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PRODUCTIVITY MANAGEMENT ANALYSIS OF CACAO AGRO-FOOD SYSTEM IN TABASCO, MEXICO: AN APPLICATION OF THE 'FITNESS' APPROACH

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Abstract

Survival of agro-food systems are challenging and require a fresh approach to analyse. Application of 'productivity management' perspective extends the conventional view of 'productivity' as it incorporates both 'efficiency (creation of value)' and 'effectiveness (attraction of value)' criteria into a firm's organisational configurations (set of strategies) to achieve success. We apply a 'fitness' approach to examine productivity performance of 356 cacao farmers in Tabasco, Mexico. Results reveal that both 'factors' and 'aspects' of organisational configurations are significantly positively correlated with the performance indicators. Also, 14 of the 20 productivity management elements are significantly correlated with the performance indicators with three elements ('participation in organic cacao production', 'farmer's schooling', and 'price setting') exerting strongest influence. Results also show that a set of fittest solutions, rather than a unique solution, exist amongst cacao farmers. The key policy implication is that both 'efficiency' and 'effectiveness' are valid strategies to cope with the challenging and competitive agro-food system environment. Policy makers should be aware of a set of solutions (fitness landscape) instead of just focusing on a unique solution.

Keywords: *Fitness approach, productivity management perspective, cacao agro-food system, Mexico*

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?' - Mahatma Gandhi (Monga, 2000, p. 10). This broader perception of productivity reveals its importance and potential. Pursuit of productivity allows one to survive in a competitive environment, which in turn is transforming lives of many worldwide (Robinson, 2004). In fact, a competitive environment is the most appropriate situation to develop our potential (Calva-Tellez, 2004). This is because, under a competitive environment, production will become more efficient, the benefits of productivity will be evenly distributed and the quality of life will be improved, and this applies to agriculture as well (Polan, 1995; FAO, 1997; Calva-Tellez, 2004; Robinson, 2004). This framework of competition has been implemented in many developing countries, thereby, leading to a restructuring of their agricultural sector

(e.g., reducing funds for infrastructure improvement, extension services, research and development, marketing boards, credit disbursement, etc.) (Taylor & Yuñez-Naude, 1996; Trapaga-Delfin, 1996; Pineda-Osnaya, 2004; Sanz-Cañada, 2004). An outcome of such restructuring process is that the food supply system has changed substantially and became highly competitive. Another important outcome is that the agro-food systems (AFS) have to deal with challenges amongst themselves in order to 'fit' into this new competitive environment (Solleiro & Valle, 1996; Cuevas, 2004). Thus, each industry of the AFS (i.e., the farming industry, processing industry and wholesale industry) needs to develop a set of strategies that allows them to fit into and cope within a changing competitive environment (Heinrich, 2003; Cuevas, 2004; Fritscher-Mundt, 2004). In fact, most of the AFS are still working on the development of strategies (Casaburi, 1999), and this has dramatically influenced the structure of AFS (Folkerts & Koehorst, 1997). Furthermore, there is a lack of information on the current structure of AFS in developing countries, because there are reduced public funds to study them (Requier-Desjardin et al., 2003; Echanove, 2005).

Under this changing agricultural scenario, the importance of productivity is more than clear. Increase in agricultural productivity has been one of the core strategies to succeed in competitive environments, because the 'efficiency' strategy allows 'creation of value' from agricultural activities (Polan, 1995; Zepeda, 2001). Examples include resistance to the influence of extreme climatic conditions and pest/disease attacks; production of homogenous agricultural products; enhancement of palatable attributes of crops; and increase in yield per hectare which 'ceteris paribus' should result in higher returns (Turrent-Fernandez et al., 2005). Nevertheless, an increase in productivity also leads to other problems in the short and long term, e.g., overproduction and falling prices, environmental damage (i.e., desertification, pollution), and loss of biodiversity (Marshall, 2001; Wilson, 2001; Bassols, 2004; Donald, 2004). It is also argued that following such an 'efficiency' strategy is not sufficient to meet markets' 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 consumers 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 governments in many developing countries (Requier-Desjardin et al., 2003; Zylbersztajn & Pinheiro-Machado-Filho 2003), but nowadays every industry of an AFS has to deal with the enhancement of 'effectiveness' on their own (Reyes & Muñoz 1997). 'Productivity management' perspective deals with this lack of connection between 'efficiency' and 'effectiveness' strategies (Monga, 2000). In fact, seeking of relationship between both strategies of an organisation and its external environmental conditions has been a core subject of study in the 'productivity management' literature (Prokopenko & North, 1997; Monga, 2000).

'Fitness' is a fresh approach to study development of competitive advantages (McCarthy, 2004). This approach enables identification of the configuration of a system, as well as analyse the influence of such configuration on organisation's performance (Jermias & Gani, 2004). In short, organisations belonging to AFS need to develop a set of strategies that enables them to fit into and cope within a changing competitive environment. This is particularly important in developing countries where the impacts of such competitive environment are very controversial. Therefore, implementation of this approach, which is unseen in the agriculture\agro-food industry sector till-date, has the potential to assist in studying the relationship between the configuration (set of strategies) of the industry system and its performance within its own environment.

Given this backdrop, the present study adopts the 'fitness' approach as a tool to examine productivity performance and hence survival strategies of the cacao agro-food industries in Tabasco, Mexico. This is because cacao is one of the main crops in Mexico that is traded nationally as well as internationally. Tabasco region produces some 70% of the total national production of Mexico. The main demand for cacao production is driven through demand for chocolate, particularly in Europe and the affluent northern countries. However, with rising income in Asia (e.g., China and India), new demand for chocolate will further drive up demand for cacao production. Therefore, an in-depth understanding of the productivity performance of cacao AFS in Mexico using a fresh approach, i.e., the 'fitness approach', can serve as a useful contribution to the existing productivity management literature.

The paper is organised as follows. Section 2 presents the analytical framework including key concepts and development of the 'fitness' approach. Section 3 presents the results. Section 4 provides conclusion and policy implications.

2. Analytical Framework

2.1 Study Area and the Data

The 'cacao agro-food system' in Tabasco (Mexico) was selected as the research field. A total of 400 cacao growers were selected. First, the sample size for the cacao farming industry in Tabasco, Mexico, was determined following simple random sampling procedure with a confidence level of 95% and a confidence interval of five as done by FAO (SAGARPA, 2001). Next, the selected total sample was divided into five strata based on the cacao farm size (in ha) as done by Ramirez-Diaz (1997) and Cordova-Avalos (2001). The sample frame, i.e., the total number of farmers in Tabasco region is 32,902 which give rise to a sample of 400 following the aforementioned procedure. The five strata based on cacao farm size are as follows: (i) 0-1 ha (45% sample), (ii) 1.1-3.0 ha (30% sample), (iii) 3.1-6.0 ha (15% sample), (iv) 6.1-9.0 ha (8% sample) and (v) >9.1 ha (4% sample). After screening for missing variables and information, the final sample size stood at 356 cacao farmers.

2.2 The 'Productivity Management' Perspective

Efficiency, effectiveness and productivity are useful indicators to analyse performance of an organisation. 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 resource use. 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 maximum 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) *Economic efficiency*: refers to the combination of technical and allocative efficiencies. The main outcome of being efficient is to 'create value' (Rickard, 2006).

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 & North, 1997; Monga, 2000; Rickard, 2006; Stiglitz & Walsh, 2006). An organisation is 'effective' 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. The main outcome of being effective is to 'attract value from the market'. Low productivity in AFS 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 customers' needs are meaningless (Monga, 2000).

Productivity is nowadays linked to other outcomes (APO, 2002). 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 the other, thereby ensuring survival. Productivity is basically related to competitiveness, requiring organisations to compete for their market share (survival).

However, the measurement of performance by using these indicators is somewhat slippery, especially if one wants to develop a competitive strategy. Information then turns quite scarce or inaccurate, everyone wants to protect one's advantage (e.g. technical, managerial, collusion) (Porter, 1990; Rickard, 2006; Stiglitz & Walsh, 2006). Furthermore, although it may be clear where to make an improvement (i.e., input-output-orientation); it is still unclear how to achieve improvements (i.e., management). Therefore, a managerial approach is required which concentrates more on what drives performance and how to achieve an improvement rather than measuring performance (Prokopenko & North, 1997).

'Productivity management' achieves these important steps by employing three theoretical approaches: constrained optimisation, incentives and contracts, and heterogeneous resources (Prokopenko & North, 1997; Rickard, 2006). 'Technology', 'competences' and 'operational climate' are three key 'productivity management' factors that help to meet 'fitness' condition of the organisation and are related to the incremental performance of an organisation.. The analysis of 'productivity management' factors shows that: (1) 'efficiency' is the starting point and technology and diffusion help to increase it. However, efficiency is not sufficient to align 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; and (3) the way an organisation manages its resources helps us to understand how the organisational strategies address 'efficiency' and 'effectiveness'.

Next, we introduce an approach that utilises these 'productivity management' factors to identify 'organisational configurations' which can assist in understanding the adaptation process or survival of an organisation/AFS in a competitive environment.

2.3. 'Fitness' Approach

It is difficult to trace successful 'organisational configurations' because each organisation is unique and they are under the influence of: (i) a changing environment; (ii) other organisations, and (iii) their respective configurations (e.g. entrepreneurship, leadership and innovativeness) (Baum & Singh, 1994; Nelson, 1996; McCarthy, 2004). We introduce a fresh conceptual framework, the 'fitness' approach, which can help to study condition of an AFS.

2.3.1 'Fitness' Concept

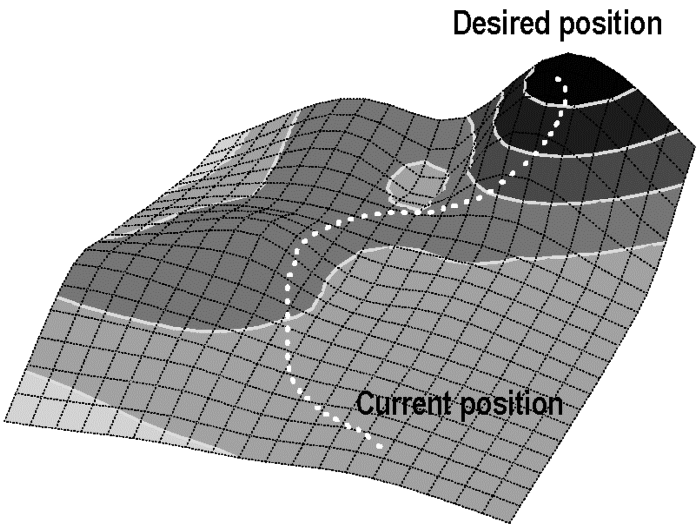
The term 'fitness' was first used by Herbert Spencer in 1864 in the context of survival of the fittest and natural selection as proposed by Darwin in his *Origin of Species* four years beforehand. After a long process of conceptualisation and refinement of the term Fisher (1930) related it to an organism's reproduction rate. Since then, 'fitness' was categorised into two 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 term 'fitness' into the management realm by contextualizing the following statements: (i) 'the effectiveness of a firm is its ability to explore its environment in the acquisition of scarce and valued resources' (Seashore & Yuthman, 1967:898); (ii) 'the primary goal of a firm is the continuation of existence without being liquidated, dissolved or discontinued' (Katz and Kahn, 1978:78); and (iii) a balance between environmental expectations placed on the firm with the resources and capabilities in the firm (Hamel & Prahlad, 1994; Miller, 1992). All this implies that such managerial view of 'fitness' is close to the biological view and its inherent property of interaction amongst variables. In brief, the 'fitness' approach helps to deal with complex and dynamic systems. In the pursuit of organisational strategies, one can be inefficient (several times) but can never be ineffective, and the 'fitness' approach can shed light to understand this dynamism.

2.3.3 'Fitness Appraisal Instruments': Scale, Value and 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?* Selections, interactions, and cluster analysis are some of the methods, but were criticised for their inability to correlate 'fitness' value/level with different organisational combinations (Selto et al., 1995; Jermias & Gani, 2004; Sinha &Van den Ven, 2005). The NK model proposed by Kauffman and Weinberger (1989) is a suitable alternative method to analyse such strategy configurations.

Under the NK model, the aforesaid questions are restated within a landscape perspective, shown as dashed line in Figure 1. There is an irregular path which influences '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.



Source: Adapted from McCarthy, 2004.

Figure 1. The 'fitness' landscape

There are a number of steps in the construction of the ‘fitness’ value. The construction of the ‘Fitness Appraisal Instrument’ (FAI) considers two main steps: (i) the variable relationship and (ii) the ‘fitness’: scale, landscape and value.

Implementation strategy involves construction of the ‘fitness’ scale, ‘fitness’ landscape and ‘fitness’ value of the organisational configurations of ‘factors’ (CF) and ‘aspects’ (CA). The CF evaluates the relationship between three factors of ‘productivity management’ (i.e., technology, competence and operational climate) and any performance indicator. The CA evaluates the relationship between seven aspects of ‘productivity management’ (i.e., innovation, diffusion, labour, skills, complementarity, vertical integration and diversification) and any performance indicator. In this study a total of five performance indicators were considered: ‘business success’, ‘price’, ‘production per ha’, ‘value of production per ha’, and ‘total production’. Also, 20 productivity management elements (e.g., age of cocoa orchard, family labour use, education, cocoa production capabilities, payment terms, price setting, diversification to other farming, etc.) were used to represent the CF and CA, respectively. The second column of Tables 2 and 3 shows the full list of 20 productivity management elements.

The ‘fitness’ landscape of an ‘organisational configuration’ 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. We considered analysing two main ‘organisational configurations’ which are based on different NK parameters: (i) the ‘organisational configuration of factors (CF)’ (i.e., $A^N=5^3$), and (ii) the ‘organisational configuration of aspects (CA)’ (i.e., $A^N=2^7$).

In order to construct fitness scale, each element is categorised into 5 responses for CF and only 2 responses for CA mainly to keep the range of fitness combinations under control. Table 1 shows how the fitness scale is constructed for CF and CA for a single productivity management element. Two examples are demonstrated: one for scale variable and the other for ordinal variable.

Table 1. Number of Responses and Fitness Scale

Productivity Management Element	Categories	Organisational Configuration of Factors (CF)		Organisational Configuration Of Aspects (CA)	
		Responses	Fitness Scale (CF)	Responses	Fitness Scale (CA)
Scale variable					
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		
Ordinal variable					
Participation in organic cacao production	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

The 'fitness' value is calculated using Eq 1

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

In Kauffman's model (Kauffman & Weinberger, 1989), the fitness function $f_i(x)$ is the average of the fitness contributions, $f_i(x)$, from each element i. Tables 2 and 3 show calculation of a fitness value of CF and CA for a single farmer (case no 46).

Table 2. Fitness Value for Organisational Configuration of Factors (CF): One Farmer

Organisational Configuration of Factors (CF)	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 organic cacao prodn.	0.2		
	Participation of family labour	0.2		
	Hired labour use in cacao prodn.	0.2		
Competence	Farmer's schooling	0.6	0.36	
	Technological & market capabilities	0.2		
	Literacy 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		
	Importance of cacao income	0.4		
	Farm v Non-farm diversification	0.4		

3. Results

The main objective of this study is to apply the 'fitness appraisal instrument' for the first time in agriculture, particularly to analyse survival strategy of an agro-food system. Two main procedures were used. First, correlation analysis of the relevant variables was conducted including a sensitivity analysis to check robustness of the relationships. Second, the 'fitness landscape' analysis was conducted to explore the strategies.

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) exploration of the landscapes of significant 'productivity management' elements.

Table 3. Fitness Value for Organisational Configuration of Aspects (CA): One Farmer

Organisational Configuration Of Aspects (CA)	Productivity Management Elements	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 prodn.	0.2		
Labour	Participation of family labour	0.2	0.20	
	Hired labour use in cacao prodn.	0.2		
Skills	Farmer's schooling	0.6	0.40	
	Technological & market capabilities	0.2		
Complementarity	Literacy 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	Importance of cacao income	0.2	0.40	
	Farm v Non-farm diversification	0.6		

Table 4. Pearson Correlation Analysis of the Organizational Configurations and Performance Indicators

	Performance Indicators				
Fitness Value	Business Success	Price	Production Per Ha	Value of Production Per Ha	Total Production
Organisational configuration of factors (CF)	0.14*	0.21***	0.24***	0.12*	0.23***
Organisational configuration of aspects (CA)	0.04	0.11*	0.21***	0.11*	0.13*

Significance level: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

3.1 Correlation Analysis

A Pearson correlation analysis was used to test the association between the 'organisational configuration of aspects (CA)' and the 'organisational configuration of factors (CF)' and 5 'performance indicators' (business success, price, yield, value of production per hectare, and total production (Table 4). It was found that the 'fitness' value of the 'organisational configuration of factors (CF)' was significantly positively correlated to all

Table 5. Correlation Analysis of the Productivity Management Element and Performance Indicators

Productivity Management			Organisational Performance Indicators				
Factors (CF)	Aspects (CA)	Elements (PME)	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 of cacao activities	0.11*	0.00	0.14*	0	0.21***
		Type of cacao bean	0.03	0.39***	0.10	0.06	0
	Diffusion	Source of cacao plant	-0.04	0.07	0.00	0.03	-0.1*
		Participation in organic cacao production	0.05	0.18**	0.21***	0.09	0.32***
	Labour	Participation of family labour	-0.01	0.05	0.00	-0.06	-0.06
		Hired labour use in cacao prodn.	-0.17**	-0.11*	-0.10	-0.05	-0.35***
Competence	Skills	Farmer's schooling	0.13*	0.03	0.16**	0.06	0.16**
		Technological & market capabilities	-0.14**	-0.07	-0.05	-0.01	-0.08
	Complementarity	Literacy 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	0.10*	-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	Importance of cacao income	0.07	-0.05	0.11*	0.04	0.27***
		Farm v Non-farm diversification	0.06	-0.10	-0.09	-0.03	0.01

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

the ‘performance indicators’. The ‘fitness’ value of the ‘organizational configuration of aspects (CA)’ was also significantly positively correlated to four ‘performance indicators’.

Table 5 shows the Pearson correlation analysis between the 20 ‘productivity management’ elements (PMEs) and the five ‘performance indicators’. Different results were obtained in this correlation analysis: (i) all ‘performance indicators’ have an association with at least four of the twenty PMEs. Specifically, ‘total production’ is associated with 10 PMEs (‘age of cacao orchard, ‘type of cacao variety’, ‘pre-harvesting of cacao activities’, ‘source of cacao plant’, ‘participation in organic cacao’, ‘paid cacao activities’, ‘farmer’s schooling’, ‘cacao business entrance’, ‘payment conditions’, and ‘cacao income importance’); the ‘value of production per hectare’ is associated with four PMEs (‘age of cacao orchard’, ‘cacao business entrance’, ‘transaction condition’, and ‘payment conditions’); ‘yield’ is associated with eight PMEs (‘age of cacao orchard’, pre-harvesting of cacao activities’, ‘participation in organic cacao’, ‘farmer’s schooling’, ‘cacao business entrance’, ‘payment conditions’, ‘price setting’, and ‘cacao income importance’); ‘price’ is associated with five PMEs (‘type of cacao bean’, ‘participation in organic cacao’, ‘paid cacao activities’, ‘commercialisation channel’, and ‘price setting); and finally the ‘business success’ is associated with seven *PMEs (‘age of cacao orchard, ‘type of cacao variety’, ‘pre-harvesting of cacao activities’,* ‘paid cacao activities’, ‘farmer’s schooling’, ‘technological and market capabilities’, and ‘cacao production capabilities; (ii) there are four PMEs (i.e., ‘participation of family labour’, ‘literacy rate of the family’, ‘quality premium’, and ‘farming v non-farming’) that were not significantly associated with any ‘performance indicators’; (iii) five PMEs (i.e., ‘type of cacao bean’ ‘source of cacao plant’, ‘technological and market capabilities’, ‘cacao production capabilities’, and ‘transaction conditions’) were associated with at least one ‘performance indicator’; (iv) four PMEs (i.e., ‘type of cacao variety’, ‘commercialisation channel’, ‘cacao income importance’, and ‘price setting’) were associated with two different ‘performance indicators’; and (v) seven PMEs (i.e., ‘age of cacao orchard’ ‘pre-harvesting cacao activities’, ‘paid cacao activities’, ‘farmer’s schooling’, ‘participation in an organic cacao program’, ‘payment conditions’, and ‘entry into the cacao business’) were associated with at least four different ‘performance indicators’. All factors and aspects had at least one match between them and the ‘performance indicators’.

3.2 Sensitivity Analysis

A sensitivity analysis was carried out to verify the reliability/robustness of these 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. Based on the ‘sensitivity analysis’, it was found that most of these significant associations are stable at different levels of random samplings, thereby providing confidence in the results (and hence not shown here).

3.3 Exploration of the Fitness Landscape

The exploration is achieved by plotting the fitness landscapes of the ‘organisational configuration of factors (CF)’. Two graphical tools are used to plot these landscapes: profile and polar graphs. The basic idea of ‘profile’ graph 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 & Lewicki, 2006). Therefore, the objects are given visual identities that are unique for configuration of values and can be identified by the observer. Examining such 'profiles' help to discover specific sets of both simple relations and interaction 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).

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 CF was grouped into 5 classes in descending order: class I (fitness value of 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).

The first attempt to look at the fittest 'organisational configuration' is by analysing the fitness landscape. Figure 2 shows an example of 25 cases representing five cases from each of the five classes. 'Technology' 'competence' and 'operational climate' are plotted from left to right. The heights of each point represent their partial 'fitness' value. The points are joined 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 feature.

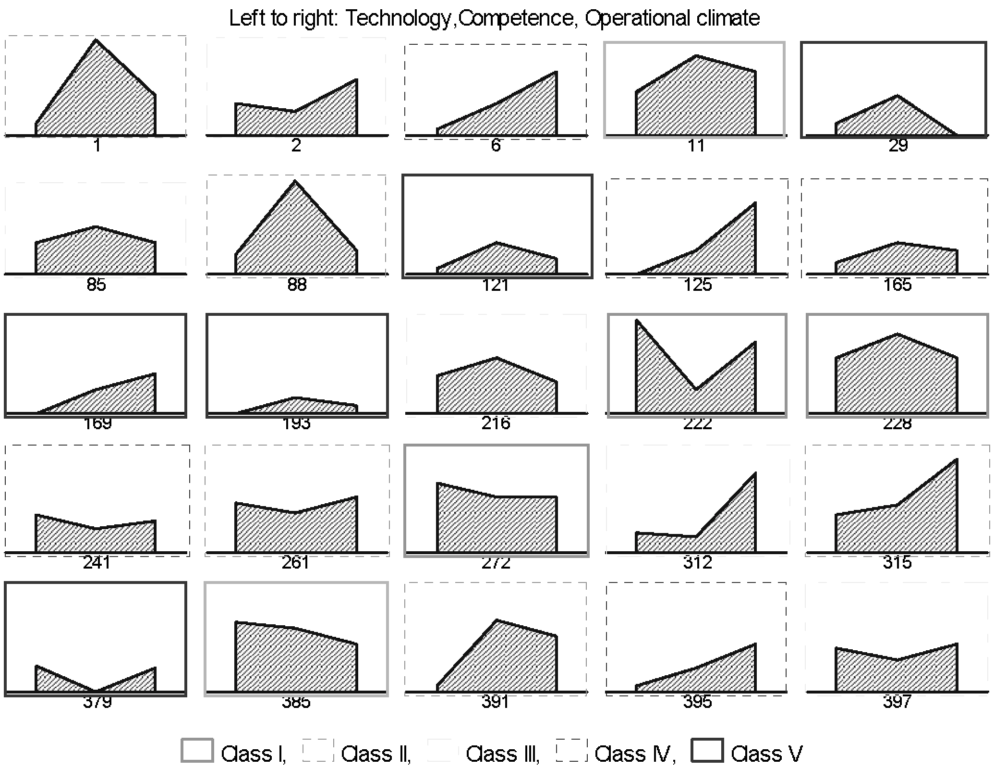


Figure 2. Fitness Values of Organisational Configuration of the Factors (Technology, Competence, and Operational Climate)

One option is to examine the shape of the profile (Figure 2). 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: (i) ‘gable’, a very triangular roof, which shows that ‘competence’ is the most important factor contributing to the ‘fitness value’ (e.g. case nos. 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 together. 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 in the data. This leads to the conclusion that a farmer only needs to build up his/her current configuration (or strategies) in order to achieve a higher level of fitness. This means that in the same ‘roof shape’, for instance case 379 could build up its internal ‘organisational configuration’ to reach case 222. On the other hand, this result would indicate that such a mosaic of profiles respond 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, discussed below.

3.4 Fitness Value and the Productivity Management Elements

Identification of the ‘fittest’ organisational configuration (hereafter only referred to as the ‘fittest’) leads to a detail exploration of the ‘fitness’ value, the PMEs and the respective cases. From the total sample of 356 farmers, the maximum ‘fitness value’ belongs to case 285, and the minimum ‘fitness value’ to case 193. Table 6 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 all performance indicators, nor the ‘fittest’ has any maximum value of all performance indicators.

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 and none of the 356 farmers could achieve it, which suggests a need to seek for improvement by all at varying levels.

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 PME is used for this purpose (Figure 3). Three cases are plotted, the ‘fittest’ (case 285), the ‘least fit’ (case 193) and the case with ‘maximum price’ (case 222).

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 five 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., ‘type of cacao variety’ (CCVRTY), ‘s rate of the family’ (STYRT), and ‘quality premium’ (QUALITY). The implication is that the 'least fit' could improve its performance by improving the lower values of some PMEs to the position of the levels observed with the 'fittest'. In this particular case, 12 PMEs need to be improved in order for the 'least fit' to become competitive. Another option for the 'least fit' (case 193) is to move its lower PME values to the levels observed with the case 'maximum price' (case 222). In this case, nine PMEs need to be improved. Finally, the 'maximum price' case could also improve its fitness value by changing low values of some PMEs to the level observed with the 'fittest'.

Table 6. Comparing the Values of Performance Indicators Between the Fittest, the Least Fit, and Selected Cases (i.e., cases with maximum values for any indicator)

Variable	Selected Cases	Performance Values				
		193 (Least fit)	285 (Fittest)	222 (Max price)	366 (Max yield)	360 (Max total production)
Fitness value	Organisational Configuration of factors (CF)	0.35**	0.61*	0.56	0.58	0.53
Performance indicators	Business success	2	4	5*	4	4
	Price ($ kg^{-1})	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

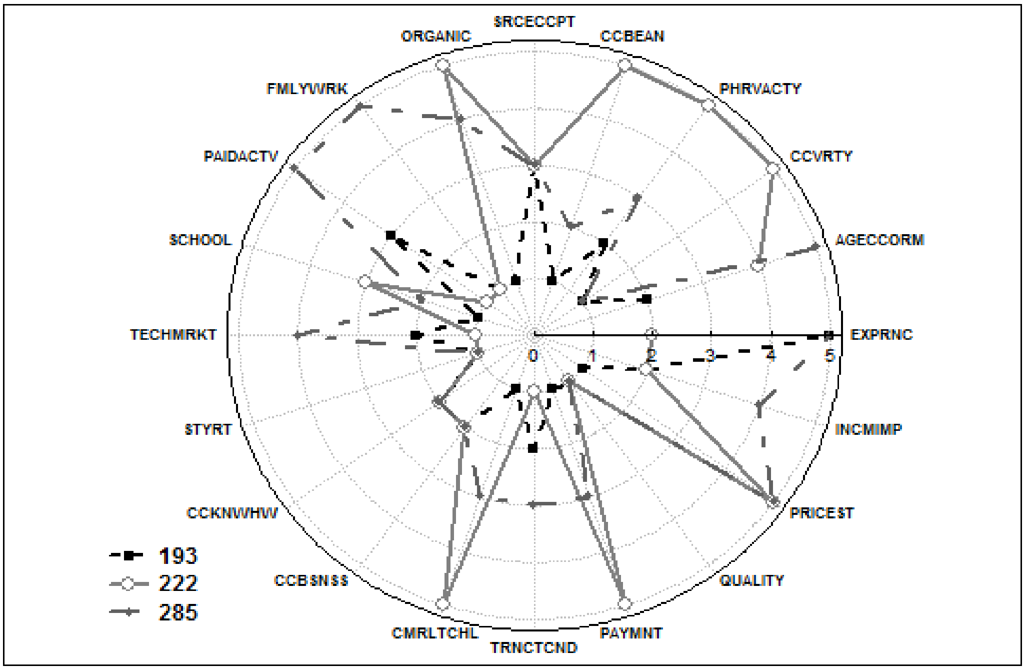


Figure 3. Maximum and Minimum Fitness Values and Their Productivity Management Element

The conclusion is that 'fittest' is the benchmark which would guide other cases/farmers to improve their performance because it is assumed that the 'fittest' is coping best under the current environmental and competitive conditions, so the possibilities for success (and adapt) by copying the 'fittest' is higher.

4. Conclusions and Policy Implications

This study applied the 'fitness approach', for the first time, to analyse productivity performance, specifically the relationship between the 'organisational configurations' (i.e., a set of strategies) and the 'performance indicators' of a randomly selected 356 cacao farmers from Tabasco, Mexico using the productivity management perspective that incorporates both 'efficiency' and 'effectiveness' criteria. The results revealed that there is a significant positive relationship between 'organisational configurations' and 'performance indicators'. In fact, 14 of the 20 'productivity management elements' are significantly related to the performance indicators. This led to the identification of the 'fittest' organisational configuration, and in turn its core 'productivity management elements'. From these empirical results which incorporated sensitivity analysis of robustness, it was suggested that the 'fitness' approach is reliable and could overcome one of the main limitations of traditional methods of performance analysis, e.g., using the narrowly defined productivity approach. 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 'fitness' approach provides an opportunity to identify the full potential of all the individuals and organisations involved in an AFS.

The key policy implication from this study is that both 'efficiency' and 'effectiveness' are two valid strategies that enable an AFS to cope within a challenging and competitive environment. Hence, policy makers should be aware of a set of solutions (based on a 'fitness' landscape) instead of just focusing on a unique or individual solution (based on productivity measure) which is often narrow in scope.

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