Distribution and Processing Systems for the Stable Supply of Products from Agriculture, Forestry and Fisheries

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Abstract

A stable supply of agricultural commodities is the keystone of food security and economic development. Fluctuations as a result of weather, war and epidemics have had critical impacts on civilisation, with human progress and resilience depending on both the versatility of processing technologies, and the efficiency of agri-produce distribution systems.

To garner all of the harvest of the Green Revolution, we need to improve postharvest technology, infrastructure and markets. Efficient marketing or processing can optimize product utility, shelf-life and nutritional balance, as well as commercial attractiveness, to improve profitability for agribusiness and value for money for consumers. And throughout history, these goals have been achieved through postharvest research, innovation and investment.

In developing countries, improvements can be made to product quality, to postharvest systems and market access, to pest and disease control and to the management of contaminant risks. But success depends on practice. And it also requires adequate infrastructure and good governance! Increased government investment in postharvest research and development will have significant economic impact. By linking farmers to markets, governments deliver benefits to the whole community, because they are boosting:

* Food security and trade,
* Community health and nutrition, and
* Rural incomes and employment.

Introduction

Modern agriculture has progressed greatly through the growth and improvement of production systems. Demand has been boosted by the postharvest distribution of commodities to population centers in distant markets, and the creation of new products that extend shelf-life, add value and encourage consumer purchasing.

These developments are not new! Rice and spices have been traded for centuries to procure precious metals, fabrics, pottery, and sea products (Diamond, 1998), while the history of food processing is probably older than that of agriculture! Even hunter-gatherers preserved food by drying, to provide sustenance in the hard times. In the last century however, population growth and urbanization, and increases in agricultural productivity, have been paralleled by increased deforestation, and greater demands for transport, communications, utilities and land. Amidst these challenges, it has been the Green Revolution, ongoing socio-political development, and a **postharvest-technology revolution** that have, hand-in-hand, facilitated rural

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development and the attainment of food security within the global economy.

Why postharvest? In considering the community impacts of agricultural research, Goletti and Samman (1999) suggested that the production surpluses and rainy season harvests of the Green Revolution have been important drivers of postharvest research and development. Johnson *et al.* (2000a) reviewed the ways in which postharvest research contributed to rural development, noting that postharvest technologies become more complex along with economic development (Tsubota, 1999), and that technology development should be undertaken with the involvement of industry, and adapted to suit local agri-ecological conditions and cropping patterns (De Padua, 2000).

Postharvest processing improves scope for development Goletti and Samman (2000) also suggested that globalization and postharvest systems have a mutual synergy and importance in developing countries, and that a broad-based approach to postharvest quality improvement and agri-industry development was needed, using small and medium enterprises as the engine of growth. Goletti and Samman (2000) suggested that the starch industry in Vietnam was a good illustration of how low-value commodities such as cassava could be processed into high-value commodities such as starch, for use in a variety of industries. They noted the emergence of large-scale starch-processing enterprises in Vietnam, but suggested that small to medium-sized enterprises actually ran at higher levels of capacity, with fewer constraints in terms of raw materials or market access. Provision of more capital and technology for the small to medium-sized industries would enhance the efficiency of the entire industry and contribute substantially to rural community development. The Vietnam starch industry study provided empirical evidence to support a broad-based approach to growth, recognizing that while "bigger is not always better", a continuum of enterprise size from small to large could function well as a driver of development (Goletti and Samman, 2000).

Globalization Several authors have been cautiously optimistic about likely impacts on developing country economies of globalization and accession to the World Trade Organisation (WTO) (Lan, 2000; Gerhardus, 2000 and Manalili, 1999; 2000). Johnson *et al.* (2000a) concluded that to enable all of the groups affected by rural industry development to respond to global pressures and opportunities, there was a need to review previous research and development impacts within national and global frameworks, paying special attention to the institutional dimension. They suggested that national and regional frameworks that capitalized on competency-enhancing linkages would strengthen market chains and provide opportunities for a more holistic/collective approach to postharvest problem solving.

In recognition of their particular importance in rural development, within the context of globalization, and the urgency in assisting the poorest sectors of rural communities, this paper will focus on the postharvest distribution and processing systems that are vital elements of economic growth and prosperity.

Starting with the smallholder

From the earliest times, rural communities capitalized on bountiful harvests and the autumn herd-cull. They stored produce and simply processed foods for the winter or dry seasons, and exploited production of high-value, easily transported commodities for trade and wealth generation. They also manufactured tools, food products, craftware, clothing and shelter for their own use and for barter. They developed lifestyles and community structures that reduced health risks from unclean water, food poisoning, dietary deficiencies or disease; and they held festivals and feasts.

In the latter, food consumed in excess to dietary requirements was stored as body fat to serve as both insulation and reserves for the lean pickings of winter. Processed products, animals, handicrafts, trade commodities, food stocks and fodder were also sold to traders from other places, who brought exotic foods and fabrics, trinkets and tools, spices and slaves, and information and ideas from the outside world.

In more remote communities today, little has changed in terms of self-sufficiency (although slavery has, thankfully, almost disappeared). But the flow of trade depends on costs — sometimes there is insufficient profit for buyers to come, and little incentive for rural smallholders to produce surpluses for sale (Heinmann, 2000). In the face of globalization, the only options for remote communities are to:

* Optimize self-sufficiency,
* Produce high-value easily transported trade commodities,
* Encourage environmentally sensitive agri-tourism, and
* Proactively extend and improve their links to markets and to the rest of the world,

if they are to prosper and reverse the migration of the young to the cities.

And today, we can see communities at different points on a scale of development, with product demand and progress hampered by geographic isolation, wars, climatic extremes and inadequate infrastructure, finance and governance.

Linking farmers to development

In considering agribusiness as a driver in rural development, Mutulu *et al.* (2000) noted that globalization and market liberalization are powerful drivers for development, but there are grave risks that the most needy will be marginalized. Sudden abandonment of high market protection and state regulation of marketing can have adverse effects if the environment for agribusiness and the private sector remains unfavorable. They suggest that it is important to assess the stage of development first (Table 1) and structure/focus development initiatives to match capacity for change.

Table 1 Stages of development: Focal points for agribusiness support in developing economies (Mutulu *et al.*, 2000)

Stage I	High ratio of "self-sufficiency" production, with surplus production as the market supply.
Stage II	Large number of small enterprises, little coordination in market supplies resulting in high price fluctuations, low productivity of agricultural enterprises in production, marketing or provision of services.
Stage III	Increasing specialization of agricultural farms and marketing entities, start of "business entity" formation.
Stage IV	High degree of competition forcing a number of "business entities" out of market, slow adjustment process of agribusiness entities to rapidly changing market requirements.

While various communities/countries differ in their stages of development, the drivers or areas in which interventions for development can be made have both a global dimension and an appropriate/community specific dimension. The identification and planning of "appropriate" interventions involves assessment of the "stage of development" of the target community and the regional and national economies. It also involves the education of communities to improve communication and understanding, as well as their abilities to deal with the opportunities and risks associated with globalization and market development.

While this agenda for industry improvement seems daunting, even for developed countries, Dietz (2000) cited development linkages that have succeeded in assisting smallholders to develop and run quality systems, and proposed that the critical components for a project to improve quality and market access were:

* Cooperative supply pools,
* Clear communication of quality standards,
* Financial incentives for quality,

* Farmer understanding and attention to food safety,
* Definition of quality control, and
* Monitoring and ongoing re-evaluation of the entire system.

The applicability of these components within the matrix of development stage as proposed by Mutulu *et al.* (2000) can be considered by examining some examples of rural development and change.

Development Stage I - Remote communities need " suitable" products Take the case of "hill-tribe" communities in the border regions of Thailand, Vietnam, Myanmar, China and Laos. One of the targets of development has been to introduce and promote alternatives to opium poppy *(Papaver somniferum)* production. Considerable progress has been made in some communities, particularly in promoting alternative enterprises, education and community development. However, Berenyi (1998) noted that despite efforts to popularize cash crop substitutes, opium production may have increased significantly in the wider Indo-China region. This may be partly the reason why the opium originally found favor as a source of supplementary income for isolated communities in the region — it is both a high value commodity with a ready market, and it is easily stored and transported.

Berenyi (1998) expressed the view that successful phasing out of poppy production would require greater investment in transport and communication systems, education, and other infrastructure and (importantly) the ongoing introduction of high-value enterprises/product technologies. In remote hill-tribe villages near the Thai border, these types of investments are being undertaken with considerable success by the Royal Project Foundation (http://www.cyber-image.com/royalproject/main.htm), which has also encouraged community drive and ambition, and a sense of "Thai identity", to help foster on-going progress.

This example indicates that in addition to the requirements listed by Dietz (2000), particular product attributes will remain for remote communities, whether they are on high mountains or remote tropical islands: Products should be of high value and easily stored/transported, and a "sense of community" needs to be encouraged. The latter is important since it underpins cooperative marketing and the harnessing of community leverage with local government and politicians. Other examples include coffee and cocoa as cash crops for remote communities in Papua New Guinea (PNG) and black pearls and the pharmaceutical extracts of kava (*Piper methysticum*) for some Pacific Island Nations.

Development stage II community - Premiums for quality cocoa In Papua New Guinea, the Australian Agency for International Development (AusAID), the Australian Centre for International Agricultural Research (ACIAR) and the International Cocoa Confectioners' Organisation (ICCO) are supporting research by the PNG Cocoa and Coconut Research Institute (CCRI) to introduce cocoa cultivars which produce beans with superior flavor potential, as well as fermentation and drying procedures suited to small-scale production (Hollywood *et al.*, 1996). The projects will provide opportunities for smallholders to produce, store and market high quality "flavor cocoa" (as opposed to lower value "bulk cocoa" tainted as a result of over-fermentation or smoke contamination), within a cooperative marketing framework. But as suggested by Hanak-Freud (1999) in relation to cocoa marketing in Indonesia, there must be buyer commitment to pay a premium for quality if the project technologies are to be accepted and willingly adopted by smallholders.

Development stage III - Niche marketing Other opportunities which improve incentives for buyer premiums for quality are "ethical trading" and "fair trading"[1], that emphasize environmentally sound production and processing, minimal use of chemicals, and sourcing directly from remote communities. Examples here include the "Green and Black" brand of organic chocolate and the cosmetic products sold by the *Body Shop* Company. Contract production for niche markets and "Brand-Name" marketing can also deliver improved benefits to remote communities, with examples including pumpkins for Japan produced in some Pacific Island Nations and the marketing of "New Guinea" coffee.

Development stage IV community - Rural Partnership Initiatives The process of change is of course not

restricted to developing countries; globalization is also affecting farmers in Australia and Japan. For example in the 1980s, it was recognized that the Queensland tobacco industry would decline once protection measures were phased out. A Queensland Government initiative under an umbrella called "Choices" aimed to provide new agri-enterprise opportunities for farmers in the region, and to help them acquire new skills as a "bridge to tomorrow" (Campbell, 1998). The program explored the economic and technical feasibility of new agricultural commodities, and encouraged the development of locally based value-adding enterprises (e.g. coffee roasting and blending, fruit processing, mango wine). The program has been successful in diversifying local industries, although some growth has occurred through additional investment in "major crops" such as sugar and banana, while other "boutique" enterprises (e.g. Tea-tree oil) have suffered fluctuating fortunes. The "Choices" program has since evolved as part of the state-wide "Rural Partnership Initiative", recognizing that the future of rural communities and industries depends upon their ability to adapt to changing economic conditions through access to new markets, and value-adding technologies, the updating of skills for managing sustainable businesses, and enhancement of the community's "global awareness".

On-going flexibility The strength of the Rural Partnership Initiative lies in involving rural **and** regional groups representing industries and issues, to foster rural economic development on the basis of "community interest". The process involves facilitation and networking assistance for interest groups, with emphasis on improving capability for managing change on a cooperative self-help basis.

(http://www2.dpi.qld.gov.au/business/ruralpartnerships.html).

Groups are encouraged to:

* Identify issues and opportunities,
* Develop and implement strategies,
* Identify skills held and needed,
* Identify knowledge and expert advice requirements, and
* Strengthen group skills and expertise.

It is important to note however, that the Rural Partnership Initiative builds upon a good network of regional farmer information centers, where producers can access key information for the establishment, management and marketing of enterprise outputs, as well as locally based rural extension specialists and agribusiness consultants who can encourage market-chain approaches to new enterprises. The outcome of the "Rural Partnership Initiative" has been on-going diversification of rural enterprises, a strengthening of focus in enterprise development and quality chains, and improvement of individual / community interest group skills and capabilities.

Synergies with others In developing countries, many Non-Governmental Organizations (NGOs) are supporting local community initiatives that emulate some of the aims of the Rural Partnership Initiative and the principles proposed by Dietz (2000). In seeking to enhance the impacts of the NGO efforts, international donors and country governments can assist by the provision of the sort of information and technical back-up that underpins such activities in developed countries.

Regrettably in many countries, farmers have a "siege-mentality" with respect to the import of agricultural

[1] "Ethical trading" can be defined in any number of ways. The present focus is a relatively narrow one on the sourcing overseas of goods for consumer sale in a developed country such as Australia (or the UK) and activities undertaken to ensure that such goods have been produced under internationally acceptable labor standards. On this basis, trading can be judged to be more or less ethical on a spectrum from ethical to unethical. "Fair trade" on the other hand is a phrase which has come to cover different although related concerns over the economic relationship between the supplier and the buyer. Those who support "fair trade" products seek to ensure that the producers — generally marginalized small-scale producers of food products — receive a price for their product above that which they could otherwise receive. The opposite of such "fair trade" is "conventional trade". (http://www.parliament.the-stationery-office.co.uk/pa/cm199899/cmselect/cmtrdind/235/235r07.htm#h10)

produce, which under WTO guidelines should be considered if sanitary/phytosanitary provisions can be met. One important on-going challenge is to foster understanding amongst the rural community that "trade is a two-way thing". Enhancing the community's "global awareness" will foster this change, along with recognition that relationship-building and export market development occur through constructive dialogue and innovation, to encourage "win-win" outcomes.

Distribution and processing systems: issues and possibilities

This paper has discussed the overarching issues and used examples to illustrate that two elements of rural development: distribution and processing systems are important for both developed and developing economies. The final part of this paper will consider some emerging key issues that are influencing research, development and governance/regulation of distribution and processing systems, using tropical fruit and legumes as commodity examples.

1 Distribution systems and market access

Tropical fruit The last 25 years have seen new possibilities emerge as transport and cooling systems have extended market options for tropical fruit. Communities have become more aware of the dietary benefits and convenience of increased fruit consumption which has also been directly related to rising incomes in many developing countries (Champ *et al.*, 1994; Widjajanti and Li, 1996). Considerable research and development expenditure has focused on improving technology for fruit production and postharvest handling and processing. And recently, additional emphasis has been placed on molecular improvement of produce suitability and quality, product development (Uehara, 1999), quality assurance (Wong *et al.*, 2000; Tongdee, 2000), contaminants (Karanth *et al.*, 1998; Kennedy *et al.*, 1998) and value chain management (Hofman, 2000; Dietz, 2000). As many of these issues have been reviewed by other authors (e.g. see Johnson *et al.*, 2000b), this paper will concentrate on just two issues affecting tropical fruit industries: value chain management and market access.

Value chain management It is inevitable that retaining market share and competitiveness will depend on maintaining quality and reducing costs. Ultimately in reaching what Mutulu *et al.* (2000) (Table 1) describe as Stage IV development, this will involve a reduction in the number of suppliers at each step in the market chain, and the development of long-term interdependent relationships (Christopher, 1997). For example, smaller numbers of producer-suppliers may be achieved through farm amalgamations, or as horizontal alliances between farmers through cooperative structures or existing merchants/consolidators (Manalili, 2000). In considering the implications for developing countries who are at earlier stages of development, Wilson and Jantrania (1993) concluded that close business relationships were an integral part of less sophisticated community development stages, but suggested that the intentional cultivation of relationships in order to achieve strategic/ national/community aims was a more recent approach, driven in part by globalization, free trade and consumer demands for reliable quality. Key issues are:

* The extent to which all members of the chain have access to important timely information and are empowered to negotiate benefits and innovation processes, and
* A balancing of power, so that the needs of one player or section of the chain do not dominate.

Value chain or supply chain management approaches build upon the concepts of quality assurance (QA), hazard analysis of critical control points (HACCP) and total quality management (TQM) (which focus on product quality and integrity) (Wong *et al.*, 2000; Dietz, 2000), to increase emphasis on personnel, organizational structures and business relationships. Membership of an integrated supply chain allows the benefits of strategies such as relationship selling (Jackson, 1993) to be extended, by developing a capacity to

respond to and anticipate on-going customer needs, as well as to match the quality and value offered by competitors. Of course, such responsiveness depends on both the relationships within the supply chain, and the links for, and capacity of, research and development to fine-tune quality management and develop necessary technologies. In all situations, sharing of information throughout the supply chain is the key to:

* Analyzing market trends,
* Overcoming bottlenecks (e.g. poor product flow) that limit the chain's efficiency,
* Auditing product quality, and
* Solving problems which threaten product competitiveness .

Such knowledge is the basis for industry development strategies - strategies to improve the quality of the product the consumer receives, to develop new, more valuable products (Gwynne, 1998), to manage costs and consumer response throughout the chain, and to act as a barrier to potential competitive suppliers (Christopher, 1997). Under technology-intensive western conditions (and increasingly in developing countries), membership of integrated supply chains provides the opportunity to use information technology for sourcing or transmitting essential information throughout the chain in real time, which is essential in removing constraints such as poor product flow (over- and under-supply).

Whether they involve a major chain supplying the mass consumption market, or a smaller niche supply, the imperative for all industries is to prepare for the future by developing the necessary skills and linkages to deliver consistent quality as required by chain relationships. In developing countries, the industrial crop and fruit processing industries, which already have strong links to multinational companies, have most immediate potential for benefiting from value chain principles, since there is already interdependency between producers and buyers, and there are also additional opportunities afforded by "ethical" and "fair" trading.

Development stage III - Thai durian and longan industries The emergence of industries based around smallholders supplying to mobile packhouses operated by buyers from major markets (for example the Thai durian and longan industries) also represents opportunities for capitalizing on the implementation of value chain principles. Descriptions of the longan and durian industries (Tongdee, 1997; 2000; Nanthachai, 2000; Metussin, 2000) suggest that the industries are facing development stage IV challenges for managing market expansion and regional competitiveness.

Linking research and development (R & D) to the supply chain Postharvest research and development investment is one of several strategies that will contribute to the further development of industries such as the longan and durian industries. But unfortunately, links between research and development and other processes of development (such as value-adding, market-access negotiations, other government policies, the forging of new strategic alliances within industry) in these industries and others, may be relatively fragile. Along with the members of the Global Postharvest Forum PhAction (Johnson *et al.*, 2000a), we propose that to successfully stimulate desirable change, research and development planning needs to be undertaken from the market issues back to production.

Planning research and development within the context of supply chain management and "stage of development" involves characterizing the production, distribution and marketing systems within an industry[2] and the effects of socio-political influences (e.g. government policies which provide assistance or incentives, often independent of improvements in product market performance) (Fig. 1) . Using quantitative and qualitative research methods (La Gra, 1990), and a participatory process of data collection and analysis (Scoones and Thompson, 1994), the areas that are most limiting profitability of the industry as a whole can be identified and appropriate action planned.

R & D knowledge links Supply chain management is about improving relationships and product flow. If we think of "research knowledge" outputs as inputs into the supply chain, collaborative research linkages such as those funded by ACIAR and JIRCAS, can be seen to have a special role in chain management. The research

linkages function in two dimensions, one aims to improve the "knowledge product" supply chain, by examining blocks in the knowledge delivery chain, and by fostering sharing, etc. The other dimension concerns the role of collaborative researchers and their linkages within the agricultural product supply chain, and the improvement of synergies by linking Australian or Japanese researchers with (say) Thai or Vietnamese researchers. R & D links are a special contribution to relationship building, with the potential to streamline and rationalize knowledge generation. Through the links, the researchers can gain new perspectives (or missing facts) on "production issues" or "market quality issues" and reduce the "international cost" of new knowledge.

Acceptance of supply chain approaches In all of the "development stage" examples given in this paper, the sustainable adoption of any new "improvements" (including new R & D links) will depend on sufficient benefit from the outcomes flowing back through the supply chain to encourage those who bear the "cost" (including risks) of the advances. By developing a thorough understanding of the ways in which value (or knowledge) is accumulated and benefits distributed throughout the supply chain, research (and other industry development activities) can potentially be targeted in ways that have both:

* The greatest potential to improve profitability and
* The greatest chance of sustained implementation,

because benefits are likely to flow to those sharing the knowledge or implementing the improved practices.

Comment The international focus on value chains will have important implications for the developing countries that are already involved in international trade:

* Influential buyers will seek to reduce costs by eliminating links and dealing directly with supplier groups (including sources of knowledge), and this may or may not disadvantage developing countries,
* Small but entrepreneurial sellers (and independent technical consultants) may be able to reach "boutique" market customers they never knew existed, and resourceful buyers will find many new suppliers (Neal, 2000).

The challenge for developing countries will be to join compact, intimate chains in which there is close

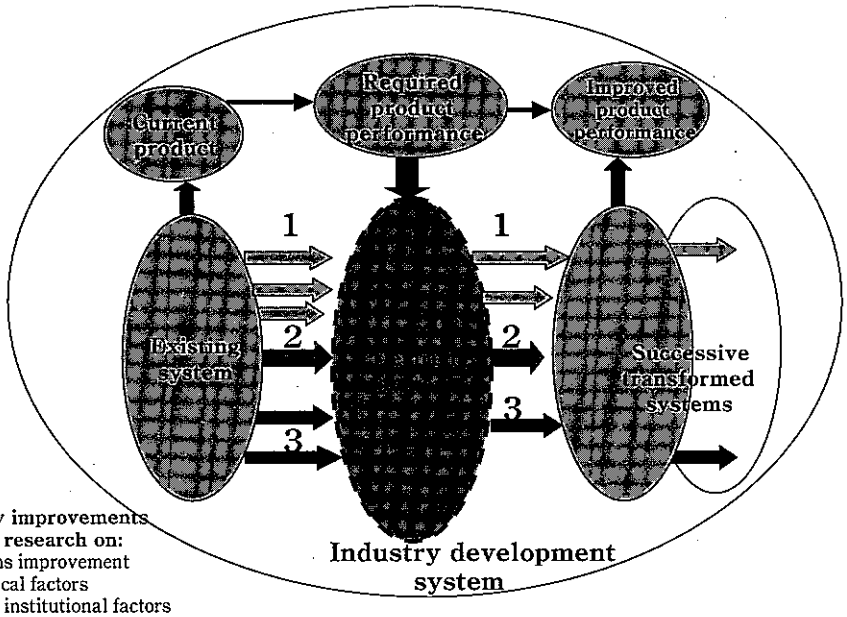

Fig.1 Integrated strands of research to enhance product performance

[2] Including value-adding and product processing opportunities.

cooperation, good communication, early access to new knowledge and improved profits (e.g., potentially, the Thai longan and durian industries). In accessing "boutique" markets, linkages through "ethical trade" groups or NGOs may offer additional advantages.

Market access/quarantine Addressing supply chain quality and relationships is only half of the modern equation for market access. The other half involves the challenges associated with meeting sanitary and phytosanitary requirements of target export markets. Johnson *et al.* (2000a) cited the example of the Australian and Filipino mango industries which have both succeeded in satisfying phytosanitary requirements for market access to Japan through major investments in research and development. In both cases, strong business partnerships have underpinned the development and growth of the markets, hand-in-hand with attention to quarantine and quality standards compliance, and strong retail product promotion. These industries are succeeding. But in considering quarantine requirement compliance and market access approval for other commodities or countries, it is essential that marketing potential be considered. There is little point investing in market access compliance if customer demand for the product does not exist! In accessing new markets, the adage "Fresh is Best" is not necessarily true. Processing and novel product development can add value to perishable commodities while overcoming many of the access restrictions imposed on fresh product.

Global marketing provides the opportunity for countries to have the capability for determining that there is a shortfall in supplies of radishes to Osaka in July (for example), or that pickled radishes are becoming popular in Sydney. And modern communication, technology and infrastructure development and transport make it feasible for growers in (say) Tonga to supply them!

The new economy is all about competing for the future, the capacity to create new products and services and the ability to transform business into new entities that yesterday couldn't be imagined and the day after tomorrow may be obsolete. *Tapscott*

2 Processing systems

Legumes In many parts of Asia, grain legumes play an important role as protein sources in diets. Their ease of storage and transport provides advantages over animal protein sources, but in some cases, constitutive digestive inhibitors prevent consumption in the raw state. Johnson *et al.* (2000a) noted the long history of making fermented foods (e.g. tempeh, soy sauce, miso, natto) (Phithakpol *et al.*, 1995; Uehara, 1999), and many of these foods use legumes as a primary ingredient. Since the processes may have evolved by chance when produce was stored for too long, it is interesting to note that such processes often improve nutritional value, digestibility and microbial safety. In addition to extending shelf-life, fermentation can inactivate digestion inhibitors, improve protein or vitamin content and eliminate mycotoxins[3] from a food ingredient. And, more recently the dietary value for women of the phyto-oestrogens in legumes has also been recognized.

While the history of food processing may be older than agriculture, opportunities occur at all stages of development (Mutulu *et al.*, 2000; Goletti and Samman, 2000) to utilize product innovation as a driver of growth. When commercialized, fermented food products also add value and increase profitability and market opportunities. The production and sale of fermented foods can represent another source of income for women in households, with the additional advantage that income flow can be extended beyond the cropping seasons. In recognition of the importance of food products as a source of income, the Food and Agriculture Organisation of the United Nations (FAO) has devoted one part of its Information Network for Postharvest Operations (INPhO) website/CD-ROM to recipes that incorporate traditional food uses (http://www.fao.org/inpho) (Johnson *et al.*, 2000a).

In producing such foods for sale, microbial[4] contaminant risks to consumers can emerge as a problem.

[3] Ruminant digestive systems also eliminate mycotoxins!

But in developing countries, "transitional" approaches such as guidelines for household production and packaging, and the supply of certified starter cultures, can reduce such risks. Ultimately, consumer purchasing will favor products that are tested or "certified" to comply with set safety guidelines, and mass — manufactured in modern factories. The range of indigenous fermented foods provides a base upon which any country can begin to develop a local food industry and access export markets. But the key to success depends upon developing the technological capability for mass-producing these products (Uehara, 1999), as well as other products familiar to regional neighbors and ethnic communities in Australia, Europe and North America. Given the high demand for such products in the region, and the increasing costs of production in some (e.g. Japan, Korea, Taiwan), opportunities for production in Southeast Asian countries must increase (Johnson *et al.*, (2000a).

Food-borne problems While food safety in developing countries has been a perennial problem, and a driver for improvement of food preservation and storage technologies, in developed countries, food-borne problems have not gone away! In fact they have become more serious and represent a new and challenging problem for us all (Table 2). In 1999, the FAO, the World Health Organisation (WHO) and the WTO, co-sponsored a conference on International Food Trade Beyond 2000 in Melbourne Australia, in recognition of the global transformation of the food system.

Table 2 Food contaminant risks (after Taylor, 2000; van der Venter, 2000)

Organisms		Biological or chemical compounds
Bacteria	**Protozoa**	**Mycotoxins**
Escherichia coli O157	*Cyclospora cayetanensis*	Aflatoxins, Fumonisins
Enteroaggregative *Escherichia coli*	*Cryptosporidium parvum*	Zearalenone, Trichothecenes Ochratoxins
Listeria monocytogenes	**Helminths**	
Multi-drug resistant *Salmonella typhimurium* DT 104	*Anisakis* spp.	**Pesticide residues**
Salmonella enteritidis	**Prions**	**Veterinary drugs**
Campylobacter jejuni	Transmissible spongiform	
Vibrio vulnificus	encephalopathies	**Environmental contaminants**
Streptococcus parasanguinis		Dioxins, Chlorinated biphenyls
	Other agents	Furans
Viruses	Cholera, "aeromonas",	Heavy metals
Hepatitis E	Rotavirus	
Norwalk virus and like viruses		**Food allergens**
		Immunoglobulin E (IgE) mediated
		Celiac disease (gluten)
		Lactose intolerance, favism
		Anaphylactoid reactions
		Idiosyncratic reactions (sulfite-induced asthma)

The conference highlighted the reasons for new concerns about food-related health problems, reviewed the most significant technical innovations in the food industry, and made recommendations, for global co-ordination of effort, in order to effectively address the problem (Byron, 2000; Taylor, 2000; Taeymans, 2000; van der Venter, 2000). Some of the issues and opportunities have also been summarized by Maneepun (1999), Liu (1999); Johnson *et al.* (2000a) and Noguchi (2000).

Food safety In reviewing the need for a co-ordinated global response to the threat of food-borne diseases,

[4] Contamination of fermented foods by undesirable microorganisms can increase food safety risks and mycotoxin levels.

van der Venter (2000) suggested that several factors have influenced the epidemiology of the emerging food-borne problems listed in Table 2:

* *Changes in the pathogens*
  * Natural selection and * therapeutic use of microorganisms.
* *Development*
  * Access to different foods due to production system/environmental changes,
  * Long and complex food chains increasing chances for contamination,
  * Lack of knowledge/ negligence by food handlers and* increased mass catering.
* *Poverty and pollution*
  * Environmental contamination, and poor social conditions,
  * Inadequate food preparation/ storage facilities, and* war and natural disasters.
* *Dietary habits*
  * Preferences for raw or hazardous foods,* and some cultural practices,
  * Diet changes due to higher living standards, urban lifestyles, convenience foods, "junk food" advertising, and
  * Food policy and nutritional recommendations and campaigns.
* *Health sector*
  * Staff losses, privatization of health services *, and*
  * Effects of HIV infection and immuno-suppressive treatments on immunity.
* *Demographic changes*
  * Reduced natural resistance as a consequence of less breast feeding,
  * Longer life expectancy and* birth rate changes.
* *Travel and migration*
  * Trans-border migration and* tourism.
* *Trade in food, animal feed and animals*
  * Smuggling and rapid movement of food, and animals by sea and air* .
* *New food-borne disease carriers*
  * Undercooked or ill-stored street foods, and
  * Contamination of food and animal feeds by excreta (van der Venter, 2000).

The development of workable solutions to the food safety impacts of these factors is the key to addressing the current crisis. Van der Venter (2000) endorsed the need for a thorough understanding of the causal agents of food-borne problems, noting that while the most prominent were of microbial origin, other biological as well as chemical agents were a cause for concern.

Some approaches for mycotoxins and pesticides To reduce mycotoxin and pesticide residue risks, low-cost monitoring and remediation systems are needed. For example, integrated management systems and biological control offer considerable scope for reducing aflatoxin contamination of peanuts (Wright *et al.*, 1999; Dorner *et al.*, 1989; 1998 and Pitt, 1999), while Keller *et al.* (1999) suggested that molecular regulation of the aflatoxin biosynthetic pathway would further reduce contaminant risks. Development of these sorts of technologies will enhance international capabilities for certifying and labelling produce as "low-risk" ?

Product labelling and allergens Another challenge raised at the Melbourne conference was the need for strategies to address food allergies that can affect segments of the population. In further considering this global problem, Taylor (2000) noted that international agreement had been reached that foods and ingredients that are known to cause allergies should always be declared on product labels (Table 3) and that there was an urgent need for government regulatory agencies to adopt and enforce these recommendations. Taylor (2000) also signalled that the consumption of genetically modified foods had implications with respect to food

allergies since it was possible that some genetic modifications might code for novel proteins that could be or could become allergens.

Obviously, food labelling may not be the first imperative for Stage I developing communities. But whatever the stage of development, pathways are needed that do not impede a community's advance to Stage IV. As well, particular effort is needed with respect to food safety, to ensure that remote communities do not become "reservoirs of infection" (See footnote overleaf).

Noting that food-borne problems are a global issue, van der Venter (2000) emphasized that "a unified and joint approach by all countries and relevant international organisations is a prerequisite for the identification and control of all emerging food-borne problems that threaten human health and international trade".

There was a need for:

* A global information system for monitoring food-borne problems,
* Promotion and coordination of research on food-borne problems,
* Standardization of sampling and analysis of food-borne problems,
* Design and implementation of national food control systems[5] in developing countries, aiming to achieve a high level of protection equivalent to that of trading partners,
* Development of a plan of action for global food safety control, to encourage and assist countries to develop acceptable and efficient food control systems and to indicate the "minimum requirements" for food safety control,
* Strengthening of national and international capacities for risk assessment, and
* Support for food safety training, education and communication (van der Venter, 2000).

This action plan, and the concerns expressed by van der Venter (2000) and Taylor (2000), highlight the need for increased attention to R & D directed at reducing risks in all sectors including:

* Better management of production and urban/rural water systems to minimize risks of contamination by spoilage organisms, human pathogens and chemical contaminants,
* Postharvest treatment, packaging, storage and transport, marketing and consumption of produce using technologies that minimize the build-up of damage or consumer hazards, and
* Strategies for addressing the social and geo-political impediments to risk reduction.

Table 3 Common allergenic foods. These, and products of these, should be declared on food labels when they constitute 5 % or more of the food product (after Taylor, 2000)

Cereals containing gluten (wheat, barley, rye, barley, oats),
Crustacea,
Eggs,
Fish,
Peanuts, soybeans,
Milk and lactose,
Tree nuts,
Sulfites (when present at over 10mg/kg).
Adopted by Codex Alimentarius Commission (CAC) 1999

[5] Without regulation of food safety, non-complying countries could "become reservoirs constituting a threat to global food safety" (van der Venter, 2000).

New technologies

Given that food safety has become a culinary minefield, the need for food processing systems that can effectively and reliably minimize health risks is obvious. But food safety is only one of the considerations influencing customer purchase. Other factors include: appetite (what the consumer feels like eating), sensory appeal (flavor, appearance, texture, etc.), nutritional and dietary benefit (protein, fat, vitamins, fiber, calories, etc.) and advertising and lifestyle factors. All these factors need to be considered by the modern food industry as a phenonemon which is both a result, and an opportunity, that arises from the solid scientific foundation to food processing that has emerged in the last century (Taeymans, 2000). Inevitably, new applications for the technologies listed in Table 4 will expand scope for manufacturing products with more of the qualities that constitute "consumer appeal".

"A better understanding of the complexity of foods and drinks has had profound implications for process and product quality." (Taeymans, 2000).

Noguchi (2000) and Taeymans (2000) summarize some of the issues and technologies (Table 4) that are emerging as the food industry recognizes the importance of moving from "food security" to "secure food". They indicate that exciting options are being pursued, with the promise of greater energy efficiencies, consumer attractiveness and food safety, and some at least will have application in developing countries. As was noted by De Padua (2000) however, it will be necessary to develop technologies in a participatory manner if developing country uptake is to be successful.

Table 4 Innovations in food technology (Taeymans, 2000; Noguchi, 2000)

Irradiation
Microwave processing
Thermo-sonication
Freeze drying and freeze concentration
Modified atmosphere packaging (MAP) and active packaging

Conclusions

This paper has reviewed the ways in which processing and distribution systems underpin the stable supply of products from agriculture, forestry and fisheries. It has described their roles as drivers of development, and considered the implications of globalization, as well as the emergence of 21st century "super-bugs" causing food-borne disease. The paper has also discussed supply chain management as it applies to both agri-produce and research knowledge and the importance of giving special consideration to the needs of remote communities.

Distribution and processing systems have played a significant role in the evolution of modern society over the last century. They are the means by which both developed and developing countries will bridge the gap between the "haves" and the "have-nots" of our society. They link the farmer to the towns, and the towns to the world.

The importance of distribution and processing systems at the village level was apparent when a New York Times journalist visited remote Jilin Province in Northeast China in 1998, to observe local government elections. Friedman (1999) noted that of the two candidates for Mayor, amongst the usual promises to the electorate, one candidate promised to get the villagers' vegetables to the townshop more quickly, while the other promised to give everyone the technology for making bean curd!

As Friedman (1999) also noted: Globalization has given more power to individuals to influence both

markets and nation-states than at any time in history.

'Let's not ask what markets we should export to, after having decided what to produce; rather, let's first study the global framework within which we operate and then decide what to produce.'

Jacob Frenkel, Governor of Israel Central Bank, quoted by Friedman (1999).

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