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# STRUCTURAL ANALYSIS OF AGRICULTURE: A METHODOLOGICAL PERSPECTIVE

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## **ABSTRACT**

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The structure of agriculture and of its food and fibre systems have changed considerably over the past century, reflecting internal and external factors such as institutional, societal (demographic and consumer), technological, economic, human capital, and financial causes. Within a static setting, the analysis of the structure of agriculture can be undertaken with the traditional structure-conduct-performance (S-C-P) model of industrial organisation economics which stems from neoclassical economic theory. However, in a period of relatively rapid change in information and communication technologies, in business and consumer expectations and in institutional factors, alternative tools and approaches are required.

Changes that are expected to occur cannot be predicted within the boundaries of the neo-classical approach and historical data reported by traditional sources. For long term planning and policy, it is necessary to develop an understanding of expected changes and develop scenarios for the likely structure of agriculture and of its food and fibre system. The purpose focused “cause approach” suggested in this paper may be more appropriate for planning and policy analysis. In this paper, the economics and business strategy literature are brought together to understand and predict better the likely structures of agriculture.

# AGRICULTURAL STRUCTURAL ANALYSIS: A METHODOLOGICAL PERSPECTIVE

## INTRODUCTION

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Recently, the Queensland Department of Primary Industries initiated a project to find out the likely structure of the Queensland rural sector in 2010. The project seeks to provide a comprehensive industry wide analysis of the likely structure and performance of the Queensland rural sector in 2010. This should assist the government and policy makers to prioritise their research, development and extension budget. The project recognises that the Queensland food and fibre industry is undergoing major change arising from technological change, globalisation, changing consumer expectations, and change associated with post-industrial farming that will have significant implications for rural society and farm businesses.

This research is intended to assist policymakers within Queensland agriculture, lenders and service providers for agribusiness, residents of rural communities and rural organisations to better understand the nature of the structural changes and implications. A major issue that will be faced is the expected rapid structural change, and the implications these changes will have for both the size and characteristics of the primary producer base and the altering service needs of rural society. Structural change in agriculture will also lead to significant shifts in farm policy and rural development.

The changing structure of the agriculture sector is an important and frequently studied, but imperfectly understood aspect in the agricultural economics literature. This paper aims to provide some additional insights into the “**causes of agricultural structural change**” that have direct and indirect impact on the likely structures of agriculture and its food and fibre system.

This paper starts with the commonly used definition of structural change in the economics literature. The conceptual framework to study the structure of agriculture is then discussed. The paper then reviews literature that can assist in understanding the causes of structural change at an industry and farm level. Finally, approaches to predict the likely structure of agriculture are detailed from traditional and contemporary business literature.

## STRUCTURAL CHANGE

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“Structural change” is defined in the *New Palgrave Dictionary of Economics* as “a change in the relative weight of significant components of the aggregative indicators of the economy, such as GDP, exports and imports, and population and labour force”. The focus here is on the **process** by which growth brings about this structural change in the economy. For structural change to take place, the changed composition of the aggregate indicators must represent an irreversible, rather than a transitory change (Goddard *et al* 1993). The **process** of structural change is brought about by resources being transferred between sectors in the economy in response to the changing pattern of consumer demand, technological development and differential rates of productivity growth.

“Structural change” at industry or sector level is typically dimensioned in terms of number and of size farms, size distribution of farms, financial characteristics, resource ownership, enterprise mix, production and market integration, barriers to entry and exit, technology and similar characteristics of industry. The focus here is on the **causes** or **driving forces** that change the direction and pace of the structural parameters in the industry or sector.

## FRAME WORK TO STUDY THE STRUCTURE OF AGRICULTURE

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Structural change in agriculture and its food and fibre system can be seen in the evolution from an agrarian economy to an industrial and post-industrial economy, and more recently to information economy and modern life sciences (biotechnology). Change affecting agriculture generally begins outside the industry with the imposition of new or changed external and internal conditions. This evolution has been marked by radical shifts in

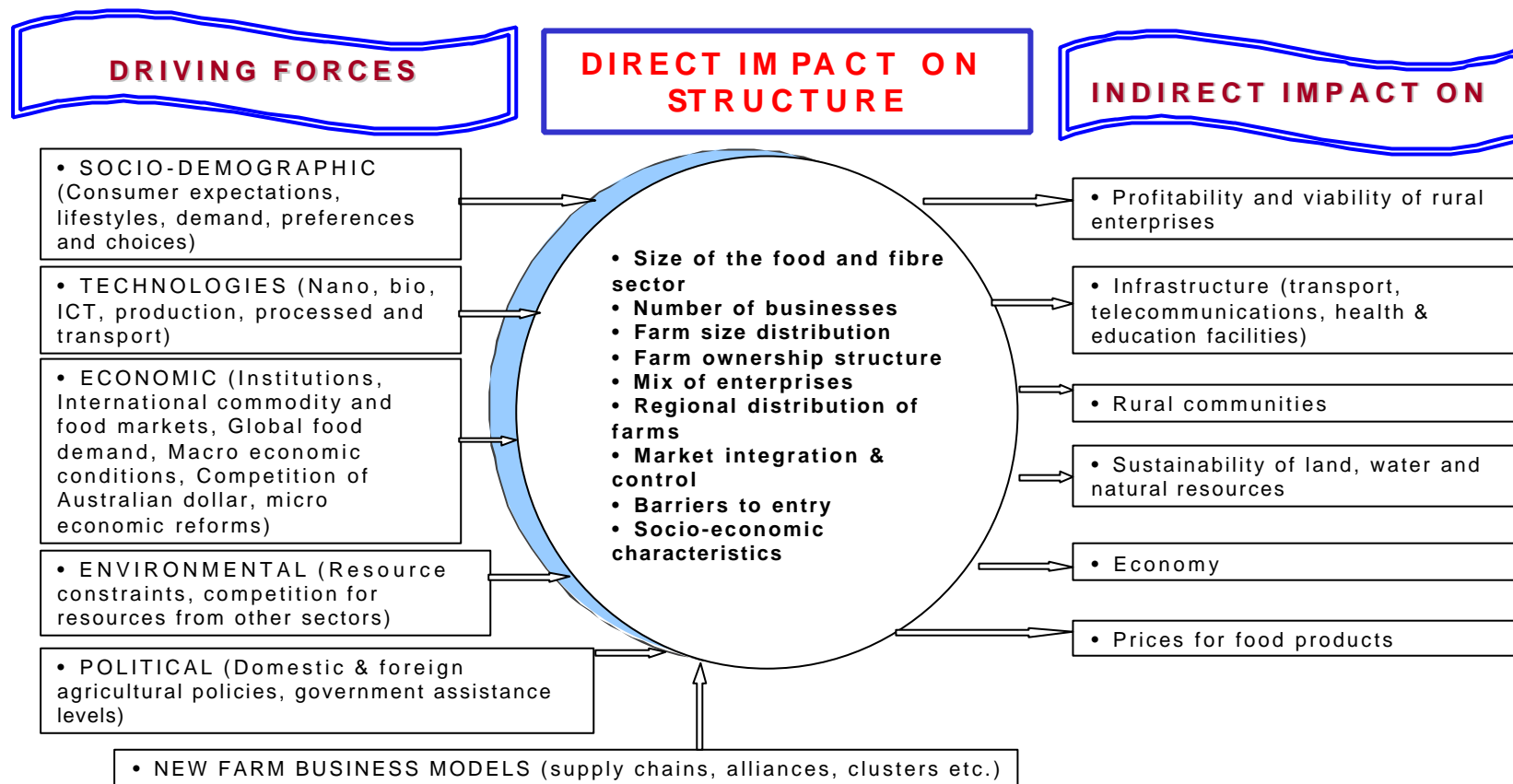
Post industrialisation of agriculture is people pursuing business strategies that allow them to sell into a market with imperfect competition  
Saxowsky and Duncan (1998)

- ✓ **Farm business environment:** Traditional /modern to post-modern. Local to global. Physical to virtual. Production and marketing risk to relationship risks. Narrow focus to broad focus. Production driven to consumer driven (chain reversal). Farm as an isolated entity and business to integrated firm in the food and fibre supply and demand chain (vertical, horizontal, clusters etc).
- ✓ **Meaning of farm and farm assets:** Production to multi-functionality of farm (such as custodians of farm's natural resources for present and future generations). Production of tangible (quantity) to intangibles (qualitative) attributes in food products.
- ✓ **The rate of change:** Periodic to continuous and discontinuous change in the farm business environment. The pace of technology development is rapid. As a result the level of competition will continue to increase.
- ✓ **Farm products and services:** Commodity, mass, bulk production to products and product services of ethical and environmental safety. Food products and services for diversified food market and consumer segments. Farmers are moving away from perfect market conditions to maximize their rewards and economic rents by diversifying, differentiating, and value adding. Basic food products for traditional markets to diversified food products and services to global markets as periods of change also are periods of opportunity.

The changed farm business environment will directly impact on the structure of agriculture in terms of the size of the sector, the regional and size distribution of farms and their ownership structure and mix of enterprises and their linkages with supply and demand chains. Change will also extend beyond the farm gate, encompassing the profitability and viability of rural businesses, infrastructure, size and nature of rural population, sustainability of land, water and natural resources.

Causes of structural change in agriculture are complex, but various models have been developed in economics and business strategy literature to explain the key causes affecting the structure of agriculture and its food and fibre system. These can be categorized as (i) "On Farm" (at farm level or internal) and (ii) "Off Farm" (at sector /industry level or external). While each of these (farm level and industry level) factors may be examined individually to explain structural change in agriculture, they are also interrelated and together provide a more complete explanation of the factors that influence structural change in agriculture.

'On farm' explanations of structural change in agriculture have been reported in Boehlje and Sonka (1998), Godden D (1997), Robert *et al* (1996), Goddard *et al* (1993), Boehlje M (1999, 1992a), and in a collection of articles produced in 1995 by the Canadian Journal of Agricultural Economics



**Figure 1: Frame work to study the structure of Agriculture**

Note: STEEP (societal, technological, economic, environmental, and political) are the causes of any change in the economy, however the interface between the cause and its consequence on the structural parameters reported in the middle is an essential aspect in understanding and empirically analysing the structural changes in agriculture.

“Although numerous forces and drivers are contributing to the structural changes that are occurring in agriculture, information and knowledge play a significant role”.  
Boehlje (1999)

An analysis of the factors giving rise to structural change at *farm level* can be categorized into four key areas – **technology**, **human capital**, **sociological** (family firm), and **financial** factors. These factors are well established and reported in agricultural economics literature since its inception. Again these factors are not mutually exclusive; for example, technology is the core cause of structural change as it impacts at the farm level as well as at the sector or industry level. Details of these impacts are discussed later in the paper. In addition, some of the models were explained from a different perspective using **New Institutional Economics**, as institutions play a major role in the way transactions are carried out in a changing farm business environment.

Traditionally, the focus of agricultural economics literature has been on *on-farm* explanations to study the structure of agriculture, while institutional, socio-demographic, new farm business models and domestic and foreign policies dominates the causes of structural change. It is imperative now to integrate causes of agricultural structural change for a better understanding of the direct and indirect impact on the rural sector. Moreover, understanding of the interface between the cause and the consequence on the structure of the sector in relation to size, ownership, location etc is essential for forecasting the likely structures of agriculture and its food and fibre system for policy purposes. Describing the structural parameters without mentioning the causes is relatively sterile in understanding the changes in agriculture sector.

## Some Economic Theory

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This section is intended briefly to summarise the essential characteristics of new institutional economics approach, and to describe how it differs from neo-classical theory in understanding the causes and consequences of structural change in agriculture.

According to traditional industry analysis, market supply and demand, prices, outputs, costs and profits in a specific industry reflect decisions taken by firms in that industry and these decisions reflect the autonomy of firms to make decisions in a competitive marketplace. Such a surrounding determines the structure and is referred to as the “industry structure” and this hypothesis referred to as the “**structure-conduct-performance paradigm**” (S-C-P) (Michael O’ Keefe et al 1998). In its simplest form, this paradigm identifies “structure” as those elements over which the firm has little control, and suggests that structural factors are the most important determinants of industry performance and vice versa. The forces influencing upon industry structure in S-C-P paradigm are presented diagrammatically in Figure 2. The S-C-P paradigm is based on the premises of neo-classical economics such as scarcity of resources, rational human behavior, complete information in transactions and zero transaction costs or frictionless economic system.

Limitations exist in using neo-classical theory to provide an assessment of the likely structure of agriculture, because it is overly abstract and incapable of dealing effectively with many current problems of interest to theorists and policymakers. Concepts of industrial organization are partially helpful as they assist in understanding the relationships between structure and performance, but do not provide an explanation of the dynamics of firm behavior, institutional factors and the interactions amongst firms at different stages within the production and distribution system. As mentioned by Boehlje and Sonka (1998), concepts from other fields of institutional economics may provide some useful tools to assist in the study of changing agribusiness structures and coordination systems.

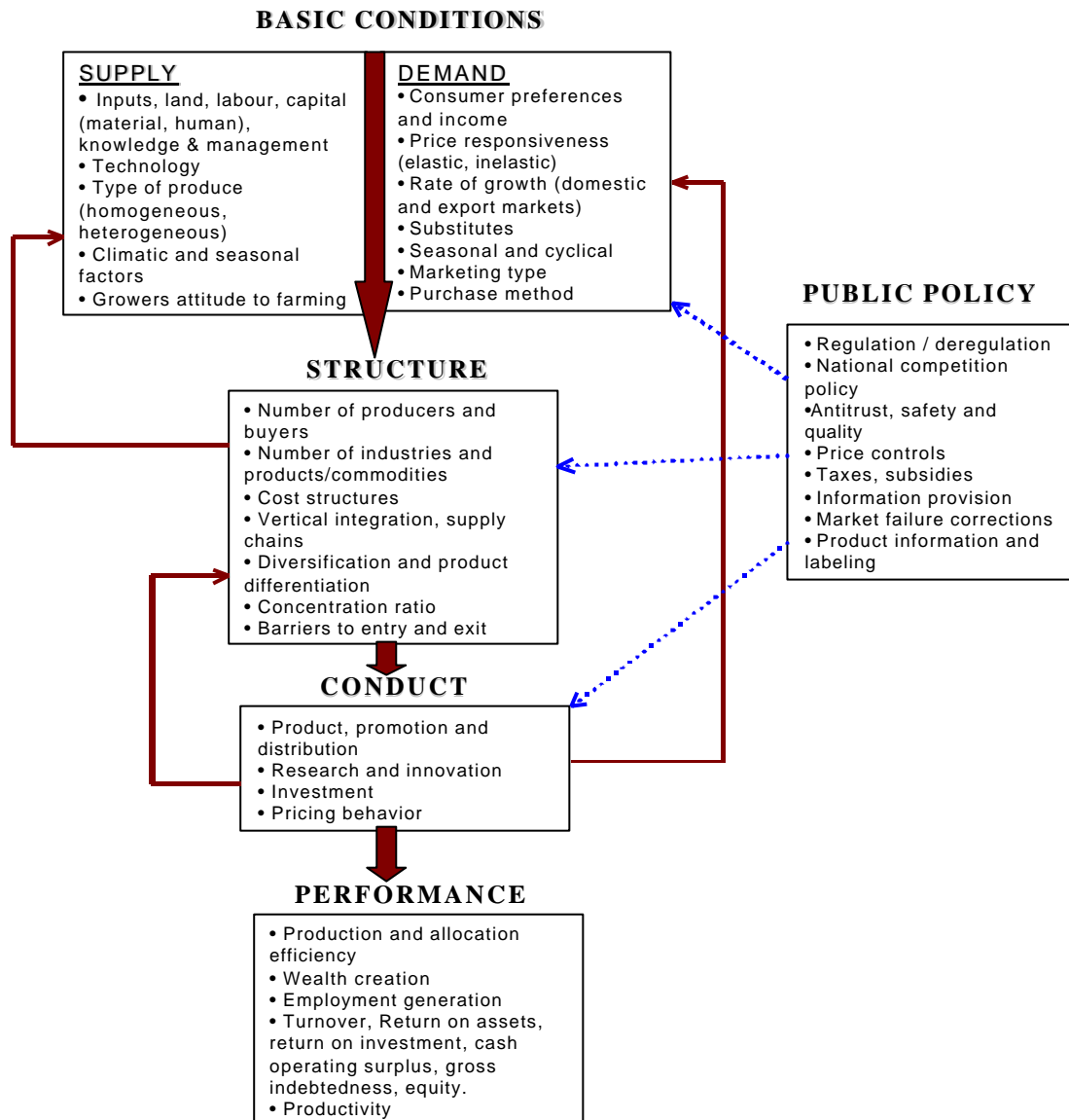


Figure 2: Traditional Industry Analysis Model

Over the past several decades, economists have given increasing attention to the role institutions play in the operation of economic systems. The focus of the institutional model is the competitive nature of the market and market forces, and the implications of this for economic behavior and the performance of industry and the firm. The new institutional economics (NIE) is an attempt to incorporate a theory of institutions into economics. It builds on, modifies, and extends neo-classical theory to permit it to come to grips and deal with an entire range of issues beyond the boundaries or assumptions of neo-classical economics (NCE). NIE *builds on* the neo-classical **assumption of scarcity** and hence competitions, which are the basis of choice, that underlie the microeconomics price theory.



“Neoclassical theory is simply an inappropriate tool to analyze and prescribe policies that will induce development. It is concerned with the operation of markets, not with how markets develop. How can one prescribe policies when one doesn't understand how economies develop?

North D C (1994)

NIE views economics as a theory of choice subject to constraints; it employs price theory as an essential part of the analysis of institutions and it sees changes in relative prices as a major force inducing change in structure. NIE *modifies* the **rationality assumption** of NCE. The incomplete information and limited mental capacity to process information determine the costs of transacting which underlie the formation of institutions. Institutions<sup>i</sup> are formed to reduce uncertainty in human exchange. In addition to modifying the rationality assumption, it *adds* institutions as a critical constraint and analyses the role of transaction costs as the connection between institutions and costs of production. It *extends* economic theory by incorporating **human behavioral norms, ideas, and ideologies into the analysis**.

The continuous interaction of institutions (rules of the game of a society) and industry in the economic setting of scarcity, and hence competition, is the key to structural change. Competition forces industries to continually invest in skills and knowledge to survive or evolve.

While it would be incorrect to say that traditional analysis abstracted completely from institutional structure, there can be little doubt that the usual treatment of institutions was superficial. It can be observed from Figure 2, that public policy was reported in the traditional industry analysis, which affects the structure of the industry. The existence of political, legal, monetary and other systems were certainly recognised, but these systems were often regarded as neutral in their effect on structural parameters. Some times these were taken as given and institutional influence was considered not of much importance. By contrast, new institutional economics seeks, at a minimum, to demonstrate that institutions truly matter and that institutions are themselves regarded as legitimate objects of economic analysis.

One objective of the NIE is to examine systematically the relationship between property rights<sup>ii</sup> and institutions. It follows from the arguments of North (1994) that property rights have economic value and must be enforced in a societal recognised manner. The central thesis of the property rights view is the proposition that the particular structure of property rights in an economy influences the allocation and utilisation of economic good and services in specific and predictable ways. The value of traded goods and services depend, *ceteris paribus*, on how the property rights over this good are defined. Since individuals try to maximise utility, any change in the system of property rights will have a specific and predictable influence on the allocation of resources, the composition of goods and services produced, on the distribution of benefits etc.

The concepts of **transactions costs and principle agent theory** conceived by Coase (1937) and expanded by Williamson (1985) indicate that, the form of vertical linkages and coordination in an economic system depends on economies of scale suggested by neo-classical theories, and also on the costs incurred in completing transaction using various coordination mechanisms. These costs and the performance of various coordination mechanisms are partly dependent upon the relationships between the transacting parties (the principle and the agent) in the agribusiness system.

## REVIEW OF LITERATURE ON STRUCTURAL ANALYSIS AT 'INDUSTRY / SECTOR' LEVEL

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### The Socio-demographic factors

The structural changes in consumer purchasing patterns are brought about by increases in incomes, increased value of time in the society, and other demographic changes (population growth, aging population, women participation in the labour market and multicultural world). These changes have produced significant structural changes in the food sector in terms of what and where it is produced and in what form it is provided to the consumer year round. At the aggregate level, the increase in income, education, and information have resulted in more food choices for consumers.

The food economy of future is based on functional preferences, emotions of consumers, personal, non-materialistic or post materialistic values.

Socio-demographic trends and food and consumer lifestyles will be more dominant in the future and directly impact on the structure of agriculture and the food and fibre system. From the research of 'consumer lifestyles' learning network, Gali et al. (2000) found that 7E<sup>iii</sup>'s related to food and consumer lifestyles have emerged as major forces in the 21<sup>st</sup> Century. They are **E**thics, **E**ntertainment, **E**mpowerment, **E**gonomics, **E**fficiency, **E**nvironment and **E**ternal.

The implications of the 7Es of consumer lifestyles related to food provide a base for the food and fibre system to search both unmet preferences and a better way of meeting those preferences. Therefore, long-term performance capacity of food and fibre system can be argued to be bounded by its capacity to capture information about consumer needs and new technologies to satisfy needs. The '7E attributes' are relevant to many consumers and are major criteria for market segmentation in the 21<sup>st</sup> century. Market segmentation is comprised of people who for whatever reason, prefer different combination of attributes to other groups of people.

The study of Gali *et al* (2000) found that the food economy of the future is based on functional preferences, emotions of consumers, personal, non-materialistic or post-materialistic values. The affluent consumers are becoming increasingly 'eclectic'. Individually they encompass a great variety of interests, and values and influences collectively with an evolving process of fragmentation that wanders through the food market. It appears from the above analyses that niche markets will become a more regular and integrated part of food markets as a whole in the new millennium. This will ultimately impact on the structure of agriculture and its food and fibre system in terms of what and where food is being produced and what form it is provided to the diversified consumer.

### The Technological Factors

One major cause of the current changes in agriculture is technology. Although development of technology has been ongoing for centuries, current technological developments are pushing considerable changes upon agriculture. As in the past, **production technologies** lead to greater output which in turn exerts pressure on commodity prices. Information and communication technologies (ICT) allow producers to almost immediately learn about and quickly respond to market opportunities as a result of the rapid movement of information and product. Consequently the level of competition is also reaching new heights.

Because of technological advances in **processing, transport and ICT**, the ability of the food industry to operate in a global market place is becoming a reality and will have a profound effect on how individual farms interact with the other elements of the food production and distribution system chain. The majority of the changes underlying ‘globalisation’<sup>iv</sup> reduce the costs of undertaking transactions. The branch of economics most relevant to study the globalisation is NIE discussed previously, which suggests that as transaction costs are altered, new forms of vertical coordination may arise. Through competition, the least cost system of vertical coordination should determine the industrial structures that emerge.

The changes in transaction costs implicit in the globalisation process suggest that relationships between individual farms and the rest of the food chain will be much closer than in the past. The closeness of relationship suggest a reduction in the degree of managerial independence which farmers have traditionally enjoyed.

## New Farm Business Factors

The focus of competition shifted from “firm versus firm to chain versus chain”.

A number of business strategy concepts, sourced from strategic management literature, assist in understanding and predicting industry structure. Such concepts have been largely derived from work undertaken by Porter (1985) and Prahalad and Hamel (1994) to develop competitive advantage theory. Porter’s analysis is based on neoclassical industrial organisation economics, which argues that “industry” is the main determinant of firm profitability, that is, industry structure determines conduct, which then determines profitability as mentioned in Figure 2. By the late 1980s firms were pursuing a different agenda not directly related to the original industry premise (Prahalad and Hamel 1994).

More recently, *resource advantage theory* (O’ Keeffe *et al* 1998) provides a new explanation of the perspective of the firm – the Resource-Based View (RBV) of the firm. RBV is based on the concept that performance and sustainable competitive position depend primarily on the resources of the firm. The key challenge of the firm is to transform basic resources into core competencies, which will form the foundation of the competitive position in specific market segments. O’ Keeffe *et al* (1998) wrote that industry accounts for 8-10% of firm profitability and the firm accounts for 45-55%. Therefore, while the firm and the industry both contribute to firm performance, the contribution of the firm is about four-five times greater.

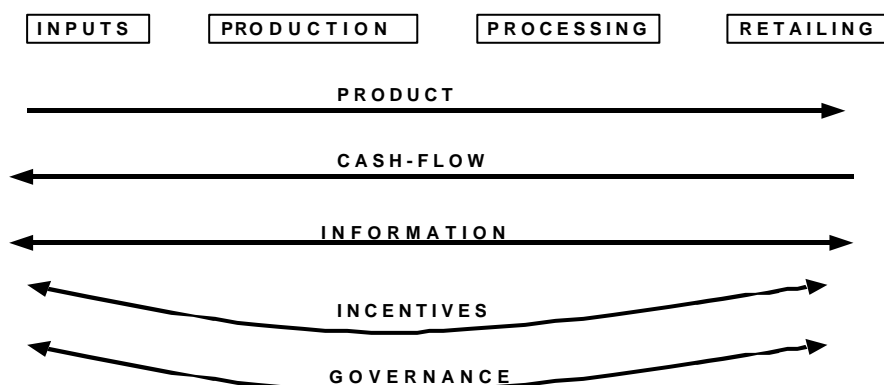


Figure 3: Critical Dimensions of a Value chain

Emerging arguments relating to *strategic alliances* may explain the implications of various changes within the structure of the agribusiness system vertically, horizontally and geographically. **Value chains** are a set of integrated and more dynamic organisational units whose coordinated efforts produce a marketable product/service. The value chain is the focus of competition in agribusiness in the future, and supermarkets are currently the value/supply chain leaders in the food industry. The emergence of value chains has changed the risk focus for farmers from price/production considerations to market/relationship risk considerations.

Figure 3, illustrates the critical dimensions of a value chain. The focus of competition shifted from “firm versus firm to chain versus chain”. Agribusiness success depends on the cooperative strength of the whole supply chain from producer to consumer. Value chain analysis provides powerful strategic insights for farm managers. The success of farming in the future increasingly depends on the ability to control what happens in the value chain outside the boundaries of the farm. Evolution of agribusiness will be from a fragmented commodity agriculture to more closely coordinated market driven supply chains with a differentiated product focus. Increasingly, consumers not producers are deciding what should be grown, and supply chains have been formed to give consumers what they want and when they want it on a global basis.

A key component of rural development in developed countries is the growth of production and marketing linkages between farm and non-farm sectors. The growth of these linkages contributes to the development of **clusters**. Clusters are defined as geographical concentrations of interconnected farm producers, related farm producers, processors, wholesalers, retailers, agribusinesses, farm organisations and other institutions in a particular industry or sector. The idea of ‘clusters’ is that factor inputs are abundant and accessed through globalisation, while the productivity and prosperity of firms within the clusters will, through competition and cooperation, set new rules for locational competitive advantage.

## Environmental Constraints

The greatest challenge for agriculture over the next 10 to 20 years is environmental constraints, which could directly or indirectly affect the structure of agriculture in terms of location and crop mix. Environmental constraints could be studied in four domains: **climate**, **water**, **soil**, **flora** and **fauna**.

**Climate variability** is an important feature of agriculture, which emphasizes risk management strategies, and understanding the Southern Oscillation Index to predict the El Nino effect and weather patterns. Due to the **global warming** phenomenon, green house gas control will become a feature of the agriculture sector. There is likely to be continued pressure and perhaps incentives to provide carbon sinks by maximizing on-farm tree cover increasing organic content of the soil. Carbon credits and taxes may bring extra benefits and costs to the agriculture sector.

Competition for **water** will influence the expansion of some industries in some areas. Water prices, water trading, and the demand of managing salinity will accelerate the move toward more water use efficient crops and consequently change the product mix of the industry. Maintaining the condition of **soils** is a constant challenge to agriculture. The ability of producers to control increasing soils acidity, declining soil structure and fertility and erosion will be a major determinant of farm profitability and sustainability, which will impact the size of the operation and suitability of crops in different types of soils. Urban and rural residential development is taking good agricultural land out of production. The extent of the problem and whether it is encouraging agriculture into more marginal areas is unclear at the current stage of research.

Not only on-farm effects of natural resource issues, their off-farm agricultural activities in terms of polluting water streams (eg. The issues of pollution of Great Barrier Reef by Sugar cane farms in north Queensland) pollution of neighbouring environment (eg. The issue of air pollution by cotton growers on neighbouring community) also a critical dimension in understanding the institutional constraints on farming that impact on structure of the industry.

Other factors outlined in Figure 1 such as the **economic** and the **political** are not detailed in this paper. Interested readers could refer to the Productivity Commission report on 'Trade and Assistance Review' annual publication, which illustrates the government policies and assistance levels to agriculture. National competition policy reports reveal the micro economic reforms in Australian Agriculture and implications on structure of the industry.

## REVIEW OF LITERATURE ON STRUCTURAL ANALYSIS AT 'FARM' LEVEL

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### The Technology Factor

The technology model is based on two key concepts relating to economic theory and application: – (1) economies of scale; and (2) the adoption of technology. These concepts are explained below.

The literature defining the concept of *economies of scale* has tended to focus on the long-run cost curve in agricultural production and distribution, and the determinants that shape and shift that curve. These key determinants include the underlying production relationships and technology involved; Government policy (taxation, regulation, subsidies, controls); risk dimensions (risk preferences, production, marketing and financial risks); and input and output market structure and behaviour.

According to the economies of size model, the growth in farm size in many developed countries, including Australia, largely reflects the relative prices of labour and capital. Higher costs of labour in the non-farm sector have resulted in a high opportunity cost for farm labour. The high price of labour relative to capital has encouraged the development of technology to substitute machinery and equipment for labour. This has enabled the remaining labour force to increase productivity.

Another concept of the technology model is that of *adoption and diffusion of new technology*. According to this concept, technical change results in new production practices that may be adopted by producers. However, farmers adopt new technologies at different rates for a number of reasons including different salvage values of the current technology, different costs of technology adoption, different financial capacities to acquire the new technology, and different human capital skills in assessing the risks and rewards of new technology.

Farm size growth that incorporates the substitution of capital for labour is not expected to be as dominant in the future as in the past. This is largely because wage rates between the farm and non-farm sectors have stabilised, and capital costs have increased relative to labour costs (Kislev and Peterson 1986).

The technology of the future is seen to be biotechnology, information and communication technologies, and nanotechnology<sup>v</sup>. Biotechnology appears to be scale neutral compared with capital technologies of the past, however this may not be the case for information and nano technologies because of the financial and human capital investment involved.

### **The Human Capital Factors**

The human capital model of farm structure analysis utilises three interrelated concepts: human capital investments and managerial capacity; household economics and time allocation; and relative labour incomes in agriculture versus non-agriculture.

Rodgers (1988) argued that managerial input is critical to the underlying cost and production relationships of any firm. Managerial capacity can be impacted upon by investments in human capital, where such investments can increase the ability of management to process information and to adopt cost-reducing and output increasing technologies to maintain larger scale farms. Managerial input varies from farm to farm because of differences in experience, education and the skill levels of farm managers. Because of these differences in managerial input and human capital investments, different sizes and structures of farms will develop over time. It is therefore possible that disequilibrium could exist in the industry as farms adjust at different rates to technical, market, regulatory and other external changes.

The concept of household economics, combined with relative labour incomes in farming compared to other employment opportunities available for farmers, may provide a partial explanation for farm size, as well as the development of lifestyle farms or part time farming activities.

### **The Sociological Factors**

The sociological model embodies the behaviour of individuals in a family context and the decisions that are made to develop and maintain a family and extended family farm business operation.

The sociological model is described by the family firm life cycle. The first stage is *the entry or establishment stage* – the prospective farm entrepreneur evaluates the opportunities in the industry compared to other occupational alternatives and determines whether or not to enter the industry. The second stage is the *stage of growth and survival* – the entrepreneur attempts to expand the resource base by purchasing or using additional inputs. New techniques of production are evaluated for their efficiency and profitability as well as their ability to increase the volume of production through intensification or expansion into new enterprises. A major consideration during this stage is the maintenance of a debt-equity structure that will guarantee survival during years of low income due to production shortfalls or low prices/margins. The third stage in the family firm life cycle is the *exit or disinvestment stage* – that is, the process of retirement and the inter-generational transfer of property.

A key issue in an agricultural industry dominated by sole proprietorship is that of the efficiency of the firm over the family firm life cycle. Although a family business may be very efficient during the prime stage of an entrepreneur's life, inefficiencies may exist during the entry and exit stages. Delineation of the ownership of assets and the control of decisions are useful tools in the evaluation of the attributes of family farms.

### **The Financial Factors**

The financial model combines concepts of production theory and financial theory into an integrated model of firm behaviour (Lownberg-DeBoer and Boehlje 1986).

The financial model defines farm inputs as durables (land and improvements to the land) and non-durables (seed, fertiliser and chemicals). Durable inputs influence wealth in two ways. First, through their contribution to the production of agricultural products and second, through appreciation (depreciation) which directly increases (decreases) wealth. Non-durable inputs contribute to wealth only through the production process.

The optimal mix of durable and non-durable inputs used in the production process is a reflection of both relative factor prices and relative capital gains/losses. Therefore, the value of the firm is maximised subject to financing and survival constraints. The financial constraint indicates that the acquisition of durable and non-durable inputs requires differential amounts of financial capital, and input purchases are limited by the availability of debt and equity capital. The survival constraint reflects the cash flow requirements that the firm must meet to continue in business. Production inputs and capital assets typically contribute to cash earning.

If capital gains on durable inputs are positive, but zero on non-durable inputs, capital gains will tend to offset part of the cost of acquiring the durable inputs, resulting in the substitution of durable for non-durable inputs. Similarly, capital losses would have the opposite effect. Therefore capital gains/losses and finance charges will impact upon the choice of farm outputs. For example, according to neoclassical marginal analysis theory, if the durable input (land) produces a higher marginal return from one product compared with another, the use of durables in the production of the first product will be increased. Increased capital gains on durable inputs will lead to a change in the input cost ratio that will favour production with the durable assets and comprise a larger share of the output mix.

## HOW TO PREDICT THE LIKELY STRUCTURE OF AGRICULTURE, ITS FOOD AND FIBRE SYSTEM?

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For all of human history people have tried to develop methods for predicting the future. Generally they are designed to help decision makers to better understand future possibilities in order to make timely informed decisions. These are forecasting and foresight methods, both predict the future however the way they see the future is quite different. Forecasting involves making estimates of the future values of variables of interest using information available in the current period. Foresight is simply a way of understanding the change by standing in the future, rather than projecting into the future with assumption about how the current system works.

An alternative approach called ‘final cause’ by Boehlje (1999) in essence argues that the future drives current actions, which then generates current and future outcomes. The important perspective of the systems dynamic approach is to understand the current and future driving forces for agriculture and then predict the likely structure from the ‘systems dynamics’ of those causes. It involves the construction of influence diagram and quantifying/simulating the interrelationships.

### Systems Dynamics and Scenario planning

The underlying goal of systems dynamics method is to propose a set of hypothesis about how relationships within the structure of a system influence its behavior, given a set of interactions among driving forces. The systems dynamics concept is similar to the ‘ice berg’ analysis suggested by Van der Heijden (1996). It is a method for understanding the underlying structure of the situation by inferring **patterns** and **trends** in the **events**, which are observed. By documenting such a discussion in the form of an influence diagram, this underlying structure can be revealed.

This starts with the articulation of a number of important variables, considered important for the likely structure of agriculture. The next step is the development of simple influence diagrams around these variables. The linkages made clear in the influence diagram can then be used to start understanding the causal relationship.

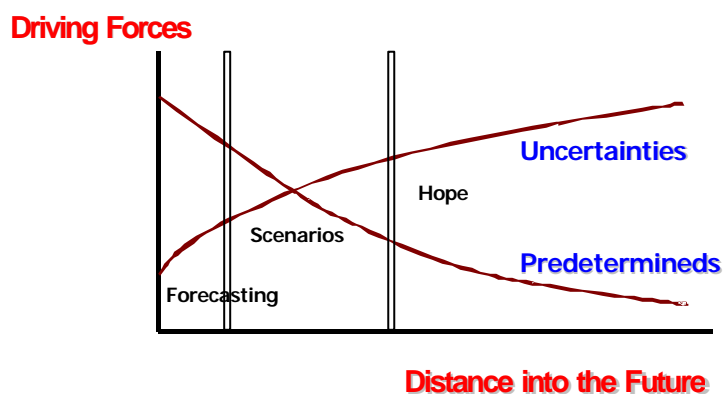
According to ‘iceberg analysis’, the world can be viewed at three difference levels. At an **event** level, there is viability of rural communities. Events can be observed, and the agriculture sector can be perceived through the events that present themselves. By plotting the number of farm businesses, a

variable was defined and trend examined. As soon as essential events present themselves, underlying patterns and structure are investigated in order to understand the situation. Scenario planning goes one step beyond from systems dynamics, that there is much more to be said than just reporting events and casual relationships of variables. It assumes structure underneath the events, driving these in one direction to another. The assumption is that events do not just happen at random, but they are related to each other through a structure where cause drives effects with one event leading to another. Structure here is based on the analyst's perception of causality, which connects the system together through casual links. These structures are used to project the future behavior of events under consideration in systems dynamics.

Scenario planning goes beyond systems dynamic and involves a qualitative understanding and systematically classifying elements in the system. Understanding of this system requires processes that facilitate the logical organisation and analysis of a large range of relevant but seemingly disparate data. This analysis has been undertaken across **three** categories based on the notion of **predicability** and its **impact** on the events under study:

- ◆ **Critical uncertainties** are events that are not possible to see as an ongoing stream. Issues, events, topics, parameters that may or may not eventuate or have a high impact which can undergo bifurcation. It is in the critical uncertainty area that the first generation scenario planning becomes particularly important. For example, what will be the long term effect of the genetically modified organisms on environment?
- ◆ **Predetermined elements** are highly predictable elements, issues, events, topics, parameters that will eventuate/happen as a matter of the evolution of time, often called predetermined elements (such as productivity growth).
- ◆ **New ways** are imaginable and unbelievable events, which will revolutionise the society (such as bio-sensors).

## DRIVING FORCES CLASSIFICATION



**Figure 4: The balance of predicability and uncertainty in the business environment**

*Source: Van der Heijden (1996)*



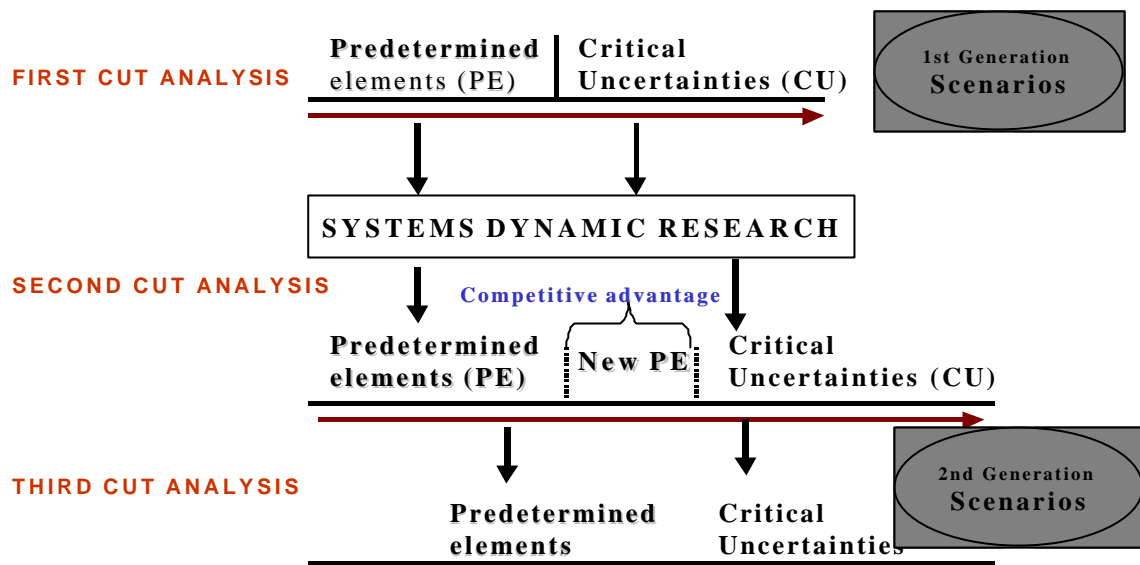


Figure 5: Stages in Uncertainty Analysis

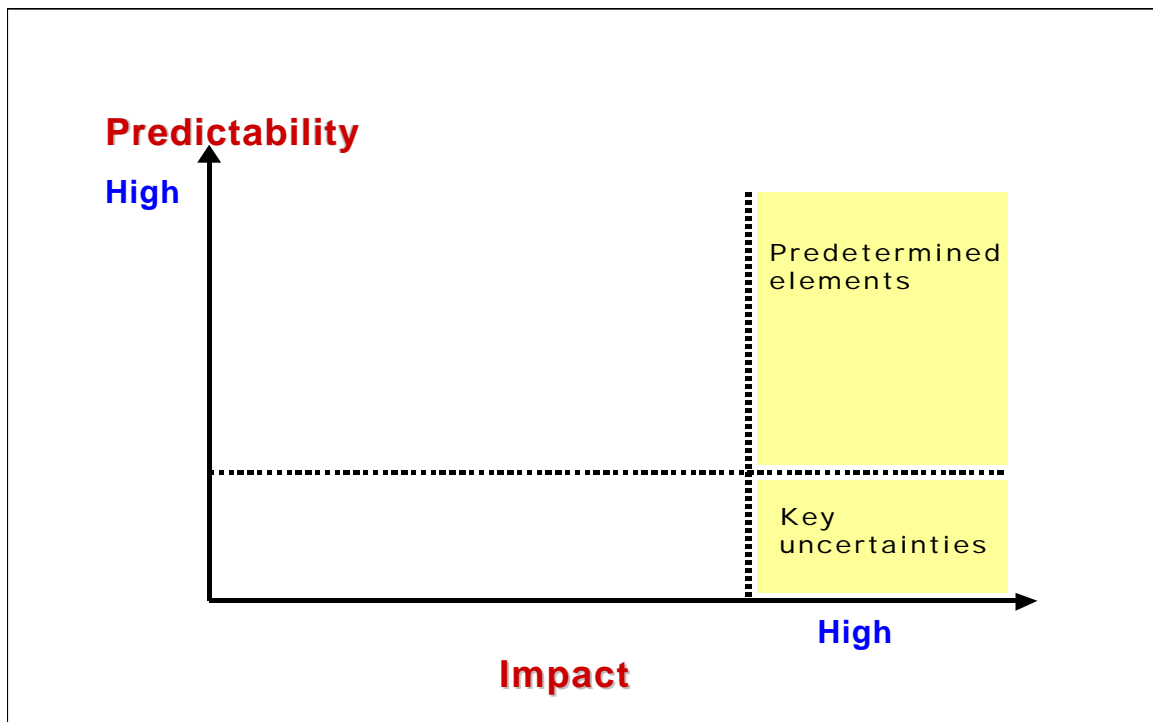


Figure 6 Driving Forces Matrix for 'Agricultural Structural Analysis'.

The phenomenon of pre-determinism is based on the assumption of stable structure pertaining over the planning period. The analysis of pre-determinism draw on historical information and relationships in part for specification, but they are not limited to history if new relationships and determinant of the

future that are not part of history have become part of the decision nexus and economic environment of agriculture sector.

The relationship between predetermined and uncertain elements widens with the length of the timeframe being used, this is illustrated in Figure 4. Scenario planning helps to extend the systems dynamic analysis by using processes to priorities and quantify the driving forces into a matrix of possible and plausible futures upon which new research questions can be asked and deeper analysis can be undertaken. This is conventionally referred to a first and second scenario generation. The iterative stages of uncertainty are shown in Figure 5.

An uncertainty matrix was a useful tool in considering the impact and certainty of each of the forces. Forces which may have high impact are included in the matrix others of low impact may not be analyzed further. These categories are illustrated in Figure 6.

Each category of driving force can be analyzed under the context of future structure of agriculture and food and fibre system. A series of essential questions were used to guide the analysis and assist in developing a complete influence map of the systems.

## **CONCLUDING REMARKS**

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In summary, forecasts are a statistical and qualitative summary of expert opinion. A scenario is much more a conceptual description of a future based on cause and effect using systems dynamic concepts. Unexpected influences and unforeseen variables that do not feature in the expert's model of the farm business environment can be considered in systems dynamics and scenario analysis. The scenario planner is not in the forecasting straight jacket. The starting point is the main uncertainties facing the farm business. Scenarios address key uncertainties through chains of cause and effect. Scenarios let the decision-maker look not just at outcomes, but also at the driving forces which could move the business one way or the other.

The foregoing discussion raises more questions than it answers in understanding the causes of structural change in agriculture and its food and fibre system. Clearly, there is a long way to go in searching for answers, developing theories and empirical analysis. The New Institutional Economics literature hopefully can provide a new understanding of structure and performance of agriculture and its food and fibre system. The systems dynamic and scenario analysis could provide a broader canvas to understand and predict the likely structures of agriculture.

The research initiated by Queensland Department of Primary Industries's Business Strategy Unit is seeking to embody these new hypotheses developed from diverse fields to create an analytical framework that will enable an understanding beyond the boundaries of traditional analysis of structural changes in agriculture. In the process, the study will enrich these theories and so enable to deal effectively with a wide range of contemporary issues affecting the structure of agriculture to be dealt with effectively beyond the scope of traditional approaches and analysis.

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## END NOTES

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<sup>i</sup> According to North (1994), Institutions are the rules of the game of society or more formally are the humanly devised constraints that structure human interaction. They are composed of formal rules, informal constraints, and the enforcement characteristics of both.

<sup>ii</sup> Property rights refer to the sanctioned behavioral relations among people that arise from the existence of things and pertain to their use.

<sup>iii</sup>, **Empowerment:** Consumers in elite societies are learning to see the world as a single system in which human being's empowerment in its original form is as a centre. A shift from defining health purely by how one looks to thinking of balanced body, mind and soul may give rise to increased consumer interest in functional foods, foodaceuticals and nutraceuticals.

**Entertainment:** Evident in the entertainment industry when food products and services that satisfy physical needs and entertains at the same time. Appetite for amusement will force food industries to inject entertainment content into the food products and services. The forces underlying entertainmentisation of the food services will shift consumer expectations. Ultimately in the future, one of the differentiating factors between all manners of goods and services will be their entertainment content. For example, in many theme restaurants, food very often is considered less important than the 'total dining experience'.

**Ethics:** Mutual confidence of both producers and consumers in the traditional food market is typically implicit rather than explicit, indeed so implicit that its importance can be overlooked. But in today's food business, these issues of behavioural norms and ethics can be altogether central. Ethics in food business goes well beyond the traditional values of quality and reliability, and takes on social responsibilities as well. The search for new rules and values is being apparent in today's food business.

**Eternal:** There are at least two ways in which consumers perceive time today as perpetual. One is as an ever-accelerating rate of living. Consumers have a sense that a lot is happening at once, that they are doing many things at the same time, that they never have enough time and they are constantly struggling to keep up with the demands of modern life. Another way of perceiving time is as essentially non-existent. Those are the moments when time seems to stand still, moments of rest, mediation or wonder. They are also the moments when humans become aware of their relation with the past, their heritage and when they see themselves as a part of a continuing tradition. The pressing demands of the present and the immediate future often prevent consumers from appreciating the larger picture. People are finding a need to reconcile these two modes, which interacting as trends alongside each other, are giving rise to new patterns of consumer behaviour.

**Environment:** One facet of ethics represents a growing concern about environmental issues. Increased consumer awareness of environmental issues about where foods come from and how they are raised and brought to market. For example in matters of food safety, environmental degradation, pollution, accountability and transparency in food chain seemed to be not only a business issue but also a moral one. Because of uncertainty of future, consumers are fearful about the food safety and environmental issues and they crave for security and concern for inter and intra generational equity. A key reason new consumers are so demanding is the fact that they have been lied to and misled so often, not just by big business by government leaders and policy makers, particularly across Europe, one can see consumers no longer willing to tolerate ethical and environmental issues related to food.

**Efficiency:** Consumers of today and more so in the future take care of daily chores in the most efficient manner, to leave more time for personal and family activities. Technology is enabling the efficiency and convenience in food purchasing, preparing and eating. One facet of technology is Internet shopping. The interesting aspect about the Internet shopping is the fact that internet businesses are able to bundle products and services either on their own, or those of a trading partner who is just one click away to create holistic solutions targeted at consumers life styles online at a single point.

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The other facet is convenience, which include the proliferation of ready to eat, ready to heat and ready to cook food products and food service industries.

**Egonomics:** Feeling unconnected in the de-personalised information age, consumers are drawn to customised, individualised products and services. “Me”, “myself” and “I” are the driving forces behind Egonomics (Faith Popcorn 1998) which satisfies basic human need to feel important. ‘Me’ wants customisation, ‘myself’ wants to be a person with a name, not a face-less consumer with a number; and ‘I’ demand individual attention and personal service. Consumers realise that each and every one is unique human being with a basic right to happiness and fulfilment. Egonomics means that food business must become more personal striving to meet often-idiosyncratic consumer needs, choices, and fantasies.

<sup>iv</sup> Many farmers are concerned about the globalisation concept and some argue that globalisation is the main cause of structural change in agriculture. However, in this paper, globalisation is considered as a consequent trend, primarily caused by technological advances and little by government policies.

<sup>v</sup> Nanotechnology is the precise manipulation of matter on a nanometre scale. Its applications include manufacturing of new chemicals, molecules and proteins, genetic engineering, construction of microscopic self-replicating devices and microscopic machines.