances to the organisation, the substance of strategy remains unstructured, unprogrammed, none routine, and none repetitive. Not only are strategic decisions related to the environment and none routine, but they also are considered to be important enough to influence the overall performance of the organisation (Snow and Hampbrick, 1980, Mintzberg, 1984; Chaffe, 1985). Thus, a strategy permits a new direction to be charted which impacts on organisational structure and performance (Miller, 1987; Sundaram and Black, 1992). This theoretical concept will also aid the construction and analysis of the organisational configuration.

Organisational configuration sheds light on describing organisations, revealing their complex and systemic nature, and drawing distinctions among organisations, avoiding confusions born of excessive aggregation and aiding prediction.

The relationship between factor and aspects

As mentioned in section 2.3.4, the "productivity management" approach provides core factors that influence the performance of an organisation i.e. "technology", "competence", and "operational climate". Some aspects were also highlighted in each factor. A total of 7 aspects were identified i.e. innovation, diffusion, labour, skills, complementarity, vertical integration and diversification. The specification between "factors" and "aspects" relies on the following explanation. As in other managerial approaches, "productivity management" proposes a modular construction to analyse performance (Prokopenko and North, 1997). The modular system permits the analysis of different levels (i.e. factors and aspects) and different categories (number of aspects). This modular system has been successfully used as a tool to analyse performance. Some of these examples are balance scorecards, value chain, and quality analysis (Porter, 1985; Kaplan and Norton, 1991; Prokopenko and North, 1997; QSTG, 2000).

Value chain was proposed by Porter (1985) who divided the factors which contribute to performance into two main groups. The first was called primary activities and the second called supporting activities. Then each activity was divided into different action levels, 5 in the primary activities and 4 in the supporting activity. Such categorisation has permitted to carry out studies on diversification, competitive strategy and technological change (Solleiro and Valle, 1996; Holsapple and Singh, 2001; Turner and Stylianou, 2004; Kumar et al., 2006). This modular perspective has permitted researchers to examine different levels of complexity and therefore to highlight problems and potential opportunities as well (Sollerio and Valle, 1996).

Kaplan and Norton (1991) proposed a study of the organisational strategies by considering two main levels. The first level considered 4 main elements financial, internal business, learning and growth and customer. The second level was comprised of different items linked to each main element of the first level. This modular perspective has permitted the identification of a pragmatic, implementable strategic information framework which in turn promotes the communication and consensus of the organisation's strategy and forces the relationship of business functional goals (Kaplan and Norton, 1996; Littler et al., 2000).

Finally, quality management has also implemented the use of modular systems to analyse the performance of organisations (QSTG, 2000). One of these systems was developed by the European Foundation for Quality Management. This modular system analyses an organisation at two main levels. The first refers to enablers and results, and the second level refers to 8 main elements (leadership, people, policy and strategy, partnership and resources, processes, people results, customer results, society results, and key performance results). This method permits practitioners to observe the dynamic relationships between improved performance and implementation of interventions based on the different levels of the method. The modular system has shown satisfactory results in different areas such as business, health care service, and charities (McKerron et al., 2003; Thomas and Webb, 2003; Minkman et al., 2007).

Such a modular system does, however, have limitations. First, the number of levels and the assignment of different categories in each level are mostly empirical and need to be modified for each practical situation.

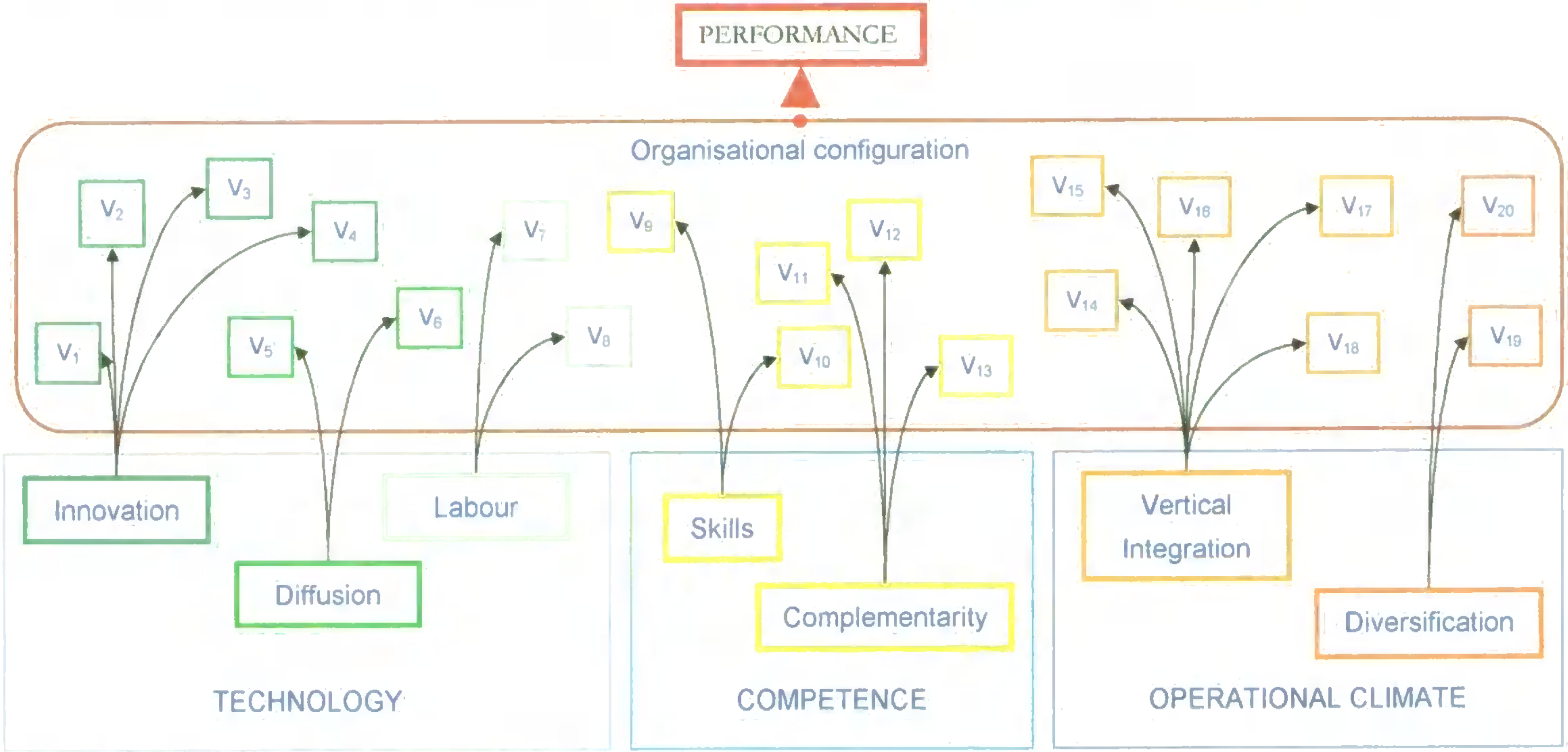
A second limitation is the scale of measure in each item. Most of them do not consider direct measures, so they rely on a subjective assessment. Finally, although it is recognised that their application could be implemented in any organisation, most of the main applications of these methods have concentrated on big organisations with different degrees of complexity (Solleiro and Valle, 1996; Littler et al., 2000; Minkman et al., 2007).

This study took into account these modular characteristics and decided to use this approach in the construction of the Fitness Appraisal Instrument. Furthermore, this perspective permits a new exploration of the "fitness" approach such as a reduction of variables and responses without giving up the theoretical model (Jermias and Gani, 2004, 2005).

6.1.2. Organisational configuration

From the "productivity management" perspective, three main factors and seven key aspects were selected to construct the theoretical "organisational configuration" (Figure 6-1). The selection of variables takes into consideration the particular conditions of the farming industry at the Cacao Agro-Food System (CAFS) in Tabasco (Mexico) which was discussed in sections 5.2 and 5.3. This section introduces briefly the theoretical framework to explain how the selected variables, hereafter referred to as "productivity management" elements, are related to each other to construct the "organisational configuration".

Figure 6-1. The model to construct a theoretical organisational configuration based on the productivity management factors



Source: After Prokopenko and North, 1997; Rickard, 2006

Technology is an important factor of "productivity management" perspective, and three "productivity management" aspects were selected from "technology" factor: "innovation", "diffusion" and "labour". These three "productivity management" aspects have a positive relationship with organisational performance.

Therefore, this study has selected four variables related to "innovation": the age of cacao orchard (V_1), the type of cacao variety (V_2), the pre-harvesting cacao activities (V_3) and the type of cacao bean (V_4). Two variables were selected from "diffusion": the source of the cacao plant (V_5) and participation in organic cacao program (V_6). This study has selected two variables relating to "labour": the participation of family labour (V_7) and the number of selected crop activities hired by farmers (V_8). All these "productivity management" elements are discussed in detail in section 6.1.3.

Another important factor of "productivity management" perspective is "competences". Two "productivity management" aspects were selected from "competence" factor: "skills" and "complementarity". All aspects have a positive relationship with organisational performance. Therefore, this study selected two variables related to "skills": school attendance (V_9) and technological and "market capabilities" (V_{10}). Finally, three variables were selected from "complementarity" aspect: studying ratio (V_{11}), production capacities ((V_{12}) and business entrance (V_{13}). All these "productivity management" elements are discussed in detail in section 6.1.4.

Finally, "operational climate" is an important factor in the "productivity management" perspective. Two main "productivity management" aspects were selected from "operational climate" factor: "vertical integration" and "diversification". These aspects have a positive relationship with organisational performance. Five variables were selected from "vertical integration" aspect: commercialisation channel (V_{14}), transaction conditions (V_{15}), payment conditions (V_{16}), quality premium (v_{17}) and price setting (V_{18}). This study has selected two variables related to the "diversification" aspect: the importance of cacao income (V_{19}) and farming versus non-farming activities (V_{20}). All these "productivity management" elements are discussed in detail in section 6.1.5.

6.1.3. Technology

Innovation

This study focuses on four "productivity management" elements related to innovation: the age of the cacao orchard (V_1), the type of cacao variety (V_2), pre-harvesting cacao activities (V_3) and the type of cacao bean (V_4).

The age of the cacao orchard dramatically influence the volume and quality of cacao production. In fact, a high percentage of the world cacao tree stock is of an advanced age. Thus, a significant proportion of the world's cacao planting is reaching or has already reached the end of its economic life (Knight, 1999). Cacao is a perennial tropical crop and it is estimated that economic life of cacao starts between the 4^{th} and 7^{th} year and ends around its 40^{th} year. This can change depending on the use of hybrids or traditional trees. Thus, the maximum production is given between the 11th and 20th year and the minimum after 40th year (Mossu and Coste, 1992; Yanes, 1994; Ramirez, 1997; Knight, 1999). Since there is a strong relationship between the age of the cacao orchard and production, this "productivity management" element shows it is in the interest of farmer to keep cacao production at optimum levels by regenerating the cacao orchard before it is 30 years old. The age of a cacao orchard was transformed into a "productivity management" element of 5 categories considering a productive life from 1 to 49 years (Appendix C). It is assumed that a younger cacao orchard provides higher performance.

The variety of cacao trees expresses the quality of the cacao bean which recently has been used to address different markets, i.e. especially the luxury cacao market (Minifie, 1970; CCI, 1991; ICCO, 2005). According to Minifie (1970), Wood and Lass (1985), Mossu and Coste (1992), and Knight (1999), cacao is divided into two main groups: bulk and fine or aromatic cacao beans. Such difference arises from the variety of the cacao tree. Whilst "criollo" and "trinitario" trees are considered the source of fine cacao beans, the "forastero" tree is related to bulk cacao beans. The latest gene studies indicate that there are no significant differences between "criollo", "trinitario" and "forastero" trees. Therefore, the fineness is related to other factors such as selection, ecological conditions, etc. Nevertheless, considering findings in section 5.2, this study takes into consideration the fact that "criollo" trees are highly related to fine cacao. Thus, the presence of this "criollo" variety gives an advantage to farmers, that is, they could place their production in special niche markets where a premium price is paid for such particular cacao characteristics. "Trinitario" is also related to high quality. Ramirez (1997) argues that the cacao acreage of "trinitario" cacao orchards is vast in Mexico. Finally, "forastero" is associated to low fineness, but vigorous agronomical characteristics (Wood and Lass, 1985; Mossu and Coste, 1992; Knight, 1999). The absence/presence of such three types of cacao trees produce a matrix which was transformed into a "productivity management" element of 5 categories, considering the presence or absence of "criollo" or "trinitario" trees in the cacao orchard. It is expected that the presence of varieties related to fine or aromatic cacao trees would lead to higher performance (Appendix C).

Originally, cacao was cultivated under a canopy system (Wood and Lass, 1985; Mossu and Coste, 1992; Knight, 1999), and in many regions of Latin America, and this particular agro-ecosystem prevails rather than the plantation system (i.e. Malaysia, Brazil). There are different activities for establishing and maintaining cacao under a canopy system (Wood and Lass, 1985; Mossu and Coste, 1992; Knight, 1999): (i) Nursery activities (i.e. construction of nursery, shading, establishing the beds, supplying the soil, filling the bags, sowing the seeds, maintenance); (ii) preparation of the forest land (i.e. boundary marking, slashing undergrowth, felling forest trees, marking paths and the drainage or irrigation system, extraction of stumps, creation of wind-rows, marking-out for cacao trees, establishing essential temporary and permanent shading, digging planting holes, filling in the holes, realigning the stakes after hole-digging, planting the trees); (iii) pre-harvesting activities (i.e. weeding, cutting back shade trees, pruning and sucker removal, insecticidal treatments, fungicidal treatments, fertiliser application, irrigation), (iv) harvesting and opening, (v) post-harvesting activities (fermentation and drying). As already stated, most of the cacao orchards are old. Therefore, the core activities concentrate on maintenance after obtaining a closed-integrated canopy (after 4-5 years) (Wood and Lass, 1985; Mossu and Coste, 1992; Knight, 1999) This study focuses on the presence of six maintenance activities: (i) cutting back shade trees, (ii) pruning, (iii) weeding, (iv) crop protection, (v) fertilisation, and (vi) irrigation. Several authors suggest that there is a close relationship between the number of activities carried out by the farmer on the cacao orchard and the performance achieved by such activities (Balasimha, 2006; Olaiya and Fagbayide, 2006; Vieira et al., 2006). However, farmers have also reduced the number of pre-harvesting activities as a consequence of the influence of external factors (e.g. falling international price, withdrawing of public funds to cacao production) (Flood and Murphy, 2004). Under a canopy system, cacao trees maintain a biological productivity which allows farmers to obtain a minimum outcome and this is a special characteristic of the perennial tropical crops (Samson, 1986; Ramirez, 1997; Cordova, 2001). This "productivity management" element is constructed from the 6 pre-harvesting activities mentioned above. This "productivity management" element consists of five categories. It is assumed that the more activities that are carried out, the higher performance is achieved (Appendix C).

Post-harvesting activities are also considered of vital importance because they provide the well-known chocolate quality. The main post-harvesting activities are fermentation and drying (Wood and Lass, 1985;

Mossu and Coste, 1992; Knight, 1999). From this post-harvesting knowledge, it is possible to classify the cacao bean into three different types: (i) fresh, (ii) non-fermented and (iii) fermented. Fresh cacao is obtained after the cacao seeds are extracted from the cacao pod, packed into plastic containers, and brought to the collecting points or the processing units (Wood and Lass, 1985; Mossu and Coste, 1992; Knight, 1999). Under the Mexican cacao norm, it is recognised that there are two types of non-fermented cacao: (i) "lavado" which is a cacao bean that has been partially fermented (less than two days) and (ii) "beneficiado" which is a cacao bean that has been washed in order to separate some cacao by-products (e.g. husk, leaves) (Ramirez, 1997). Although the international market does not accept this type of cacao bean, domestic-traditional chocolate industries prefer non-fermented cacao beans (Cordova, 2001; Gonzalez and Amaya, 2005). In fact, there are also several traditional Mexican foods that use none-fermented cacao beans. The most important food is "mole". Additionally, fermented cacao is considered as the commodity bean which meets international standards (e.g. LIFFE, Codex Alimentarius). The curing activities are normally performed by the farmer, and in few regions they are carried out by processing units (called in Mexico as "beneficiadoras"). It is argued that such "beneficiadoras" were encouraged so as to obtain the best cacao quality. The absence/presence of such types of cacao beans produces a matrix which was transformed into a "productivity management" element of 5 categories (CCBEAN). It is expected that the presence of fermented beans in the production would lead to a higher performance (Appendix 2).

Diffusion

Diffusion has played an essential role in the improvement of agricultural performance. This study focuses on two "productivity management" elements related to the diffusion of "technology": the source of cacao plant (V_5) and participation in the organic cacao program (V_6).

As mentioned before, cacao orchards need to be rehabilitated, so a farmer should use a more high-quality, high-yield, and disease resistant cacao plant to secure production success for the next 20 years. The production and dissemination of cacao hybrids has been mainly carried out by public institutions (Wood and Lass, 1985). However, Cordova (2001) and Opoku et al. (2006) also stress that such institutions frequently fail to fully assist all farmers. Therefore, the lack of cacao hybrids leads them to look for another supplier (i.e. own cacao orchard, relatives or friends). Then, three sources of cacao plants are recognised: (i) own cacao orchard, (ii) relative's/friend's orchard, and (iii) public programs. The presence/absence of these three sources of cacao plants produces a matrix which was transformed into a "productivity management" element of 5 categories. It is expected that the presence of cacao plants obtained by public programs would lead to a higher performance (Appendix C).

Technology not only refers to efficiency aspects but also to effective goals. Thus, a change of how cacao is produced leads a supplier being able to satisfy particular niche markets where consumers are keen to pay a premium price for such products. One of these new growing markets is that of organic products (Ayenor et al., 2004; Radi, 2005). Organic production is based on a strict process of certification which requires some time to convert conventional systems into organic one. This will take 3 to 5 years in cacao orchards under canopy (Gonzalez and Amaya, 2005). The move into an organic program, the number of certificated years, and being organically certified were categories in the construction of this "productivity management" element related to organic production and its diffusion. It is assumed that the closer the farmers are to certification, the higher the performance will be (Appendix 2).

Labour

Technology is also related to labour. This study focuses on two "productivity management" elements: the participation of family labour in the crop activities (V_7) and the crop activities for which farmers hire labour (V_8).

Cacao farming systems were widely promoted on a single owner system. Therefore, family members have provided a considerable amount of available labour, especially during the harvesting season (Wood and Lass, 1985). However, this pattern has changed. That is, cacao farmers do not have such amounts of available labour anymore (Ramirez, 1997; Cordova, 2001). This leads to different results. On the one hand, few changes are observed as the main activities in the production f cacao are carried out by the farmer. On the other hand, there are some cases (i.e. elderly farmer, female farmers) where production collapses especially when family members do not participate in cacao activities (section 5.2.). This "productivity management" element was constructed based on the degree of participation of the family members into cacao activities by using 5 categories. Farmers benefit from the availability of family labour. Therefore, higher levels of participation lead to a higher level of performance (Appendix C).

There are some activities for which a farmer needs to hire labourers. These activities cover a number of situations (e.g. complexity of the activity, level of skills, available equipment, and orchard size). The payment of any activity should be covered from higher outcomes obtained (Ramirez, 1997). However, it is possible to find an internal subvention of cacao production which comes from other source of income (Cordova, 2001). This study focuses on 7 labour activities which are normally carried out by hired labourers: (i) cutting back shade trees, (ii) pruning, (iii) weeding, (iv) crop protection, (v) fertilisation, (vi) irrigation and (vii) harvesting. The additive property of these 7 activities produces a "productivity management" element of five categories. It is assumed that the more activities that are paid or for which labourers are hired out the better organisational performance is achieved (Appendix C).

6.1.4. Competence

Another important factor of "productivity management" perspective is "competence". Two main aspects were selected from this factor: "skills" and "complementarity". Both "productivity management" aspects have a positive relationship with organisational performance.

Skills

Skills are considered as one of the main aspects in the achievement of higher agricultural performance levels. Agriculture has moved from unskilled to highly skilled industry. Two "productivity management" elements are related to this important aspect: Education (V_9) and technological and market capabilities (V_{10}).

Education is the basic source in the acquisition of skills, and is normally provided by the government. Several studies agree that there is a significant relationship between the number of school years and the performance achieved in any productive system, something which also applies to cacao production (FAO, 1997; Ramirez, 1997). The number of school years was transformed into a "productivity management" element with 5 categories. It is expected that the higher the level of education based on school years, the higher the performance achieved by those farmers (Appendix C).

Agriculture is moving from a government-controlled sector to a free-market industry. Thus, farmers require additional capabilities both to create value from their products and to attract value from the market. This is crucial, especially in those countries where a policy of agricultural liberalisation has been fully implemented (Echanove, 2005). However, many studies confirm that farmers have not developed the same skills that would enable them to obtain and manage basic marketing capabilities (Know how to sell their product) as they normally have with the technological ones (know how to produce their products) (Solleiro and Valle, 1996; Valle, 2004). This aspect is explored by measuring to what extent the farmer's domain includes more technological capacities rather than marketing ones. This information was transformed into a "productivity management" element of 5 categories (Appendix C). It is expected that increments of performance would come from both sides.

Complementarity

"Complementarity" is another important aspect in order to achieve higher performance levels. Agricultural production is mainly in the hands of single owners and/or family businesses and this influences the production and business decisions. Three "productivity management" elements are related to this important aspect: studying rate of the family (V_{11}), production capacities (V_{12}) and business entrance (V_{13}).

Farmers not only benefit from their own educational level but also from knowledge externalities. According to Weir and Knight (2004, 2006), it appears that a higher level of efficiency requires some investment in education in the household, since this reduces the costs of adapting the new technology to their particular situation. The knowledge externality was measured by employing the ratio between the number of family members who were studying and the total of the family members living in the household. This "productivity management" element was transformed into 5 categories. It is expected that the higher ratio values are related to higher level of performance (Appendix C).

Extension service has been the main source in the development of production capabilities among farmers (Wood and Lass, 1985). However, for those countries where cacao is the centre of domestication (i.e. Latin

America), family knowledge also provides some of the basic capabilities for the production of cacao which have been transmitted from one generation to another (Ramirez, 1997). Cacao farmers in Mexico have benefited from both sources of cacao production capabilities. It is accepted that capabilities from a formal training source (i.e. extension service) leads to higher production (Ramirez, 1997). However, Mexico eliminated its extension service infrastructure since 1987, and instead has sponsored a private advisor system, although this has proved to be insufficient and has made little impact (SAGARPA, 2002). Considering either family or training as the main sources, cacao production capability is measured by asking the extent of the influence of such sources. This "productivity management" element was constructed with 5 categories. It is expected that training source provides the highest levels of performance (Appendix C).

Many governments control the cacao business, as cacao is a premier cash crop whose export provides significant foreign exchange for them (Are and Gwynne, 1974). This situation has ruled the cacao business for more than 40 years ago. However, as the market is liberalised, entry into the cacao business is changing. For instance, internal and external market information also leads farmer to decide to enter the cacao business. Family and market seem to be the main information sources that influence entry into the business (Ramirez, 1997; Cordova et al., 2001). Considering family or market information, entry into the business is measured by asking the extent of the influence of such sources; this "productivity management" element was constructed with 5 categories. It is expected that the market information source will provide the highest level of performance (Appendix 2).

6.1.5. Operational Climate

Finally, the operational climate factor plays an important role in the "productivity management" perspective, and two main aspects were selected from this factor: "vertical integration" and "diversification". Both "productivity management" aspects have a positive relationship with organisational performance.

Vertical integration

"Vertical integration" is an important aspect in the achievement of higher performance levels. Agriculture has been integrated as the demand becomes more complex (e.g. bulk, customised). Five "productivity management" elements are related to this important aspect: commercialisation channel (V_{14}), transaction conditions (V_{15}), payment conditions (V_{16}), quality premium (V_{17}) and price setting (V_{18}).

As mentioned above, there is a new configuration between sellers and buyers. This new configuration leads sellers and buyers to look for the most efficient and effective exchange. Cacao has also moved from a public-controlled industry to a free-market industry. Therefore, sellers (i.e. farmers) are supposed to have more options as to where to sell their products (Gilbert, 1997; Ruf and Yoddang, 1998). Farmers not only look for the most profitable option, but also for the most favourable (Cordova, 2001). From section 5.3, three main channels of commercialisation were identified: union of farmers, middlemen network and the chocolate industry. It is also found that farmers select different buyers in order to maximise their benefits. The presence or absence of such types of marketing channels produces a matrix which was transformed into a "productivity management" element of 5 categories. It is expected that the presence of the food industry on such channels would lead to a better organisational performance (Appendix C).

It is argued that relational exchange conditions contribute to the achievement of a successful vertical integration (Eastham et al., 2001; Storer et al., 2003; Bourlakis and Weightman, 2004). Relational exchange is based on long term arrangements. Thus, many organisations base their success on relational conditions. However, discretional exchange is also a common practice in agro-food systems. In fact, it is argued that such an exchange pattern is the most appropriate way to achieve high levels of performance (Eastham et al., 2001; Bourlakis and Weightman, 2004) Section 5.3 highlights that both transaction conditions (relational and discrete) are present in the CAFS. A "productivity management" element, to measure the farmer's preference between a relational and discrete exchange pattern, is constructed by using 5 categories. There is little evidence about which exchange pattern is most successful, but it is assumed that a relational one is rather more effective in the long term.

In the international arena, cacao is one of the best-organised markets, and there are clear and comprehensive terms and conditions in such a commercial environment (Wood and Lass, 1985; Gilbert, 1997). Section 5.2 highlights that at a production site, these perfect exchange conditions seem to disappear. For instance, the conditions of payment make a difference as to which buyer is selected. The time of payment plays an important role especially for small farmers (Cordova, 2001). The frequency of immediate payment serves to construct a "productivity management" element with 5 categories. It is argued that farmers are always more likely to prefer an immediate payment. Therefore, an immediate payment would lead to the acquisition of higher levels of performance.

Vertical integration permits quality to be controlled, stimulated, and increased (Eastham et al., 2001; Bourlakis and Weightman, 2004). Markets ask for a standard commodity quality which in turns gives a benchmark for payment (e.g. discounts or premiums). The cacao bean has a specific quality standard which is normally followed by sellers and buyers (Wood and Lass, 1985). As discussed in section 5.3, farmers of the CAFS sell their cacao production mainly fresh. Thus, "curing" industries cope with the particular quality standard of such a fresh product (e.g. seeds from fully ripe cacao pods; seeds without by-products such as stones, branches, leaves; organic cacao, fine cacao). This control leads "curing" industry to have higher efficient levels or a more diversified production. Therefore, farmers should be paid according to this quality basis. The question to be asked, however, is how often does this occur? A "productivity management" element based on quality premium was constructed with 5 categories (Appendix C).

The cacao price is set on international regulated markets, taking into consideration previous stocks, production and consumption estimations

(Flood and Murphy, 2004). Two main stock markets serve as a reference for the cacao price: London and New York (Gilbert, 1997). In the last two decades, the cacao price has decreased and shown cyclical variations between production season and years (Gilbert, 1997; Flood and Murphy, 2004). Perennial tropical crops suffer from such price volatility. Thus, farmers would look for more stable prices. The search for such price stability is measured by asking how often price is fixed by their buyers. This "productivity management" element was constructed with 5 categories. It is expected that a fixed price strategy will enhance the organisational performance (Appendix C).

Diversification

The major benefits of efficiency are obtained in single-product systems, but it is also accepted that systems also diversify in order to increase effectiveness. The "diversification" aspect is studied by implementing two "productivity management" elements: importance of cacao income (V_{19}), and farming versus none-farming activities (V_{20}).

The structure of any industry changes as workers can move from one industry to another (Rickard, 2006). This phenomenon happens also in agriculture (e.g. part-time farming, multi-product farming). It is argued that farmer can benefit from other productive systems, even if those systems are not related to agriculture (Boehlje and Eidman, 1984; Coelli and Fleming, 2004). One way to look for diversification sources is through income source. This brings information on how the cacao income is still important to the farmer household. Thus, the degree of importance of the cacao income serves to construct a "productivity management" element with 5 categories (INCMIMP). It is expected that the more important the cacao income is to the farmer household, the better the performance.

However, it is also argued that farmers are more likely to increase their income inside the farming sector (Boehlje and Eidman, 1984; Coelli and Fleming, 2004). There is little known about whether non-farming activities are more significant to cacao production than farming activities (Wood and Lass, 1985). Therefore, this study examines the influence of such non-farming activities on cacao production. This variable was constructed from the following question: to what extent farmer is working either on a non-farming sector or a farming sector. This variable consists of 5 categories. It is expected that both sectors would lead to higher performance levels (Appendix C).

6.1.6. Performance indicators

This study employs two types of performance indicators: traditional and alternative.

Traditional

In agriculture, performance is based on technical and economical indicators. Technical indicators include relationships among production, yield, labour, area, etc (Polan, 1995). These are practical and well-recognised by farmers and researchers. Economical indicators are based on monetary units, or non-dimensional values, among them, profit, value added, etc (Turner and Taylor, 1995). Such economical indicators are very practical, but in most cases are also very difficult to obtain because of the lack of records, seasonal production, type of products, etc. This study selected four traditional performance indicators: (i) "Total production" which refers to the "bean unit" based on fermented and dried cacao. (ii) "Price" which refers to the price of cacao based on Mexican pesos (exchange rate: 10 Mexican pesos per 1 US dollar in 1995). (iii) "Yield" which refers to the ratio between production and acreage ($Kg \cdot Ha^{-1}$) based on the "bean unit". (iv) "Value of production per hectare" which is also based on the price of the "bean unit" (10 Mexican pesos per 1 US dollar). These performances can be compared with other studies related to cacao (Yanes, 1994; Gilbert, 1997; Ramirez, 1997; Cordova, 2001).

Alternative

According to other authors, traditional performance indicators are limited (Forsman, 2004). The use of alternative indicators significantly contributes to expanding our understanding of the success of an organisation (Forsman, 2004; Murphy, 2005). Thus, a life cycle approach is suitable for measuring business performance success.

In the agricultural sector, which is characterised by the individual "entrepreneur" rather than a management team, the firm frequently exhibits a "life cycle" that parallels the "life cycle" of the farmer (Boehlje and Eidman, 1984). Thus, farming activities and farmers will pass through at least three stages during the farming production.

The first stage is the "entry or establishment" stage. In this stage, the prospective farmer evaluates the opportunities in farming compared to other occupational alternatives and determines whether or not to enter the "farming" industry. An individual who decides to accept the challenge of starting a farming activity must then acquire the "critical mass" of capital resource and managerial ability which is necessary to establish a viable economic unit (Boehlje and Eidman, 1984).

The second stage in the family-firm cycle can be identified as a stage of "growth and survival". During this stage, the farmer attempts to expand the resource base by acquiring the services of additional inputs through purchase or lease. New techniques of production are evaluated as to their efficiency and profitability as well as their ability to increase production at reduced costs. In the later years of the "growth and survival" stage, emphasis may shift from expansion to consolidation of gains, reduction of costs, and stabilisation of income (Boehlje and Eidman, 1984; Biesebroeck, 2005).

The third stage in the family-firm cycle is the "exit or disinvestment" stage. Two major processes are involved in this stage: the process of retirement and the intergeneration transfer of property. During retirement, the farmer attempts to reduce his/her farming responsibilities while maintaining sufficient control of farm assets to generate adequate retirement income. However, few farmers plan for their retirement years. Furthermore, most farmers give as little consideration to the problem and process of transferring the farm to the future generations as they do to retirement (Boehlje and Eidman, 1984; Taylor et al., 1998).

In brief, farmers possess multiple goals during their farming lifetime. For example, during the "entry and establishment" years, a farmer may place a high priority on income maximisation and the opportunity for growth and expansion. During the "growth and survival" stage, increased emphasis may be placed on risk aversion, and the farmer may want to spend more time with their family. During the "exit or disinvestment" stage of the "life cycle", income maximisation typically becomes a low priority goal compared to security and risk aversion (Boehlje and Eidman, 1984). Therefore, it would be not surprising to find many farmers following quite different "organisational configuration" patterns because they are in different stages of the farming "life cycle".

This "productivity management" element was constructed from the stages above mentioned and others suggested by Craig and Moores (2005). The "productivity management" element consists of 5 categories (Appendix C).

6.2. Fitness: scale, landscape and value

Considering section 3.3, there are a number of steps in the construction of the "fitness" value and in the analysis of the "fitness" value according to a particular theory. The construction of the "Fitness Appraisal Instrument" (FAI) considers two main steps: (i) the variable relationship and (ii) the "fitness": scale, landscape and value. Whilst, the first step has already been discussed above, the second step is discussed below. This section is divided into three subsections: subsection 6.2.1 discusses the fitness scale, subsection 6.2.2 examines the fitness landscapes, and subsection 6.2.3 discusses the construction of the fitness value.

Subsection 2.3.4 highlighted the importance of different aspects in each core factor of the productivity management approach, and subsection 6.1.1 emphasised the importance of integrating the analysis of both levels of aggregation, i.e. "factors" and "aspects". These levels of aggregation were treated as "organisational configurations" and operationalised in the "fitness" approach as landscapes in section 6.2. Thus, this section discussed the construction of the scale, landscape and fitness value of the "factor's organisational configurations" and the "aspect's organisational configuration". The "factor's organisational configuration" evaluates the relationship between three factors of "productivity management" (i.e. technology, "competence" and "operational climate") and a performance indicator. The "aspect's organisational configuration" evaluates the relationship between seven aspects of "productivity management" (i.e. innovation, diffusion, labour, skills, complementarity, vertical integration and diversification) and a performance indicator.

6.2.1. Fitness scale

First, the "fitness" scale looks at the homogeneity of the variables. This implies that there are only categorical variables. Therefore, it is necessary to fix the number of responses in each variable. Then, each response is given a "fitness" scale which is a number from 0 to 1. As mentioned above, there are two "organisational configurations". Therefore, the scale assigned for each "organisational configurations" is calculated separately.

The number of responses to the "factor's organisational configuration" is fixed in 5 responses. The number of responses to the "aspect's organisational configuration" is fixed in 2 responses. Some "productivity management" elements are already based on 5 responses (ordinal values). However, other "productivity management" elements are interval values. Therefore, the interval values are transformed into 5-response "productivity management" elements. The 5-response "productivity management" elements are used to analyse the "factor's organisational configuration".

Furthermore, all these 5-response "productivity management" elements are transformed again to obtain a set of 2-response "productivity management" elements. The reduction takes into consideration both theoretical knowledge and empirical results obtained in sections 5.2, 5.3 and 6.1. These 2-response "productivity management" elements are used to analyse the "aspect's organisational configuration". The data set includes both ordinal and interval variables. The transformation of these variables is explained below.

Ordinal Variables

Table 6-1 shows an example of the transformation of "ordinal" responses and the assignation of the fitness scale to each "organisational configuration". In this case, the fitness scale of "factor's organisational configuration" was given by dividing the response value by five. That is for a response value of 3, the fitness scale is 0.6 (3/5).

The fitness scale of the "aspect's organisational configuration" was given as follows: first, a breaking point was selected from the responses of the "factor's organisational configuration" and two new response groups were obtained (in this particular case, response 1 refers to "non-participation" and response 2 refers to the remaining responses i.e. already certified, 3 years of certification, 2 years of certification, and 1 year of certification). Subsequently, the fitness value for each new response was given by considering either the maximum value or the minimum value shown in the fitness scale of the "factors organisational configuration". In this case was 1.0 for response 2 and 0.2 for response 1. The fitness scale for each "organisational configuration" is given in appendix C.

Table 6-1. Number of responses and fitness scale: ordinal variables

PRODUCTIVITY MANAGEMENT ELEMENT	CATEGORIES	FACTOR ORGANISATIONAL CONFIGURATION		ASPECT ORGANISATIONAL CONFIGURATION	
		RESPONSES	FITNESS SCALE	RESPONSES	FITNESS SCALE
Participation on organic cacao	Already certified	5	1.0	2	1.0
	3 year of certification	4	0.8		
	2 year of certification	3	0.6		
	1 year of certification	2	0.4		
	Non participation	1	0.2	1	0.2

Interval variables

The transformation of "interval" responses and the assignation of the fitness scale to each "organisational configuration" required a different as shown in Table 6-2. First, the "fitness" element, for example "age of the cacao orchard" was grouped into 5 categories. Later, as suggested in section 6.1, the ranking procedures took into account some important theoretical assumptions inherent to the variable, in order to maintain the ranking attribute. In this particular case, the maximum increment of yields of cacao trees was obtained between 11-20 years therefore this category was ranked as 5, the following category is 01-10 years ranked as 4, then 21-30 years ranked as 3, and so on (Table 6-2).

Table 6-2. Number of responses and fitness scale: scale variables

PRODUCTIVITY MANAGEMENT ELEMENT	CATEGORIES	FACTOR ORGANISATIONAL CONFIGURATION		ASPECT ORGANISATIONAL CONFIGURATION	
		RESPONSES	FITNESS SCALE	RESPONSES	FITNESS SCALE
Age of cacao orchard	11 – 20 years	5	1.0	2	1.0
	01 – 10 years	4	0.8		
	21 – 30 years	3	0.6		
	31 – 40 years	2	0.4	1	0.4
	> 40 years	1	0.2		

The fitness scale at the "aspect's organisational configuration" was given considering the process explained above and the theoretical assumptions inherent to the variable. The breaking point was selected considering that average yields of cacao trees diminish from 30 years (Wood and Laas, 1985). Therefore, response 1 includes group "31-40 years" and ">40 years" and response 2 refers to the remaining responses (Table 6-2). Subsequently, the maximum value for each response was given, so 1.0 for response 2 and 0.4 for response 1 was assigned. The fitness scales for other scalar "fitness" elements are given in appendix C.

6.2.2. The fitness landscape

As mentioned in section 3.3 the "fitness" landscape refers to an "organisational configuration" and is calculated from the formula A^N, where A refers to the number of responses (or categories) and N refers to the number of variables. This study has considered analysing two main "organisational configurations" which are based on different NK parameters: (i) the "factor's organisational configuration" (i.e. A^N=5^3), and (ii) the "aspect's organisational configuration" (i.e. A^N=2^7).

As mentioned in section 3.2, it is important to keep low values in the landscape, otherwise the landscape (A^N) is much vaster than firms can effectively explore. This is one of considerations that will be discussed in chapter 8.

The landscape A^N=5^3 (factor's organisational configuration) evaluates the three factors of "productivity management": "technology", "competence" and "operational climate". Table 6-3 illustrates the number of combinations of this landscape 5^3 which provides a combination of 125 configurations.

Table 6-3. Factor's organisational configuration (5^3)

CONFIGURATIONS	FACTOR 1	FACTOR 2	FACTOR 3
No. 001	1	1	1
No. 002	1	1	2
No. 003	1	2	2
. . .	. . .	. . .	. . .
No. 124	5	5	4
No. 125	5	5	5

The landscape A^N=2^7 ("aspect's organisational configuration") evaluates the seven aspects of each factor of "productivity management": "innovation", "diffusion", "labour", "skills", "complementarity", "vertical integration", and "diversification". Table 6-4 illustrates the number of combinations of this landscape $A^N=2^7$ which provides a combination of 128 configurations.

Table 6-4. Aspect's organisational configuration (2^7)

CONFIGURATIONS	ASPECT 1	ASPECT 2	ASPECT 3	ASPECT 4	ASPECT 5	ASPECT 6	ASPECT 7
No. 001	1	1	1	1	1	1	1
No. 002	1	1	1	1	1	1	2
No. 003	1	1	1	1	1	2	2
. . .	. . .	. . .	. . .				
No. 127	2	2	2	2	2	2	1
N0. 128	2	2	2	2	2	2	2

6.2.3. Fitness value

This section discusses how the fitness value is calculated. This is done by using the equation 1.

$$f_i(x) = \frac{1}{N}\sum_{i=1}^{N} f_i(x)$$

In Kauffman's model (Kauffman and Weinberger, 1989), the fitness function $f_i(x)$ is the average of the fitness contributions, $f_i(x)$, from each element i. This study considered two "organisational configurations": "factors" and "aspects". The calculation of the fitness value for each "organisational configuration" aggregated the "productivity management" elements and in turn obtained compound variables for both "organisational configurations". The use of compound variables was proposed by Jermias and Gani (2004, 2005) in order to examine a theoretical model of four factors i.e. strategy choice, degree of centralisation, types of control, and management account systems. Each factor was formed by different items, so these items were aggregated in order to obtain the fitness contribution of each factor. The aggregation procedure consisted of calculating the un-weighted sum of the "fitness" contribution of each factor. The un-weighted sum permits the parameter K=0 to be kept, so the interaction between variables is null. Additionally, the un-weighted sum permits the problems of comparability to be overcome as mentioned in subsection 3.2.4. Thus, this study followed the same procedure described by Jermias and Gani (2004, 2005) to calculate the "fitness" contribution of the "factor's organisation configuration" and the "aspect's organisational configuration".

Fitness value for factor's organisational configuration

Table 6-5 shows the calculation of the total "fitness" value of one farmer (case 46) for the "factor's organisational configuration". There are two main steps: (i) calculation of "fitness" contribution and (ii) calculation of total "fitness" value. The "fitness" contribution is calculated by the average of the "productivity management" elements of each factor (i.e. "technology", "competence" and "operational climate"). For instance, the "technology" factor has 8 "productivity elements" which produce a "fitness" contribution of 0.625, the "competence" factor has 6 "productivity elements" which result in a fitness contribution of 0.36, and the "operational climate" factor has 7 "productivity elements" which produce a "fitness" contribution of 0.60. Subsequently, the total "fitness" value is calculated by applying equation 1. The resulted total "fitness" value for this particular farmer is 0.53 (Table 6-5).

Table 6-5. Fitness value for factor's organisational configuration: one farmer

FACTOR	PRODUCTIVITY MANAGEMENT ELEMENTS	FITNESS SCALE	FITNESS CONTRIBUTION	TOTAL FITNESS
TECHNOLOGY	Age of the cacao orchard	0.8	0.625	0.53
	Type of cacao variety	1		
	Pre-harvesting cacao activities	1		
	Type of cacao bean	1		
	Source of cacao plant	0.6		
	Participation in an organic cacao	0.2		
	Participation of family labour	0.2		
	Paid cacao activities	0.2		
COMPETENCE	School attendance	0.6	0.36	
	Technological & market capabilities	0.2		
	Studying rate of the family	0.2		
	Cacao production capabilities	0.4		
	Cacao business entrance	0.4		
OPERATIONAL CLIMATE	Commercialisation channel	1	0.60	
	Transaction condition	0.2		
	Payment conditions	1		
	Quality premium	0.2		
	Price setting	1		
	Cacao income importance	0.4		
	Farming v Non-farming diversification	0.4		

Fitness value for aspect's organisational configuration

Following the same procedure above described, the total "fitness" value is subsequently calculated by applying equation 1. Table 6-6 shows the calculation of the total "fitness" value of one farmer (case 46) for "aspect's organisational configuration". The "fitness" contribution is calculated by the average of "productivity management" elements of each aspect (i.e. "innovation", "diffusion", "labour", "skills", "complementarity", "vertical integration" and "diversification"). For instance, the "innovation" aspect has 4 "productivity elements" which produce a "fitness" contribution of 0.85, the "diffusion" aspect has 2 "productivity elements" which produce a "fitness" contribution of 0.20, the "labour" aspect has 2 "productivity elements" which produce a "fitness" contribution of 0.20, the "skills" aspect has 2 "productivity elements" which produce a "fitness" contribution of 0.40, the "complementarity" aspect has 3 "productivity elements" which produce a "fitness" contribution of 0.20, the "vertical integration" aspect has 5 "productivity elements" which produce a "fitness" contribution of 0.56, and the "diversification" aspect has 2 "productivity elements" which produce a "fitness" contribution of 0.40.

Table 6-6. Fitness value for aspect's organisational configuration: one farmer

ASPECTS	VARIABLE	FITNESS SCALE	FITNESS CONTRIBUTION	TOTAL FITNESS
INNOVATION	Age of the cacao orchard	0.8	0.85	0.40
	Type of cacao variety	0.8		
	Pre-harvesting cacao activities	0.8		
	Type of cacao bean	1		
DIFFUSION	Source of cacao plant	0.2	0.20	
	Participation in organic cacao	0.2		
LABOUR	Participation of family labour	0.2	0.20	
	Paid cacao activities	0.2		
SKILLS	School attendance	0.6	0.40	
	Technological & market capabilities	0.2		
COMPLEMENTARITY	Studying rate of the family	0.2	0.20	
	Cacao production capabilities	0.2		
	Cacao business entrance	0.2		
VERTICAL INTEGRATION	Commercialisation channel	0.6	0.56	
	Transaction condition	0.2		
	Payment conditions	1		
	Quality premium	0.2		
	Price setting	0.8		
DIVERSIFICATION	Cacao income importance	0.2	0.4	
	Farming v Non-farming diversification	0.6		

The NK-model does not recommend including cases which have a missing value in the "fitness" contribution values (Jermias and Gani, 2004). Therefore, the same logic is applied in this study for the calculation of the total fitness value in each "organisational configuration". As a consequence, 41 cases are omitted from the analysis.

6.3. Hypothesis

The main objective of this study is to identify the organisational configurations of the "farming industry" of the cacao agro-food system in Tabasco (Mexico). "Productivity management" provides three core factors from which 7 aspects and their "productivity management" elements have been used as key variables to construct the "organisational configurations" of each farmer. It is also assumed that there is not a universal configuration that is optimal for every environment in which these farmers operate. "Productivity management" postulates that there is a proper match between such factors and the organisational performance, Therefore, it is assumed that there will be a relationship between the "fitness" value of the proposed "organisational configuration" (i.e. factor and aspect) and the selected "performance indicators". This argument leads to the proposal of the following hypotheses and their expected predictions:

Hypothesis 1

Null hypothesis: The "fitness" value obtained for the "factor's organisational configuration" described in section 6.1.2 is not positively associated with any of the "performance indicators" selected in subsection 6.1.6.

Alternative hypothesis: There is a positive association between the "fitness" value obtained for the "factor's organisational configuration" described in section 6.1.2 and at least one of the 5 "performance indicators" selected in subsection 6.1.6 (Table 6-7).

Hypothesis 2

Null hypothesis: The "fitness" value obtained for the "aspect's organisational configuration" described in section 6.2 is not positively associated with any of the "performance indicators" selected in subsection 6.1.6.

Alternative hypothesis: There is a positive association between the "fitness" value obtained for the "aspect's organisational configuration" described in section 6.1.2 and at least one of the 5 "performance indicators" selected in subsection 6.1.6 (Table 6-7).

Hypothesis 3

Null hypothesis: None of the 20 "productivity management" elements described in subsections 6.1.3, 6.1.4, 6.1.5 is positively associated with any of the 5 "performance indicators" selected in subsection 6.1.6.

Alternative hypothesis: There is a relationship between at least one of the "productivity management elements" described in subsections 6.1.3, 6.1.4, 6.1.5 and at least one of the 5 "performance indicators" selected in subsection 6.1.6 (Table 6-7).

Table 6-7. Predicted signs of the fitness values of factors and aspects of organisational configuration and of performance indicators (hypotheses H1, H2 and H3)

PRODUCTIVITY MANAGEMENT ELEMENTS				PERFORMANCE INDICATOR				
	FACTORS	ASPECTS	VARIABLE	BUSINESS SUCCESS	YIELD	VALUE OF PRODUCTION PER HA	TOTAL PRODUCTION	PRICE
Fitness value (H1 and H2)			Factor's organisational configuration	+	+	+	+	+
			Aspect's organisational configuration	+	+	+	+	+
Productivity management Elements (H3)	TECHNOLOGY	INNOVATION	Age of the cacao orchard	+	+	+	+	+
			Type of cacao variety	+	+	+	+	+
			Pre-harvesting cacao activities	+	+	+	+	+
			Type of cacao bean	?	?	?	?	?
		DIFFUSION	Source of cacao plant	+	+	+	+	+
			Participation on organic cacao	+	+	+	+	+
		LABOUR	Participation of family labour	?	?	?	?	?
			Paid cacao activities	+	+	+	+	+
	COMPETENCE	SKILLS	School attendance	+	+	+	+	+
			Technological & market capabilities	?	?	?	?	?
		COMPLEMENTARITY	Studying rate of the family	+	+	+	+	+
			Cacao production capabilities	?	?	?	?	?
			Cacao business entrance	?	?	?	?	?
	OPERATIONAL CLIMATE	VERTICAL INTEGRATION	Commercialisation channel	?	?	?	?	?
			Transaction condition	?	?	?	?	?
			Payment conditions	+	+	+	+	+
			Quality premium	+	+	+	+	+
			Price setting	+	+	+	+	+
		DIVERSIFICATION	Cacao income importance	+	+	+	+	+
			Farming v Non-farming	?	?	?	?	?

7. Analysis of the FAI

As mentioned earlier, one of the main objectives of this study is to apply the "fitness appraisal instrument" for the first time in agriculture, particularly in the analysis of an agro-food system. This chapter, therefore, provides an analysis of the implementation of the "Fitness Appraisal Instrument" in the cacao agro-food system in Tabasco (Mexico). Two systematic procedures were used to analyse this empirical implementation of the "fitness approach". First, a correlation analysis of the interested variables selected for this study and second, the landscape analysis refers to the exploration of the "fitness" landscape.

The correlation analysis is implemented at two levels: (i) to test the relationship between the "fitness" value of the proposed "organisational configurations" and key "performance indicators"; (ii) to test the relationship between all selected "productivity management" elements and the key "performance indicators". This provides more information about what factor or aspect is influencing the "fitness" value. The exploration of landscapes, also considered two levels of analysis: (i) the search for the "fittest" value and (ii) the exploration of the landscapes of significant "productivity management" elements.

This chapter is divided into two main sections: section 7.1 concentrates on testing the research hypotheses developed in section 6.3, and section

7.2 focuses on scouting the fitness landscapes to identify patters (similar or distinctive) across farmers.

7.1. The fitness analysis

This section analyses the level of association between the "factor's organisational configuration" (i.e. "technology", "competence" and "operational configuration") and 5 "performance indicators" (i.e. "business success", "yield", "value of production per hectare", "total production" and "price"). It also analyses the level of association between the "aspect's organisational configuration" (i.e. "innovation", "diffusion", "labour", "skills", "complementarity", "vertical integration" and "diversification") and the same 5 "performance indicators".

The section is divided into three main subsections: subsection 7.1.1 discusses the statistical description of the dataset, subsection 7.1.2 examines the relationships between the constructed fitness value and selected organisational performance indicators, subsection 7.1.3 verifies the reliability of the correlation findings by conducting a sensitivity analysis, and subsection 7.1.4 discusses the results based on the hypothesised (predicted) and actual relationships.

7.1.1. Descriptive statistics

A total of 397 questionnaires were distributed to farmers of the cacao agro-food system in Tabasco (Mexico). Data from the questionnaire were transferred, transformed and analysed by employing EXCEL® and STATISTICA® programs.

Here, the statistical description of three groups of variables is discussed: (i) the "fitness" values of the "factor's organisational configuration" and "aspect's organisational configuration", (ii) the "performance indicators", and (iii) the 20 selected "productivity management" elements mentioned in section 6.1. Table 7-1 shows six items of descriptive statistics –i.e. valid number of cases (N), mean, minimum value (MIN), maximum value (MAX), standard deviation (S.D.) and standard error (S.E.). Further statistics values (e.g. frequency, mode) are available in appendix D. The dataset was reduced because 41 cases were omitted due to the implementation of the "NK-model". The omission is due to the elimination of those cases which had a missing value in any of its fitness contribution values. All this was explained in section 6.2.3. Therefore, the analysis of the "fitness appraisal instrument" was carried out with 356 valid cases.

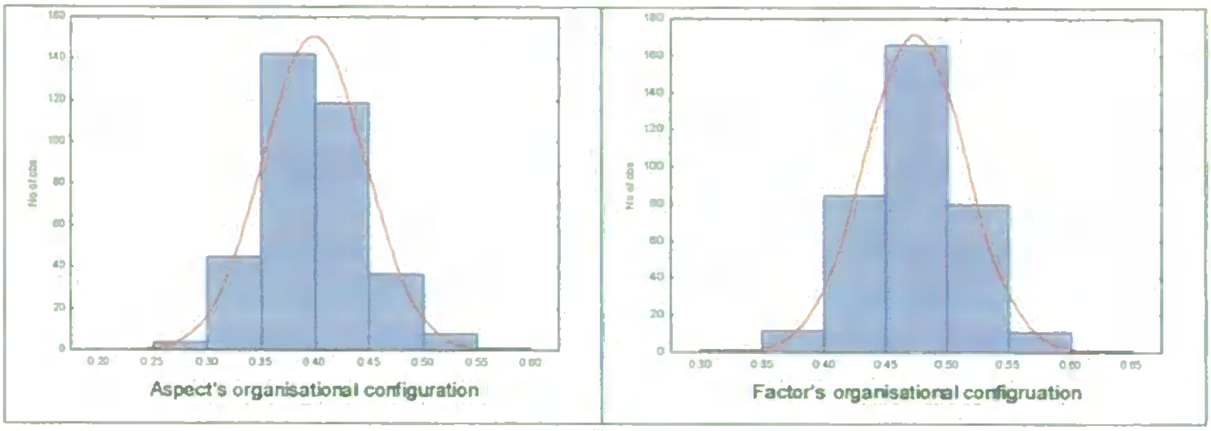
The computed mean scores of the "fitness" values for the "aspect's organisational configuration" and the "factor's organisational configuration" are very similar, 0.40 and 0.47 respectively. This indicates that none of the cases reaches the theoretical "fittest" value of 1.

Table 7-1. Descriptive statistics of the fitness values, performance indicators and productivity management element.

FACTORS		ASPECTS	VARIABLE	N	Mean	Min	Max	S.D.	S.E.
FITNESS VALUE			Aspect's organisational configuration	356	0.40	0.26	0.56	0.05	0.002
			Factor's organisational configuration	356	0.47	0.35	0.61	0.04	0.002
PERFORMANCE INDICATORS			Total production	356	904	40	10,000	1,236	66
			Value of production	356	15,027	600	175,000	20,429	1,083
			Yield	356	397	100	933	190	10
			Value of production per hectare	356	7,092	1,325	42,000	4,323	229
			Price	356	15.30	7.50	34.00	2.21	0.12
			Business success	356	2.12	1	5	0.85	0.05
Productivity Management Elements	Technology	Innovation	Age of cacao orchard	356	3.25	1	5	1.35	0.07
			Type of cacao variety	356	1.75	1	5	1.22	0.07
			Pre-harvesting cacao activities	356	2.46	1	5	1.22	0.07
			Type of cacao bean	356	1.25	1	5	0.63	0.03
		Diffusion	Source of cacao plant	356	3.08	1	5	0.71	0.04
			Participation in organic cacao	356	1.44	1	5	0.96	0.05
		Labour	Participation of family labour	356	1.43	1	5	0.98	0.05
			Paid cacao activities	356	3.90	1	5	1.05	0.06
	Competence	Skills	School attendance	356	1.85	1	5	0.87	0.05
			Technological & market capabilities	356	3.21	1	5	1.11	0.06
		Complementarity	Studying rate of the family	356	1.58	1	5	0.93	0.05
			Cacao production capabilities	356	1.97	1	4	0.33	0.02
			Cacao business entrance	356	2.10	1	5	0.88	0.05
	Operational Climate	Vertical integration	Commercialisation channel	356	2.49	1	5	0.81	0.04
			Transaction condition	356	2.10	1	5	0.99	0.05
			Payment conditions	356	3.25	1	5	1.49	0.08
			Quality premium	356	1.12	1	5	0.47	0.03
			Price setting	356	1.92	1	5	1.29	0.07
		Diversification	Cacao income importance	356	2.99	1	5	1.52	0.08
			Farming v Non farming	356	4.61	1	5	0.73	0.04

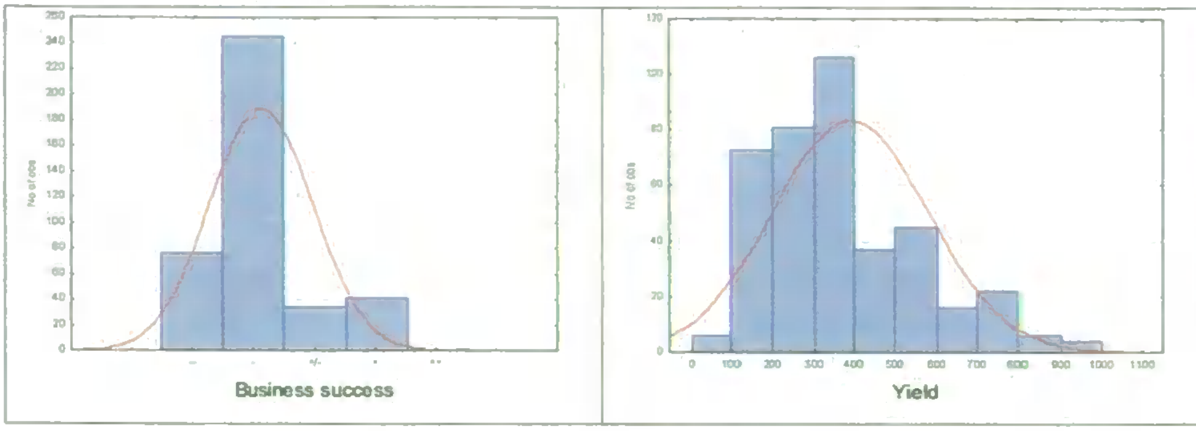
The standard errors of "fitness" values are very low, implying that there is less variation in the "fitness" values across farmers (Figure 7-1).

Figure 7-1. Histogram: fitness values of factors and aspects organisational configuration



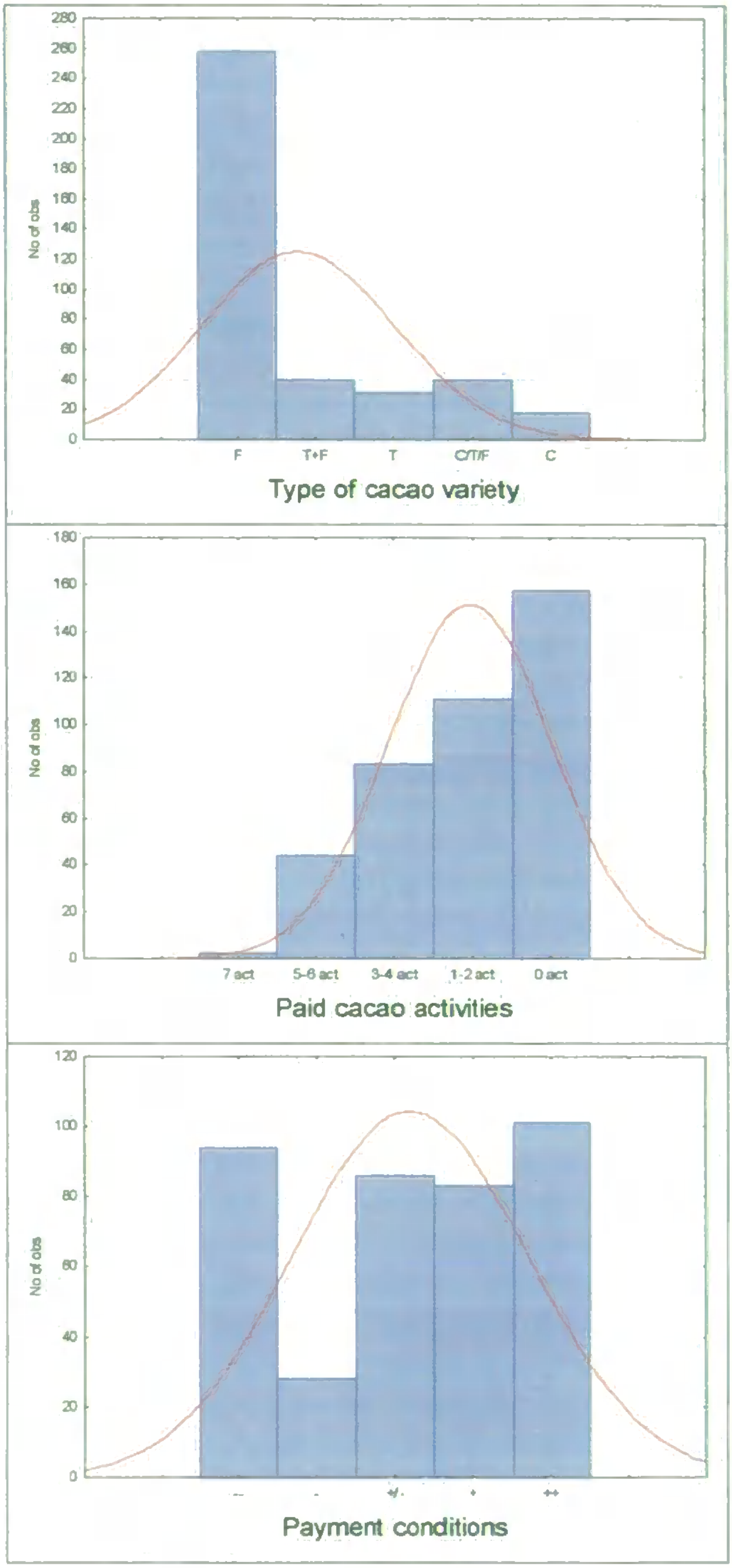
As mentioned in section 6.1.5, there are 5 variables relating to "performance indicators" (i.e. "total production", "yield", "value of production per hectare", "price", and "business success"). The mean values of such performance indicators are similar to those reported by other authors (Ramirez, 1997; Cordova, 2001). However, the values of the yield are slightly different. Such a difference will be discussed in subsection 7.2.2. Figure 7-2 shows the histograms of "business success" and "yield". The histograms confirm a relatively normal distribution of both "performance indicators". Both histograms slightly deviate to the left and have a little peak in the middle.

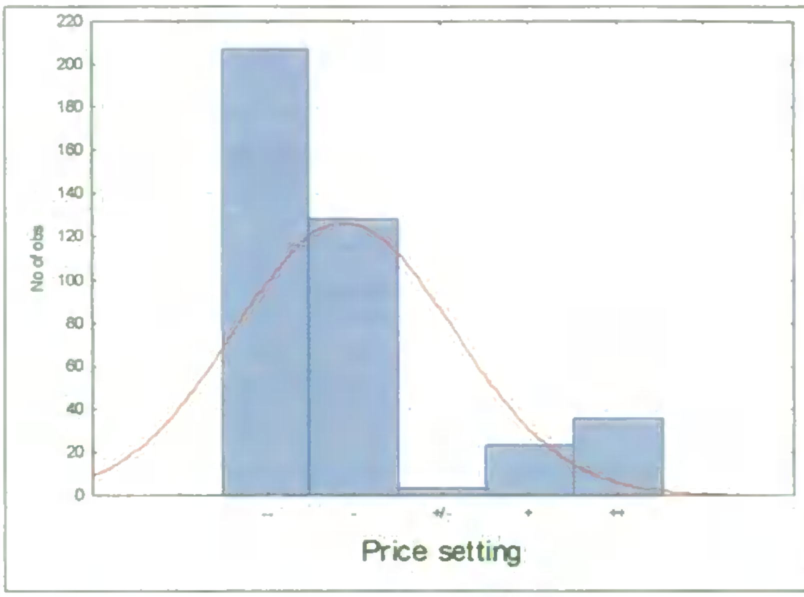
Figure 7-2. Histogram of performance indicators: business success and yield



These "performance indicators" were transformed into their standardised value (i.e. z value), as suggested by Jermias and Gani (2004). Finally, looking at the mean value, the twenty "productivity management" elements could be gathered into three main groups: (i) Nine "productivity management" elements whose mean is below 2, highlighted in gold, (ii) 5 variables whose mean is between 2 and 3, highlighted in yellow, and finally (iii) six variables whose mean is above 3, highlighted in green. Values closer to 1 are related to low "performance indicators" and values closer to 5 are considered to be positive related to higher "performance indicators". In general, the distribution of low and high values of the "productivity management" elements is considered as good. Figure 7-3 shows the four common types of distributions that "productivity management" elements presented. However, the most frequent distribution was that from the "type of cacao variety".

Figure 7-3. Histograms of productivity management elements: main type of distributions





7.1.2. Correlation testing

As mentioned above, there were 356 valid cases. A Pearson correlation analysis was used to test the association level between the "aspect's organisational configurations" and the "factor's organisational configurations" and 5 "performance indicators" i.e. business success, price, yield, value of production per hectare and total production (Table 7-2).

Table 7-2. Pearson correlation analysis of the organisational configuration and performance indicators

FITNESS VALUE	PERFORMANCE INDICATOR				
	BUSINESS SUCCESS	PRICE	PRODUCTION PER HA	VALUE OF PRODUCTION PER HA	TOTAL PRODUCTION
Factor's organisational configuration	0.14*	0.21***	0.24***	0.12*	0.23***
Aspect's organisational configuration	0.04	0.11*	0.21***	0.11*	0.13*

Significant level: * $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

It was found that the "fitness" value for the "factor's organisational configuration" was significantly positively related to all the "performance indicators". The "fitness" value for the "aspect's organisational configuration" was also significant on four "performance indicators". "Business success" was not significantly associated with this "organisational configuration".

Table 7-3 shows the Pearson correlation analysis between the 20 "productivity management" elements and the 5 "performance indicators". Different results were obtained in this correlation analysis.

(i) All "performance indicators" have an association with at least four of the twenty "productivity management elements". "Total production" is associated with 10 "productivity management" elements. The "value of production per hectare" is associated with 4 "productivity management" elements. "Yield" is associated with 8 "productivity management" elements, "price" is associated with 5 "productivity management" elements, and finally "business success" is associated with 7 "productivity management" elements.

(ii) There are four "productivity management" elements that were not significantly associated with any "performance indicator" (i.e. "participation of family labour", "studying rate of the family", "quality premium", and "farming v non-farming").

(iii) Five "productivity management" elements were associated with at least one "performance indicator", highlighted in gold (i.e., "type of cacao bean" "source of cacao plant", "technological and market capabilities", "cacao production capabilities", "transaction conditions",).

Table 7-3. Correlation analysis of the productivity management element and performance indicators

PRODUCTIVITY MANAGEMENT			ORGANISATIONAL PERFORMANCE INDICATORS				
FACTORS	ASPECTS	ELEMENT	BUSINESS SUCCESS	PRICE	PRODUCTION PER HA	VALUE OF PRODUCTION PER HA	TOTAL PRODUCTION
Technology	Innovation	Age of cacao orchard	**0.22*** **	-0.06	**0.18** **	**0.16** **	**0.11***
		Type of cacao variety	**0.17** **	0.04	0.08	0	**0.14** **
		Pre-harvesting cacao activities	**0.11***	0	**0.14***	0	**0.21*** **
		Type of cacao bean	0.03	**0.39*** **	0.1	0.06	0
	Diffusion	Source of cacao plant	-0.04	0.07	0	0.03	**-0.1***
		Participation in organic cacao	0.05	**0.18** **	**0.21*** **	0.09	**0.32*** **
	Labour	Participation of family labour	-0.01	0.05	0	-0.06	-0.06
		Paid cacao activities	**-0.17** **	**-0.11***	-0.1	-0.05	**-0.35*** **
Competence	Skills	School attendance	**0.13***	0.03	**0.16** **	0.06	**0.16** **
		Technological & market capabilities	**-0.14** **	-0.07	-0.05	-0.01	-0.08
	Complementarity	Studying rate of the family	0.02	-0.04	-0.02	0.06	-0.08
		Cacao production capabilities	**-0.13***	0.05	0.02	-0.01	0.06
		Cacao business entrance	0.06	-0.04	**-0.11***	**0.11***	**-0.18** **
Operational Climate	Vertical integration	Commercialisation channel	-0.07	**0.15** **	0.04	-0.04	0.1
		Transaction condition	0.04	0.09	0.03	**0.14** **	-0.01
		Payment conditions	-0.06	0.05	**0.1***	**-0.15** **	**0.22*** **
		Quality premium	0.06	-0.05	0.04	-0.04	0.04
		Price setting	0.07	**0.49*** **	**0.11***	0.09	0.04
	Diversification	Cacao income importance	0.07	-0.05	**0.11***	0.04	**0.27*** **
		Farming v Non farming	0.06	-0.10	-0.09	-0.03	0.01

Significant level: * $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

(iv) Four "productivity management" elements were associated with two different "performance indicators", highlighted in yellow (i.e. "type of cacao variety", "commercialisation channel", "cacao income importance", and "price setting").

(v) Seven "productivity management" elements were associated with at least four different "performance indicators", highlighted in green (i.e. "age of cacao orchard" "pre-harvesting cacao activities", "paid cacao activities", "school attendance", "participation in an organic cacao program", "payment conditions", and "entry into the cacao business".

All factors and aspects had at least one match between them and the "performance indicators". This preliminary result will be further analysed in the following subsections.

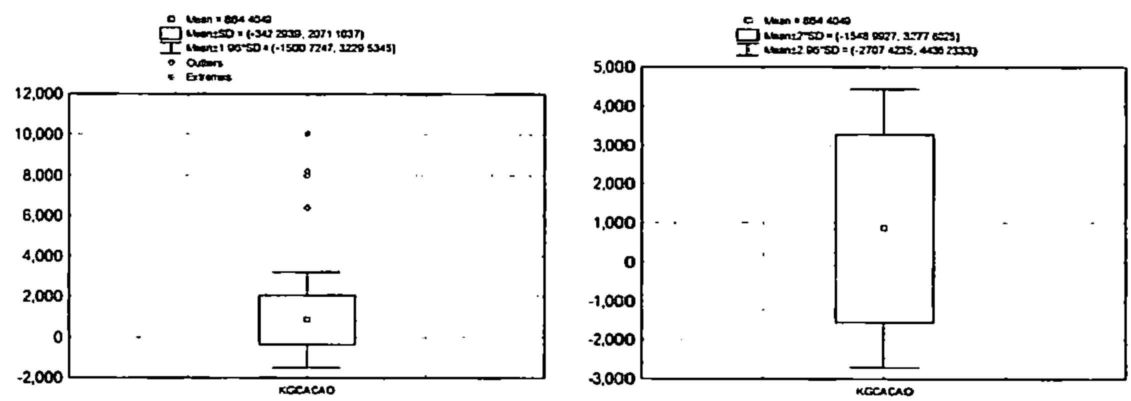
7.1.3. Sensitivity analysis

A sensitivity analysis was carried out to verify the reliability of the findings. This was done in two ways. First a systematic sub-sampling was done by eliminating the outliers and/or extreme values. Next, a random sub-sampling was done by selecting 75% of the cases at random and also 50% of the cases at random from the full sample.

Sensitivity analysis from systemic sampling

A systemic sampling consists of the elimination of cases with outliers and/or extreme values. The box plot was the tool used to identify the outliers and/or extreme values. Two values of standard deviation were considered to remove the outliers and/or extreme values. The first set of valid cases (N=344) was obtained by selecting a 1 Standard Deviation from the whole data set. Figure 7-4.a shows that 12 cases were removed from the whole data set by selecting 1 Standard Deviation. The second valid cases (N=349) were obtained by selecting 2 Standard Deviations from the whole data set. Figure 7-4.b shows that 7 cases were removed from the whole data set by selecting 2 Standard Deviations.

Figure 7-4. Outliers and extreme values of total production



(a) (b)

Table 7-4 shows the Pearson correlations for "factor's organisational configuration" and "aspect's organisational configuration" on the 5 "performance indicators". "Factor's organisational configuration" did not show any significant change in most of the "performance indicators". On the other hand, "aspect's organisational configuration" was influenced by this systemic sampling in almost all the "performance indicators" but "price". From this result, it is concluded that the data set is robust and there is no significant influence of outliers and/or extreme values on the valid data set.

Table 7-4. Sensitivity analysis from systematic sampling: 1 and 2 standard deviation (SD)

SAMPLING	N	PERFORMANCE INDICATOR				
		BUSINESS SUCCESS	PRICE	YIELD	VALUE OF PRODUCTION PER HECTARE	TOTAL PRODUCTION
Factor organisational configuration (55)						
Original	356	0.14*	0.21***	0.24***	0.12*	0.23***
SD 1	344	0.09	0.22***	0.09	0.2***	0.18**
SD 2	349	0.1	0.22***	0.11*	0.21***	0.21***
Aspect organisational configuration (27)						
Original	356	0.04	0.11*	0.21***	0.11*	0.13*
SD 1	344	0.01	0.19***	0.09	0.1	0.09
SD 2	349	0.01	0.19***	0.1	0.09	0.1
Significant level: * $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$						

Sensitivity analysis from random sampling

A random sampling consists of selecting some random subsets of the cases in order to analyse correlation changes as a result of the random sampling. The two sets of random sampling were carried out considering two percentage of the dataset: First, by drawing 75% of the valid data set and second, by drawing 50% of the valid data set. Furthermore, for each new data set selected by random sampling also 5 random repetitions were carried out.

As mentioned in section 6.2, the "fitness" value for the "factor's organisational configuration" was significantly associated with all "performance indicators". The "sensitivity analysis" shows that "yield" was not influenced by random sampling, "price" and "total production" were slightly influenced, and "business success" and ""value of production per hectare" were more influenced by both random samplings and their 5 repetitions. Thus, this suggests that the significant association found in the correlation analysis is reliable in at least in three "performance indicators" (Table 7-5).

Table 7-5. Sensitivity analysis from random sampling: drawing 50% and 75% of data set (S) and 5 repetitions (R)

OC	S %	R	N	PERFORMANCE INDICATOR				
				BUSINESS SUCCESS	PRICE	YIELD	VALUE OF PRODUCTION PER HECTARE	TOTAL PRODUCTION
FACTOR	100	-	356	0.14*	0.21***	0.24***	0.12*	0.23***
	75	1	268	0.13*	0.23***	0.25***	0.16*	0.18**
		2	265	0.13*	0.27***	0.22***	0.12*	0.22***
		3	277	0.1	0.25***	0.25***	0.1	0.24***
		4	261	0.06	0.15*	0.18**	0.1	0.23***
		5	268	0.11	0.18**	0.24***	0.15*	0.27***
	50	1	185	0.23**	0.29***	0.35***	0.19*	0.28***
		2	171	0.03	0.14	0.16*	0.07	0.19**
		3	177	0.09	0.1	0.22**	0.02	0.25**
		4	179	0.18*	0.31***	0.26***	0.2**	0.24**
		5	170	0.2**	0.2**	0.23**	0.13	0.23**
ASPECT	100	-	356	0.04	0.11*	0.21***	0.11*	0.13*
	75	1	268	0.05	0.14*	0.22***	0.19**	0.11
		2	265	0.03	0.11	0.21**	0.12*	0.08
		3	277	0.05	0.10	0.26***	0.12*	0.13*
		4	261	-0.01	0.08	0.15*	0.1	0.15*
		5	268	0.07	0.02	0.21**	0.14*	0.15*
	50	1	185	0.15*	0.14	0.21**	0.14	0.11
		2	171	-0.06	0.07	0.21**	0.09	0.15*
		3	177	0.06	0.07	0.2**	0.1	0.12
		4	179	0.03	0.14	0.22**	0.12	0.15
		5	170	0.15*	0.06	0.18*	0.09	0.14
Significant level: * $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$								

From subsection 7.1.2, it was found that the "fitness" value for "aspect's organisational configuration" was significantly associated with 4 "performance indicators". This sensitivity analysis by random sampling shows that "yield" is not influenced by random sampling at all. Both "Value of production per hectare" and "total production" are slightly influenced by random sampling. And, "price" is negatively influenced by this "sensitivity analysis" (Table 7-5). "Business success" was significant in two repetitions. This result suggests that the reliability of the "fitness" value for the "aspect's organisational configuration" is relatively weaker when compared to the relationship between this result and the correlations of the "fitness" value for the "factor's organisational configuration".

A "sensitivity analysis" was also carried out to test the association between the 20 "productivity management" elements and 5 "performance indicators". The "sensitivity analysis" used the above procedure. The tables of this particular "sensitivity analysis" are displayed in Appendix C. It was found that "productivity management" elements remain significant in both random samplings and their 5 respective repetitions when their significance is at least 99% (Table 7-6).

Therefore, fourteen "productivity management" elements are reliable in at least one "performance indicator" i.e. "age of cacao orchard", "type of cacao variety", "pre-harvesting cacao activities", "type of cacao bean", "participation in organic cacao", "paid cacao activities", "school attendance", "technological and market capabilities", "cacao business entrance", "commercialisation channel", "transaction condition", "payment conditions", "price setting" and "cacao income importance". The least reliable "productivity management" elements are "source of cacao plant", "cacao production capabilities". This confirms that the set of "productivity management" elements was reliable and the results arising from these variables are robust.

Table 7-6. Sensitivity analysis 3: Identification of the productivity management element that have consistent expected sign

PRODUCTIVITY MANAGEMENT			ORGANISATIONAL PERFORMANCE INDICATORS				
FACTORS	ASPECTS	ELEMENT	BUSINESS SUCCESS	PRICE	PRODUCTION PER HA	VALUE OF PRODUCTION PER HA	TOTAL PRODUCTION
Technology	Innovation	Age of cacao orchard	**0.22*** **	-0.06	**0.18** **	**0.16** **	**0.11***
		Type of cacao variety	**0.17** **	0.04	0.08	0	**0.14** **
		Pre-harvesting cacao activities	**0.11***	0	**0.14***	0	**0.21*** **
		Type of cacao bean	0.03	**0.39*** **	0.1	0.06	0
	Diffusion	Participation on organic cacao	0.05	**0.18** **	**0.21*** **	0.09	**0.32*** **
	Labour	Paid cacao activities	**-0.17** **	**-0.11***	-0.1	-0.05	**-0.35*** **
Competence	Skills	School attendance	**0.13***	0.03	**0.16** **	0.06	**0.16** **
		Technological & market capabilities	**-0.14** **	-0.07	-0.05	-0.01	-0.08
	Complementarity	Cacao business entrance	0.06	-0.04	**-0.11***	**0.11***	**-0.18** **
Operational Climate	Vertical integration	Commercialisation channel	-0.07	**0.15** **	0.04	-0.04	0.1
		Transaction condition	0.04	0.09	0.03	**0.14** **	-0.01
		Payment conditions	-0.06	0.05	**0.1***	**-0.15** **	**0.22*** **
		Price setting	0.07	**0.49*** **	**0.11***	0.09	0.04
	Diversification	Cacao income importance	0.07	-0.05	**0.11***	0.04	**0.27*** **

Significant level: * $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

7.1.4. Comparison of hypothesised (predicted) and actual relationships

This subsection examines the results of the hypotheses mentioned in section 6.3. Both previous subsections indicate that the "fitness" value for the "factor's organisational configurations" and the "aspect's organisational configurations" have a significant association with some of the "performance indicators".

Furthermore, based on the "sensitivity analysis", these significant associations remained stable at different levels of random samplings. At the same time, the associations between the "productivity management" elements and the "performance indicators" were also tested in a similar way. Table 7-7 shows the extent of the match between the hypothesised and actual results.

Hypothesis 1

It is clear from Table 7-7 that the null hypothesis of no relation between the "fitness" value obtained by the "factor's organisational configuration" and 5 "performance indicators" is very sharply rejected.

Hypothesis 2

It is also clear from Table 7-7 that the null hypothesis of no relation between the "fitness" value obtained by the "aspect's organisational configuration" and 5 "performance indicators" is rejected.

Hypothesis 3

It is clear from Table 7-7 that the null hypothesis of no relation between 14 "productivity management" elements (i.e. "age of the cacao orchard", "type of cacao variety", "source of cacao plant", "pre-harvesting cacao activities", "type of cacao bean", "participation on organic cacao", "paid cacao activities", "school attendance", "technological & market capabilities", "cacao production capabilities", "cacao business entrance", "commercialisation channel", "transaction condition", "payment conditions", "price setting", "cacao income importance", and "farming v none farming" activities) and 5 "performance indicators" is rejected very sharply. On the other hand, it is also clear that the null hypothesis of no relation between 4 "productivity management" elements (i.e. "participation of family labour", "studying rate of the family", "quality premium", "farming v none farming") is accepted.

Factor's organisational configuration

The result of hypothesis 1 indicates three main implications. (i) There is a positive relationship between the "factor's organisational configuration" and the 5 "performance indicators". This suggest the existence of the "fittest" organisational configuration, which in turn would provide information on the key "productivity management" elements. (ii) This positive relationship also suggests that the rank order of the responses shows consistency. Therefore, the "productivity management" elements could be used as a level of improvement.

Table 7-7. Hypotheses testing H1, H2 and H3: Comparison of the predicted and actual results

PRODUCTIVITY MANAGEMENT			ORGANISATIONAL PERFORMANCE INDICATORS				
FACTORS	ASPECTS	ELEMENT	BUSINESS SUCCESS	PRICE	PRODUCTION PER HA	VALUE OF PRODUCTION PER HA	TOTAL PRODUCTION
FITNESS VALUE		Factor organisational configuration	√*	√***	√***	√*	√***
		Aspect organisational configuration		√*	√***	√*	√*
Technology	Innovation	Age of cacao orchard	√***		√**	√**	√*
		Type of cacao variety	√**				√**
		Pre-harvesting cacao activities	√*		√*		√***
		Type of cacao bean		(+) ?***			
	Diffusion	Source of cacao plant					x*
		Participation in organic cacao		√**	√***		√***
	Labour	Participation of family labour					
		Paid cacao activities	(-) x**	(-) x*			(-) x***
Competence	Skills	School attendance	√*		√**		√**
		Technological & market capabilities	(-) ?**				
	Complementarity	Studying rate of the family					
		Cacao production capabilities	(-) ?*				
		Cacao business entrance			(-) ?*	(-) ?*	(-) ?**
Operational Climate	Vertical integration	Commercialisation channel		(+) ?**			
		Transaction condition				(+) ?**	
		Payment conditions			√*	(-) x**	(√ ***
		Quality premium					
		Price setting		√***	√*		
	Diversification	Cacao income importance			√*		√***
		Farming v None farming					

Significant level: * $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

That is, a farmer can increase his/her "fitness" by moving from his/her lower response level to the next immediate response level in the interested "productivity management" element (i.e. from a weaker position to a stronger position). This implication will be discussed further in the next section. (iii) The "sensitivity analysis" showed that the "factor's organisational configuration" is highly reliable. However, the association with the "performance indicators" of "business success" is relatively less strong.

Therefore, the results based on "business success" should be taken with some caution. The strongest association to "price" indicates that farmers are seeking for strategies to attract value from market. Therefore, the empirical results found in section 5.3 are confirmed here. Additionally, the positive association with "yield" confirms the need to create value for market which was also discussed in section 5.3.

Aspect's organisational configuration

The test result of Hypothesis 2 has two main implications. (i) The positive association implies that the "aspect's organisational configuration" is well aligned with the environmental conditions. This would also invite to the identification of the "fittest" organisational configuration and its respective "organisational configuration" based on key "productivity management" elements. (ii) As mentioned in section 6.2, this particular "organisational configuration" was an alternative arrangement based on the "aspects" of the "productivity management" factors. The intention of this special arrangement was to test the affect of a reduction of responses (i.e. from 5 to 2 responses). Although the "aspect's organisational configuration" was highly significant in 4 "performance indicators", it was relatively weaker in the "sensitivity analysis" compared with the "factor's organisational configuration". Therefore, it was decided not to provide any further analysis using this particular arrangement (i.e. reduction from 5 to 2 responses).

Productivity management elements

Hypothesis 3 shows that several "productivity management" elements were highly significantly associated with each "performance indicator". Considering this particularity, the discussion of the "productivity management" elements is detailed below.

The "age of cacao orchard" is strongly associated with "business success", "yield", and "value of production per hectare". The positive association between the "age of cacao orchard" and "business success" confirms that there is a close relationship between the cacao orchard and farmers' perception of success. That is, farmers are aware of the condition of their cacao orchard. Therefore, the older the orchard is, the lower is the farmers' perception of success. According to Boehlje and Eidman (1984) this perception is very important to achieve higher levels of performance. However, it is normally underestimated in tropical perennial production as suggested by many ecological studies (Rice and Greenberg, 2000; Donald, 2004). This study emphasises this influence of the perception of farmers. The positive association between "yield" and the "age of cacao orchard" confirms that an ageing cacao orchard is less productive than a young one (Wood and Lass, 1985) and the fact that the average age of cacao orchard is around 30 years indicates the urgent need to look for strategies to rehabilitate the cacao orchards. As mentioned in subsection 5.3.1, the identification of "frosty rot pod" in Tabasco (Phillips et al., 2006), a mortal disease, increases the urgent need to look for a renovation of the cacao orchards. Both natural conditions would lead to a drastic reduction of the production of cacao in Mexico which in turn would be the excuse for eliminating the coupon law to import cacao at any time and without consideration for the farming industry. Therefore, this scenario is a real challenge for the farming industry in the CAFS and the policy agricultural developers.

The "type of cacao variety" is strongly associated with "business success" and "total production" The positive association between the "type of cacao variety" and "business success" confirms that farmers recognise the quality of cacao trees and express this recognition in terms of success. Furthermore, as shown in section 5.3.1, a successful business is related with "criollo" variety. The positive association between the "type of cacao variety" and "total production" considers the possibility that farmers with more acreage have "trinitario" and "criollo" varieties, and "forastero" varieties are placed in small cacao plots. Such differentiation was not considered in other studies (Ramirez, 1997, Cordova et al., 2001). Therefore, this study emphasises the importance of cacao orchards planted with varieties oriented to fine cacao. This important result will be discussed in the next chapter.

"Pre-harvesting cacao activities" were strongly associated with "total production". Therefore, this confirms that most of the pre-harvesting activities are carried out in cacao orchards which have more than 5 Ha. However, it was seen that many farmers carry out less pre-harvesting activities in their cacao orchards. According to Rice and Greenberg (2000) the inherent biological yield of cacao under canopy permits farmers with small cacao orchards to reduce the number of agricultural activities without a significant reduction of production. This would explain why farmers with small cacao orchards prefer to reduce the number of pre-harvesting activities and may allocate their time and resources to carrying out other activities.

"Type of cacao bean" is strongly associated with "price". The positive association between "type of cacao bean" and "price" suggests that farmers recognise the importance of adding value to their products. Fermenting or "sun" drying is one of the immediate options. However, the number of farmers who perform such activities and the characteristics of such farmers are unknown.

"Participation in organic cacao" is strongly associated with "price", "yield" and "total production". The positive association between "participation in organic cacao" programs and "price" confirms farmers are drawn to the idea of looking for new ways to attract value e.g. introduction of organic production. This product differentiation strategy would influence positively the farmers' perception of the market. The results in other cacao regions are a good benchmark (Ayenor et al., 2004; Raynolds, 2004; Bacon, 2005). The positive association between "participation in organic cacao" and "yield" suggests that farmers still respond positively to public agricultural development programs. It is clear that this organic cacao program was not directly related to yield improvement as in previous programs (after 2001). But the yield difference between those farmers who participate in this program and those who do not is higher. Therefore, a further examination about the impacts of this type of public program is needed.

"Paid cacao activities" are strongly associated with "business success" and "production". However, the negative association was unexpected. It was argued that the more the farmers need to hire for cacao activities the less success or production they would have. Cordova et al. (2001) identified that a cacao orchard bigger than 5 hectares is more likely to require more hired labour, because of the need to maintain the orchard in optimal productive condition. Therefore, it seems that the bigger a cacao orchard is the more hired labour is required. Furthermore, if the cacao price is more attractive, a farmer is more likely to hire labour to carry out specialised activities (e.g. cutting down, crop protection). Furthermore, this study found that a farmer with low production due to having a small cacao orchard is less likely to hire labour. Therefore, the size of cacao orchard would be the main explanation for this unexpected result.

"School attendance" is strongly associated with "yield" and "total production". The positive association between "school attendance" and "yield" confirms the results of different studies related to education and agricultural performance (Makki et al., 1999; Zepeda, 2001; Weir and Knight 2004, 2006). This implies that the incorporation of young farmers with more skills and higher levels of education would be a necessary condition to improve efficiency and effectiveness in the cacao system.

"Technological & market capabilities" is strongly associated with "business success". However, it was found that this association is negative. This negative result would suggest that farmers are more conscious about the importance of market capabilities rather than the technological ones. Lattre et al., (1998) and Ruf and Yoddang, (1998) explain that after the participation of more middlemen, farmers are seeking for better channel where to distribute their products. This would explain the new market perception of farmers in CAFS. Therefore, farmers need more information and skills to understand and stay in the market.

"Cacao business entrance" is strongly associated with "total production". It was found that this association is negative. This result would suggest that the family greatly influence the decision to enter the cacao business. The lack of a supportive network, like the family, leads to a lower performance. The production of cacao is a family business, so this result is similar to those reported by Murphy (2005) and Anderson et al. (2005).

The "commercialisation channel" is strongly associated with "price". The positive association between a "commercialisation channel" and "price" confirms the empirical result from section 5.3. That is, farmers look for the best channel to sell their product (Lattre et al., 1998; Ruf and Yoddang, 1998). At this time, "private" and "union" structures are similar options. The difference in price is obtained abroad. However, to reach such especial price would imply looking at the internal "organisational configuration", seeking for the "limitations" and developing strategies to reduce such limitations.

The "transaction condition" was strongly associated with "value of production per hectare". The positive association between "transaction conditions" and "value of production per hectare" would confirm the importance of a relational exchange which leads to higher "value of production per hectare". This is confirmed by some authors who suggest that without a transparent and fair vertical integration, farmers will receive less value from their production (Batt, 2003; Cadilhon et al., 2003; Christopher, 2004).

"Payment conditions" is strongly associated with "value of production per hectare" and "total production". However, the direction of association is mixed. A negative association with "value of production per hectare" was obtained, so this finding suggests that farmers accept some negative payment conditions i.e. late payments. A delay in payment is reported by Cordova (2001). During the "import substitution" period, a farmer, was usually paid after he delivered the product to the "curing plant". A farmer waited for the "recovery" price (the term applied to the ratio between the weight of the fermented cacao obtained after "curing" activities and the weight of the fresh cacao collected during the harvesting activities) after the cacao production season. As things stands at present, curing plants managed by the farmer union (UNPC) have failed to pay immediately. Therefore, a farmer has to wait up to 2 or 3 months to be paid. On the other hand, middlemen do not have this financial situation and can pay immediately. However, middlemen do not give any "recovery" price. Finally, a positive association with "total production" was obtained as well, so this finding suggests that an immediate payment incentives the production. Therefore, the presence of both results may confirm the existence of both types of payment conditions (i.e. immediate and delayed).

"Price setting" was strongly associated with "price". The positive association between "price setting" and "price" confirms that farmers are stimulated by stable prices. That is, cacao prices are less likely to fluctuate over the harvesting season. As a result, cacao farmers react positively in the production and harvesting activities. This situation, however, was not seen in 1999 when prices reached rock bottom. Flood and Murphy (2004) highlight the fact that unstable price dramatically affects the production of cacao. Therefore, a negative change in the international prices could influence this stable price setting. Strategies to manage price risk are needed to avoid this possible scenario.

"Cacao income importance" is strongly associated with "total production". The positive association between "total production" and "cacao income importance" confirms that farmers dedicated mostly to cacao production have the highest performance. This finding is reported by Ramirez (1997) but he suggested that this type of farmer will be reduced in number. Further analyses are needed to confirm such a prediction. On the other hand, the existence of part-time farmers who continue maintaining their cacao orchard was also confirmed. The income diversification of farmers has been discussed in different studies (Ramirez, 1997; Hill, 2000;

Cordova et al., 2001). Therefore, it is important to pay attention to such a structural change especially for the development and implementation of public cacao programs.

In brief, "Participation in organic programs", "school attendance" and the "age of cacao orchard" have a strongly association with all "performance indicators". Therefore, they are considered as the main "productivity management" elements in the "fitness appraisal Instrument".

7.2. Exploration of the fitness landscapes

This section discusses the visual exploration of the two groups of landscapes. This section is divided into two main sections: subsection 7.2.1 shows the first group of landscapes that is constructed from the "fitness" value of the "factor's organisational configuration" and subsection 7.2.2 shows the second group of landscapes that is constructed by using the highly significant "productivity management" elements and their respective "performance indicator".

7.2.1. Exploring the "fittest" organisational configuration

The identification of the fittest "organisational configuration" is one of the main purposes of the "fitness approach". According to the literature review a visual examination is suggested. The exploration is achieved by plotting the fitness landscapes of the "factor's organisational configuration". Two graphical tools are used to plot these landscapes: profile and polar.

The basic idea of "profile" graphs is to present individual units of observation as particular graphical objects where values of variables are assigned to specific features or dimensions of the objects i.e. usually one case=one object. The assignment of the objects changes as a function of the configuration of values (Hill and Lewicki, 2006). Therefore, the objects are given visual identities that are unique for configurations of values and can be identified by the observer. Examining such "profiles" helps this study to discover specific sets of both simple relations and interactions between variables.

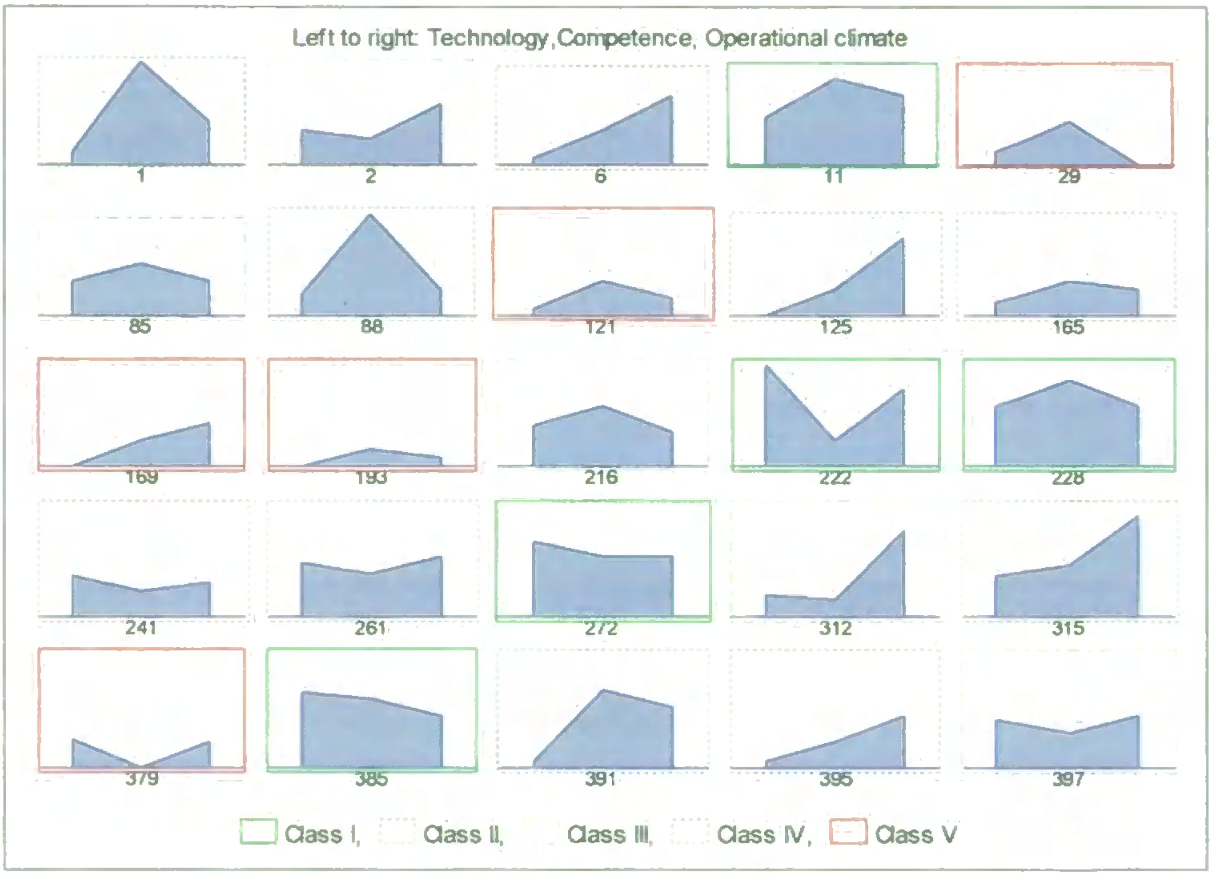
A "polar" graph (r, q) represents the location of a point (in 2D space) by its distance (r) from a fixed point on a fixed line (polar axis) and the angle (q, in radians) from that fixed line. "Polar" graphs are used to visualise functions. "Polar" graphs also offer an intuitive way to present relations involving a variable representing direction (Hill and Lewicki, 2006).

Fitness landscape: "factor's organisational configuration"

The first attempt to look at the fittest "organisational configuration" is by analysing the fitness landscape. As mentioned in subsection 7.1.4 the "factor's organisational configuration" was used as a valid landscape to be explored. The exploration of the fitness landscape consists of a visual examination of the validated sample (N=356) and their respective fitness values of each key factor (i.e. "technology", "competence", and "operational climate"). A profile graph was used to visualise this fitness landscape. Before the graphical analysis, the fitness value for the "factor's organisational configuration" was grouped according to 5 classes: class I (0.56-0.61), class II (0.51-0.55), class III (0.46-0.50), class IV (0.41-0.45), and class V (0.35-0.40).

Figure 7-5 shows an example of 25 cases considering 5 cases for each class. From left to right "technology" "competence" and "operational climate" are plotted. The highs of each point represent their partial "fitness" value. The points are linked in order to produce a "roof shape". Both the constructed area and the "roof shape" are the base from which to look for any potential particularity.

Figure 7-5. Fitness values of organisational configuration of the factors technology, competence, and climate operational



The first particularity arises from the constructed "area" of the profile. So class I will occupy a much bigger area than class II, and so on to class V. For example, case 11 belongs to class 1 and therefore its area is much bigger than case 88 which belongs to class 2. Then, the area of case 88 is much bigger than that of case 85 which belongs to class 3. The same procedure is used for class 3, 4 and 5. Thus, case 121 has the smallest area of all the cases previously mentioned for each class. For the purpose of the explanation, all these cases share a similar "profile" shape.

The second particularity takes into consideration the shape of the profile (Figure 7-5). The "optimal" profile would be a high "flat" roof shape (∏) which in turn gives maximum partial "fitness" values to "technology", "competence", and "operational climate" factors. Five main roof shapes were found (Figure 7-5):

(i) "Gable", a very triangular roof, the gable means that "competence" is the most important factor to the "fitness value" (e.g. 85, 88, and 228),

(ii) "Salt box", similar to a gable roof, but the two sides of it are not symmetrical. Therefore, "competence" is still the main contributor to the fitness value. It also shares this contribution with either "technology" ("left salt box", e.g. 29) or "operational climate" ("right salt box", e.g. 1, 391, 165),

(iii) "Left shed", similar to a gable roof but the maximum point comes from the left side. Therefore, the most important factor that contributes to the "fitness value" is "technology" factor (e.g.385, 272),

(iv) "Right shed", similar to a gable roof but maximum point comes from the right side. Therefore, the most important factor that contributes to the "fitness value" is "operational climate" factor (e.g. 6, 395, 125, 169, 315), and finally

(v) "M roof", this is like the gable roof, but has two triangular roofs that bind. Therefore, "technology" and "operational climate" are the main contributors to the "fitness value" (e.g. 2, 222, 241, 261, and 379).

Considering only the shapes of the highest and lowest "fitness values" (i.e. 11, 222, 228, 272, 385, and 29,121, 169, 193, 379 respectively), it is possible to appreciate that all types of "roofs" are present. This leads to the conclusion that a farmer only needs to build up his/her current configuration in order to achieve a higher level of fitness. This means in the same "roof shape", for instance case 379 could build up their internal "organisational configuration" to reach case 222. On the other hand, this result would indicate that such a mosaic of profiles responds to different situations in the environment. Therefore, a change from one profile (i.e. "M roof") to another (i.e. "gable roof") would not necessarily be appropriate. A further investigation should be done by analysing in detail the "fitness" values.

Fitness value and "productivity management" element

The identification of the "fittest" organisational configuration (hereafter only referred to the "fittest") leads to a detail exploration of the "fitness" value, the "productivity management" element and the respective cases. Considering the valid dataset (N=356), the maximum "fitness value" belongs to case 285, and the minimum "fitness value" to case 193. By comparing the values of the performance indicators of the "fittest" and the least fit (cases 285 and 193 respectively) with those cases which show the maximum performance values (Table 7-8), it is possible to know more about the performance of these particular cases.

Table 7-8. Comparing values of performance indicators between the fittest, the least fit, and selected cases (i.e. maximum values)

VARIABLE		PERFORMANCE VALUES				
	SELECTED CASES	193	285	222	366	360
Fitness value	Factor Organisational Configuration	0.35**	0.61*	0.56	0.58	0.53
Performance indicators	Business success	2	4	5*	4	4
	Price ($)	12.5	15.7	34*	15.5	17.5
	Yield (Kg Ha-1)	280	648	538	933*	666
	Value of production per hectare ($ Ha-1)	3500	10174	18292	14461	11655
	Total Production (Kg)	140	1620	3497	2799	10000*

* Maximum values

** Minimum values

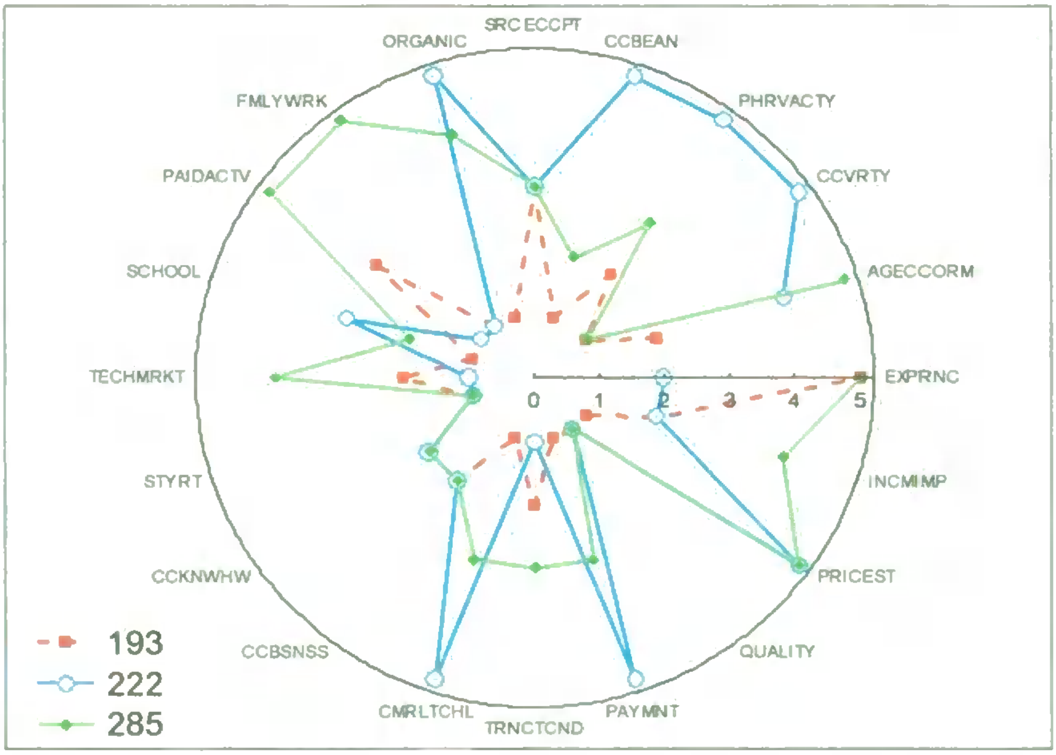
Table 7-8 shows that the "least fit" (193) has lower performance values and the "fittest" (285) performs much better. Neither, the least fit has any minimum value of performance indicators, nor the "fittest" any maximum value of performance indicator. However, Table 7-8 also shows three selected cases which contain maximum values in one of their performance indicators, i.e. the highest price value or "maximum price" is obtained by case 222, the "maximum yield" by case 366 and "maximum production" by case 360. This outcome suggests that the "fittest" would perform much better. For instance, the "fittest" could increase the price of cacao beans by looking at the "organisational configuration" of case 222; it also could increase the yield by looking at the "organisational configuration" of case 366, and so on. Furthermore, one can observe that all these selected "maximum" cases would also benefit from the "fittest". For instance, case 222 could improve the yield; case 366 could improve the price, and so on. Thus, the "fittest" and "maximum" cases could improve their performance by looking at their close neighbours. A fitter neighbourhood is characterised by higher "fitness" values.

However, it is important to bear in mind that cases with "maximum" values are considered statistically outliers. This particular characteristic makes "maximum" cases less reliable than the "fittest", because these cases or outliers need to be further scrutinised in order to validate (i) their performance values; (ii) the inherent relationship between their "organisational configuration" and environment; and (iii) the potential to be reproducible. Outliers may be data entry errors or values that need a special explanation. The improvement of performance based on outliers would lead to frustration because the inherent relationship between the "organisational configuration" and respective environment could be exceptional. Thus, the possibility of reproducing the same effect among other cases would be simply not achievable.

In brief, the "fittest" is a benchmark from which other farmers with lower performance indicators could start to improve performance. The improvement process starts by looking at the neighbourhood; that is looking for new shapes or "fitness" values. The theoretical "fittest" organisational configuration has the "fitness" value of 1. This study found that the theoretical "fittest" was not found, so this suggests a need to seek for more improvement. The possibility of having a set of "fittest" points is high and very useful for practical reasons, but as mentioned before, some other considerations need to be taken into account, especially if these "fittest" points include outliers._According to literature, the "fitness" landscape changes once a variable (productivity management element) is added or altered. Therefore, the number of variables plays an important role in the search for the "fittest". The selection of the number of variables could be a limitation at this point.

The next step is to look at the main characteristics of the "organisational configuration" of the "fittest". A polar graph of the categories of each "productivity management" element (PME) is used for this purpose (Figure 7-6). Three cases are plotted, the "fittest" (285), the "least fit" (193) and the "maximum price" (222).

Figure 7-6. Maximum and minimum fitness values and their productivity management element



The "least fit" has only one PME with the highest rank (EXPRNC), so most of its PMEs are located inside the graph of the "fittest". The "fittest" has 5 PME with the highest ranks (i.e. 5): "age of cacao orchard" (AGECCORM), "participation of family labour" (FMLWRK), "paid cacao activities" (PAIDACTV), "price setting" (PRICEST), and "farming v non farming" (EXPRNC), and 3 variables with the lowest rank (i.e. 1): "type of cacao variety" (CCVRTY), "studying rate of the family" (STYRT), and "quality premium" (QUALITY).

The "maximum price" has 7 PME with the highest ranks (i.e. 5): "type of cacao variety" (CCVRTY), "Pre-harvesting cacao activities" (PHRVACTY), "type of cacao bean" (CCBEAN), "Participation in organic cacao" (ORGANIC), "commercialisation channel" (CMRLTCHL), "payment conditions" (PAYMENT), and "price setting" (PRICEST), and 6 variables with the lowest rank (i.e. 1): "participation of family labour" (FMLYWRK), "paid cacao activities" (PAIDACTV), "technological and marketing capabilities" (TECHMARKT), "studying rate of the family" (STYRT), "transaction conditions" (TRNCTCND), and "quality premium" (QUALITY).

The "least fit" could improve its performance by moving the lower values of some PMEs to the position of those values at the "fittest". In this particular case, 12 PMEs need to be changed in order for the least fit to be improved. Another situation is that the "least fit" (193) moves its lower PME values to those that are the highest in the "maximum price" (222). In this case, 9 PMEs would be improved. Finally, the "maximum price" case could also improve its fitness value by moving the lower values of some PMEs to the position of those values at the "fittest".

Nevertheless, such changes need to be carefully examined because as the "fitness" approach suggests each "organisational configuration" responds to a particular environment. The improvement of the "fittest" would be manifested once it matches the environment where a "maximum price" is placed. For instance, it was found that the variety of "criollo" cacao produces fine quality and in turn this product attracts more value. The condition in which farmers produce particular varieties as was observed in some cases of the data set, is not sufficient to achieve the maximum price, so more elements such as ways of curing cacao, gain access to good communication and transportation, the demand for such products, among others are becoming very important as well.

In brief, the "organisational configuration" is given by the combination of the category values of each PME. The "fittest" is a benchmark from which other farmers can compare their limitations and opportunities. The "fittest" can also be improved as other farmers show interesting "organisational configurations". Nevertheless, it is important to highlight some limitations, because as expressed in the "fitness" theory each combination responds to specific environmental conditions, so special attention is needed.

Conclusions

The exploration of the fitness landscape gives a better idea about the mosaic of strategies (or profiles) that a farmer has developed in order to fit into his/her environment. The strategies found cover different combinations, but single factor (i.e. "gable" and "shed" roofs) and double factors (i.e. "salt box" and "M" roofs) were more common. The "competence" factor has two types of strategies: "gable" (roof) as a unique source to achieve higher "fitness" value and "salt box" which can be complemented by either "technology" or "operational climate" factors. The "M" strategy ("M" roof) which combines "technology" and "operational climate" also draws attention, as it suggests a balance between the productive actions and the interactions between industries (i.e. farming and curing industries). The exploration of the fitness landscape requires good graphical tools to visualise the partial "fitness" values of each factor. Profile graphs were used to achieve this.

One of the main goals of the "fitness" approach is to find, at least theoretically, the "fittest" organisational configuration which has a value of 1. The analysis showed that this theoretical "fittest" organisational configuration was not found in the data set, instead the empirical "fittest" was considered as that with the highest "fitness" value i.e. 0.61. The "fittest" is a reliable benchmark, because it shows relevant performance indicators. Cases with lower fitness values can improve their performance by emulating the "organisational configuration" of the "fittest". It was also found that the "fittest" does not have any maximum performance, so this would lead to the conclusion that even the "fittest" could improve its performance. The analysis of the "organisational configuration", that is the combination of categorical values of all PMEs, reinforced this idea of complementarity. Nevertheless, it is also argued that these changes should be contextualised in the environment of such particular "maximum" cases.

Thus, this study concludes that the "fittest" is the benchmark which would permit other cases to improve their performance because it is assumed that the "fittest" matches most of the current environmental conditions, so the possibilities for success (and adapt) are higher. Some cases with "maximum" performance were also found. This led this study to consider the possibility of implying the existence of a set of "fittest", because of two main reasons: (i) both the "fittest" and "maximum" cases could improve each other's performance by looking at the "organisational configuration" respectively and (ii) the interaction would help to construct a non-plus-ultra "organisational configuration". Finally, it is also discussed that a movement from one category value to another higher one would change the "fitness" landscape, however, this was not considered in this study and will need further investigation to confirm this statement of "fitness" theory.

7.2.2. Exploring the performance indicators of the farming industry

This section explores the fitness landscape which is constructed by graphing the significant "productivity management" elements (i.e. pre-harvesting activities, source of cacao bean, participation in organic cacao, paid cacao activities, cacao business entrance, payment conditions, and cacao income importance) and the performance indicators (i.e. "business success", "price", "production per , hectare", "value of production per hectare", and "total production"). Some non-significant "productivity management" element landscapes are plotted and discussed as well.

Graphical tool

The exploration of the landscape was carried out by employing the surface plot tool (SPT) of SATATISTCA®. With the SPT, a surface is fitted to the data (variables corresponding to sets of XYZ). X and Y were assigned to "fitness" elements and Y was used to graph the performance indicators. Two important considerations need also to be taken into account: fitting type and stiffness parameter.

There are 5 predefined functions available for the drawing of the 3D graphs in the SPT (Hill and Lewicki, 2007):

(i) Linear, e.g. $Z = a + bX + cY$,

(ii) Quadratic, i.e. second-order polynomial function to the points,

(iii) Distance Weighted Least Squares (DWLS), i.e. a curve is fitted to the data by using the following procedure: a polynomial (second-order) regression is calculated for each value on the X variable scale to determine the corresponding Y value such that the influence of the individual data points on the regression decreases with their distance from the particular X value),

(iv) Negative Exponential Weighted Least Squares (NEWLS), i.e. this surface is based on a polynomial regression algorithm similar to the one used in the Distance-Weighted Least Squares procedure. However, the weights that determine the influence of individual data points on consecutive segments of the curve (depending on their distance from the given segment) are calculated according to a negative (decreasing) exponential function;

(v) Spline, i.e. curves of any complexity can be described by a sequence of segments defined as polynomials. For bivariate data sets (correlations that involve two variables), to determine the curve, the spline procedure solves cubic equations for every point at a regular interval (for more information on cubic interpolation.

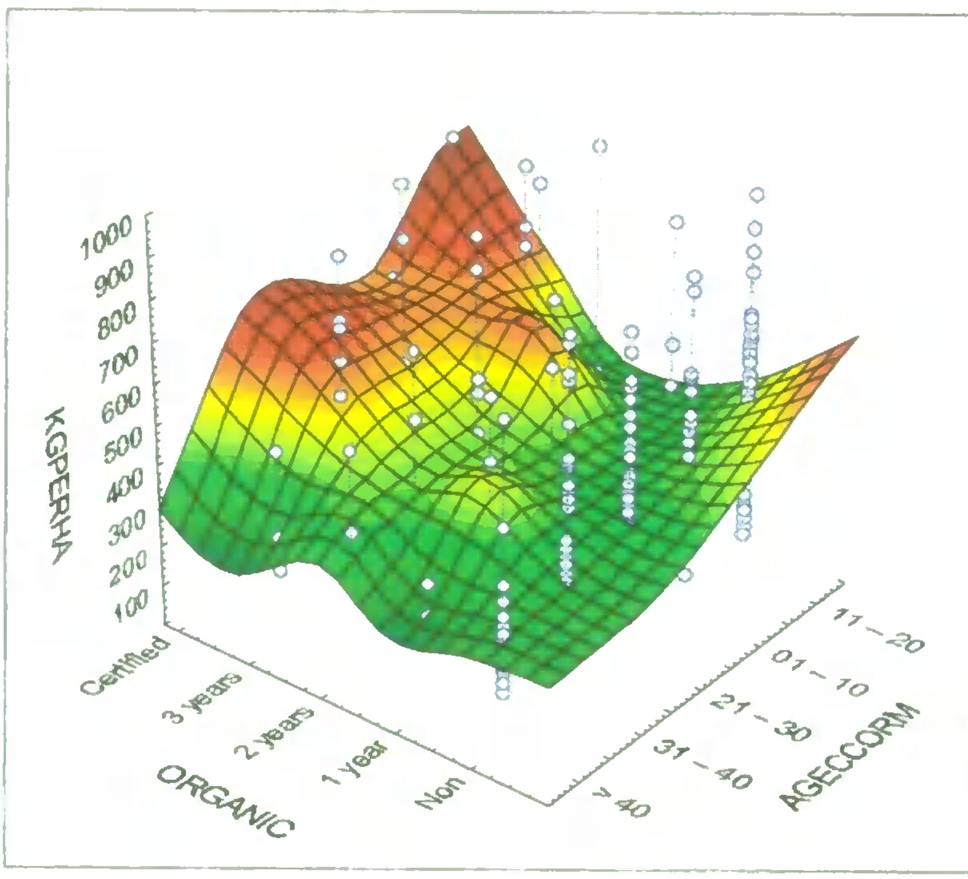
The weight in the DWLS, NEWLS, and Spline fits is determined by the Stiffness parameter (Hill and Lewicki, 2007). The value of this parameter ranges from 0 to 1. The lower the coefficient, the more the shape of the curve is influenced by individual data points (i.e., the curve "bends" more to accommodate individual values and subsets of values). Large values of the parameter produce smoother curves that adequately represent the overall pattern in the data set at the expense of local details.

DWLS were selected as the first method to construct and analyse the fitness landscape. The selection of this function was based on the capacity to discover small changes in the landscape (Hill and Lewicki, 2007). Nevertheless, the DWLS method produces some distortions, so the NEWLS method was also employed to plot the landscape. This method, in many circumstances, offers an adequate balance between preventing points at remote sub-regions from biasing the curve while not ignoring them entirely. The value of the stiffness parameter was fixed at 0 in all graphs. The raw data were also plotted in order to observe the contribution to the computed 3 Dimension surface.

Yield

This "performance indicator" has 3 strongly significant "productivity management" elements (i.e. the "age of cacao orchard", "participation in an organic program", and "school attendance"). The first "yield" landscape was based on the exploration of the "age of cacao orchard" and "participation in an organic program" (Figure 7-7).

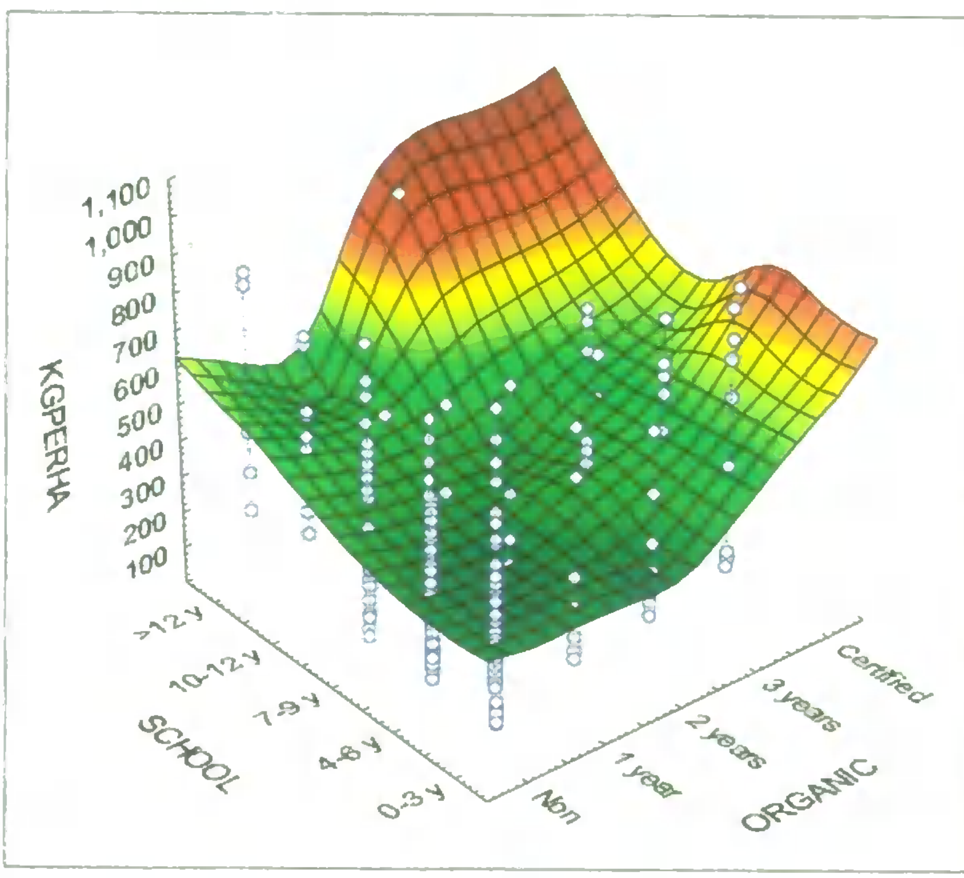
Figure 7-7. The effect of the age of cacao orchard and participation in organic program on yield



This graph was constructed by using the DWLS method. As expected the yield per hectare decreases when the age of cacao orchard is over 30 years. This result is observed clearly in the category non-"participation in an organic program" (None). Once the "participation in an organic program" is added, it is possible to observe a difference between the yield obtained by farmers who do not participate in the organic cacao program and that obtained by farmers who do participate. This would suggest that "participation in an organic program" is a positive stimulation for the achievement of higher levels of yield from 400 to 700 Kg Ha^{-1}. However, the values of yield are still very low in comparison to the values obtained by INIFAP (Mexican Institution of Agricultural Research) which reaches 2000 Kg Ha^{-1}.

The second "yield" landscape is constructed from "school attendance" and "participation in an organic program" (Figure 7-8).

Figure 7-8. The effect of school attendance and participation in an organic program on yield



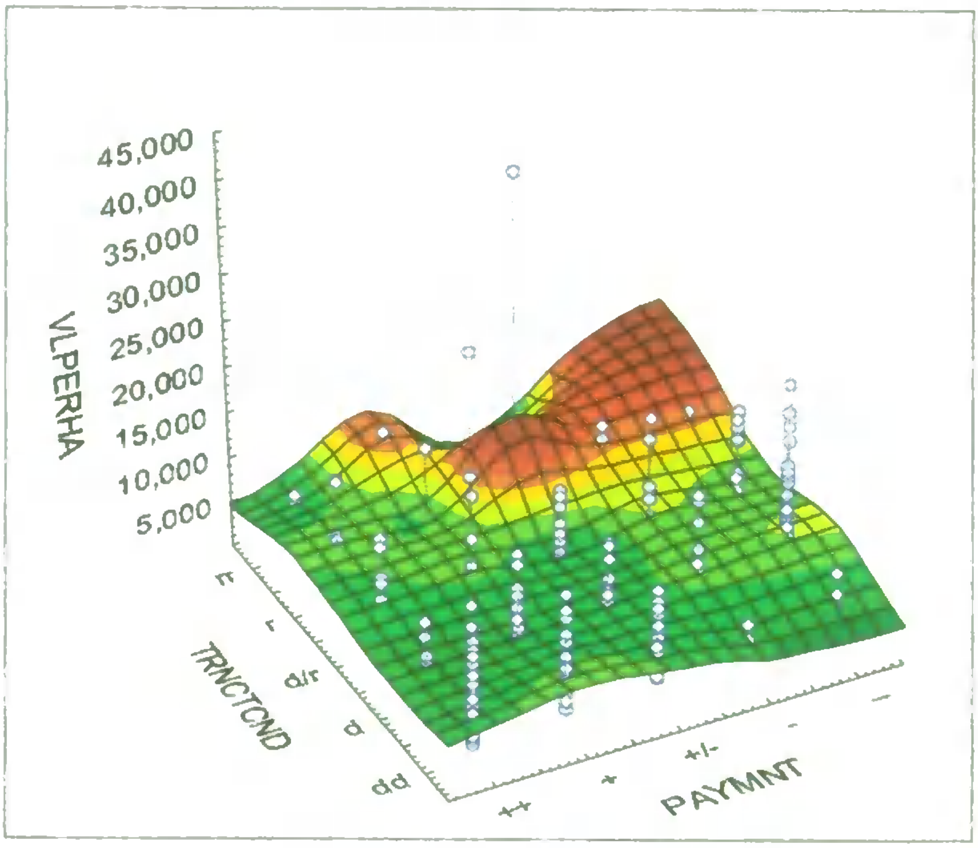
This graph was constructed by using the NEWLS method, because there were some distortions when using the DWLS method. It was confirmed that education is a core variable which drives positively the yield per hectare. However, it was very interesting to observe that the "participation in an organic program" complements somehow the educational gap of those farmers with a low educational level (up to 6 years of school), acting as a complementary source. This could be clearly observed in "certified" farmers and in those with a low level of education (0-3 years).

Both DWLS and NEWLS methods were employed in the construction of the "yield" landscape. Both selected methods apply the inverse values of the variances for the residuals as weights and compute weighted least squares estimates. These variances are usually not known, but they are often proportional to the values of the independent variable(s), and this proportionality can be exploited to compute appropriate case weights (Lewicki, 2007). By comparing the landscapes of figures 7-7 and 7-8, there is an overestimated yield curve in figure 7-8, even though the analysis in each case is based on the same sample of farmers. This inconsistency can be explained as follows. In figure 7-8, there are few cases in some categories of organic variable (i.e. "certified" and "3 years") and school variable (i.e. ">12 y" and "10-12y"). Owing to this peculiarity, fitting methods (DWLS and NEWLS) misrepresent the yield curve in those areas where there is a lack of information. The misfit of a function is a common characteristic in modelling and predictive analyses (Lewicki, 2007). Thus, the number of cases may influence the construction and analysis of performance landscapes by using SPT.

Value of production per hectare

Three variables are strongly associated with "value of production per hectare" ($p<0.01$): the "age of cacao orchard", "transaction conditions" and "payment conditions". The first "value of production per hectare" landscape was constructed by employing "transaction conditions" and "payment conditions" (Figure 7-9). This graph was constructed by using the DWLS method. "Transaction condition" was positively significant, that is the more "relational" the transaction condition is the more value per hectare will the farmer receive.

Figure 7-9. The effect of transaction payment conditions and payment conditions on value of yield

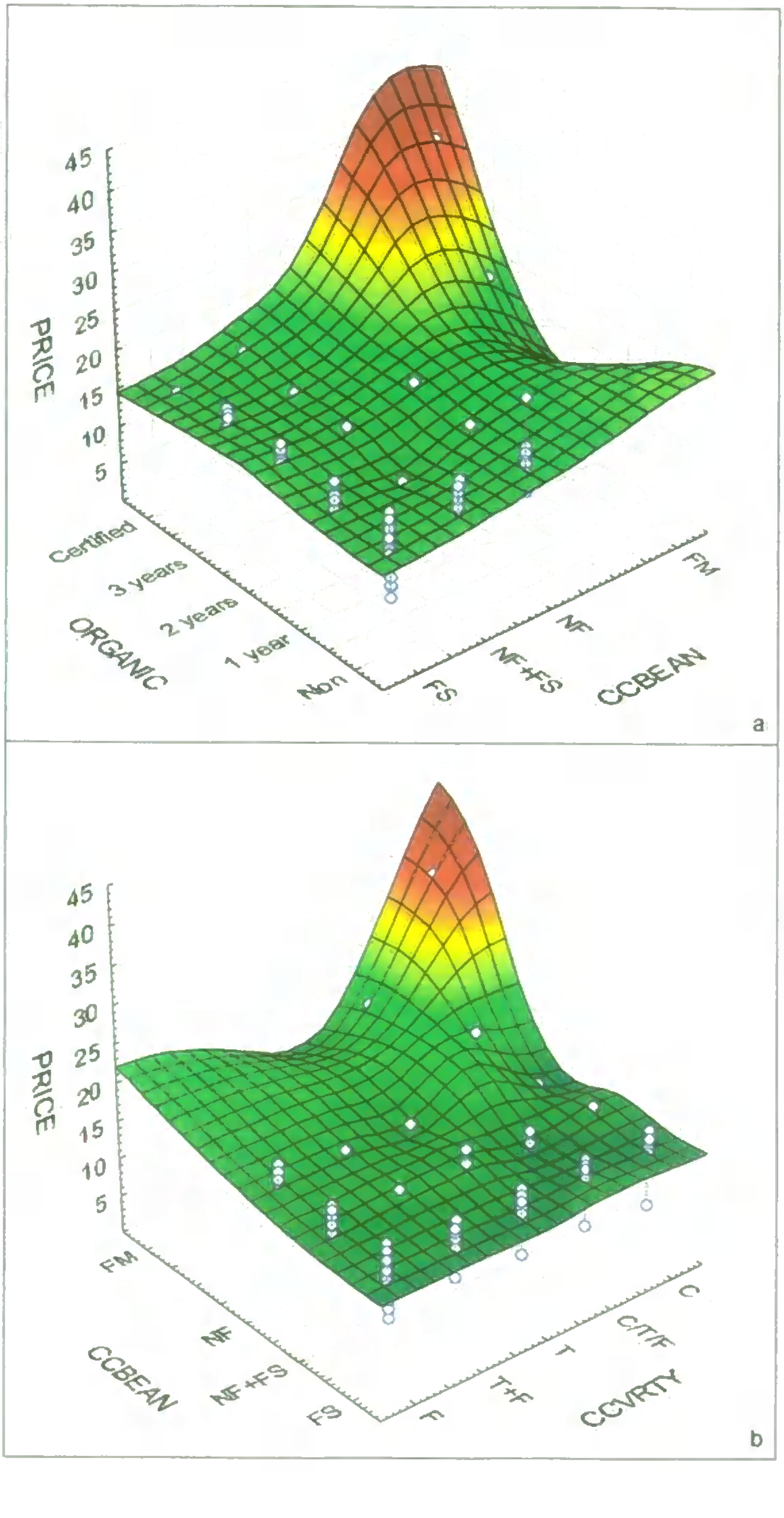


On the contrary, the more "discrete" the transaction condition is, the less value per hectare does the farmer receive. "Payment conditions" were negatively significant. This means that farmers are more likely to accept delay on payment in order to receive a better value per hectare. The combination of both "productivity management" elements shows that farmers prefer to keep a "relational" transaction (for instance those "curing" plants owned by the UNPC), although they have to finance this relationship by accepting delays for payment. However, a win-win relationship is obtained because farmers would receive more value under this relational exchange. The "age of cacao orchard" has been included in previous discussion of performance indicators. Therefore, this "productivity management" element is not used in the construction of other landscapes.

Price

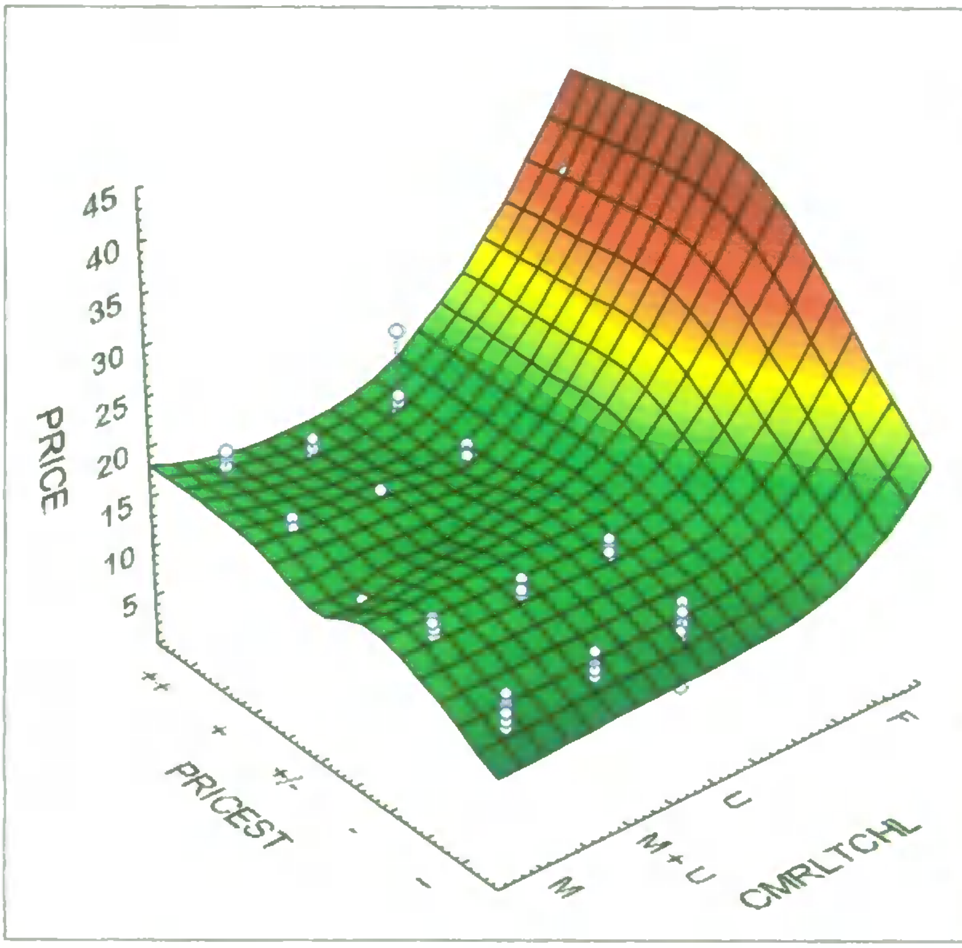
Four "productivity management" elements are strongly significant with "price": "type of cacao bean", "participation on organic cacao", "commercialisation channel" and "price setting". The first "price" landscape is constructed from the "type of cacao bean" and "participation in an organic program" (Figure 7-10a). This graph was constructed by using DWLS method. It can be seen that the "participation in an organic program" leads to higher cacao prices being obtained. However, this also requires fermenting and drying the cacao ("curing"). If farmers sell "non-fermented" (NF) and "fermented" cacao (FM), prices also increase even though there is no participation in an organic program. The selling of "fresh" cacao is not influenced by the different levels of participation in the organic cacao program. This peculiarity is explained by the fact that organic cacao production had not been placed in any organic market by the time this study was carried out. Furthermore, the high price value at fermenting and certified positions is due to the finest quality of cacao bean rather than the organic characteristic. As mentioned in section 5.3.1 "fine" cacao refers to the "type of variety": "criollo" (C), as shown in Figure 7-10b. This graph was constructed by using the DWLS method.

Figure 7-10. (a) The effect of participation in an organic program and type of cacao bean on product price; (b) The effect of type of cacao bean and type of cacao variety on product price



Two "productivity management" elements related to the vertical integration aspect are also significant to "price". Figure 7-11 shows the influence of "Price setting" and "commercialisation channel" on "price". This graph was constructed by using DWLS method.

Figure 7-11. The effect of price setting and commercialisation channel on price

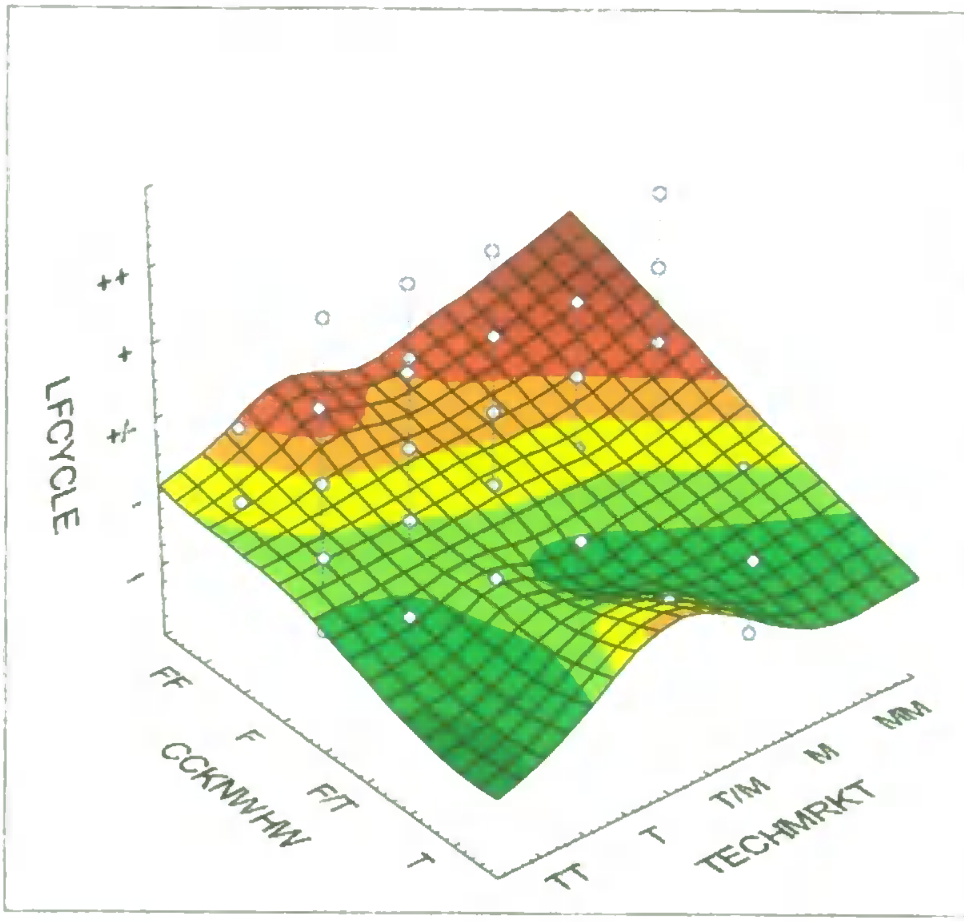


As discussed in section 5.3.1, farmers have two main "commercialisation channels": the network of middlemen (M) and the UNPC (U). The cacao price seems to be uniform in both channels. The difference is made by the inclusion of a new "buyer". As was mentioned in section 5.3.1, this particular "buyer" is a "chocolate" firm located in Europe. Farmers look for stable prices throughout the season. In this study, it was found that stable prices normally reach higher values. Organisations of both main channels of commercialisation use a stable price policy to attract farmers' cacao beans.

Business success

Four "productivity management" elements are strongly associated with "business success" ($p<0.01$): the "age of cacao orchard", "type of cacao variety", "paid cacao activities", and "technological and market capabilities". Some of the combinations of these "productivity management" elements have already been discussed above, and will show the same pattern here. Therefore, a "business success" landscape was constructed from "cacao production capabilities" and "technical and market capabilities" (Figure 7-12). This graph was constructed by using DWLS method. As mentioned in subsection 7.1.4, the association between "technology and market capabilities" and "business success" is negatively correlated, so the business perception of "growing" and "developing" is given of "marketing capabilities" rather than technological ones. "Cacao production capabilities" are also negatively significantly associated with "business success", so the main source of such capabilities is the family, rather than exogenous training. This landscape shows a combination of "marketing capabilities" and cacao production capabilities based on "family" results in higher levels of "business success".

Figure 7-12. The effect of the age of cacao orchard and technology and market capabilities on business success

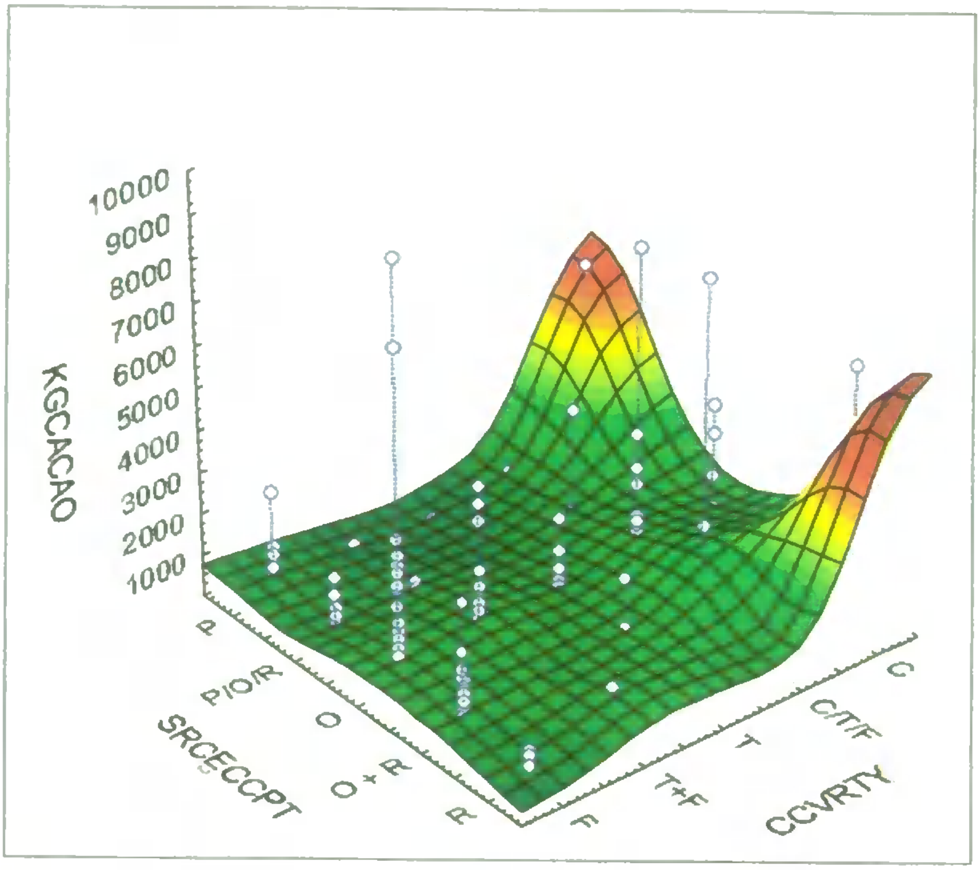


Total production

This performance indicator has 8 strongly significant "productivity management" elements ($p<0.01$): "type of cacao variety", "pre-harvesting cacao activities", "participation in an organic cacao", "paid cacao activities", 'school attendance", "cacao business entrance", "payment conditions", "cacao income importance". Some "productivity management" elements have been discussed above (i.e. "participation in an organic cacao program" and "school attendance"). Therefore, none of them are considered in this examination.

The first "total production" landscape is based on the "type of cacao variety" and the "source of cacao plant" (Figure 7-13).

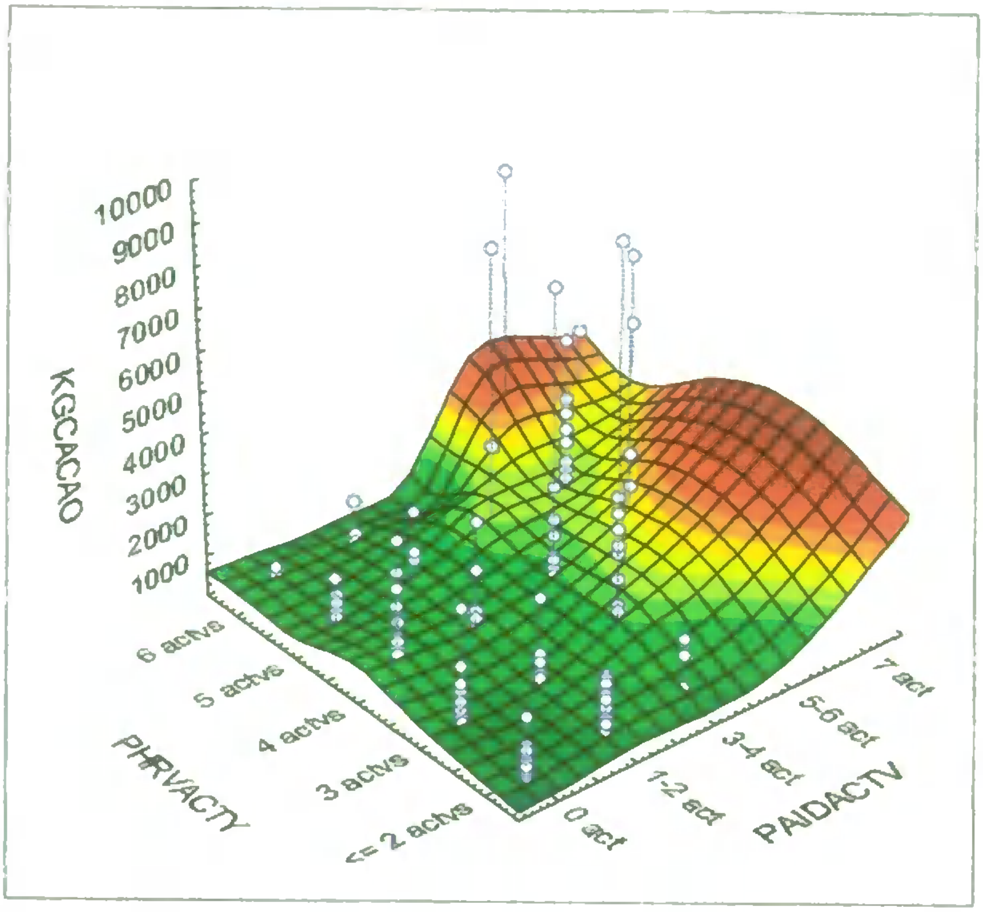
Figure 7-13. The effect of source of cacao plant and type of cacao variety on total production



This graph was constructed by using DWLS method. It is shown that the variety of "criollo" (C) is concentrated in some farmer orchards. It was found that such a variety came from either public programs or from cacao orchards of relatives or friends. Most of the farmers have orchards mainly based on a combination of "forastero" (F) and "trinitario" (T) cacao varieties which in turn are more productive. However, neither of these show any difference in the "yield per hectare". This results shows that there are some cacao orchards mainly planted with "criollo". Therefore, the potential to increase the export of such "fine" cacao is feasible in the short term, as was suggested in section 5.3.1.

The second "total production" landscape was constructed from "pre-harvesting cacao activities" and "paid cacao activities" (Figure 7-14).

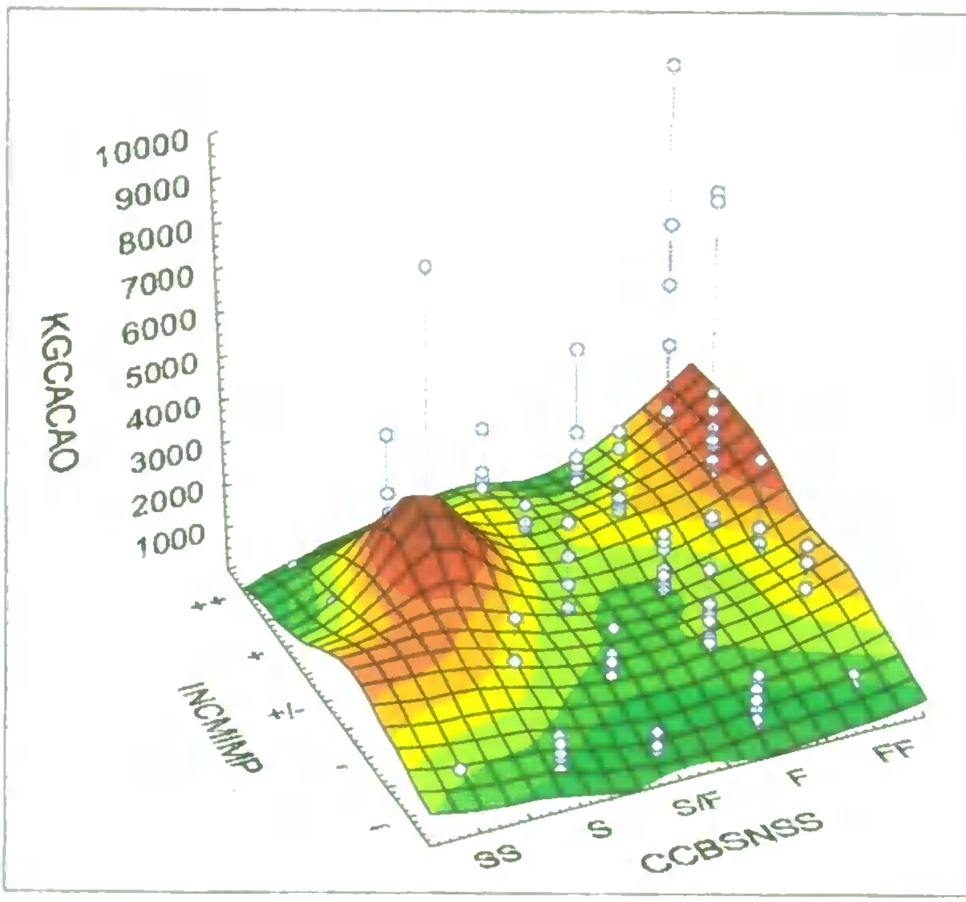
Figure 7-14. The effect of pre-harvesting cacao activities and paid cacao activities on total production



This graph was constructed by using the DWLS method. "Pre-harvesting cacao activities" was positively significant. Thus, farmers who perform most of the basic pre-harvesting activities (i.e. pruning, crop protection, fertilisation, shade control, weeding, and irrigation) obtained more production. "Paid cacao activities" was negatively significant. This means that farmers are not performing all their activities. Actually, as is shown, most farmers hire labourers for carrying out specific production activities and this is more evident in those cacao orchards where the production is more than 2000 kilograms (or the acreage is above 5 hectares).

The last "total production" landscape is based on "Cacao business entrance" and "importance of cacao income" (Figure 7-15). This graph was constructed by using DWLS method. It was found that "cacao business entrance" is negatively significant. Contrary to what was expected, "family" had a greater influence on the production of cacao than "self-decision" which is based on market conditions. "Cacao income importance" is, however, positively associated with "total production".

Figure 7-15. The effect of cacao business entrance and importance of cacao income on total production



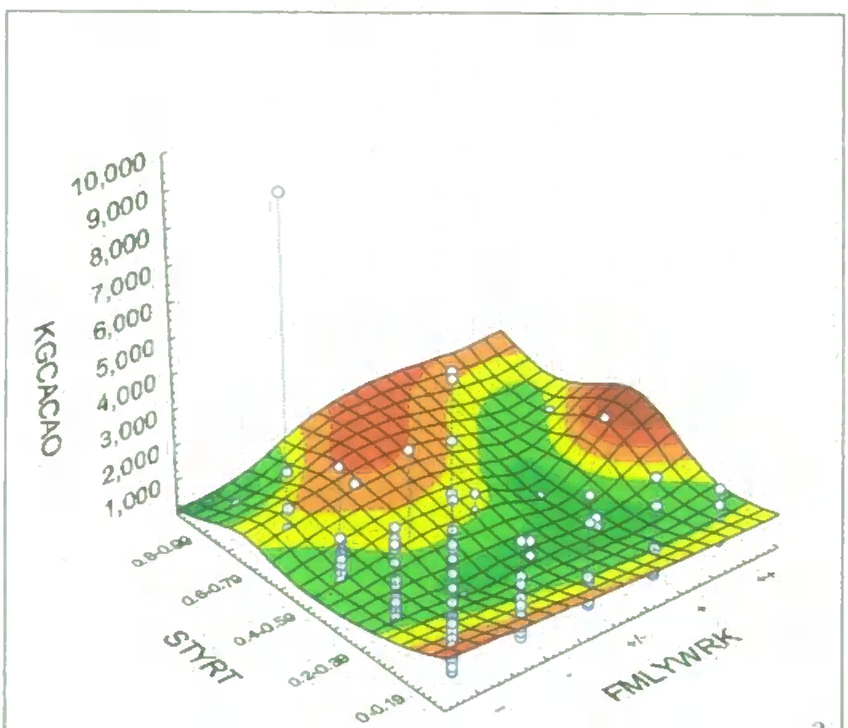
From the landscape, it can be observed that there is a new group of farmers who were not influenced by the family. This new group of farmers also bases its income on cacao production. A further research of this group of farmers is required in order to know their characteristics. The "age of cacao orchard", "participation on organic program", "school attendance", and "transaction conditions" were excluded from this analysis, because they were already explored in other "performance indicators".

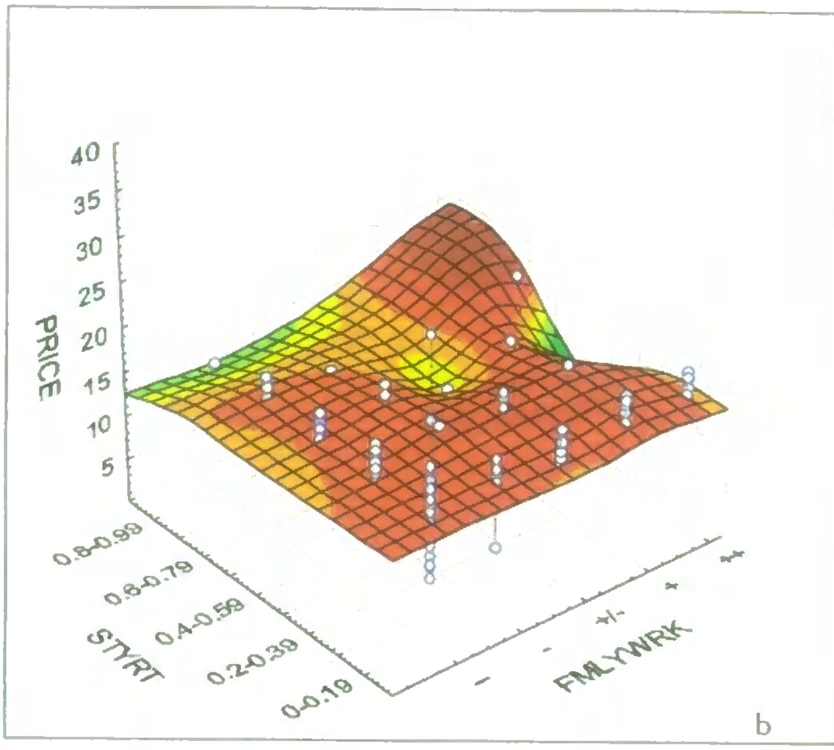
"Non significant" landscapes

These landscapes correspond to those "productivity management" elements with non significant association with performance indicators (i.e. "farming v non farming", "participation of family labour", "study rate of the household" and "quality premium"). Figure 7-16 shows two landscapes based on such non significant "productivity management" elements.

These graphs were constructed by using the DWLS method. It can be observed that these landscapes are too complex to identify a specific pattern. Thus, a further examination of these particular "productivity management" elements cases was not considered.

Figure 7-16. The effect of studying rate of the family, and participation of family labour on (a) total production and (b) price





Conclusions

The "technology factor" is based on two main activities creating and diffusing technology. The average age of cacao trees is about 28 years. Therefore, the rehabilitation of a cacao orchard is necessary in order to improve production and to face attack from new diseases that had affected dramatically the cacao production in South America (Phillips et al., 2006). It was observed that the recent cacao public program was oriented to meet market needs rather than to improve cacao yield. That is, the organic cacao program is not concern with the rehabilitation of cacao orchards. Furthermore, it was observed that the use of hybrids is very low. Farmers obtain their cacao plants mainly from other orchards (e.g. relatives or friends).

This study emphasises this interesting finding suggesting that a decoupling has occurred between the agricultural policies created to support farmers and the needs of the cacao farmers. Technology assists to the development of different products. It was found that such differentiation is based on especial varieties available in some cacao farms. This strategy should be incorporated in the portfolio of research institutions. By doing this, farmers then would have more options to choose. As discussed before, farmers hire more seasonal labour as the size of their cacao orchards increases. This is still a major limitation for cacao production. Therefore, it is important that research institutions take the labour into consideration.

"Competence factor" helps to increase the yield. This study found that higher levels of education lead to an improvement in production. It was found that farmers are more likely to be successful if they have both "productive" knowledge and "marketing" training. In fact, knowledge and training are necessary to adapt to a competitive environment. Therefore, it was interesting to observe that the "participation in an organic program" filled the educational gap of farmers, acting as a complementary source. It will be interesting to study the neighbourhood where these organic cacao orchards are located and to find out if the farmers who are not in such program are influenced by organic production. However, other variables were less significant for the achievement of higher levels of performance.

The "operational climate" factor influences the relationships between farmers and other industries (e.g. "curing", "wholesaling" and, "chocolate"). Farmers recognise the advantage of the power of association. Nevertheless, sometimes they need to accept negative exchange conditions (payment). It was found that a reduction of intermediaries increase the value gained by farmers. However, the modification of the channel of commercialisation will be a long process. Agricultural activities depend on biological factors. Therefore, price should be less variable and take into account the current situation at the national level. This, however, implies the transparency of the whole system in order to construct a win-win strategy. Farmers who concentrate exclusively on cacao production are more likely to obtain a higher performance. The identification of such farmers is very important for developing strategies based on "efficiency". There are farmers, however, who combine cacao with other activities and the characterisation of these is important to identify their most suitable strategies.

Graphical tools are very useful in the analysis of the landscapes. Furthermore, the selection of the fitting methods (i.e. DWLS and NEWLS) and the stiffness play an important role in the construction of the landscape because of their capacity to discover small changes in the landscape. However, a fitting method can overestimate or underestimate the landscape. Therefore, results could also be misled.

8. Validation of the FAI

The main aim of this study is to utilise the "fitness approach" to analyse the farming industry of the cacao agro-food system (CAFS) in Tabasco, Mexico, using three factors (i.e. technology, competence, and operational climate) drawn from the "productivity management" perspective. Chapter 5 provided the analytical discussion of the "fitness appraisal instrument" which was developed and implemented in the farming industry of CAFS. Chapter 6 analysed the implementation of the "Fitness Appraisal Instrument" at two main levels of analysis. First, it was analysed at the level of association between 2 "organisational configurations" (i.e. factors and aspects) and 5 performance indicators (i.e. "business success", "price", "yield", "value of production per hectare", and "total production"); and at the second level the exploration of the "fitness" landscape and the landscapes of key "productivity management" elements and their influence on the "performance indicators" were examined. The next step is to validate the results obtained by the implementation of the "Fitness Appraisal Instrument". The validation of the results takes into consideration a discussion of the results in the theoretical and empirical framework. Therefore, this chapter presents a discussion of the main findings of the implementation of the "Fitness Appraisal Instrument" and is divided into 4 subsections. Subsection 8.1 discusses the theoretical and methodological implications of the FAI. Subsection 8.2 examines the main empirical findings related to "organisational configuration". Subsection 8.3 provides some practical implications. Subsection 8.4 summarises the findings of the FAI.

8.1. Theoretical and methodological implications

Different factors have been influencing the ways human produce and consume food (Wood et al., 2000; Marshall, 2001; Donald, 2004; Robinson, 2004). Most of the studies related to these important factors conclude that all organisations involved in the production and supply of food need to be more efficient and effective. These qualities not only permit organisations to achieve their own objectives but also to deal with and adapt to more competitive environments (Calva, 1996; 2004). Therefore, many scholars orient their efforts to shed light on how to help organisations to transit from their current position to an competitive one (Porter, 1985, 1990). The "fitness" approach has the potential to achieve this. The relationship between an internal configuration (i.e. organisational configuration) and its environment (i.e. performance), which in turn leads to the identification of the "fittest" organisational configuration (hereafter named simply as the "fittest") which provides a benchmark for improvement, are two important outcomes that respond to the research question on which this study is based: how one can move from a current position to a more optimal (or desirable) position (i.e. where we are, where we want to be, and how we will get there).

This subsection contextualises theoretically the findings of the implementation of the "fitness appraisal instrument" to analyse the "organisational configurations" of the farming industry in CAFS. This study was explorative in nature, and filled some of the gaps in the empirical applications of the "fitness" approach in the social realm.

One of the main core issues in the "fitness" literature in all academic realms, from biology to social disciplines, is to study the relationship between an internal structure (e.g. capacity, genes, strategies) of a system and its environmental conditions. These studies consider different relationships, for instance: the relationship between the capacity of catalysts and specific reactions or ligand (Kauffman and Beinberger, 1998), between organisational configurations and performance (Jermias and Gani, 2004, 2005), and between strategies and market share (Levinthal and Warglien, 1999), between technology management and competition (McCarthy, 2003). As mentioned before, there are few empirical social studies which provide systematic procedures for the performance and analysis of this important relationship (Jermias and Gani, 2004, 2005).

This study evaluated this core issue by analysing the relationship between two "organisational configurations" (i.e. factors, and aspects) and some "performance indicators". As mentioned in section 7.1 the correlation analysis performed showed a significant association between the fitness value of "organisational configurations" and some "performance indicators". Jermias and Gani (2004, 2005) suggest the use of "correlation" analysis to evaluate this relationship and found similar results which in turn provides a validation of the result of this study. In brief, this study confirmed the relationship between internal structures and environmental conditions and also provided useful information that would fill the gap left by the lack of a systematic procedure on performing this empirical analysis in the social context. To progress this work, it is needed to conduct more empirical studies that consider the analysis of the relationship between internal structure and environmental conditions.

Another core issue related to the "fitness" approach is the consideration of the "fittest". The "fittest" refers to the internal structure of a system (e.g. biological, social) which corresponds to the highest fitness value. This fitness value indicates that this particular system can successfully adapt to a specific environmental condition (Kauffman and Weinberger, 1989; McCarthy, 2004). The "fittest" in the original program is assigned randomly and it changes if different periods of time are considered in the analysis (i.e. mainly in modelling studies) (Kauffman and Weinberger, 1989; Frenken, 2006). Other studies, obtained the "fittest" from the empirical implementation of the NK model, discussed in section 3.2 (Jermias and Gani, 2004, 2005). This study calculated the "fitness" value of an "organisational configuration" by implementing the NK model as proposed empirically by Jermias and Gani (2004, 2005). In this study, none of the "organisational configurations" met the theoretical "fitness" value (i.e. 1), so the highest fitness value obtained was 0.61 (i.e. the fitness value for factor organisational configuration). Similar results were obtained in social empirical studies (Jermias and Gani, 2004, 2005). This led this study to conclude that the sample does not contain any internal structure which results in the "fittest" theoretical value (i.e. 1). Additionally, this finding contrasts with some results from modelling studies which assume a full match between the number of internal structures and the number of observations in the sample (Ma and Nakamori, 2005; Frenken, 2006; Susuki and Arita, 2007).

As mentioned above, the main goal of a "fitness" approach is to identify those internal structures with lower, higher and the highest fitness values. Besides classification, another use of the fitness value is to improve the performance. The "fittest" is the benchmark for improvement (McCarthy, 2004). In this study two "fittest" points are obtained: that theoretically calculated (i.e. 1) and that empirically found (i.e. 0.61). In fact, this provides an interesting outcome because it suggests that the potential for improvement has not been fulfilled (fitness value 1). As a result of this gap, this study suggested that the "fittest" is perfectible, and subsection 7.2.1 explained how the "fittest" could improve its performance. Another possibility was to propose that the "fittest" could consist of a set of fitter values. The "fitness" approach considers this situation by increasing the parameter K. However, a set of fitter values has only been studied in some simulation studies (Gavetti and Levinthal, 2000; Solow et al., 2002; Siggelkow and Levinthal, 2003; Sommer and Loch, 2004). It seems that the idea to have a set of fitter cases as the "fittest" has the potential to improve the performance and therefore should not be discarded.

The fitness approach suggests that there are two main improvement streams (Kauffman and Weinberger, 1989; McCarthy, 2004): by looking at systems with fitter internal structures either in the neighbourhood, (i.e. "local" searching) or further outside its neighbourhood, (i.e. global scouting). The "fittest" is considered the global point of reference and some fitter values close to a particular system are considered the local benchmarks.

An internal structure is the combination of responses (A) and variables (N). Responses and variables are important parameters in the calculation of "fitness" landscapes (Kauffman and Weinberger, 1989; McCarthy, 2004). This study proposed an evaluation of two different landscapes: $A^N=5^3$ and $A^N=2^7$. These landscapes were selected by considering the modular property of the "productivity management" approach which in turn provides two levels of analysis "factors" and "aspects" discussed in section 6.1.2 (Prokopenko and North, 1997). Although, the analysis shows that both landscapes were significant, the landscape 2^7 was weaker in comparison to 5^3. Thus, it was concluded that the reduction of responses might influence the result. However, empirical and modelling studies did not provide evidence to support this finding, because these studies fix the number of responses and variables (Jermias and Gani, 2004, 2005; Ma and Nakamori, 2005; Frenken, 2006; Susuki and Arita, 2007). Thus, this finding suggests that further investigation should be considered because there would be limitations inmaking a comparison with other studies and in understanding how the dynamic of fitness landscape works if it relies on these important parameters, A and N (Kauffman and Weinberger, 1989; McCarthy, 2004).

Another important parameter is K, this parameter is related to the amount of interconnection among variables (i.e. epistasis), and this creates trade-offs or accumulative dependency (Kauffman and Weinberger, 1989; McCarthy, 2004). Whilst modelling studies largely consider the inclusion of this parameter (Ma and Nakamori, 2005; Frenken, 2006; Susuki and Arita, 2007), empirical studies concentrated on the assumption of null interaction among variables (i.e. K=0) (Jermias and Gani, 2004, 2005). This study also considered this conservative assumption in the calculation of the fitness value, this is K=0. This conventional decision permitted this study to calculate the fitness value without any further complication, because as Jermias and Gani (2004, 2005) emphasised, it is not clear what algorithm should be used in order to take into account such variable interconnection, that is if it must be multiplied, divided, etc. However, it would be useful to consider this important parameter in further empirical studies.

The identification of the "fittest" allowed its internal structure to be examined: "organisational configuration". Thus, the classification of these "organisational configurations" and the identification of its "productivity management" elements were two tasks carried out in this study. The identification of the "organisational configuration" was focused mainly on the "fittest" and it was carried out by an exploration of the categories of "productivity management" elements. This exploration was unique in nature, as other empirical studies did not consider this application (Jermias and Gani, 2004, 2005). Furthermore, in some strategy studies, the use of this information is very important and has practical applications, so this could be useful for further investigations (Solleiro and Valle, 1996; Harland et al., 1999; Rose et al., 2005).

The computation of "fitness" values is based on single variables (Kauffman and Weinberger, 1989; McCarthy, 2004). However, in order to take into account theoretical models which were very useful in social studies (e.g. value chain, productivity management, quality, organisational excellence), some empirical studies have attempted to consider the use of compound variables. For instance, Jermias and Gani (2004, 2005) use a compound variable "types of management accounting systems used by the business-units" which was constructed by 14 items and such items were measured on a seven point Likert-type scale (1=negible; 7=very intensive). The compound variable permits researcher to operationalise theoretical models in the NK model, in this particular case the relationship between strategic choice, organisational design and, management accounting systems (Jermias and Gani, 2004, 2005). This basic idea was also brought into this study. Whilst the way of aggregation, i.e. weighted sum of variables, might not influence the results (both factors and aspects were significantly associated), a limitation was found: the fitness landscape is more complex because each variable consists of an amalgamation of responses. Thus, it is important to consider this hidden limitation.

Another core outcome of the "fitness approach" is the idea of exploring the "fitness landscapes". Many authors persuade readers to foster the use of the "fitness approach" by using this powerful and practical visualisation (Levinthal and Warglien, 1999; McCarthy, 2004; Sommer and Loch, 2004). However little is known about how to draw it. This study explored the landscapes by employing a 3-Dimension graphical tool. The different responses of a pair of significant "productivity management" elements and it was possible to draw their contribution to "performance indicators" on a three-dimensional graph by using this tool. The fitted curve of the landscape can be constructed (i.e. shape, size, colour, and resolution) by using different curve fitting methods (e.g. Linear, Quadratic, Distance-Weighted Least Squares (DWLS), Spine, Negative

Exponentially Weighted Least Square (NEWLS) provided by STATISTICA®. This study employed two fitting methods (i.e. DWLS and NEWLS) in order to obtain the minimum distortion of the data. The applications of these smoothing procedures are (i) to reveal non-salient overall patterns of data, and (ii) to use the identified pattern to develop quantitative models of the investigated phenomenon (Hill and Lewicki, 2007). This study found this graphical option very useful and some of the results are to be discussed later and complement some of the insights on how to visualise the landscape.

Finally, it is important to relate the "fitness" approach to other traditional approaches. The main difference between "fitness" approach and traditional approaches relies on the assumption that the "fitness" is based on complex systems, so a change occurs at moments of instability. These are also known as bifurcations in solution space when, some new aspects or elements appear and grow in the system re-structuring it, invading new dimensions and leading to emergent properties and attributes (McCarthy, 2004). In contrast, traditional approaches are based on linearity, so a change occurs on the permissible threshold (function or dataset) (Chiang, 1984).

Nevertheless, all approaches shed light on the fact that models are metaphors to aid the explanation of our surroundings. The first issue that is shared by all approaches is the consideration of a theoretical "fittest" point. For example, traditional approaches also calculate the "fittest" (i.e. efficiency value=1), but it is still not clear, how this most efficient point will improve further. According to traditional approaches, these efficient points should wait for an improvement in technology or the simple inclusion of a more efficient point (Coelli et al., 1998; Cooper et al., 2000; Zhu, 2003; Ray, 2004). Therefore, the "fitness" approach would be more interesting than traditional approaches, because this empirical study found that the full potential of improvement had not yet been achieved so even the "fittest" could still improve its performance by exploring the whole landscape. This study suggests that improvement should be sought outside the average, frontier or production approach proposed by other scholars (Färe et al., 1994).

The second issue that is shared by all approaches is the consideration of the improvement of performance. This is achieved by the scouting of the different solutions. For instance, whilst data envelop analysis techniques based the improvement of organisations by looking at their most efficient peers, global searching (Coelli et al., 1998; Cooper et al., 2000; Zhu, 2003; Ray, 2004), mathematical economics considers production functions that include local and global points which could be used to achieve further improvements (Chiang, 1984). Acknowledge of local and global points in both approaches (i.e. "fitness" and traditional) seems to be very useful for determining organisational effectiveness. Nevertheless, prospective studies are needed to find out the real effectiveness of the "fitness" approach. Traditional studies would benefit from this empirical study by considering that models are metaphors, and that is how one should use them, not the other way around.

8.2. Organisational configuration: practical implications

As mentioned before, an "organisational configuration" sheds light on descriptions of organisations, revealing their complex and systemic nature, and drawing distinctions among organisations, avoiding confusions born of excessive aggregation and aiding prediction (Miller, 1987; Ding and Field, 2005). This section discusses some of the empirical findings related to "organisational configuration".

Firstly, the empirical and modelling studies related to "organisational configuration" concentrate on analysing predefined "organisational configurations" such as, diversified, decentralised, innovative (Jermias and Gani, 2004, 2005; Ma and Nakamori, 2005). The differences between such classified "organisational configurations" were highlighted by using the "fitness" approach. Although, this study did not consider comparing predefined "organisational configurations", it provided an extended application of "fitness" approach: classification. This study attempted to classify "organisational configurations" by considering the use of a "profile" technique. The technique uncovered five different patterns which depend on the partial "fitness" values obtained in "technology", "competence" and "operational factors". It was found that performance improvement could be fostered by a consideration of the increasing of each fitness contribution value or a change of the pattern of the strategy (i.e. gable, salt box, shed, or "M" roof). "Organisational configurations" are unique but can be categorised in order to organise reality from a point of view relevant to the objectives of any study being undertaken: classification, analysis and improvement. However, further investigations should be considered in order to support this finding.

Secondly, this study employed 20 "productivity management" elements (PME) to construct the "organisational configuration". These PME stemmed from two levels of aggregation taken from the "productivity management" approach: (i) factors i.e. technology, competences and operational climate, and (ii) aspects i.e. innovation, diffusion, labour, skills, complementarity, vertical integration, diversification. Subsection 7.2.1 analysed the graphical shape of the PME and it was found that lower fitness values produced polar graphs which are placed inside that of the "fittest", i.e. inscribed, and higher fitness values produced polar graphs which are placed in some points outside that of the "fittest", i.e. crossed. A polar graph technique was used to analyse these 20 PMEs and it was found that those "organisational configurations" with a lower fitness value produced a polar graph which was placed inside that of the "fittest", i.e. inscribed, and those "organisational configurations" with a higher fitness value produced a polar graph which was placed in some points outside that of the "fittest", i.e. crossed. The identification of these crossed points led this study to suggest an opportunity for performance improvement from "the fittest" to its neighbourhood. However, some limitations were also highlighted. The use of this technique was very useful, and also confirms some of the results in other studies where the analysis of whole industries and the improvement of performance are the main concerns (Porter 1990; Solleiro and Valle, 1996).

Thirdly, the identification of a different set of "organisational configurations" is useful from two conceptual points of view: resource endowment and strategies. It has been argued that the development of an organisation (and its society) is based on the natural occurrence of resources. Some of the variables used to construct the "organisational configuration" would refer to this idea, such as "age of cacao orchard", "type of cacao variety", "participation of family labour", among others. Some of these "productivity management" elements were significant, so this would confirm the importance of the resource endowment as shown in other studies (Temu and Due, 2000; Kebbeh and Miezan, 2003; Tschackert, 2004; Dogliotti et al., 2005). It is also argued that the way resources are managed has a relevant effect, so the development of strategies about such resources is fundamental for development (Chaffe, 1985). Some of the variables used to construct the "organisational configuration" would refer to strategy, such as "channel of commercialisation", "participation in organic programs", "cacao income importance", among others. Some of these "productivity management" elements were significant, so this would confirm the importance of the strategy as shown in other studies (Solleiro and Valle, 1996; Forsman, 2004)

Finally, the identification of an "organisational configuration" would have an impact at two managerial levels: level in private organisations and level in public organisations. At the private organisation level, the usefulness of an "organisational configuration" relies on the fact that one can select a subset of similar organisational configurations (i.e. farmers) and try to carry out further research in order to improve their performance. The improvement would be homogeneous as the "organisational configurations" are similar. Therefore, success is more likely to be achieved. This result has great implication at the farm level, because a solution that is good for a farmer does not necessarily have to be the same for another farmer as one can find unique solutions for each case. The risk of failure is lessened. This assumption is fairly support by evidence of studies based on farm typology (Shepherd and Soule, 1998; Duvernoy, 2000; Daskalopoulou and Petrou, 2002; Tittonell et al., 2005; Andersen et al., 2007). This identification of "organisational configuration" can also be used by different industries that want to improve relationships with their suppliers and customers. That is, firms need to understand the "organisational configuration" of suppliers and customers in order to develop the best strategy for each of them. Failing to do this, a firm will not able to adapt to its surroundings which comprise of more organisations (i.e. suppliers and customers), and in turn the firm's chance of success will be also reduced. This has been highlighted in many of the studies of supply chain management (Solleiro and Valle, 1996; New and Westbrook, 2004; Valle, 2004; Stadtler and Kilger, 2005).

The usefulness to public agencies is similar. The difference, however, relies on the use of public funds which are scarce and need to have the major possible impact. As mentioned before, the existence of different types of "organisational configuration" leads to different ideas on how to develop agricultural development strategies. The strategies, however, are valid under a competitive environment. That is, the main purpose of developing different public strategies is to increase diversification.

8.3. Productivity management elements: strategies

Some interesting outcomes resulted from exploring the "productivity management" elements. These results are contextualised theoretically in this section. The results of the implementation of the "fitness appraisal instrument" demonstrate that there are some typical strategies relating to the "farming" industry in the CAFS. These are (i) efficiency, (ii) effectiveness and (iii) cooperation. These strategies rely on the evidence found in the analysis of the three main factors of "productivity management" perspective i.e. "technology", "competence" and "operational climate".

Strategies for efficiency

The first strategy is "efficiency". It was discussed in subsection 2.3.2 that organisations need to achieve efficiency to create value (Coelli et al., 1998; Calva, 2004; Rickard, 2006). This study identifies the creation of value by analysing the findings of key "productivity management" elements drawn from the 3 "productivity management" factors (i.e. "technology", "competence" and "operational climate"). They are discussed below.

The analysis of the "age of cacao orchard" implies that the "farming" industry has stopped rehabilitating cacao orchards, so the average age of cacao orchards is 28 years. Wood and Lass (1985) and Mossu and Coste (1992) observed that the economic life span of cacao orchards is 30 years. Therefore, this result implies that without any renovation of the cacao orchards, the yield of the "farming" industry in the CAFS will be affected dramatically and reduced by the fifty percent in the next ten years.

The number of "pre-harvesting activities" carried out by farmers is very low._However, the number of "pre-harvesting activities" is increased, the bigger the size of the cacao orchard. Both of these findings were reported by Ramirez (1997) and Cordova et al. (2001) at a local level and also by Flood and Murphy (2004) and ICCO (2005) at the international level and it is explained that price and commercialisation issues are the main driving factors.

Another finding related to efficiency was the implementation of an "organic cacao program". This public program was seen as a positive reaction to increase the yield of cacao orchards. However, the actual farm level yield is significantly lower (i.e. average 388 Kg Ha^{-1}) than that obtained in the National Research Institution of Agriculture –INIFAP (2000 Kg Ha^{-1}) and the acreage covered by this organic cacao program is only about one sixth of the total cacao acreage in Tabasco (SAGARPA, 2001, 2002). Several authors pointed out (Valle, 2004; Gonzalez and Amaya 2005) that cacao public programs could change their direction because of new government elections in 2006.

Considering the competence factor, it was also found that most of the farmers have a poor level of education (4.8 years of school). This educational characteristic is related to low agricultural performance, poor adoption of technology, and little interest in a market orientation as reported by FAO (1997), Ramirez (1997) and Weir and Knight (2004, 2006). It was also found that organic cacao program has a complementarity effect which compensated for the lack of education. That is, some farmers with a low level of education reached higher levels of performance under the "organic cacao program". This would be explained by the fact that from 1987 to 2003 there was not any extension service to cacao because it was eliminated in 1987 due to the implementation of neo-liberal reforms (ASERCA, 1991). Therefore, the farmers with low level of education react highly positively to the technical services which are considered in the "organic cacao program".

It was argued that the liberalisation of cacao production would increase its proficiency, because price would be one of the main incentives to increase efficiency. However, for most of the farmers, price is the main limitation to increased production. This would be explained by the fact that the cacao price reached its lowest level in 1999 and increased only slightly thereafter. This situation is also seen in other parts of the world (Flood and Murphy, 2004).

Considering the "operational climate" factor, it was expected that new private organisations would be interested in cacao production and a new vertical integration among the different industries could be expected. However, as discussed in section 5.2, both the private and the UNPC structure have concentrated mainly on the "curing" industry rather than the "farming" industry. If any support has been given to the "farming" industry, it has remained biased (i.e. the UNPC has a great influence on the distribution of public funds) and very limited (i.e. only one sixth of the cacao acreage is covered). This means that the entire improvement of efficiency relies only on the farmer. This is a peculiarity of the implementation of structural reforms in Mexico which differ from other cacao producing countries (Gilbert, 1997; Lattre et al., 1998; Ruf and Yoddang, 1998).

Finally, it is found that farmers also diversify their produce. More farmers now combine cacao production with other activities. This phenomenon represents a challenge in many part of the world (Hill, 2000) because public funds should take such structural changes into consideration in the "farming" industry. In fact, the allocation of public funds only in the production without considering topics such as conservation and diversification has been greatly criticised, especially in developed countries. This experience should be considered in Mexico, as reallocation of public funds is given out by Mexican Government in recent times.

Therefore, it is concluded that the "organisational configuration" based on an efficiency strategy is weak and decoupled. It is weak for the reasons mentioned above. But an interesting result is that the efficiency strategy of the farming industry is decoupled from research and diffusion. It seems that farmers are again alone in the search for a better level of efficiency. Furthermore, without an extension service institution, the efforts at the INIFAP are ineffective. The realisation of such a decoupling phenomenon has been discussed by other studies (Swinnen et al., 2000; Ayenor et al., 2004; Spielman, 2007). The results of this study highlight this interesting situation for the farming industry in CAFS.

Strategies for effectiveness

The second strategy is based on the "effectiveness" of the organisations which is related to the achievement of organisational objectives (Prokopenko and North, 1997; Monga, 2000; Rickard, 2006). This study evaluated effectiveness by analysing the price taken by the farmers, and found that higher prices stem from three "productivity management" elements: "type of cacao variety", "type of cacao bean", and "channel of commercialisation".

The "type of cacao variety" refers to the production of "fine" cacao beans rather than "bulk" ones and in turn premium prices are achieved (ITC, 2001; ICCO, 2005). Subsection 5.3.1 mentioned that this fine cacao is related to the "criollo" variety. The "criollo" variety was found in the CAFS. Although some farmers produced the "criollo" variety, only a single case is actually exporting this special cacao bean. Therefore, considering the fact that a farmer's association based on "criollo" orchards can be certified, there is an interesting potential to increase the supply of "fine" cacao. However, as other authors suggest, the market of fine cacao is small and very demanding (Wood and Lass, 1985; ITC, 2001; ICCO, 2005). Therefore, any initiative to increment the acreage of such "criollo" orchards in Tabasco should consider the current demand for "fine" cacao beans.

Most of the farmers in the CAFS sell their cacao as fresh beans. Therefore, it is argued that few farmers are utilising the scope of the first value added: fermented bean. This situation, however, appears not to have significantly changed because of two main reasons. Firstly, as mentioned in subsection 5.3.2, the "curing" industry is being enhanced at both sides of the supply chain structure: the network of middlemen and UNPC. Secondly, as Ramirez (1997) and SE (2002) claim the natural conditions of the harvesting season which is characterised by a heavy rainy season and high humidity, limit the possibility of the farmers to carrying out this activity on their own. Nevertheless, this study also found that there are other farmers who add value by only drying the cacao bean and not fermenting it. As mentioned before, non-fermented cacao is not accepted in international "commodity" markets (Wood and Lass, 1985; ITC, 2001). However, there is a special niche market in Mexico for this type of cacao bean and some farmers have already identified this. The prices of non-fermented cacao bean are similar to that of the "commodity" quality. Gonzalez and Amaya (2005) argued that this is another potential market which has not been fully exploited.

Finally, the channel of commercialisation plays an important role in attracting value from the market and in turn achieving effectiveness. As mentioned above, the local channel of commercialisation (i.e. middlemen and UNPC) provides low prices. Therefore, seeking a closer relationship with intermediate consumers (i.e. the chocolate industry) would provide higher prices. On the one hand, "fine" cacao is the first example and has been discussed above. On the other hand, organic cacao is the second example. Nevertheless, organic cacao did not show any significant difference in price in this study. The main explanation was based on the fact that the export of organic cacao started in the middle of 2006. That is, by the time this study was carried out, there were no customers for the organic products, so these were directed into the traditional commercial channel. Therefore, it is expected that the exports of organic cacao would increase in the following years. This would also lead to a further examination of this controversial public program being carried out.

In sum, the "organisational configuration" based on an "effectiveness" strategy is also weak and dispersing. It is weak and dispersing because of the fact that isolated cases are better than the vast majority (i.e. only one "fine" cacao producer, and one sixth of total cacao acreage is organic). Nevertheless, it shows that different strategies addressing the market arose from the implementation of neoliberal policies which in turn resulted in a more competitive environment. Therefore, "organisational configurations" respond to different contexts which sometimes are unique. It was also confirmed that the government was fostering an "effectiveness" strategy by customising the production of some farmers (i.e. organic cacao). Therefore, to encourage a further diversification and consolidation of any system (including agro-food systems), it is necessary to think of a set of solutions rather than a unique one (Nelson, 1982, 1996; Porter, 1990; McCarthy, 2004; Jermias and Gani, 2004; Rickard, 2006).

Strategies for cooperation

It is argued that in a competitive environment, there will be losers and winners. This study found that the "farming industry" faces international competition, and therefore needs to create a strategy to fit into this new environment. The last strategy which arises from the study of the organisational configurations is "cooperation". As mentioned in chapters

4 and 5, the CAFS was established under a cooperative monopoly structure. Farmers understood the importance of being together and being led by the government, so it was expected that farmers would conserve this cooperative structure after the implementation of structural reforms. However, as has been discussed in chapter 5, this did not happen. If fact, by looking at the "organisational configuration" it can be seen that farmers are divided, so whilst some prefer a relational exchange pattern based on cooperative principles, others prefer a more discrete pattern based on business principles. This was supported by the division also at the channel of commercialisation: private and union. This finding is consistent with international studies related to the implementation of agricultural structural reforms (Ruf and Yoddang, 1998; Flood and Murphy, 2004).

Farmers have maintained their UNPC structure because it is more beneficial not only in terms of economic returns, but also as a network that permits farmers to share knowledge, decisions, and support in general (Cordova, 2001). Thus, middlemen should understand some of these concerns in order to achieve their goals. This study also found that the cooperation between farmers and UNPC would be dramatically affected without the support of public funds. This suggests that UNPC is still underdeveloped and urgently needs to achieve higher levels of skill and ability. Ramirez (1997) and Cordova (2001) have reported this finding in their studies. In this situation, it is highly likely that the aim of consolidating the UNPC will fail (Flood and Murphy, 2004). In conclusion, the "organisational configuration" shows that farmers are not developing any internal strategies that will enable them to cooperate with the CAFS.

Therefore, they depend highly on decisions made by those in the upper strata (i.e. the "curing" and "wholesaling" industries).

Production, supply and consumption of food

Production in the "farming" industry is characterised by low yields and bulk quality which in turn supports some of the exploratory results in section 5.3.1 and those findings in the current literature review (ITC, 2001; Ayenor et al., 2004; Flood, and Murphy, 2004; ICCO, 2005). Low yields were related mainly to the age of cacao orchards which, on average, are at the end of their most productive period (20-30 years) and decrease in pre-harvesting activities. Both factors are also highlighted in other studies (Wood and Lass, 1985; ICCO, 2005; Olaiya and Fagbayide, 2006). It was found that the implementation of an extension service for the last three years showed yield differences between those farmers who participated in the organic cacao program and those who did not. Production, therefore, is decoupled from research and extension. Without these main supporting activities it is less likely that farmers can cope with challenging and competitive environments.

The supply of cacao, as mentioned above, is characterised by a dual structure. This dual structure has largely influenced decisions made by farmers, so farmers are seeking the best price for their products and also for the best place to obtain other benefits. As considered by some authors that was the main expected result of a free market framework (Ramirez, 1997; Flood and Murphy, 2004). Nevertheless, the gathering of cacao is still highly concentrated, so farmers do not participate actively. This situation will change once the organic production starts to flow to international markets. The international experience of organic cacao trading is, so an optimistic outcome is expected (Raynolds, 2004; Radi, 2005).

As mentioned above, the consumption of cacao is indirectly influencing the whole farming industry. However, the main influence was observed in the implementation of organic production systems and the production of fine cacao. In a competitive environment, consumers and their preferences are two components that are needed in order to achieve success (Porter, 1985, 1990). The farming industry also has examples of how a bulk, raw production could move to a more value added one, but this change would be faster if other linkages are also involved as mentioned in section 5.3. Some of the studies of supply chains emphasise this new attitude, so the initiative could come from private or public actions (Kaplinsky and Morris, 2000; Trienekens and Zuurbier, 2000; Eastham et al., 2001; Zylbersztajn and Pinheiro, 2003).

8.4. FAI, the final judgment

This study attempted to develop an instrument which permits an understanding of the relationship between the internal configuration of an organisation and its performance. The "fitness" approach was used to develop the FAI, and to analyse the organisations of the farming industry of the CAFS. Some of the results have been shown in chapter 7, and this chapter has contextualised the result with the literature review. This last section discusses three core remarks in order to conclude that the FAI is a suitable instrument to answer three main points: where the organisations are, where they want to be, how they are going to achieve these aims.

The first remark refers to the NK model. NK model is based on the biologic evolutionary theory and has been applied to explain social phenomena. This study shows that agriculture can also benefit from this approach. In fact, one of the main issues on international agenda is to provide a more competitive and sustainable framework which agricultural systems need to adapt to and cope with. Therefore, the application of an approach which is based on complex theory and adaptive principles sheds light on the interaction between the organisations and their environment and the mechanism need to develop successful strategies. This highlights the main difference to those traditional approaches which seek to homogenise the strategies for the sake of efficiency something which would be contrary to competition.

The second remark is related to the high degree of applicability of the NK model. That is, the parameters of the NK model are simple but reliable, so they are very flexible for examining different theoretical models. The parameters are simple because they guide the researcher to construct the "fitness" landscape without taking into consideration other further assumptions. The parameters are also reliable because they set systematically the extension and properties of the landscape. Both characteristics have been very useful for examining different theoretical models in social studies such as management strategy, manufacturing, accounting systems. Thus, the FAI has confirmed the pragmatic operationalisation of NK model as well.

The third remark refers to the empirical findings of the implementation of FAI which in turn leads to a better understanding of the "farming" industry in the CAFS. The "farming" industry is characterised by organisations which pay little interest to technology, rely heavily on external support and are divided into two main groups due to the source of supply channels. Technology plays an important role in gaining efficiency, but the farming industry has neither the infrastructure and competencies nor the funds and organisation to overcome this situation. The implementation of NGO or public programme led organisations to mobilise synergies, and interesting effects were found. Nonetheless, these programs are very limited, so the positive impact could be never achieved in the long term. Finally, competition does not solve everything, so synergy and cooperation are other options for achieving success. Farmers have learnt and benefitted from cooperative experience, so the search for cooperative strategies is an appropriate starting point for improvement in performance. Some of these findings have been also highlighted in the literature review, others were hidden but now are visible for organisations and policy makers.

Nevertheless, the FAI also has limitations. Some of these limitations revolve around three issues: (i) cross-sectional studies rather than longitudinal, (ii) the assignment of fitness scale based on theoretical backgrounds, and (iii) the size of the landscape A^N. In brief, the FAI is an instrument which contributes to an understanding of the relationship between internal organisational configurations and challenging and more competitive environments, particularly in agricultural systems.

9. Conclusions and Policy implications

This section aims to summarise and draw conclusions from this study. This chapter is divided into 5 sections: section 9.1 summarises the research problem and reviews the research question, section 9.2 reiterates the aims and objectives of this research, section 9.3 concentrates on the discussion of the dynamics of agro-food systems, section 9.4 refers to the importance of identifying "organisational configurations", and 9.5 summarises the overall findings, draws conclusions and provides recommendations emerging from this study.

9.1. Problem identification

The food supply system is changing rapidly and becoming highly competitive due to various policy reforms in most countries of the world. Therefore, the study starts with the realisation that organisations need to develop a set of strategies that permits them to fit into and cope with a changing competitive environment. It is also argued that, in a competitive environment, the production becomes more efficient, the benefits of production are distributed evenly and the quality of life is improved. Most developing countries have been persuaded to make policies that show awareness of such a competitive framework. As a result, a restructuring of their agricultural sectors has been carried out (i.e. reducing funds to infrastructure, extension service, research and development, marketing boards and credit). The outcome of such reforms or restructuring of agriculture led the agro-food systems to take on the challenges themselves in order to fit into this new competitive environment. Thus, each industry of the agro-food system (i.e. from the farming industry, through to the processing and wholesaling industry) needs to develop a set of strategies that permits it to fit into and cope with a changing competitive environment.

Increasingly, agricultural productivity has been one of the core strategies to achieve success in competitive environments, because this "efficiency" strategy allows value to be created from agricultural activities (i.e. reduced risk of problems caused by climate conditions and biological attacks, obtaining more homogenous agricultural products, developing quality attributes in food and increasing yield which "ceteris paribus" should result in higher returns). However, the increase of production also leads problems to be faced in the short and long term (i.e. overproduction and falling prices, environmental damage, and loss of diversity and food cultural identity). It is also argued that increasing production is not sufficient to attract value from market. It is, thus, necessary to know more about intended consumer, their needs and peculiarities (i.e. wishes, regulations, and transaction conditions).

Therefore, the development of a strategy to be "effective" is required. In the past, the effectiveness of the production was controlled by the government, but nowadays every industry of in an agro-food system has to deal with the development of an "effectiveness" strategy on its own. There have been some attempts to study both strategies: "efficiency" (create value) and "effectiveness" (attract value). But the literature review revealed that the dominant focus is to study the "efficiency" and "effectiveness" separately, leading to incomplete and inconsistent results.

Searching for a relationship between the internal strategies of an organisation and the external environmental conditions has been a core issue in the "productivity management" literature. Because it is argued that such a compatible arrangement permits organisations to survive and grow. Other authors suggest that such arrangements are different. In fact, unique configurations have been identified that are difficult to own or emulate. These particular arrangements are considered crucial when developing competitive advantages which, in turn, permit organisations to adapt to changing environments as well as to successfully interact with other organisations. The "fitness approach" is one of the ways to study this issue using a holistic framework. This approach permits the identification of the configuration of a system, and the analysis of the relationship of such configuration and the performance of the organisation. Although, "fitness" is a novel approach in social science, it is used to a limited extent in different disciplines, e.g. manufacturing and accounting.

Thus, organisations need to develop a set of strategies that permit them to fit into and cope with a changing competitive environment. It is expected that organisations in agro-food systems also develop particular configurations in order to survive and compete in such an environment. This is particularly important in developing countries where the impacts of such competitive environments are very controversial. Two processes of adaptation that allow agro-food systems to adapt have been identified:

(i) those carried out by the whole agro-system and (ii) those carried out by each industry of such an agro-food system. Furthermore, the "productivity management" perspective considers both core strategies for achieving success: "efficiency" and "effectiveness". These strategies are built into the internal structure (or "organisational configuration") of the organisation and every "organisational configuration" is considered unique.. The uniqueness of an "organisational configuration" stems from the environmental conditions and the internal capabilities. Finally, the "fitness approach" permits researchers to study and analyse the relationship between "organisational configuration" and "environmental conditions". Therefore, in order to address the research question "how can an organisation consistently transit/move from its current position to a pertinent (desired, competitive, sustainable) position in order to survive in a competitive environment" the study has utilised an exploratory framework: the "fitness approach".

9.2. Aim and objectives

As mentioned earlier, this study argues that organisations need to develop a set of strategies that permit them to fit into and cope with a changing competitive environment. Therefore, the main aim of this study is to develop an exploratory framework based on the "fitness approach" to analyse the relationships between the "organisational configuration" and "performance indicator" of an organisation.

The specific objectives of this research were:

1. To broaden our understanding of the anatomy of an agro-food system using a combination of systems approach and supply chain management perspectives. The analysis of the anatomy of the cacao agro-food system in Tabasco (Mexico) has enabled the study to pinpoint the key industries and their relationships that integrate with the CAFS.

2. To develop an exploratory framework under a "fitness approach" that has enabled the identification of the factors and aspects of "organisational configurations" of an organisation.

3. To implement this exploratory framework – the "fitness approach"- in order to analyse and evaluate the farming industry of the cacao agro-food system in Tabasco, Mexico.

By addressing these objectives, the present study has made the following contributions to the existing literature on agro-food systems. Firstly, it stimulated the debate on the survival of local agro-food systems in developing countries. Secondly, it has provided evidence of the importance of utilising the "productivity management" perspective in order to develop a theoretical framework. Thirdly, the study has contributed towards a better understanding of how to address the key "productivity management elements" affecting the performance of an individual or a firm by applying the "fitness approach". Finally, the study implemented this "fitness approach" framework for the first time to examine a key industry in the agro-food system (the "farming" industry) – the "organisational configuration" of the farmers, the performance of the farmers and the internal and external environments affecting performance of the farmers.

9.3. The CAFS industries: main features

The mapping of chains is a useful tool to analyse an agro-food system. This tool was used to develop a Quick Anatomical Assessment to analyse key industries of the "cacao agro-food system". The Quick Anatomical Assessment was developed by employing three anatomical aspects (i) product, (ii) by-products and (iii) interactions which provide 11 anatomical elements –i.e. association, supply structure, destination of products, cacao product, value added, cacao bean, quality, participation in the organic cacao program, by-products, agro-products, contract and support. Four industries were analysed: (i) farming (176 cases), (ii) curing (37 cases), (iii) wholesaling (6 cases) and (iv) chocolate (7 cases). The visualisation of the anatomy of the CAFS was carried out by employing "correspondence analysis" and *Chi*-square analysis. The visualisation consisted of identifying the main features of each industry of the CAFS by evaluating the distributions of different categories of 11 elements of three anatomical aspects (Table 5-4). This analysis was complemented by contrasting these findings with information from the literature review. Thus, another main outcome of the implementation of the Quick Anatomical Assessment is to bring highlight some changes in each industry and the CAFS as a whole.

The analysis of the anatomy of the CAFS showed that each industry shares some features (i.e. categories of anatomical elements). Some of these similarities explain why the anatomy of the CAFS has slightly changed in the last two decades after implementation of a neo-liberal agricultural policy. For instance, the CAFS is characterised as a producer of mainly "raw" and "bulk" cacao beans. Value added is given by a local and very small "chocolate" industry. However, the potential to produce, process and commercialise cacao by-products and agro-products has not been fulfilled. There are also dissimilarities among CAFS industries. For instance, there is a clear division between the two main supply cacao chains in the CAFS: private and union -related. According to the literature review, such a structure is new (ASERCA 1991; Ramirez, 1997) and its presence is explained by the fact that such division fosters competition which, in turn, permits the efficiency of the CAFS to be increased. Another contribution of this anatomical analysis is the recognition of a potential to diversify "farming" and "curing" industries by integrating the know-how developed in other industries or by specific organisations. Finally, this anatomical analysis suggested that internal competition has generally been good, especially because all industries need to forge an alliance to achieve common objectives. So this alliance would include "extended" objectives (i.e. social responsibility, sustainability) in order to improve quality of life. If this did not happen, the CAFS would face a critical situation which is worsening due to two events close at hand (i) the presence of a lethal fungal disease, FPR, which will reduce the production of cacao by up to 80% and (ii) the full liberalisation of cacao products in 2008 which will permit different firms to import cacao products (e.g. chocolate, powder, butter, bean) without any quota restriction. Therefore, the analysis of the anatomy of the CAFS concludes that collaboration between all industries of the CAFS is needed to cope with both new challenges. Public programs play an important role in the design and implementation of such a strategy of collaboration.

The analysis of the anatomy of the CAFS allowed the main characteristics of each industry to be identified, and by comparing such characteristics it is possible to shed light on the possible changes that have taken place or potentially could happen.

The main features of the "farming" industry are (i) products: raw, bulk, and fresh beans which are sold in the local market, (ii) by-products: cacao by-products and agro-products which are used internally or sold locally, and (iii) interactions: social, union-related, non-contract, and non-supported which are variable due to wholesaler competition. This set of features shows that the "farming" industry is at a disadvantage because it does not show any improvement in key anatomical elements (e.g. quality, destination, support) which would boost its potential. By comparing this information with other industries (ASERCA, 1991; Ramirez, 1997; Flood and Murphy, 2004), some peculiarities can be highlighted. For instance, some farmers are modifying their production systems in order to meet new markets, i.e. organic and fine cacao. The fact that farmers produce by-products and even commercialise some of them provides an opportunity to increase the income of farmers. Finally, the interaction between the "farming" industry and other industries would increase and improve through better conditions of work (e.g. contracts, funding, and training).

The main features of the "curing" industry are (i) products: raw, bulk, fermented beans which are sold locally, (ii) by-products: one cacao by-product which is sold, and (iii) interactions: social, private, short contract and production support. Such features show that the "curing" industry is a key player for both farmers and wholesalers, and this position has helped them to develop some independence albeit very limited. By comparing this information with other industries (ASERCA, 1991; Ramirez, 1997; Flood and Murphy, 2004), some particularities are identified. Some curing plants take more control of their produce, look for new customers and markets, and apply for funding to implement new projects. They are interested in increasing capacity by considering other products (e.g. by-products and agro-products), and some plants now have new infrastructure to develop these projects. Finally, a few "curing" plants have a more independent interaction with their upper actor linkages, and are much closer linkages to their suppliers. This provides them with a strategic position for the achievement of their goals.

The main features of the "wholesaling" industry are (i) products: raw, bulk, and fermented and non-fermented beans which are sold in the national and international market, (ii) by-products: non-production, and (iii) interactions: business, private, short and long contract, and non-support which is variable due to fierce competition in this industry. These features show that the "wholesaling" industry controls the CAFS. By comparing this information with other industries (ASERCA, 1991; Ramirez, 1997; Flood and Murphy, 2004), one main peculiarity can be highlighted. Wholesalers have mainly concentrated on supporting the "curing" industry which, in turn, has caused the development of the "farming" industry to be delayed. This is a serious problem considering that the increasing influence of the FPR disease and full market liberalisation are forthcoming events.

The main features of the "chocolate" industry are (i) products: final, bulk, products which are sold nationally, (ii) by-products: cacao by-products and agro-products which are sold as raw or processed products in the local market, and (iii) interactions: business, private, none contract and non-support. Such features show that the "chocolate" industry is a special industry. This study argues that these firms are farmers with the capacity to produce chocolate. By comparing this information with other industries (ASERCA, 1991; Ramirez, 1997; Flood and Murphy, 2004), some particularities were identified. Although the "chocolate" industry has a relatively small impact on the CAFS, it shows a higher degree of development related to production and commercialisation of by-products. This provides a set of different opportunities to increase the capacity of the CAFS. Furthermore, the knowledge accumulated in this industry could lead to the development of a "grinding" industry. However, this is hypothetical, and would need further support and investigation.

The anatomical analysis has contributed towards a better understanding of the cacao agro-food systems in Tabasco (Mexico) through the identification of key features of selected industries. In this particular case, the mosaic of initiatives in the four industries which were "hidden" in previous studies is visible now. Therefore, further studies can be carried out on such particular initiatives (e.g. diversification of the agro-ecological cacao system, development of cacao by-products). Some of the similarities (or dissimilarities) were treated sometimes as "changes". However, further studies are needed to identify the magnitude and direction of the dynamics of the CAFS. This exploratory analysis has provided useful information about the general structure of the CAFS in this regard.

The analysis of the anatomy of the CAFS was carried out by using "correspondence analysis" and *Chi*-square analysis. Both analytical tools have permitted the analysis of the distribution of different categories of selected anatomical elements in the different industries of CAFS and have complemented each other by comparing the spatial solution and *Chi*-square analysis. One of the main issues of using "correspondence analysis" was to select an appropriate number of dimensions to explain the position of the points. The number of dimension permit this study to visualise the similarities (or dissimilarities) of each industry. Most of the solutions were obtained by using less than three dimensions. As discussed in Chapter 5, the selection of the number of dimensions is critical. For instance, a smaller dimensional solution clusters an industry that in fact belongs to another category. This could confuse the results. However, this study did not have many problems with such a particular situation. *Chi*-square analysis was also performed to complement the visual interpretation and the combination of both analyses was fruitful. Nevertheless, it was found that it is necessary to increase the sample size for the "wholesaling" and "chocolate" industries in order to validate some *Chi*-square analysis. As an exploratory tool, "correspondence analysis" is very effective, and as suggested, its results should be complemented with other analytical tools such as loglinear.

9.4. Fitness and organisational configurations

The main objective of this study was "to develop an exploratory framework under a "fitness approach" that permits the analysis of the relationship between the "organisational configurations" and the "performance indicators" of the farmers in an agro-food system. To achieve this, three main steps were carried out (1) the construction of the "Fitness Appraisal Instrument", (2) the implementation and analysis of the "Fitness Appraisal Instrument" and (3) the validation of the findings. Each step involved specific activities which were carried out systematically. A brief description of these three steps is given below.

The construction of the "Fitness Appraisal Instrument" consisted of two main parts. The first part referred to the review of the "productivity management" perspective and the identification of three core factors (i.e. "technology", "competence", and "operational climate") and their respective aspects. The "technology" factor provides the opportunity to be efficient and consisted of three aspects, i.e. "innovation", "diffusion", and "labour". The "competence" factor ensures the ability to be effective and consisted of two aspects i.e. "skills" and "complementarity". The "operational climate" factor creates the desire to succeed and consisted of two aspects, i.e. "vertical integration" and "diversification". Twenty key "productivity management elements" were obtained from these three factors and their seven aspects (Table 6-7). Five "performance indicators" were selected (i.e. "business success", "price", "yield", "value of production per hectare", and, "total production"). As with other managerial approaches, "productivity management" proposes a modular construction to analyse performance (Porter, 1985; Kaplan and Norton, 1996; Prokopenko and North, 1997; QSTG, 2000). The modular system permits an analysis of different levels (i.e. factors and aspects) and different categories (number of responses). Thus, this study took into consideration this modular characteristic and carried out the analysis at both levels (factors and aspects) which, in turn, led this study to have two different "organisational configurations" respectively.

The second part of the construction of the "Fitness Appraisal Instrument" consisted of computing the "fitness" values of both "factor organisational configurations" and "aspect organisational configurations" by employing the NK-model proposed by Kauffman and Weinberger (1989). The "factor organisational configuration" was based on three compound variables (factors) and five responses ($A^N=5^3$). The "aspect organisational configuration" was based on seven compound variables (aspects) and two responses ($A^N=2^7$). The research hypotheses were established to analyse the relationship between the "fitness" value of both factors and aspects of the "organisational configuration" and the five "performance indicators".

Hypothesis 1

Null hypothesis: The "fitness" value obtained for the "factor organisational configuration" described in section 6.1.2 is not positively associated with any of the "performance indicators" selected in subsection 6.1.6.

Alternative hypothesis: There is a positive association between the "fitness" value obtained for the "factor organisational configuration" described in section 6.1.2 and at least one of the 5 "performance indicators" selected in subsection 6.1.6 (Table 6-7).

Hypothesis 2

Null hypothesis: The "fitness" value obtained for the "aspect organisational configuration" described in section 6.2 is not positively associated with any of the "performance indicators" selected in subsection 6.1.6.

Alternative hypothesis: There is a positive association between the "fitness" value obtained for the "aspect organisational configuration" described in section 6.1.2 and at least one of the 5 "performance indicators" selected in subsection 6.1.6 (Table 6-7).

Hypothesis 3

Null hypothesis: None of the 20 "productivity management" elements described in subsections 6.1.3, 6.1.4, 6.1.5 are positively associated with any of the 5 "performance indicators" selected in subsection 6.1.6.

Alternative hypothesis: There is a relationship between at least one of the "productivity management elements" described in subsections 6.1.3, 6.1.4, 6.1.5 and at least one of the 5 "performance indicators" selected in subsection 6.1.6 (Table 6-7).

The implementation of the "Fitness Appraisal Instrument" was carried out in the "farming" industry of the cacao agro-food system in Tabasco (Mexico). The FAI was applied to 397 farmers by personally visiting them. After the recording and clearing of data, 41 cases were deleted or omitted from the analysis. The final database consisted of 356 cases. The analysis of the data obtained by the "Fitness Appraisal Instrument" consisted of two main parts: (i) to look at the relationship between the "fitness" value of factors and aspects of "organisational configuration" and the five "performance indicators"; and (ii) to look at the exploration of the "fitness" landscape.

In the first part of the analysis of the "Fitness Appraisal Instrument", Pearson's correlation analysis and sensitivity analysis were carried out to test the above mentioned hypotheses. It was found that both factor and aspect "organisational configurations" are significantly related to all the "performance indicators" ($p<0.05$). Thus, null hypothesis 1 and hypothesis 2 were rejected, and alternatives were selected. The same procedure was carried out for the "productivity management" elements. As a result, 16 "productivity management elements" were significant in at least in four "performance indicators" ($p<0.05$). Therefore, Null hypothesis 3 was also rejected for these 16 "productivity management elements". There was no relation between the remaining four "productivity management" elements (i.e. "participation of family labour", "studying rate of the family", "quality premium", "farming v none farming") and the "performance indicators".

The second part of the analysis of the "Fitness Appraisal instrument" consisted of the exploration of "fitness" values and "productivity management elements" in order to identify the "fittest organisational configuration". (i) The "fitness" value of each factor was plotted on a profile graph. The use of this technique showed that profiles can be classified into 5 types based on the "roof" shape (e.g. "gable", "shed", "salt box", and "M") which in turn correspond to a strategic combination of "technology", "competence" and "operational climate" factors. It was concluded that the achievement of higher levels of "fitness" requires first an improvement in the internal strategy, and then a search new strategy (i.e. changing the "roof"). The 20 "productivity management elements" were plotted on a polar graph. This graphical option permitted the differences between the theoretical "fittest" organisational configuration and the observed one to be identified. The main finding here is the realisation that the "fittest" organisational configuration is a benchmark from which other farmers can improve their performance. (ii) A 3-dimensional graphical tool was used to plot each "performance indicator", and a pair of significant "productivity management" elements. The searching of this landscape was very useful because it permitted the understanding of the visual interaction between "productivity management" elements and the "performance indicators". A number of tentative conclusions could be drawn from the implementation of this "fitness" approach.

This study was explorative in nature, and filled some of the gaps in the empirical applications of the "fitness" approach in the social realm. Some of the main findings were: (i) The positive association found between the "fitness" value and performance indicators confirmed that there is a relationship between internal structure and environmental conditions, (ii) there is a gap between the theoretically "fittest" organisational configuration (i.e. 1) and the observed fittest organisational configuration (i.e. 0.61). And, (iii) the "fittest" organisational configuration is can be further improved or instead a set of fitter organisational configurations could be considered as the "fittest".

With regard to the NK model, (i) this study proposed to evaluate two different landscapes: $A^N=5^3$ and $A^N=2^7$. The landscapes were selected by considering the modular property of the "productivity management" approach. Although, the analysis shows that both landscapes were significant, landscape 2^7 was weaker in comparison to 5^3. It was concluded that the reduction of responses might influence the result. (ii) The calculation of the "fitness" value was based on the assumption of a null interaction between variables (i.e. factors and aspects), this is $K=0$. Whilst this decision permits a better understanding of the construction and interpretation of this particular landscape, it still limits to making a statement on other landscapes where one variable influences another i.e. $K>0$ (which under the original model is called epistasis). (iii) The use of compound variables, i.e. factors and aspects, did not influence the result. However, the original model is more rigid with this issue and does not attempt to use such variables.

The relation between "fitness" theory and other traditional approaches relies on two common issues: the identification of "fittest" points i.e. average, outliers, and the way to look for improvement (i.e. by searching in the local and global neighbourhood). The "fitness" approach is more interesting than traditional approaches, because this empirical study suggests that (i) the full potential of improvement is not achieved, so even the "fittest" organisational configuration could improve its performance by exploring the whole landscape, (ii) the searching of local and global fitter points helps to design better strategies. Nevertheless, more empirical studies are needed to support these findings.

The analysis of the "organisational configurations" consisted of the classification and identification of their "productivity management" elements. This study attempted to classify "organisational configuration" by considering the use of a "profile" technique. As mentioned above, this technique uncovered five different patterns. This new application could be extended in order to characterise an industry. The identification of "organisational configuration" was focused mainly on the "fittest", and it was carried out by an exploration of the categories of "productivity management" elements. This exploration was unique in nature, as other empirical studies did not consider this application.

Second, there is a core discussion about the magnitude (positive and negative) of the productivity concepts. Here, the definition of productivity is extended from efficiency to effectiveness. Technology is one of the main sources of explanation in the productivity literature, and this study also found similar results. Competence is another factor which is highly associated with an improvement in performance. This study also confirmed this important issue. Therefore, the way of achieving higher levels of performance by focusing on the denominator of the productivity equation –the input was fully corroborated. Nevertheless, this study also emphasises the importance of the numerator of the productivity equation –the output as well. That is farmers, in such competitive environments, are allocating resources to attract value (effectiveness) rather than create value (efficiency). This study argues that such a pattern would be explained by a natural response of the "decoupling" between sources of efficiency (i.e. research institutions, extension services) and the "farming" industry. This phenomenon was explained by the fact that the government is supporting both sides of the equation of productivity. With respect to the inputs, the government is funding activities to increase yield. With respect to the outputs, the government is supporting farmers in developing their marketing capabilities by implementing programmes where they can participate actively in the selling process. This finding confirms other theories such as "product diversification" and "value added", which are the foundation of "competitive advantages".

Finally, this study also concluded that the implementation of a free market environment is positive. A free market fosters an improvement in the internal capacity of each individual, organisation and system. It is clear that competition as an option to deal with a changing environment has disadvantages. One of the main disadvantages, as many authors suggest, is its predatory effect. Therefore, under competitive rules, it is clear that cacao farmers who do not adapt will have to exit the "farming" industry. Cooperation, however, is the other side of the same coin. This study found that this strategy is very important, especially for perennial tropical crops. Farmers are rebuilding the interaction between themselves and with other linkages (e.g. farmers are dealing directly with the "chocolate" industry at a national and international level). This study shows a good potential to improve cooperation through identification of the different "organisational configurations". A balance between both competition and cooperation is necessary maintain these positive adaptive dynamics, and in the future bring equity to the whole system.

9.5. Conclusions, recommendations and limitations

In summary the key points are:

1. The production and consumption of food has changed dramatically in the last decades. Therefore, organisations at all levels of the food supply chain need to develop strategies to cope with these changes and adapt to more competitive environments. The analysis of the agro-food system (AFS) and its key industries (i.e. farming) is one of the main points in the agenda of researchers, and different approaches need to be developed and implemented to achieve this. The objectives of this study focused on the development of two instruments to analyse the AFS and its key farming industry: the Quick Anatomical Assessment and Fitness Appraisal Instrument respectively. Both instruments were implemented and provided useful information to shed light on the research question: how can an organisation transit from a current position to another optimal or desired position.

2. According to literature, agro-food systems are dynamic. The Quick Anatomical Assessment is a very useful instrument to diagnose and analyse the main features of the industries in the CAFS. These features emphasise the similarities and dissimilarities among CAFS industries.

Besides information from these results and through data available from the literature, it is also possible to indentify further changes. However, a longitudinal study is necessary to discover and analyse the dynamic of the whole CAFS and its industries.

3. The Quick Anatomical Instrument is based on two analytical tools: "correspondence analysis" and *Chi*-square analysis. Since the purpose of the study was to analyse the distribution of the categories of anatomical elements for different industries of the CAFS, these analytical tools complemented each other satisfactorily. As exploratory tools, both of them were very useful to analyse the anatomy of the CAFS.

4. The relationship between internal configuration and environmental conditions is one of the core issues of the "fitness" approach. This relationship was employed to analyse the key "farming" industry of the CAFS by developing and implementing a Fitness Appraisal Instrument. The implementation of this instrument was explorative in nature, as few such empirical studies have been carried out in social studies. The results showed that there is a relationship between "organisational configurations" and their "performance indicators". This led the identification of the "fittest" organisational configuration, and in turn its core "productivity management elements". Nevertheless, further investigation is needed in order to corroborate these findings. From these empirical results, it was suggested that the "fitness" approach is reliable and could overcome one of the main limitations of traditional methods which limit their findings to the sample (DEA) or technology available (comparative-static).

5. The NK model was used to analyse the relationship between internal configuration and environmental conditions. Its applications to the study of social phenomena are restricted mainly to modelling, so there are very few empirical studies which shed light on the implementation of this model. This study used and adapted some of the concepts, methods, parameters available in the literature review and also implemented some graphical techniques to explore the results. This study has concluded that the full potential of the NK model is not yet fulfilled, so other studies need to provide further complementary information.

6. Both instruments provide useful information to characterise the CAFS and its industries. The main findings on the CAFS are (i) the CAFS is an industry based on raw and bulk products, so this is the main limitation to its coping with the free market agreement to start in 2008. (ii) In 2006, the presence of a lethal fungal disease in Tabasco was identified. This disease threatens the whole CAFS, because there is no leadership to cope with this situation, as the structure of the CAFS is still developing as a result of the competition in the "wholesaling" industry. (iii) All industries have many resources and ideas that could be shared an improvement in the diversification of the CAFS. And, finally (iv) the allocation of public funds has a positive impact on the CAFS industries, but this would be more effective if the allocation of such resources considers the different "organisational configurations". This would create value as well as attracting value from the market as a condition for survival in this currently competitive environment.

Contributions

The production and consumption of food is changing dramatically. Therefore, it is important to have instruments that permit analysis of an agro-food system as a whole and its separate elements. This study developed two exploratory instruments in order to achieve the above. These instruments permit analysis of the anatomy of an agro-food system, and also the farming industry by examining the relationship between internal structures (e.g. resources, strategies) and their environments.

This study has attempted to identify and analyse factors and aspects of "organisational configurations" of the "farming" industry in the Cacao Agro-food System in Tabasco (Mexico) by employing key elements of the "productivity management" perspective. Given such endeavour, the research findings have empirical contributions. The most significant contribution resides in the "fit" between such key factors and aspects of "organisational configurations" and the performance of the organisation. This particular relationship has been separately examined in other studies by using different approaches, therefore, resulting in incomplete and inconsistent findings

The "Fitness Appraisal Instrument" could be adapted to analyse other agro-food systems. This is particularly important since many countries still base their economies on agricultural production. Governments need to be more effective to achieve national goals and the "Fitness Appraisal Instrument" provides an opportunity to identify the full potential of all the individuals and organisations involved in an agro-food system.

The evolution of agro-food systems cannot be seen as a linear process any longer. In fact, major changes arise from moments of instability. Therefore, new subsystems or organisations appear and develop in the agro-food system, re-structure the agro-food system, explore new dimensions and lead to newly emerging properties and attributes. This particular dynamic should be also taken into consideration for the key co-players (i.e. research and development institutions, universities, service and material suppliers). If agro-food systems are changing, then co-players should assist in this change. Thus, co-players should be even more pro-active as a source of dynamism. This is especially important for R&D institutions and universities.

Policy implications

The results are also of practical importance to policymakers. Under liberalisation conditions, the cacao programs should take into consideration a wider "solution space" to achieve national development goals. Efficiency is one of the main strategies in the creation of value. However, it is also important to contextualise the efficiency strategies at the level of the firm considering different conditions (i.e. organisational configurations). Avoiding this would increase the polarisation between actors. It is recommended to provide resources to the Mexican Institution of Agricultural Research (INIFAP), so they can share the developed technology with farmers. The INIFAP should have more resources to diffuse their products. The diffusion activity will help the INIFAP to identify other specific needs of cacao farmers. The "Fitness Appraisal Instrument" will assist with such identification.

Effectiveness is another main strategy to attract value from the market. This has been less explored, because it requires different capacities and resources which normally are limited in government infrastructures. However, drawing attention to this strategy would impact positively in the long term, and a sustainable effect is expected. The elaboration and diffusion of a market diagnosis, which considers the products of the "farming" industry and the national and global demand, will help the "farming" industry to have a better picture of its market position and ensure it to carry out more challenging projects based on its knowledge and resources.

Lack of information is the main limitation to tracing the development of any agro-food system. The capacity to identify and also to forecast such dynamics would be possible if policies drew attention to the importance of information systems. The Mexican government has proposed the re-establishment of "product system boards" based on competitive principles. Therefore, the "cacao system board" should consider the lack of information as a main issue on its agenda that needs to be solved. By filling this gap, farmers will have accurate and opportune information to enable the make better decisions.

The fitness appraisal instrument and the quick anatomical assessment permit policymakers to have useful tools to analyse the cacao agro-food system and its key industries.

Recommendations for further research

The questions raised by this study warrant further investigation. Firstly, the research needs to be extended to other industries of the AFS (e.g. processing, wholesaling, catering) in order to address the whole picture. However, in order to compare such industries, it is necessary to draw attention to the study variables (or "productivity management" elements). Also, given that a buyer (e.g. the "curing" industry, the "wholesaling" industry and the "chocolate" industry) has a significant role in the performance, it would be fundamental to compare the "organisational configuration" of those farmers (i.e. sellers) who are linked to specific buyers. This would lead to an understanding of the exchange pattern between seller and buyer and, in turn, the effect of such interaction on performance. Secondly, a vast knowledge of the industry is required in order to set the number of responses and the hierarchical position of such responses. This is very important when new variables are of interest for the researcher. The reduction of responses, as proposed in this study, is at this moment not recommended, but it seems that a number between 2 and 5 responses is appropriate for a clear understanding. The larger number of responses and variables are considered the more combinations are to be analysed. This results in excessive numbers of alternatives that an organisation could actually explore. Thirdly, this study was based on a cross-sectional investigation. Therefore, it is expected that a longitudinal study would provide deeper knowledge and truer confirmation of causal relationships, and changes in "organisational configurations". This is especially important for the study of perennial tropical crops. Ideally, a term of three production cycles would give more information on the changes of "organisational configurations".

Limitations

One limitation of this study is the assumption that each "productivity management" element is independent of the other "productivity management" element (K=0) and makes an independent contribution to the overall "fitness" value. In a "productivity management" model with more than one element, it is likely that the contribution of each element is affected by the state of the other elements. This will be left for future research.

While data collected from survey and personal interviews can enable researchers to explore the richness of the reliability of obtaining information that is not publicly available, socially desirable bias due to subjects' responses to the "Fitness Appraisal Instrument" should be taken into consideration.

This study only investigated two "organisational configurations": the first based on three factors (i.e. "technology", "competence" and "operational climate"), and the second based on seven aspects (i.e. "innovation", "diffusion", "labour", "skills", "complementarity", "vertical integration" and "diversification") of the "productivity management" perspective. Twenty "productivity management" elements and 5 "performance indicators" (i.e. "business success", "price", "yield", "value of production per hectare", and "total production") were also analysed. Therefore, this study has recognised that other "productivity management" elements or variables might also play a significant role for other "performance indicators". Whilst most empirical studies on "fitness" landscapes have been conducted in manufacturing or service firms, this study was targeted at a single-owner organisation (i.e. farmer). As such, no claim for external validity and generalisation of the results beyond the sampling frame can be made.

Due to measurement error, landscapes could be hard to identify by simply looking at the graph, although, if revealed, they may turn out to be interpretable and reliable (Hill and Lewicki, 2006). Therefore, this exploration requires further analyses that look for the difference between groups (i.e. obtained by responses of "productivity management" elements), and the effect of interactions of particular responses in each "productivity management" element. Potentially, this would permit validation of the existence of such hills on the landscapes by analysing whether "performance indicators" obtained by the combination of the maximum expected values of responses are significantly different from those "performance indicators" obtained by other remaining combinations. This issue needs to be considered in further research.

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Appendix A. QUICK ANATOMICAL ASSESSMENT

ANATOMICAL ELEMENTS	VARIABLE	CATEGORY
INDUSTRY	Type of industry	1= Farming
		2= Curing
		3= Wholesaling
		4= Chocolate
Product	Destination of products	1= Local
		2= National
		3= International
		4= Combination
	Type of cacao product	1= Raw
		2= Intermediate
		3= Final
		4= RIF
	Type of cacao bean	1= Fresh
		2= Non fermented
		3= Fermented
		4= Bean combination
	Type of quality	1= Bulk
		2= Fine
		3= Organic
	Participation in cacao program	1= none
		2= in process
		3= certified
By-products	Cacao by-products	0= none use
		1= Internal use (recycling, consumption)
		2= to sale as raw product
		3= to sale as processed product
	Agro-products	0= none use
		1= Internal use (recycling, consumption)
		2= to sale as raw product
		3= to sale as processed product
Interaction	Type of association	1= Social
		2= Independent
	Type of supply structure	1= Union
		2= Private
		3= Union + Private
	Type of contract	1= None contract
		2= Short term
		3= Long term
	Type of support	1= None support
		2= Production
		3= Infrastructure

Appendix B. CORRESPONDENCE ANALYSIS

Observed Table (Frequencies); Row variables: INDUSTRY(4); Column variables: PRODUCT(2)

	Raw	Final	Total
Farming	176.00	0.00	176.00
Curing	37.00	0.00	37.00
Wholesaling	6.00	0.00	6.00
Chocolate	0.00	7.00	7.00
Total	219.00	7.00	226.00

Variables and number of categories:

Row variables: INDUSTRY(4)

Column variables: PRODUCT(2)

Eigenvalues: 1.000

Total chi-square=226.000 df=3 p=0.000

	Singular	Eigen-	Perc. of	Cumulatv	Chi		
1	1.00	1.00	100.00	100.00	226.00		
	Row	Coordin.	Mass	Quality	Relative	Inertia	Cosine²
Farming	1.00	0.18	0.78	1.00	0.02	0.02	1.00
Curing	2.00	0.18	0.16	1.00	0.01	0.01	1.00
Wholesaling	3.00	0.18	0.03	1.00	0.00	0.00	1.00
Chocolate	4.00	-5.59	0.03	1.00	0.97	0.97	1.00
Raw	1.00	0.18	0.97	1.00	0.03	0.03	1.00
Final	2.00	-5.59	0.03	1.00	0.97	0.97	1.00

Observed Table (Frequencies); Row variables: INDUSTRY(4); Column variables: BEAN(4)

	Fresh	Non fermented	Fermented	Combination	Total
Farming	159.00	15.00	2.00	0.00	176.00
Curing	2.00	3.00	20.00	12.00	37.00
Wholesaling	0.00	1.00	2.00	3.00	6.00
Chocolate	0.00	3.00	0.00	0.00	3.00
Total	161.00	22.00	24.00	15.00	222.00

Variables and number of categories:
Row variables: INDUSTRY(4)
Column variables: BEAN(4)
Eigenvalues: .7984 .1268 .0194
Total chi-square=209.701 df=9 p=0.000

	Singular	Eigen-	Perc. of	Cumulatv	Chi
1	0.89	0.80	84.52	84.52	177.25
2	0.36	0.13	13.42	97.95	28.14
3	0.14	0.02	2.05	100.00	4.31

	Row	Coordin.	Coordin.	Mass	Quality	Relative	Inertia	Cosine²	Inertia	Cosine²
Farming	1.00	-0.45	0.04	0.79	1.00	0.17	0.20	0.99	0.01	0.01
Curing	2.00	1.82	0.09	0.17	1.00	0.59	0.69	0.99	0.01	0.00
Wholesaling	3.00	1.83	-0.25	0.03	0.85	0.11	0.11	0.83	0.01	0.02
Chocolate	4.00	0.04	-3.01	0.01	1.00	0.13	0.00	0.00	0.97	1.00
Fresh	1.00	-0.47	0.11	0.73	1.00	0.18	0.20	0.94	0.08	0.06
Non	2.00	0.04	-1.07	0.10	1.00	0.12	0.00	0.00	0.90	1.00
Fermented	3.00	1.82	0.17	0.11	0.98	0.39	0.45	0.97	0.02	0.01
Combination	4.00	2.04	0.07	0.07	0.96	0.31	0.35	0.96	0.00	0.00

Observed Table (Frequencies); Row variables: INDUSTRY(4), Column variables: QUALITY(3)

	Bulk	Organic	Fine	Total
Farming	112.00	63.00	1.00	176.00
Curing	21.00	16.00	0.00	37.00
Wholesaling	6.00	0.00	0.00	6.00
Chocolate	4.00	3.00	0.00	7.00
Total	143.00	82.00	1.00	226.00

Variables and number of categories:
Row variables: INDUSTRY(4)
Column variables: QUALITY(3)
Eigenvalues: .0192 .0012
Total chi-square=4.62260 df=6 p=.5930

	Singular	Eigen-	Perc. of	Cumulatv	Chi
1	0.14	0.02	93.93	93.93	4.34
2	0.04	0.00	6.07	100.00	0.28

	Row	Coordin.	Coordin.	Mass	Quality	Relative	Inertia	Cosine²	Inertia	Cosine²
Farming	1.00	-0.01	0.02	0.78	1.00	0.02	0.00	0.22	0.22	0.78
Curing	2.00	0.14	-0.06	0.16	1.00	0.20	0.18	0.84	0.50	0.16
Wholesaling	3.00	-0.76	-0.09	0.03	1.00	0.75	0.79	0.99	0.18	0.01
Chocolate	4.00	0.14	-0.06	0.03	1.00	0.03	0.03	0.83	0.10	0.17
Bulk	1.00	-0.10	-0.00	0.63	1.00	0.34	0.36	1.00	0.01	0.00
Organic	2.00	0.18	-0.00	0.36	1.00	0.60	0.64	1.00	0.00	0.00
Fine	3.00	-0.07	0.53	0.00	1.00	0.06	0.00	0.02	0.99	0.98

Observed Table (Frequencies); Row variables: INDUSTRY(3), Column variables: ORGANIC(3)

	None	Process	Certified	Total
Farming	14.00	47.00	3.00	64.00
Curing	0.00	16.00	0.00	16.00
Chocolate	1.00	2.00	0.00	3.00
Total	15.00	65.00	3.00	83.00

Variables and number of categories:
Row variables: INDUSTRY(3)
Column variables: ORGANIC(3)
Eigenvalues: .0671 0.0038
Total chi-square=5.88803 df=4 p=.2077

	Singular	Eigen-	Perc. of	Cumulatv	Chi
1	0.26	0.07	94.61	94.61	5.57
2	0.06	0.00	5.39	100.00	0.32

	Row	Coordin.	Coordin.	Mass	Quality	Relative	Inertia	Cosine²	Inertia	Cosine²
Farming	1.00	-0.12	-0.02	0.77	1.00	0.15	0.16	0.98	0.07	0.02
Curing	2.00	0.53	0.02	0.19	1.00	0.75	0.79	1.00	0.01	0.00
Chocolate	3.00	-0.29	0.31	0.04	1.00	0.09	0.05	0.47	0.92	0.53
Starting	1.00	-0.50	0.06	0.18	1.00	0.64	0.67	0.99	0.15	0.01
In process	2.00	0.14	0.00	0.78	1.00	0.21	0.22	1.00	0.00	0.00
Certified	3.00	-0.45	-0.30	0.04	1.00	0.15	0.11	0.70	0.85	0.30

Observed Table (Frequencies); Row variables: INDUSTRY(4), Column variables: LOCATION(4)

	Local	National	International	Combination	Total
Farming	175.00	0.00	1.00	0.00	176.00
Curing	34.00	1.00	0.00	2.00	37.00
Wholesaling	1.00	3.00	2.00	0.00	6.00
Chocolate	2.00	0.00	0.00	5.00	7.00
Total	212.00	4.00	3.00	7.00	226.00

Variables and number of categories:
Row variables: INDUSTRY(4)
Column variables: LOCATION(4)
Eigenvalues: .5898 .5099 .0034
Total chi-square=249.314 df=9 p=0.000

	Singular	Eigen-	Perc. of	Cumulatv	Chi
1	0.77	0.59	53.46	53.46	133.29
2	0.71	0.51	46.22	99.69	115.24
3	0.06	0.00	0.31	100.00	0.78

	Row	Coordin.	Coordin.	Mass	Quality	Relative	Inertia	Cosine²	Inertia	Cosine²
Farming	1.00	-0.14	0.19	0.78	0.99	0.04	0.02	0.33	0.06	0.66
Curing	2.00	-0.02	-0.13	0.16	0.51	0.01	0.00	0.01	0.01	0.50
Wholesaling	3.00	4.63	-0.24	0.03	1.00	0.52	0.97	1.00	0.00	0.00
Chocolate	4.00	-0.41	-3.92	0.03	1.00	0.44	0.01	0.01	0.93	0.99
Local	1.00	-0.13	0.14	0.94	1.00	0.03	0.03	0.46	0.04	0.54
National	2.00	4.52	-0.30	0.02	1.00	0.33	0.61	0.99	0.00	0.00
International	3.00	3.96	-0.14	0.01	0.99	0.19	0.35	0.99	0.00	0.00
Combination	4.00	-0.39	-3.98	0.03	1.00	0.45	0.01	0.01	0.96	0.99

Observed Table (Frequencies); Row variables: INDUSTRY(4), Column variables: BY-PRODUCTS(4)

	None	Internal	Raw	Processed	Total
Farming	98.00	76.00	2.00	0.00	176.00
Curing	0.00	0.00	37.00	0.00	37.00
Wholesaling	6.00	0.00	0.00	0.00	6.00
Chocolate	2.00	0.00	2.00	3.00	7.00
Total	106.00	76.00	41.00	3.00	226.00

Variables and number of categories:
Row variables: INDUSTRY(4)
Column variables: BY-PRODUCTS(4)
Eigenvalues: .9121 .4172 .0248
Total chi-square=306.029 df=9 p=0.000

	Singular	Eigen-	Perc. of	Cumulatv	Chi
1	0.96	0.91	67.36	67.36	206.13
2	0.65	0.42	30.81	98.17	94.29
3	0.16	0.02	1.83	100.00	5.61

	Row	Coordin.	Coordin.	Coordin.	Mass	Quality	Relative	Inertia	Cosine^2	Inertia	Cosine^2	Inertia	Cosine^2
Farming	1.00	-0.46	-0.07	-0.03	0.78	1.00	0.12	0.18	0.97	0.01	0.02	0.03	0.00
Curing	2.00	2.09	-0.35	0.00	0.16	1.00	0.55	0.79	0.97	0.05	0.03	0.00	0.00
Wholesaling	3.00	-0.48	0.01	0.95	0.03	1.00	0.02	0.01	0.20	0.00	0.00	0.97	0.80
Chocolate	4.00	0.87	3.56	-0.02	0.03	1.00	0.31	0.03	0.06	0.94	0.94	0.00	0.00
None	1.00	-0.46	0.01	0.15	0.47	1.00	0.08	0.11	0.90	0.00	0.00	0.42	0.10
Internal	2.00	-0.48	-0.11	-0.21	0.34	1.00	0.07	0.09	0.81	0.01	0.04	0.57	0.15
Unprocessed	3.00	2.00	-0.23	0.00	0.18	1.00	0.54	0.80	0.99	0.02	0.01	0.00	0.00
Processed	4.00	0.91	5.52	-0.11	0.01	1.00	0.31	0.01	0.03	0.97	0.97	0.01	0.00

Observed Table (Frequencies); Row variables: INDUSTRY(4), Column variables: AGRO-PRODUCT (3)

	None	Internal	Raw	Total
Farming	10.00	145.00	21.00	176.00
Curing	37.00	0.00	0.00	37.00
Wholesaling	6.00	0.00	0.00	6.00
Chocolate	3.00	3.00	1.00	7.00
Total	56.00	148.00	22.00	226.00

Variables and number of categories:
Row variables: INDUSTRY(4)
Column variables: AGRO-PRO(3)
Eigenvalues: .7355 .0018
Total chi-square=166.608 df=6 p=0.000

	Singular	Eigen-	Perc. of	Cumulatv	Chi
1	0.86	0.74	99.76	99.76	166.21
2	0.04	0.00	0.24	100.00	0.40

	Row	Coordin.	Coordin.	Mass	Quality	Relative	Inertia	Cosine²	Inertia	Cosine²
Farming	1.00	-0.44	0.01	0.78	1.00	0.21	0.21	1.00	0.01	0.00
Curing	2.00	1.74	0.01	0.16	1.00	0.67	0.68	1.00	0.02	0.00
Wholesaling	3.00	1.74	0.01	0.03	1.00	0.11	0.11	1.00	0.00	0.00
Chocolate	4.00	0.42	-0.23	0.03	1.00	0.01	0.01	0.77	0.96	0.23
None	1.00	1.49	0.00	0.25	1.00	0.75	0.75	1.00	0.00	0.00
Internal	2.00	-0.50	0.02	0.65	1.00	0.22	0.22	1.00	0.13	0.00
Unprocessed	3.00	-0.47	-0.13	0.10	1.00	0.03	0.03	0.93	0.87	0.07

Observed Table (Frequencies); Row variables: INDUSTRY(4), Column variables: ASSOCIATION(2)

	Social	Independent	Total
Farming	119.00	57.00	176.00
Curing	22.00	15.00	37.00
Wholesaling	1.00	5.00	6.00
Chocolate	1.00	6.00	7.00
Total	143.00	83.00	226.00

Variables and number of categories:
Row variables: INDUSTRY(4)
Column variables: ASSOCIAT(2)
Eigenvalues: .0641
Total chi-square=14.4958 df=3 p=.0023

	Singular	Eigen-	Perc. of	Cumulatv	Chi
1	0.25	0.06	100.00	100.00	14.50

	Row	Coordin.	Mass	Quality	Relative	Inertia	Cosine²
Farming	1.00	-0.09	0.78	1.00	0.10	0.10	1.00
Curing	2.00	0.08	0.16	1.00	0.02	0.02	1.00
Wholesaling	3.00	0.97	0.03	1.00	0.39	0.39	1.00
Chocolate	4.00	1.02	0.03	1.00	0.50	0.50	1.00
Social	1.00	-0.19	0.63	1.00	0.37	0.37	1.00
Independent	2.00	0.33	0.37	1.00	0.63	0.63	1.00

Observed Table (Frequencies); Row variables: INDUSTRY(4), Column variables: STRUCTURE(3)

	Union	Private	Union +	Total
Farming	119.00	33.00	24.00	176.00
Curing	17.00	16.00	4.00	37.00
Wholesaling	1.00	5.00	0.00	6.00
Chocolate	1.00	6.00	0.00	7.00
Total	138.00	60.00	28.00	226.00

Variables and number of categories:
Row variables: INDUSTRY(4)
Column variables: STRUCTUR(3)
Eigenvalues: .1473 .0005
Total chi-square=33.4060 df=6 p=0.000

	Singular	Eigen-	Perc. of	Cumulatv	Chi
1	0.38	0.15	99.63	99.63	33.28
2	0.02	0.00	0.37	100.00	0.12

	Row	Coordin.	Coordin.	Mass	Quality	Relative	Inertia	Cosine²	Inertia	Cosine²
Farming	1.00	-0.18	-0.01	0.78	1.00	0.16	0.16	1.00	0.06	0.00
Curing	2.00	0.38	0.05	0.16	1.00	0.16	0.16	0.98	0.67	0.02
Wholesaling	3.00	1.29	-0.06	0.03	1.00	0.30	0.30	1.00	0.16	0.00
Chocolate	4.00	1.34	-0.04	0.03	1.00	0.38	0.38	1.00	0.11	0.00
Union	1.00	-0.23	-0.01	0.61	1.00	0.21	0.21	1.00	0.18	0.00
Private	2.00	0.64	0.00	0.27	1.00	0.73	0.73	1.00	0.00	0.00
Union +	3.00	-0.25	0.06	0.12	1.00	0.06	0.05	0.95	0.82	0.05

Observed Table (Frequencies); Row variables: INDUSTRY(4), Column variables: CONTRACT(3)

	None	Short	Long	Total
Farming	174.00	2.00	0.00	176.00
Curing	14.00	23.00	0.00	37.00
Wholesaling	0.00	3.00	3.00	6.00
Chocolate	5.00	1.00	1.00	7.00
Total	193.00	29.00	4.00	226.00

Variables and number of categories:
Row variables: INDUSTRY(4)
Column variables: CONTRACT(3)
Eigenvalues: .5920 .3064
Total chi-square=203.043 df=6 p=0.000

	Singular	Eigen-	Perc. of	Cumulatv	Chi
1	0.77	0.59	65.90	65.90	133.80
2	0.55	0.31	34.10	100.00	69.24

	Row	Coordin.	Coordin.	Mass	Quality	Relative	Inertia	Cosine²	Inertia	Cosine²
Farming	1.00	0.37	0.09	0.78	1.00	0.13	0.18	0.94	0.02	0.06
Curing	2.00	-1.13	-0.95	0.16	1.00	0.40	0.35	0.58	0.48	0.42
Wholesaling	3.00	-3.16	2.25	0.03	1.00	0.45	0.45	0.66	0.44	0.34
Chocolate	4.00	-0.62	0.73	0.03	1.00	0.03	0.02	0.42	0.05	0.58
None	1.00	0.31	0.06	0.85	1.00	0.09	0.13	0.96	0.01	0.04
Short	2.00	-1.58	-0.89	0.13	1.00	0.47	0.54	0.76	0.33	0.24
Long	3.00	-3.28	3.38	0.02	1.00	0.44	0.32	0.49	0.66	0.51

Observed Table (Frequencies); Row variables: INDUSTRY(4), Column variables: SUPPORT(3)

	None	Production	Infrastructure	Total
Farming	132.00	42.00	2.00	176.00
Curing	2.00	30.00	5.00	37.00
Wholesaling	6.00	0.00	0.00	6.00
Chocolate	7.00	0.00	0.00	7.00
Total	147.00	72.00	7.00	226.00

Variables and number of categories:
Row variables: INDUSTRY(4)
Column variables: SUPPORT(3)
Eigenvalues: .3377 .0018
Total chi-square=76.7167 df=6 p=0.000

	Singular	Eigen-	Perc. of	Cumulatv	Chi
1	0.58	0.34	99.47	99.47	76.31
2	0.04	0.00	0.53	100.00	0.41

	Row	Coordin.	Coordin.	Mass	Quality	Relative	Inertia	Cosine²	Inertia	Cosine²
Farming	1.00	-0.22	0.02	0.78	1.00	0.11	0.11	0.99	0.11	0.01
Curing	2.00	1.29	-0.02	0.16	1.00	0.80	0.80	1.00	0.03	0.00
Wholesaling	3.00	-0.71	-0.16	0.03	1.00	0.04	0.04	0.95	0.39	0.05
Chocolate	4.00	-0.71	-0.16	0.03	1.00	0.05	0.05	0.95	0.46	0.05
None	1.00	-0.42	-0.01	0.65	1.00	0.33	0.33	1.00	0.02	0.00
Production	2.00	0.70	0.03	0.32	1.00	0.47	0.47	1.00	0.21	0.00
Infrastructure	3.00	1.48	-0.21	0.03	1.00	0.20	0.20	0.98	0.77	0.02

Evaluating the distributions of different categories of 11 aspects (rows) of three anatomical elements (i.e. products, by-products and interactions) between all categories of 4 selected groups of industries (columns).

ASPECTS OF ANATOMICAL ELEMENTS	CATEGORIES	ORGANISATIONS (%)					CHI-SQUARE				ORGANISATIONS (N)			
		F	Cr	W	Ch	(W+Ch)	F-Cu-W-Ch	F-Cr	F-(W+Ch)	Cr-(W+Ch)	F+Cu+W+Ch	F+Cr	F+(W+Ch)	Cr+(W+Ch)
PRODUCT	Raw	100	100	100	-	46	226***	0	98.41***	23.17***	219	213	182	43
	Final	-	-	-	100	54					7	0	7	7
BEAN	Fresh	90	5	-	-	-	209.7***	169.15***	95.16***	8.3***	161	161	159	2
	Non fermented	9	8	17	100	44					22	18	19	7
	Fermented	1	54	33	-	22					24	22	4	22
	Combination	-	32	50	-	33					15	12	3	15
QUALITY	Bulk	64	57	100	57	77	4.62	0.9	0.97	1.66	143	133	122	31
	Organic	35	43	-	43	23					82	79	66	19
	Fine	1	-	-	-	-					1	1	1	0
ORGANIC	Starting	22	-		33	33	5.89	5.4	0.33	5.63	15	14	15	1
	In process	73	100		67	67					65	63	49	18
	Certified	5	-		-	-					3	3	3	0
LOCATION	Local	99	92	17	29	23	249.31***	14.66***	132.54***	24.35***	212	209	178	37
	National	-	3	50	-	23					4	1	3	4
	International	1	-	33	-	15					3	1	3	2
	Combination	-	5	-	71	38					7	2	5	7
BY-PRODUCT	None	56	-	100	29	62	306.03***	199.78***	57.92***	40.14***	106	98	106	8
	Internal	43	-	-	-	-					76	76	76	0
	Raw	1	100	-	29	15					41	39	4	39
	Processed	-	-	-	43	23					3	0	3	3
AGRO-PRODUCT	None	6	100	100	43	69	166.61***	158.15***	54.26***	12.37***	56	47	19	46
	Internal	82	-	-	43	23					148	145	148	3
	Raw	12	-	-	14	8					22	21	22	1
ASSOCIATION	Social	68	59	17	14	15	14.5***	0.91	14.34***	7.49***	143	141	121	24
	Business	32	41	83	86	85					83	72	68	26
STRUCTURE	Union	68	46	17	14	15	33.41***	10.41***	29.49***	6.82***	138	136	121	19
	Private	19	43	83	86	85					60	49	44	27
	Union + Private	14	11	-	-	-					28	28	24	4
CONTRACT	None	99	38	-	71	38	203.04***	109.91***	92.3***	13.14***	193	188	179	19
	Short	1	62	50	14	31					29	25	6	27
	Long	-	-	50	14	31					4	0	4	4
SUPPORT	None	75	5	100	100	100	76.72***	67.4***	4.24	40.99***	147	134	145	15
	Production	24	81	-	-	-					72	72	42	30
	Infrastructure	1	14	-	-	-					7	7	2	5

INDUSTRIES: F= Framing, Cr= Curing, W= wholesaling, Ch= Chocolate; (W+Ch)= sum of wholesaling and chocolate industries. SIGNIFICANCE: * p<0.05, ** p<0.01, *** p<0.001.
"-" =.between, "+" = The sum of organisations of the shown group of industries (N).

Appendix C. FITNESS APPRAISAL INSTRUMENT

Age of the cacao orchard	AGECCOR			years	Indicate the average age of the cacao orchard
Age of the cocoa orchard	AGECCORM	01 – 10 years	4		
		11 – 20 years	5		
		21 – 30 years	3		
		31 – 40 years	2		
		> 40 years	1		
Fitness scale of cacao orchard age, 2 responses	ageccorm[2]	01 – 10 years	4	1.0	
		11 – 20 years	5	1.0	
		21 – 30 years	3	1.0	
		31 – 40 years	2	0.4	
		> 40 years	1	0.4	
Fitness scale of cacao orchard age, 5 responses	ageccorm[5]	01 – 10 years	4	0.8	
		11 – 20 years	5	1	
		21 – 30 years	3	0.6	
		31 – 40 years	2	0.4	
		> 40 years	1	0.2	
Forastero (Guayaquil, Ceylan)	CCVTFR	No	0		Indicate the main varieties of cacao tree at

					your orchard
		Yes	1		
Trinitario (Cundeamor, amelonado, sambito, calabacillo, angoleta, patastillo)	CCVTTR	No	0		
		Yes	1		
Criollo (Lagarto, clonal, carmelo, pentagona)	CCVTCL	No	0		
		Yes	1		
Type of cocoa variety	CCVRTY	Criollo	5		
		Criollo + Trinitario + Forastero	4		
		Criollo + Trinitario	4		
		Criollo + Forastero	4		
		Trinitario	3		
		Trinitario + Forastero	2		
		Forastero	1		
Fitness scale of cocoa variety, 2 respondaces	ccvrty[2]	Criollo	5	0.8	
		Criollo + Trinitario + Forastero	4	0.8	
		Criollo + Trinitario	4	0.8	
		Criollo + Forastero	4	0.8	
		Trinitario	3	0.2	
		Trinitario + Forastero	2	0.2	
		Forastero	1	0.2	

Fitness scale of cocoa variety, 5 respondaces	ccvrty[5]	Criollo	5	1	
		Criollo + Trinitario + Forastero	4	0.8	
		Criollo + Trinitario	4	0.8	
		Criollo + Forastero	4	0.8	
		Trinitario	3	0.6	
		Trinitario + Forastero	2	0.4	
		Forastero	1	0.2	
Cutting back shade trees	CBSHTR	Yes	1		Indicate the activities that are performed in your cacao orchard
		No	0		
Pruning	PRUNNG	Yes	1		
		No	0		
Weeding	WEED	Yes	1		
		No	0		
Crop protection	CRPPROT	Yes	1		
		No	0		
Fertilisation	FRTLZTN	Yes	1		
		No	0		
Irrigation	IRRGTN	Yes	1		
		No	0		
Preharvesting cacao activities	PHRVACTY	6 actvs	5		
		5 actvs	4		
		4 actvs	3		

		3 actvs	2		
		≤ 2 actvs	1		
Fitness scale of preharvesting cacao activities, 2 responses	phrvacty[2]	6 actvs	5	1	
		5 actvs	4	1	
		4 actvs	3	1	
		3 actvs	2	0.2	
		≤ 2 actvs	1	0.2	
Fitness scale of preharvesting cacao activities, 5 responses	phrvacty[5]	6 actvs	5	1	
		5 actvs	4	0.8	
		4 actvs	3	0.6	
		3 actvs	2	0.4	
		≤ 2 actvs	1	0.2	
Fresh bean	FRESH	No	0		Indicate how cocoa bean is sold
		Yes	1		
Non-fermented bean (lavado, beneficiado)	NNFRMTED	No	0		
		Yes	1		
Fermented bean	FRMTED	No	0		
		Yes	1		
Type of cacao bean	CCBEAN	Fermented	5		
		Fermented + NonFermented + Fresh	4		
		Fermented + NonFermented	4		

		Fermented Fresh	4		
		NonFermented	3		
		NonFermented + Fresh	2		
		Fresh	1		
Fitness scale of cacao bean type, 2 responses	ccbean[2]	Fermented	5	1	
		Fermented + NonFermented + Fresh	4	1	
		Fermented + NonFermented	4	1	
		Fermented Fresh	4	1	
		NonFermented	3	1	
		NonFermented + Fresh	2	1	
		Fresh	1	0.2	
Fitness scale of cacao bean type, 5 responses	ccbean[5]	Fermented	5	1	
		Fermented + NonFermented + Fresh	4	0.8	
		Fermented + NonFermented	4	0.8	
		Fermented Fresh	4	0.8	
		NonFermented	3	0.6	
		NonFermented + Fresh	2	0.4	
		Fresh	1	0.2	
From own cocoa orchard	CCPPOWN	No	0		Indicate where your cocoa plants are obtained to rehabilitate the orchard
		Yes	1		
From relative/friend orchard	CCPPRLTV	No	0		

		Yes	1		
From public programs	CCPPPBPM	No	0		
		Yes	1		
Source of cacao plant	SRCECCPT	Public program	5		
		Public program + relative/friend + own cacao	4		
		Public program + own cacao	4		
		Public program + relative/friend	4		
		Own cacao	3		
		Own cacao + relative/friend	2		
		Relative/friend	1		
Fitness scale of source of cacao plant, 2 responses	srceccpt[2]		1	0.8	
			0	0.2	
Fitness scale of source of cacao plant, 5 responses	srceccpt[5]		5	1	
			4	0.8	
			3	0.6	
			2	0.4	
			1	0.2	
Participation on organic cacao	ORGANIC	Already certified	5		Indicate the grade of participation on an organic cacao program
		3 year of certification	4		
		2 year of certification	3		
		1 year of certification	2		

		Non participation	1		
Fitness scale of organic cacao participation, 2 responses		Already certified	5	1	
		3 year of certification	4	0.8	
		2 year of certification	3	0.6	
		1 year of certification	2	0.4	
		Non participation	1	0.2	
Fitness scale of organic cacao participation, 5 responses		Already certified	5	1	
		3 year of certification	4	0.8	
		2 year of certification	3	0.6	
		1 year of certification	2	0.4	
		Non participation	1	0.2	
Participation of family labour	FMLYWRK	Always	1		Indicate to what extent the members of your family help in the cacao production
		Almost always	2		
		Sometimes	3		
		Almost never	4		
		Never	5		
Fitness scale of the participation of family work, 2 responses	fmlywrk[2]	Always	5	1	
		Almost always	4	0.8	
		Sometimes	3	0.6	
		Almost never	2	0.4	
		Never	1	0.2	

Fitness scale of the participation of family work, 5 responses	fmlywrk[5]	Always	5	0.6	
		Almost always	4	0.6	
		Sometimes	3	0.6	
		Almost never	2	0.2	
		Never	1	0.2	
Payment of Cutting back shade trees	CBSHTR$	No	0		Indicate what production activities are paid
		Yes	1		
Payment of Pruning	PRUNNG$	No	0		
		Yes	1		
Payment of Weeding	WEED$	No	0		
		Yes	1		
Payment of Crop protection	CRPPROT$	No	0		
		Yes	1		
Payment of Fertilisation	FRTLZTN$	No	0		
		Yes	1		
Payment of Irrigation	IRRGTN$	No	0		
		Yes	1		
Payment of Harvesting	HRVSTG$	No	0		
		Yes	1		
Paid cacao activities	PAIDACTV	7 actvs	1		
		5-6 actvs	2		
		3-4 actvs	3		
		1-2 actvs	4		

		None	5		
Fitness scale of the paid cacao activities, 2 responses	paidactv[2]	7 actvs	1	0.2	
		5-6 actvs	2	0.4	
		3-4 actvs	3	0.6	
		1-2 actvs	4	0.8	
		None	5	1	
Fitness scale of the paid cacao activities, 5 responses	paidactv[5]	7 actvs	1	0.2	
		5-6 actvs	2	0.2	
		3-4 actvs	3	0.2	
		1-2 actvs	4	0.8	
		None	5	0.8	
School attendance	SCHOOLY			years	Indicate what is your school level
School attendance	SCHOOL	0-3years	1		
		4-6 years	2		
		7-9 years	3		
		10-12 years	4		
		>12 years	5		
Fitness scale of school attendance, 2 responses	school[2]	0-3years	1	0.2	
		4-6 years	2	0.2	
		7-9 years	3	0.6	
		10-12 years	4	0.6	
		>12 years	5	0.6	

Fitness scale of school attendance, 5 responses	school[5]	0-3years	1	0.2	
		4-6 years	2	0.4	
		7-9 years	3	0.6	
		10-12 years	4	0.8	
		>12 years	5	1	
Technological & market capabilities	TECHMRKT	Totally on marketing	1		To what extent your current performance depends on technological or market capabilities
		Partially on marketing	2		
		Both marketing and technology	3		
		Partially on technology	4		
		Totally on technology	5		
Fitness scale of technological & market capabilities, 2 responses	techmrkt[2]	Totally on marketing	1	0.6	
		Partially on marketing	2	0.6	
		Both marketing and technology	3	0.6	
		Partially on technology	4	1	
		Totally on technology	5	1	
Fitness scale of technological & market capabilities, 5 responses	techmrkt[5]	Totally on marketing	1	0.2	
		Partially on marketing	2	0.4	
		Both marketing and technology	3	0.6	

		Partially on technology	4	0.8	
		Totally on technology	5	1	
Total family members	TFMLYM			number of people	Indicate the total number of family members in your household
Studying family members	SFMLYM			number of people	Indicate the total number of family members who are studying
Studying rate of the family	STDYRT	0-0.19	1		
		0.2-0.39	2		
		0.4-0.59	3		
		0.6-0.79	4		
		0.8-0.99	5		
Fitness scale of the rate between studying and total family members, 2 responses	stdyrt[2]	0-0.19	1	0.2	
		0.2-0.39	2	0.2	
		0.4-0.59	3	0.2	
		0.6-0.79	4	0.8	
		0.8-0.99	5	0.8	
Fitness scale of the rate between studying and total family members, 5 responses	stdyrt[5]	0-0.19	1	0.2	
		0.2-0.39	2	0.4	
		0.4-0.59	3	0.6	
		0.6-0.79	4	0.8	
		0.8-0.99	5	1	

Cacao production capabilities	CCKNWHW	Totally family	1		Indicate where you have obtained the cacao production capabilities
		Mainly family	2		
		Both family and training	3		
		Mainly training	4		
		Totally training	5		
Fitness scale of cacao production capabilities, 2 responses	ccknwhw[2]	Totally family	1	0.6	
		Mainly family	2	0.6	
		Both family and training	3	0.6	
		Mainly training	4	1	
		Totally training	5	1	
Fitness scale of cacao production capabilities, 5 reponses	ccknwhw[5]	Totally family	1	0.2	
		Mainly family	2	0.4	
		Both family and training	3	0.6	
		Mainly training	4	0.8	
		Totally training	5	1	
Cacao business entrance	CCBSNSS	Totally family	1		Indicate the main reason to be in the cacao business
		Mainly family	2		
		Both family and self-decision	3		
		Mainly self-decision	4		

		Totally self-decision	5		
Fitness scale of cacao business entrance, 2 responses	ccbsnss[2]	Totally family	1	0.2	
		Mainly family	2	0.2	
		Both family and self-decision	3	0.2	
		Mainly self-decision	4	0.6	
		Totally self-decision	5	0.6	
Fitness scale of cacao business entrance, 5 responses	ccbsnss[5]	Totally family	1	0.2	
		Mainly family	2	0.4	
		Both family and self-decision	3	0.6	
		Mainly self-decision	4	0.8	
		Totally self-decision	5	1	
Food industry	FOOD	No	0		Indicate where you sell the production
		Yes	1		
Union farmer	UNION	No	0		
		Yes	1		
Middleman	MIDLMN	No	0		
		Yes	1		
Commercialisation channel	CMRLTCHL	Food	5		
		Food + Union	4		
		Food + Middleman	4		
		Food + Union + Middleman	4		
		Union	3		
		Union + Middleman	2		

		Middleman	1		
Fitness scale of commercialisation channel, 2 responses	cmrltchl[2]	Food	5	0.6	
		Food + Union	4	0.6	
		Food + Middleman	4	0.6	
		Food + Union + Middleman	4	0.6	
		Union	3	0.6	
		Union + Middleman	2	0.2	
		Middleman	1	0.2	
Fitness scale of commercialisation channel, 5 responses	cmrltchl[5]	Food	5	1	
		Food + Union	4	0.8	
		Food + Middleman	4	0.8	
		Food + Union + Middleman	4	0.8	
		Union	3	0.6	
		Union + Middleman	2	0.4	
		Middleman	1	0.2	
Transaction condition	TRNCTCND	Totally price (discretional)	1		Indicate to what extent you sell the product in such channel
		Mainly price	2		
		Both price and discretional	3		
		Mainly union	4		
		Totally union (relational)	5		

Fitness scale of transaction condition, 2 respond	trnctcnd[2]	Totally price (discretional)	1	0.2	
		Mainly price	2	0.2	
		Both price and discretional	3	0.2	
		Mainly union	4	0.8	
		Totally union (relational)	5	0.8	
Fitness scale of transaction condition, 5 respond	trnctcnd[5]	Totally price (discretional)	1	0.2	
		Mainly price	2	0.4	
		Both price and discretional	3	0.6	
		Mainly union	4	0.8	
		Totally union (relational)	5	1	
Payment conditions	PAYMNT	Never	1		Indicate to what extent your products are immediately paid by the buyer
		Almost never	2		
		Sometimes	3		
		Almost always	4		
		Always	5		
Fitness scale of payment conditions, 2 responses	paymnt[2]	Never	1	0.2	
		Almost never	2	0.2	
		Sometimes	3	0.2	
		Almost always	4	0.6	
		Always	5	0.6	
Fitness scale of payment	paymnt[5]	Never	1	0.2	

conditions, 5 responses					
		Almost never	2	0.4	
		Sometimes	3	0.6	
		Almost always	4	0.8	
		Always	5	1	
Quality premium	QUALITY	Never	1		To what extent your cacao is reward on a quality base
		Almost never	2		
		Sometimes	3		
		Almost always	4		
		Always	5		
Fitness scale of quality premium, 2 responses	quality[2]	Never	1	0.2	
		Almost never	2	0.2	
		Sometimes	3	0.2	
		Almost always	4	0.6	
		Always	5	0.6	
Fitness scale of quality premium, 5 responses	quality[5]	Never	1	0.2	
		Almost never	2	0.4	
		Sometimes	3	0.6	
		Almost always	4	0.8	
		Always	5	1	
Price setting	PRICEST	Never	1		Indicate to what extent cacao prices are fixed along the production cycle

		Almost never	2		
		Sometimes	3		
		Almost always	4		
		Always	5		
Fitness scale of price setting, 2 responses		Never	1	0.2	
		Almost never	2	0.2	
		Sometimes	3	0.2	
		Almost always	4	0.6	
		Always	5	0.6	
Fitness scale of price setting, 5 responses		Never	1	0.2	
		Almost never	2	0.4	
		Sometimes	3	0.6	
		Almost always	4	0.8	
		Always	5	1	
Cacao income importance	INCMIMP	Very low	1		Indicate to what extent cacao is the main household income
		Low	2		
		Neither high nor low	3		
		High	4		
		Very high	5		
Fitness scale of the importance of cacao income, 2 responses	incmimp[2]	Very low	1	0.2	
		Low	2	0.2	
		Neither high nor low	3	0.2	
		High	4	0.8	

		Very high	5	0.8	
Fitness scale of the importance of cacao income, 5 responses	incmimp[5]	Very low	1	0.2	
		Low	2	0.4	
		Neither high nor low	3	0.6	
		High	4	0.8	
		Very high	5	1	
Diversification	MLTFNCTN	Totally farming	5		Indicate to what extent your experience concentrates on farming activities
		Mainly farming	4		
		Neither farming nor non farming	3		
		Mainly non farming	2		
		Totally non farming	1		
Fitness scale of system diversification, 2 responses	MLTFNCTN[2]	Totally farming	5	1	
		Mainly farming	4	1	
		Neither farming nor non farming	3	0.6	
		Mainly non farming	2	0.6	
		Totally non farming	1	0.6	
Fitness scale of system diversification, 5 responses	MLTFNCTN[5]	Totally farming	5	1	
		Mainly farming	4	0.8	
		Neither farming nor non farming	3	0.6	

		Mainly non farming	2	0.4	
		Totally non farming	1	0.2	
Hectares	HECTARES			Ha	Indicate the size of your cacao orchard (Hectares)
Fresh bean production, Kg	KGFRESH			Kg	Indicate the cacao production of fresh bean, Kilograms
"Lavado" bean production, Kg	KGLAVADO			Kg	Indicate the cacao production of "lavado" bean, Kilograms
"Beneficiado" bean production, Kg	KGBNFCDO			Kg	Indicate the cacao production of "beneficiado" bean, Kilograms
"Fermentado" bean production, Kg	KGFRMTED			Kg	Indicate the cacao production of fermented bean, Kilograms
Total cacao production (bean), Kg	KGCACAO			Kg	
Fresh bean price, MN	MNFRESH			MN	Indicate the cacao price of fresh bean, Mexican currency (MN)
"Lavado" bean price, MN	MNLAVADO			MN	Indicate the cacao price of "lavado" bean, Mexican currency (MN)
"Beneficiado" bean price, MN	MNBNFCDO			MN	Indicate the cacao price of "beneficiado" bean, Mexican currency (MN)
"Fermentado" bean price, MN	MNFRMTED			MN	Indicate the cacao price of fermented bean, Mexican currency (MN)
Fresh bean production value, MN	VLFRESH			MN	Indicate the cacao value of fresh bean, Mexican currency (MN)
"Lavado" bean production value,	VLLAVADO			MN	Indicate the cacao value of "lavado" bean,

MN					Mexican currency (MN)
"Beneficiado" bean production value, MN	VLBNFCDO			MN	Indicate the cacao value of "beneficiado" bean, Mexican currency (MN)
"Fermentado" bean production value, MN	VLFRMTED			MN	Indicate the cacao value of fermented bean, Mexican currency (MN)
Total cacao production value (bean), MN	VLCACAO			MN	
Cacao production yield per Hectare, Kg/Ha	KGPERHA			MN	
Cacao value yield per Hectare, MN/Ha	VLPERHA			MN	
Business success	LFCYCLE	Thinking to exit	1	0.2	Considering a "life cycle perspective" what phase describes more accurately your business position?
		Stagnate	2	0.4	
		Starting	3	0.6	
		Growing	4	0.8	
		Developing	5	1	
Fitness scale for matrix [2]	FITNESS[2]				
Fitness scale for matrix [5]	FITNESS[5]				
Innovation	INNVTN[2]				
Diffusion	DFSSN[2]				
Labour	LABR[2]				
Skills	SKLLS[2]				
Knowledge externality	CMPLMNTRTY[2]				

Vertical integration	INTGRTN[2]				
Diversification	TRADE[2]				
Technology	TCHNLGY[5]				
Competences	CMPTNCS[5]				
Organisational environment	ORGNSTNA L[5]				
Questionnaire ID	RESPONDE NT				
Municipality	MNCPLTY	Cardenas	1		Indicate in which municipality is the cacao plantation
		Centro	2		
		Comalcalco	3		
		Cunduacan	4		
		Huimanguillo	5		
		Jalpa	6		
		Paraiso	7		
Gender	GENDER	Male	1		Indicate the gender of the interviewer
		Female	2		
Age of farmer	AGEFRMR			years	Indicate your age
Telephone availability	TLPHONE	No	0		Indicate if you have a telephone line
		Yes	1		

Appendix D. STATISTICS RECORDS AND SENSITIVITY ANALISYS

VARIABLE	N	Mean	Median	Mode	Frequency	Min	Max	S.D.	S.E.
Acreage of cacao	356	2.12	1.50	1.00	58.00	0.10	15.00	2.15	0.11
Total production	356	904	560	800	28	40	10,000	1,236	66
Value of production	356	15,027	8,960	Multiple	7	600	175,000	20,429	1,083
Yield	356	397	380	400	44	100	933	190	10
Value of production per hectare	356	7,092	6,000	6,000	12	1,325	42,000	4,323	229
Weighted price	356	15.30	15.00	15.00	98.00	7.50	34.00	2.21	0.12
Business success	356	2.12	2.00	2.00	217.00	1.00	5.00	0.85	0.05
Factor fitness value	356	0.47	0.47	Multiple	5.00	0.35	0.61	0.04	0.002
Aspect fitness value	356	0.40	0.40	0.38	19.00	0.26	0.56	0.05	0.002

VARIABLE	N	Mean	Median	Mode	Frequency	Min	Max	S.D.	S.E.
Municipality	356	2.93	3.00	3.00	169.00	1.00	7.00	1.42	0.08
Gender of farmer	355	1.16	1.00	1.00	297.00	1.00	2.00	0.37	0.02
Age of farmer	355	4.13	4.00	4.00	91.00	1.00	6.00	1.33	0.07
Telephone access	356	1.15	1.00	1.00	304.00	1.00	2.00	0.35	0.02
Age of the cocoa orchard	356	3.25	3.00	5.00	103.00	1.00	5.00	1.35	0.07
Type of cocoa variety	356	1.75	1.00	1.00	239.00	1.00	5.00	1.22	0.07
Pre-harvesting cacao activities	356	2.46	2.00	1.00	105.00	1.00	5.00	1.22	0.07
Type of cacao bean	356	1.25	1.00	1.00	296.00	1.00	5.00	0.63	0.03
Source of cacao plant	356	3.08	3.00	3.00	262.00	1.00	5.00	0.71	0.04
Participation on organic cacao	356	1.44	1.00	1.00	284.00	1.00	5.00	0.96	0.05
Participation of family labour	356	1.43	1.00	1.00	284.00	1.00	5.00	0.98	0.05
Paid cacao activities	356	3.90	4.00	5.00	131.00	1.00	5.00	1.05	0.06
School attendance	356	1.85	2.00	2.00	159.00	1.00	5.00	0.87	0.05
Technological & market capabilities	356	3.21	3.00	3.00	144.00	1.00	5.00	1.11	0.06
Studying rate of the family	356	1.58	1.00	1.00	234.00	1.00	5.00	0.93	0.05
Cacao production capabilities	356	1.97	2.00	2.00	325.00	1.00	4.00	0.33	0.02
Cacao business entrance	356	2.10	2.00	2.00	171.00	1.00	5.00	0.88	0.05
Commercialisation channel	356	2.49	3.00	3.00	240.00	1.00	5.00	0.81	0.04
Transaction condition	356	2.10	2.00	2.00	120.00	1.00	5.00	0:99	0.05
Payment conditions	356	3.25	3.00	5.00	98.00	1.00	5.00	1.49	0.08
Quality premium	356	1.12	1.00	1.00	330.00	1.00	5.00	0.47	0.03
Price setting	356	1.92	1.00	1.00	183.00	1.00	5.00	1.29	0.07
Cacao income importance	356	2.99	3.00	1.00	88.00	1.00	5.00	1.52	0.08
Farming v Non farming	356	4.61	5.00	5.00	252.00	1.00	5.00	0.73	0.04

VARIABLE	-95%	+95%	Geometric	Harmonic	Sum	Lower	Upper	Perctil. 10	Perctil. 90
Acreage of cacao	1.90	2.34	1.45	1.01	755.00	0.81	2.50	0.50	4.00
Total production	775	1,033	514	300	321,818	240	1,000	120	2,000
Value of production	12,898	17,157	8,868	5,660	5,349,718	4,375	17,150	2,450	30,150
Yield	377	417	354	313	141,405	253	500	200	667
Value of production per hectare	6,641	7,542	6,104	5,270	2,524,700	4,208	8,915	3,000	12,500
Weighted price	15.07	15.53	15.15	14.98	5,448.00	13.75	16.75	12.50	17.50
Business success	2.03	2.20	1.96	1.80	753.00	2.00	2.00	1.00	4.00
Factor fitness value	1.90	2.34	1.45	1.01	755.00	0.81	2.50	0.50	4.00
Aspect fitness value	775	1,033	514	300	321,818	240	1,000	120	2,000

VARIABLE	-95%	+95%	Geometric	Harmonic	Sum	Lower	Upper	Perctil. 10	Perctil. 90
Municipality	2.78	3.08	2.53	2.11	1,043.00	1.00	4.00	1.00	5.00
Gender of farmer	1.12	1.20	1.12	1.09	413.00	1.00	1.00	1.00	2.00
Age of farmer	3.99	4.27	3.86	3.52	1,466.00	3.00	5.00	2.00	6.00
Telephone access	1.11	1.18	1.11	1.08	408.00	1.00	1.00	1.00	2.00
Age of the cocoa orchard	3.11	3.39	2.92	2.56	1,156.00	2.00	5.00	2.00	5.00
Type of cocoa variety	1.62	1.87	1.45	1.28	622.00	1.00	2.00	1.00	4.00
Pre-harvesting cacao activities	2.34	2.59	2.14	1.83	877.00	1.00	3.00	1.00	4.00
Type of cacao bean	1.19	1.32	1.16	1.11	446.00	1.00	1.00	1.00	2.00
Source of cacao plant	3.01	3.16	2.99	2.88	1,097.00	3.00	3.00	2.00	4.00
Participation on organic cacao	1.34	1.54	1.25	1.15	513.00	1.00	1.00	1.00	3.00
Participation of family labour	1.32	1.53	1.24	1.15	508.00	1.00	1.00	1.00	3.00
Paid cacao activities	3.79	4.01	3.73	3.53	1,388.00	3.00	5.00	2.00	5.00
School attendance	1.76	1.94	1.67	1.52	659.00	1.00	2.00	1.00	3.00
Technological & market capabilities	3.09	3.32	2.99	2.74	1,141.00	2.00	4.00	2.00	5.00
Studying rate of the family	1.48	1.68	1.38	1.26	562.00	1.00	2.00	1.00	3.00
Cacao production capabilities	1.94	2.01	1.94	1.90	702.00	2.00	2.00	2.00	2.00
Cacao business entrance	2.01	2.20	1.92	1.74	749.00	1.50	3.00	1.00	3.00
Commercialisation channel	2.40	2.57	2.30	2.07	886.00	2.00	3.00	1.00	3.00
Transaction condition	1.99	2.20	1.87	1.66	746.00	1.00	3.00	1.00	3.00
Payment conditions	3.10	3.41	2.80	2.28	1,158.00	2.00	5.00	1.00	5.00
Quality premium	1.07	1.17	1.07	1.05	398.00	1.00	1.00	1.00	1.00
Price setting	1.78	2.05	1.61	1.41	682.00	1.00	2.00	1.00	5.00
Cacao income importance	2.83	3.15	2.54	2.08	1,065.00	2.00	4.00	1.00	5.00
Farming v Non farming	4.53	4.68	4.52	4.39	1,640.00	4.00	5.00	4.00	5.00

VARIABLE	Range	Quartile	Variance	Skewness	Std.Err.	Kurtosis	Std.Err.
Acreage of cacao	14.90	1.69	5.00	2.70	0.13	9.19	0.26
Total production	9,960	760	1,528,176	4	0	20	0
Value of production	174,400	12,775	417,323,501	4	0	20	0
Yield	833	247	35,959	1	0	0	0
Value of production per hectare	40,675	4,706	18,686,583	3	0	14	0
Weighted price	26.50	3.00	5.00	1.38	0.13	15.02	0.26
Business success	4.00	0.00	1.00	0.94	0.13	0.68	0.26
Factor fitness value	14.90	1.69	5.00	2.70	0.13	9.19	0.26
Aspect fitness value	9,960	760	1,528,176	4	0	20	0

VARIABLE	Range	Quartile	Variance	Skewness	Std.Err.	Kurtosis	Std.Err.
Municipality	6.00	3.00	2.00	0.38	0.13	0.06	0.26
Gender of farmer	1.00	0.00	0.00	1.83	0.13	1.35	0.26
Age of farmer	5.00	2.00	2.00	-0.33	0.13	-0.65	0.26
Telephone access	1.00	0.00	0.00	2.01	0.13	2.06	0.26
Age of the cocoa orchard	4.00	3.00	2.00	0.01	0.13	-1.23	0.26
Type of cocoa variety	4.00	1.00	1.00	1.40	0.13	0.56	0.26
Pre-harvesting cacao activities	4.00	2.00	1.00	0.30	0.13	-0.99	0.26
Type of cacao bean	4.00	0.00	0.00	2.80	0.13	8.70	0.26
Source of cacao plant	4.00	0.00	1.00	0.50	0.13	2.65	0.26
Participation on organic cacao	4.00	0.00	1.00	2.05	0.13	2.86	0.26
Participation of family labour	4.00	0.00	1.00	2.41	0.13	4.85	0.26
Paid cacao activities	4.00	2.00	1.00	-0.53	0.13	-0.82	0.26
School attendance	4.00	1.00	1.00	1.18	0.13	1.80	0.26
Technological & market capabilities	4.00	2.00	1.00	0.10	0.13	-0.64	0.26
Studying rate of the family	4.00	1.00	1.00	1.51	0.13	1.32	0.26
Cacao production capabilities	3.00	0.00	0.00	0.86	0.13	14.62	0.26
Cacao business entrance	4.00	1.50	1.00	0.68	0.13	0.25	0.26
Commercialisation channel	4.00	1.00	1.00	-0.99	0.13	-0.38	0.26
Transaction condition	4.00	2.00	1.00	0.59	0.13	-0.29	0.26
Payment conditions	4.00	3.00	2.00	-0.35	0.13	-1.26	0.26
Quality premium	4.00	0.00	0.00	4.73	0.13	25.09	0.26
Price setting	4.00	1.00	2.00	1.46	0.13	0.88	0.26
Cacao income importance	4.00	2.00	2.00	-0.01	0.13	-1.47	0.26
Farming v Non farming	4.00	1.00	1.00	-2.27	0.13	5.77	0.26

100%

ODUCTIVITY MANAGEMENT			ORGANISATIONAL PERFORMANCE INDICATORS				
FACTORS	ASPECTS	ELEMENT	BUSINESS SUCCESS	PRICE	PRODUCTION PER HA	VALUE OF PRODUCTION PER HA	PRODUCTION
Technology	Innovation	Age of cacao orchard	0.22***	-0.06	0.18**	0.16**	0.11*
		Type of cocoa variety	0.17**	0.04	0.08	0	0.14**
		Pre-harvesting cacao activities	0.11*	0	0.14*	0	0.21***
		Type of cacao bean	0.03	0.39***	0.1	0.06	0
	Diffusion	Source of cacao plant	-0.04	0.07	0	0.03	-0.1*
		Participation on organic cacao	0.05	0.18**	0.21***	0.09	0.32***
	Labour	Participation of family labour	-0.01	0.05	0	-0.06	-0.06
		Paid cacao activities	-0.17**	-0.11*	-0.1	-0.05	-0.35***
Competence	Skills	School attendance	0.13*	0.03	0.16**	0.06	0.16**
		Technological & market capabilities	-0.14**	-0.07	-0.05	-0.01	-0.08
	Complementarity	Studying rate of the family	0.02	-0.04	-0.02	0.06	-0.08
		Cacao production capabilities	-0.13*	0.05	0.02	-0.01	0.06
		Cacao business entrance	0.06	-0.04	-0.11*	0.11*	-0.18**
Operational Climate	Vertical integration	Commercialisation channel	-0.07	0.15**	0.04	-0.04	0.1
		Transaction condition	0.04	0.09	0.03	0.14**	-0.01
		Payment conditions	-0.06	0.05	0.1*	-0.15**	0.22***
		Quality premium	0.06	-0.05	0.04	-0.04	0.04
		Price setting	0.07	0.49***	0.11*	0.09	0.04
	Diversification	Cacao income importance	0.07	-0.05	0.11*	0.04	0.27***
		Farming v Non farming	0.06	-0.1	-0.09	-0.03	0.01

Business success: 75%

RODUCTIVITY MANAGEMENT ELEMENT			REPETITIONS (valid N)				
FACTORS	ASPECTS	VARIABLE	1 (268)	2 (265)	3 (277)	4 (261)	5 (268)
Technology	Innovation	Age of the cocoa orchard	**0.24*** **	**0.22*** **	**0.23*** **	**0.16** **	**0.22*** **
		Type of cocoa variety	**0.25*** **	**0.16** **	**0.2** **	**0.13* **	**0.18** **
		Pre-harvesting cacao activities	0.1	0.09	**0.13* **	**0.14* **	**0.13* **
		Type of cacao bean	0.02	0.06	0.04	-0.07	-0.06
	Diffusion	Source of cacao plant	-0.07	0	0.01	0	-0.06
		Participation on organic cacao	0.07	0.04	0.03	0.01	0.01
	Labour	Participation of family labour	-0.02	0.02	0	0.03	-0.03
		Paid cacao activities	**-0.21** **	**-0.13* **	**-0.12* **	**-0.14* **	**-0.13* **
Competence	Skills	School attendance	0.1	0.11	**0.13* **	**0.05**	**0.15* **
		Technological & market capabilities	**-0.18** **	**-0.16** **	**-0.13* **	**-0.17** **	-0.11
	Complementarity	Studying rate of the family	0.02	0.05	-0.02	-0.02	0
		Cacao production capabilities	**-0.14* **	**-0.14* **	**-0.12* **	**-0.15* **	**-0.16** **
		Cacao business entrance	0.09	0.08	0.05	0.07	-0.01
Operational Climate	Vertical integration	Commercialisation channel	-0.02	-0.1	-0.08	-0.11	-0.09
		Transaction condition	0.02	0.06	-0.05	-0.01	0
		Payment conditions	-0.06	-0.09	-0.1	-0.07	-0.05
		Quality premium	0.12	0	-0.01	0.11	0.1
		Price setting	0.04	0.09	0.06	0.01	0.01
	Diversification	Cacao income importance	0.07	0.03	0.06	0.09	0.11
		Farming v Non farming	0.1	0.1	0.06	0.18	0.12

Business success: 50%

PRODUCTIVITY MANAGEMENT ELEMENT			REPETITIONS (valid N)				
FACTORS	ASPECTS	VARIABLE	1 (268)	2 (265)	3 (277)	4 (261)	5 (268)
Technology	Innovation	Age of the cocoa orchard	**0.25****	**0.18***	**0.21****	**0.24****	**0.19****
		Type of cocoa variety	**0.17***	**0.16***	**0.24****	0.1	**0.18***
		Pre-harvesting cacao activities	0.09	**0.15***	0.07	**0.15***	0.11
		Type of cacao bean	0.09	-0.06	-0.04	0.09	0.06
	Diffusion	Source of cacao plant	-0.05	-0.05	-0.04	-0.05	-0.12
		Participation on organic cacao	0.12	0	0.05	0.06	0.1
	Labour	Participation of family labour	-0.08	0.07	0.07	-0.08	0.08
		Paid cacao activities	-0.08	**-0.24****	-0.1	**-0.23****	**-0.14***
Competence	Skills	School attendance	**0.18***	0.08	0.05	**0.22****	0.07
		Technological & market capabilities	**-0.15***	-0.14	-0.12	**-0.16***	-0.11
	Complementarity	Studying rate of the family	0.08	-0.07	-0.05	0.08	0.02
		Cacao production capabilities	**-0.21****	-0.06	**-0.22****	-0.05	-0.12
		Cacao business entrance	0.15	-0.02	0.05	0.08	**0.19***
Operational Climate	Vertical integration	Commercialisation channel	0.01	**-0.17***	-0.13	-0.02	-0.03
		Transaction condition	-0.02	0.09	0.07	0.02	0.07
		Payment conditions	-0.01	-0.11	**-0.17***	0.04	-0.05
		Quality premium	0.04	0.08	0.1	0.02	0.07
		Price setting	0.08	0.04	0.08	0.07	0.09
	Diversification	Cacao income importance	0.04	0.1	0.08	0.05	0.06
		Farming v Non farming	0.03	0.09	0.12	0	0.03

Price: 75%

PRODUCTIVITY MANAGEMENT ELEMENT			REPETITIONS (valid N)				
FACTORS	ASPECTS	VARIABLE	1 (268)	2 (265)	3 (277)	4 (261)	5 (268)
Technology	Innovation	Age of the cocoa orchard	-0.09	-0.05	**-0.12***	-0.07	-0.07
		Type of cocoa variety	0.05	0.09	0.1	-0.04	-0.05
		Pre-harvesting cacao activities	0.02	-0.01	0	-0.11	-0.07
		Type of cacao bean	**0.45*****	**0.44*****	**0.41*****	**0.31*****	**0.25*****
	Diffusion	Source of cacao plant	0.1	0.09	0.08	0.11	0.05
		Participation on organic cacao	**0.17****	**0.2****	**0.22*****	0.11	0.09
	Labour	Participation of family labour	0.07	0.04	0.09	0.03	0.1
		Paid cacao activities	-0.12	-0.09	**-0.13***	-0.05	-0.07
Competence	Skills	School attendance	0.1	0.04	0.01	-0.03	-0.06
		Technological & market capabilities	-0.08	-0.1	-0.06	-0.03	0.02
	Complementarity	Studying rate of the family	-0.04	-0.03	-0.03	0.02	0.02
		Cacao production capabilities	0.03	0.06	0.05	0.08	0.08
		Cacao business entrance	0.01	-0.05	-0.01	-0.04	0
Operational Climate	Vertical integration	Commercialisation channel	**0.12***	**0.19****	**0.2****	0.09	0.08
		Transaction condition	0.11	0.06	0.1	**0.13***	**0.16***
		Payment conditions	0.09	0.08	0.06	0.01	0.01
		Quality premium	-0.1	0	0	-0.04	-0.1
		Price setting	**0.53*****	**0.49*****	**0.48*****	**0.48*****	**0.46*****
	Diversification	Cacao income importance	**-0.13***	-0.02	-0.04	-0.11	-0.05
		Farming v Non farming	-0.13	-0.1	-0.1	-0.02	0.02

Price: 50%

PRODUCTIVITY MANAGEMENT ELEMENT			REPETITIONS (valid N)				
FACTORS	ASPECTS	VARIABLE	1 (268)	2 (265)	3 (277)	4 (261)	5 (268)
Technology	Innovation	Age of the cocoa orchard	-0.02	-0.11	-0.15*	0	0.01
		Type of cocoa variety	0.01	0.08	-0.06	0.12	0.05
		Pre-harvesting cacao activities	0.08	-0.1	-0.12	0.07	0
		Type of cacao bean	**0.45*** **	**0.31*** **	**0.29*** **	**0.46*** **	**0.41*** **
	Diffusion	Source of cacao plant	0	**0.15***	**0.18***	-0.01	0.04
		Participation on organic cacao	**0.25** **	0.11	0.08	**0.25** **	**0.22** **
	Labour	Participation of family labour	0.03	0.08	0.03	0.08	0.08
		Paid cacao activities	**-0.15***	-0.05	-0.09	-0.12	**-0.21** **
Competence	Skills	School attendance	0.09	-0.06	0.06	0	0.08
		Technological & market capabilities	-0.13	0	-0.07	-0.07	**-0.16***
	Complementarity	Studying rate of the family	0	-0.09	-0.08	0	-0.08
		Cacao production capabilities	0.09	0.02	0.04	0.06	0.14
		Cacao business entrance	-0.1	0.02	-0.1	0	-0.06
Operational Climate	Vertical integration	Commercialisation channel	**0.23** **	0.06	0.13	**0.17***	**0.15***
		Transaction condition	0.04	**0.16***	0.12	0.08	0.08
		Payment conditions	**0.15***	-0.07	0.01	0.09	0.09
		Quality premium	-0.04	-0.08	**-0.15***	0.03	-0.11
		Price setting	**0.48*** **	**0.51*** **	**0.41*** **	**0.56*** **	**0.48*** **
	Diversification	Cacao income importance	-0.02	-0.08	0.03	-0.11	-0.04
		Farming v Non farming	-0.23	0.03	0.01	-0.2	-0.16

Yield: 75%

PRODUCTIVITY MANAGEMENT ELEMENT			REPETITIONS (valid N)				
FACTORS	ASPECTS	VARIABLE	1 (268)	2 (265)	3 (277)	4 (261)	5 (268)
Technology	Innovation	Age of the cocoa orchard	0.2**	0.16*	0.15**	0.18**	0.21**
		Type of cocoa variety	0.01	0.04	0.06	0.01	0.1
		Pre-harvesting cacao activities	0.11	0.08	0.13*	0.14*	0.14*
		Type of cacao bean	0.17**	0.15*	0.07	0.05	0.04
	Diffusion	Source of cacao plant	-0.02	0.04	0.05	0.05	-0.01
		Participation on organic cacao	0.19**	0.14*	0.22***	0.19**	0.24***
	Labour	Participation of family labour	-0.03	0.07	0.02	-0.01	-0.04
		Paid cacao activities	-0.04	-0.07	-0.09	-0.06	-0.13*
Competence	Skills	School attendance	0.14*	0.14*	0.18**	0.11	0.14*
		Technological & market capabilities	-0.06	-0.04	-0.02	-0.04	0
	Complementarity	Studying rate of the family	0.02	0.02	-0.02	-0.02	0
		Cacao production capabilities	0.03	0.07	0.06	0.01	0.02
		Cacao business entrance	-0.05	-0.06	-0.1	-0.1	-0.07
Operational Climate	Vertical integration	Commercialisation channel	0.11	0	0.04	-0.03	0.02
		Transaction condition	-0.04	0.06	0.03	0.03	0.04
		Payment conditions	0.04	0.06	0.09	0.09	0.1
		Quality premium	0.06	0	0	0.04	0.02
		Price setting	0.12*	0.14*	0.08	0.06	0.04
	Diversification	Cacao income importance	0.15*	0.04	0.14*	0.06	0.15*
		Farming v Non farming	-0.03	-0.08	-0.1	-0.02	-0.1

Yield: 50%

PRODUCTIVITY MANAGEMENT ELEMENT			REPETITIONS (valid N)				
FACTORS	ASPECTS	VARIABLE	1 (268)	2 (265)	3 (277)	4 (261)	5 (268)
Technology	Innovation	Age of the cocoa orchard	0.19*	0.18*	**0.23****	0.15	**0.27*****
		Type of cocoa variety	0.19*	-0.02	0.08	0.07	0.02
		Pre-harvesting cacao activities	0.06	**0.2****	0.11	**0.15***	0.04
		Type of cacao bean	0.12	0.09	0.07	0.13	0.09
	Diffusion	Source of cacao plant	-0.01	0.01	0	0	-0.13
		Participation on organic cacao	**0.21****	**0.21****	**0.24****	**0.19***	**0.25****
	Labour	Participation of family labour	0.02	-0.02	-0.05	0.05	0.04
		Paid cacao activities	-0.14	-0.06	**-0.02**	**-0.16***	-0.12
Competence	Skills	School attendance	0.15*	**0.17***	0.11	**0.21****	**0.18***
		Technological & market capabilities	-0.02	-0.07	-0.03	-0.06	-0.06
	Complementarity	Studying rate of the family	0.03	-0.06	-0.04	0.01	0
		Cacao production capabilities	0.03	0.01	0.02	0.02	0.01
		Cacao business entrance	-0.08	-0.13	-0.02	**-0.18***	-0.05
Operational Climate	Vertical integration	Commercialisation channel	0.14	-0.06	0.07	0	0.1
		Transaction condition	0.06	0.01	0.07	0	0.09
		Payment conditions	0.1	0.11	0.04	**0.17***	0.04
		Quality premium	0.11	-0.04	-0.04	0.14	0.11
		Price setting	0.13	0.1	0.05	**0.18***	0.12
	Diversification	Cacao income importance	0.1	0.13	0.11	0.1	0.09
		Farming v Non farming	-0.07	-0.1	-0.1	-0.08	-0.19

Value of production per hectare: 75%

PRODUCTIVITY MANAGEMENT ELEMENT			REPETITIONS (valid N)				
FACTORS	ASPECTS	VARIABLE	1 (268)	2 (265)	3 (277)	4 (261)	5 (268)
Technology	Innovation	Age of the cocoa orchard	**0.18****	**0.14***	0.1	**0.15***	**0.2****
		Type of cocoa variety	-0.03	-0.01	0	-0.05	0
		Pre-harvesting cacao activities	-0.05	-0.02	0.01	0.01	0.01
		Type of cacao bean	**0.14***	0.09	0.04	0	-0.04
	Diffusion	Source of cacao plant	0.04	0.07	0.05	0.1	0.04
		Participation on organic cacao	0.09	0.05	0.11	0.07	0.09
	Labour	Participation of family labour	-0.08	-0.03	-0.05	-0.06	-0.08
		Paid cacao activities	0.03	-0.04	-0.06	-0.05	-0.07
Competence	Skills	School attendance	0.08	0.05	0.07	0.01	0.02
		Technological & market capabilities	0	-0.01	0.02	0	0.05
	Complementarity	Studying rate of the family	0.12	0.08	0.06	0.04	0.08
		Cacao production capabilities	-0.01	0	0	0.02	0.03
		Cacao business entrance	**0.16****	**0.14***	0.1	0.12	**0.15***
Operational Climate	Vertical integration	Commercialisation channel	-0.04	-0.07	-0.01	-0.1	-0.06
		Transaction condition	0.05	**0.17****	**0.13***	**0.16****	**0.17****
		Payment conditions	**-0.2****	**-0.16****	**-0.17****	-0.11	-0.15*
		Quality premium	-0.05	-0.05	-0.05	-0.03	-0.06
		Price setting	**0.12***	0.11	0.06	0.06	0.03
	Diversification	Cacao income importance	0.1	-0.01	0.02	0.02	0.09
		Farming v Non farming	-0.01	0	-0.04	0.03	-0.01

Value of production per hectare: 50%

PRODUCTIVITY MANAGEMENT ELEMENT			REPETITIONS (valid N)				
FACTORS	ASPECTS	VARIABLE	1 (268)	2 (265)	3 (277)	4 (261)	5 (268)
Technology	Innovation	Age of the cocoa orchard	**0.21****	0.11	**0.15***	**0.17***	**0.24****
		Type of cocoa variety	0.06	-0.06	-0.01	0	-0.02
		Pre-harvesting cacao activities	-0.08	0.07	-0.12	0.08	-0.08
		Type of cacao bean	0.08	0.04	0.03	0.07	0.08
	Diffusion	Source of cacao plant	-0.05	0.1	0.14	-0.06	-0.06
		Participation on organic cacao	0.13	0.06	0.11	0.08	**0.18***
	Labour	Participation of family labour	-0.04	-0.08	-0.11	-0.02	-0.01
		Paid cacao activities	-0.05	-0.06	0.07	-0.13	-0.07
Competence	Skills	School attendance	0.08	0.05	0.08	0.05	**0.18***
		Technological & market capabilities	-0.01	0	-0.13	0.09	-0.13
	Complementarity	Studying rate of the family	0.13	-0.01	0.03	0.09	0.09
		Cacao production capabilities	-0.04	0	0.03	-0.04	0.06
		Cacao business entrance	0.12	0.1	0.11	0.11	0.12
Operational Climate	Vertical integration	Commercialisation channel	0.03	-0.1	-0.03	-0.05	0.07
		Transaction condition	0.08	**0.2****	0.13	**0.17***	**0.15***
		Payment conditions	-0.13	**-0.17***	**-0.23****	-0.08	**-0.19****
		Quality premium	-0.01	-0.08	-0.12	0.03	-0.01
		Price setting	0.07	0.11	0.02	**0.15***	0.13
	Diversification	Cacao income importance	0.08	0.02	0.08	0.01	0.04
		Farming v Non farming	-0.03	-0.03	-0.05	-0.01	-0.14

Total Production: 75%

PRODUCTIVITY MANAGEMENT ELEMENT			REPETITIONS (valid N)				
FACTORS	ASPECTS	VARIABLE	1 (268)	2 (265)	3 (277)	4 (261)	5 (268)
Technology	Innovation	Age of the cocoa orchard	0.09	0.1	0.1	**0.18****	0.11
		Type of cocoa variety	0.02	**0.12***	**0.14***	0.11	0.11
		Pre-harvesting cacao activities	**0.19****	**0.19****	**0.2****	**0.25*****	**0.19****
		Type of cacao bean	0.03	0.07	0.02	-0.02	-0.04
	Diffusion	Source of cacao plant	**-0.13***	-0.06	**-0.13***	-0.07	-0.09
		Participation on organic cacao	**0.35*****	**0.3*****	**0.32*****	**0.36*****	**0.3*****
	Labour	Participation of family labour	-0.07	-0.02	-0.03	-0.09	-0.07
		Paid cacao activities	**-0.28*****	**-0.39*****	**-0.35*****	**-0.33*****	**-0.33*****
Competence	Skills	School attendance	**0.14***	0.08	**0.17****	0.02	**0.22*****
		Technological & market capabilities	**-0.12***	-0.09	-0.08	-0.05	-0.04
	Complementarity	Studying rate of the family	-0.07	**-0.12***	-0.07	**-0.13***	-0.05
		Cacao production capabilities	0.06	0.07	0.07	0.07	0.08
		Cacao business entrance	**-0.14***	**-0.18****	**-0.14***	**-0.15***	**-0.16****
Operational Climate	Vertical integration	Commercialisation channel	0.12	**0.13***	0.1	0.04	0.11
		Transaction condition	-0.08	0.11	0	0.02	0
		Payment conditions	**0.18****	**0.21****	**0.2****	**0.22*****	**0.27*****
		Quality premium	0.01	0.04	0	0.04	0.05
		Price setting	0.04	0.08	0.05	0.02	-0.02
	Diversification	Cacao income importance	**0.28*****	**0.25*****	**0.26*****	**0.25*****	**0.3*****
		Farming v Non farming	0.06	0.03	-0.01	0.1	0

Total Production: 50%

PRODUCTIVITY MANAGEMENT ELEMENT			REPETITIONS (valid N)				
FACTORS	ASPECTS	VARIABLE	1 (268)	2 (265)	3 (277)	4 (261)	5 (268)
Technology	Innovation	Age of the cocoa orchard	0.1	0.12	**0.08**	0.14	0.07
		Type of cocoa variety	0.08	**0.2****	**0.17***	0.12	0.01
		Pre-harvesting cacao activities	**0.2****	**0.22****	0.13	**0.25****	**0.16***
		Type of cacao bean	0.03	-0.02	-0.11	0.06	0.04
	Diffusion	Source of cacao plant	-0.03	**-0.16***	**-0.19****	-0.07	**-0.19****
		Participation on organic cacao	**0.27*****	**0.36*****	**0.36*****	**0.32*****	**0.31*****
	Labour	Participation of family labour	-0.11	-0.01	0.02	-0.1	-0.07
		Paid cacao activities	**-0.37*****	**-0.35*****	**-0.31*****	**-0.38*****	**-0.32*****
Competence	Skills	School attendance	**0.2****	0.12	0.14	**0.18***	**0.31*****
		Technological & market capabilities	-0.1	-0.07	-0.01	-0.11	-0.04
	Complementarity	Studying rate of the family	-0.01	-0.14	-0.12	-0.06	-0.01
		Cacao production capabilities	0.12	0.02	0.07	0.05	0.06
		Cacao business entrance	**-0.23****	**-0.15***	-0.12	**-0.22****	-0.14
Operational Climate	Vertical integration	Commercialisation channel	0.19*	0.02	0.13	0.08	0.13
		Transaction condition	-0.03	0.01	0.09	-0.05	-0.06
		Payment conditions	**0.28*****	**0.17***	**0.16***	**0.27*****	**0.24****
		Quality premium	0.11	-0.05	-0.02	0.07	0
		Price setting	0.02	0.06	-0.04	0.09	0.04
	Diversification	Cacao income importance	**0.3*****	**0.26****	**0.36*****	**0.23****	**0.26*****
		Farming v Non farming	-0.04	0.05	-0.03	0.03	-0.08