

CHAPTER 9

Institutional innovations and models in the development of agro-industries in India: Strengths, weaknesses and lessons

VASANT P. GANDHI AND DINESH JAIN

9.1 Introduction

Agro-industries have been given high priority in India due to their significant potential for contributing to rural and small farmer development. The emphasis on village-based agro-industries was initiated by Mahatma Gandhi in the 1920s as a part of India's independence movement. However, even today the development of agro-industries is a central part of the national development strategy due to their significant role in bringing value-addition to agriculture's output, increasing rural incomes and employment, and alleviating poverty in the countryside (India, Planning Commission 2008). Having said this, the sector faces a number of challenges and bottlenecks to its growth including difficulties sourcing raw materials, rural market imperfections, supply-chain inefficiencies, investment constraints, and product marketing challenges (Srivastava and Patel, 1994; Goyal, 1994; CII-Mckinsey, 1997; Gandhi *et al.*, 2001). Questions remain as to what institutional arrangements/models would be appropriate and should be encouraged for the organization of agro-industrial activity that would work and maximize the contribution to rural and small farmer development.

Mahatma Gandhi's approach of village agro-based industries was founded on a strong economic, social and political ideology (Goyal, 1994), but later failed because it became a blanket basis for nationalists to favour less efficient techniques of production, oppose modern industry, and foster incompatibilities with market preferences. After independence and up to the early 1980s, agro-industrial policy was dominated by the thinking of Prime Minister Nehru and his economic think-tank led by P.C. Mahalanobis, who argued that India needed large industries for the capital goods sector, while the consumer goods sector should be reserved for small-scale agro and rural industries which were labour-intensive and required less capital. This was

consistent with reducing demand on the limited available capital and savings, and expanding employment. However, such agro-industries failed because of outdated technology and management, and their inability to meet changing and expanding demand for quality goods from a rapidly growing population with rising incomes.

From the early 1980s and particularly after liberalization reforms in the early 1990s, there has been significant opening out towards promotion of agro-industries, stressing market demand, up-to-date technology and efficient management of the supply chain. However, this trend may lead to large, private, capital-intensive agro-industrial enterprises and a strong risk that the interests of small farmers and the rural poor will be bypassed. This would result in a negative outcome for rural employment, and a weakening of the development linkage for which agro-industries have been given priority in India. Major questions for the future remain on what policies and institutional models would be appropriate. In this context, this chapter examines the experience of various innovations and institutional models of organizing agro-industries that have been experimented with in India. The experiences and lessons learned may be useful for future agro-industrial development in India, as well as in other developing countries.

9.2 Features of agro-industries in India

Data from the Annual Survey of Industries (India Ministry of Planning, 2007) shows that 41 percent of all factories in India are agro-industries that contribute 19 percent of the manufacturing value added and 43 percent of manufacturing industry employment (this does not include the employment generated in the agriculture sector). These figures indicate that agro-industry contribution to both employment and manufacturing GDP is very significant, substantiating the national priority status that has historically been given to this sector in India (Table 9.1).

What are the structural and financial characteristics of agro-industries in India? Table 9.2 shows that only 21 percent of total industrial fixed capital is invested in agro-industries, while the sector employs 41 percent of Indians engaged in industrial employment. This tells us that, on average, agro-industry continues to be relatively labour-intensive and capital saving. The share of payment to labour out of the total value added is also greater at 35 percent in agro-industries, compared with 21 percent in other industries.

Furthermore, agro-industries require relatively less fixed capital and more working capital as compared with other industries (43 percent vs 30 percent). Agro-industries on average are able to generate employment for 31 persons per fixed investment of 100 000 rupees (Rs.), whereas the figure for other industries is much lower at 11 persons. These figures do not include added employment generated in agriculture and the input supply chain through backward linkages. On average, agro-industries generate 47 percent value added income over invested fixed capital annually, as compared with

TABLE 9.1
Importance of the agro-industry sector in India: some features (2005/06)

Industries	Percentage share		
	No. of factories	Employment	Net value added
Agro-based food industries	18.35	15.27	7.52
Agro-based non-food industries	22.69	27.63	11.45
Total agro-based industries	41.05	42.90	18.97
Other (non-agro) industries	58.95	57.10	81.03
All industries	100.00	100.00	100.00

Source: Ministry of Planning, 2007.

53 percent for other industries. Agro-industries are also able to absorb more inputs from other sectors (e.g. agriculture) as a percentage of the value of output compared with other industries. These features indicate that the agro-industrial sector deserves the priority given to it in the national strategy of development with employment.

The Food and Agriculture Integrated Development Action Plan (FAIDA) report of the Confederation of Indian Industry (CII) and McKinsey and Company (1997) shows that there is great scope and potential for development of food processing and agro-industries in India. However, there are various major constraints to the rapid development and growth of agro-industries in the country. The literature indicates that agro-industrial growth in India has historically been constrained by both supply of raw materials and slow growth in consumer demand for agro-industrial products (Srivastava and Patel, 1994; Boer and Pandey, 1997). Srivastava and Patel (1994), Kejriwal (1989) and Gulati *et al.* (1994) indicate that apart from the quantity of raw materials, the quality of the raw material is also a major constraint. Available raw material is often of unsuitable quality, processing varieties are frequently not available, and the period of availability of the raw material is too short and unreliable. Gulati *et al.* (1994) indicate that only about 5 percent of the fruits and vegetables grown in India are commercially processed. Both quantity and quality supply constraints indicate that there is a major need to improve the linkages between small farmer suppliers – who constitute the majority of raw material producers – and agro-industries. Effective and innovative institutional arrangements that would address multiple objectives are required.

Srivastava and Patel (1994) indicate that another major constraint is the obsolete technology used in processing, resulting in low efficiency and poor quality of output.

TABLE 9.2
Some structural and financial features of agro-industries in India (2005/06)

Description	Share of fixed capital (%)	Total persons employed per factory	Fixed capital per factory (Rs. million)	Emoluments as a percentage of net value added	Percentage of working capital to invested capital	Net value added to fixed capital	Employment to fixed capital ratio (per Rs. 222100 000s)	Material input consumed to value of output
Agro-based food industries	7.47	54.10	17.63	31.19	50.72	51.71	30.68	84.68
Agro-based non-food industries	13.41	79.16	25.60	37.44	36.55	43.84	30.92	76.84
Total agro-based industries	20.89	67.95	22.04	34.96	42.47	46.66	30.84	80.62
Other (non-agro) industries	79.11	62.96	58.11	21.10	29.51	52.63	10.83	75.82
All industries	100.00	65.01	43.30	23.73	32.68	51.38	15.01	77.01

Source: Ministry of Planning, 2007.

According to Boer and Pandey (op. cit.) a major problem in improving technology is the very small size of the average agro-processing unit, suggesting a clear need to integrate in order to achieve a larger scale of operation. However, Goyal (op. cit.) and others have shown that private sector industrial concentration is often associated with delinking from small farmer suppliers and losses in rural employment.

Srivastava and Patel (1994) show evidence of two additional major constraints to Indian agro-industrial development, namely the small market size for many processed products, and difficulties in obtaining adequate financing. The financial institutions in India are mainly geared to lending for fixed capital requirements, while agro-industries, as shown in the analysis above, have a large requirement of working capital. Banks lend working capital, if at all, at higher interest rates than other capital loans. Furthermore, the government of India typically considers processed and packaged goods as luxury items; as a result, their production is heavily taxed. There are also myriad special regulations and licensing requirements for specific agro-industries, such as the Milk Product Order for the dairy industry. These policies create disincentives for investment in higher value-added agro-processing.

9.3 Agro-industry models in India

The challenges arising from the aforementioned constraints in the creation and functioning of agro-industries on the one hand, and the need for their continued growth to contribute to rural and small farmer development on the other, call for new and innovative approaches and models for their organization in India. Several models have been tried and need to be evaluated to provide lessons for what is required in the future in India, and perhaps other parts of the developing world as well.

Whatever the nature of the model, a few key success factors have been observed (Gandhi *et al.*, 2001):

- ▶ creation of sufficient incentives for farmers to produce the required quantity and quality of raw materials, and supply the produce as stipulated in the contract (rather than sell elsewhere)
- ▶ required farm inputs and technology need to be provided and the question of who bears what costs (and risks) should be transparent and well understood;
- ▶ access to high quality processing technology;
- ▶ ability to address new and changing consumer demand through effective market intelligence;
- ▶ adequate performance and capability to attract capital for investment and growth;
- ▶ overall, adequate attention to the crucial issues of ownership, organization, management and quality control.

Some significant questions asked in this light are:

- ▶ How do the models perform in organizing production and procurement from large numbers of small farmers, thereby ensuring a significant impact on rural incomes and employment?
- ▶ To what extent are the models able to ensure adoption of appropriate modern technology and practices by the farmers, generating the required quantity and quality of output at a reasonable cost?
- ▶ Are the models able to ensure the use of up-to-date modern technology in processing and meeting the high working capital and other capital needs in a business characterized by seasonality and variability?
- ▶ Are the models able to deliver the necessary strong marketing efforts to compete in and open up nascent markets for processed agri-food products?
- ▶ Are the issues of sound ownership, management and control, adequately dealt with to ensure sustained performance in delivering benefits to the main stakeholders, including the farmers, consumers, investors and the government (nation)?

9.4 Study of different agro-industry models

This section examines a range of different agro-industry models that have emerged and developed in India. They include government, cooperative and private business initiatives, and span many sub-sectors including dairy, fruits and vegetables, grains and oilseeds, horticulture and poultry. Using the available literature, the section examines their evolution, structure and operation, and provides observations on their performance with respect to the questions posed above.

9.4.1 Model 1: The AMUL cooperative model

A model which has been quite successful in certain agro-industries (such as dairying) is the cooperative model of the Kaira District Cooperative Milk Producers' Union (AMUL). This approach evolved out of a successful dairy cooperative initiative in the Kaira district of Gujarat state. Even though milk was produced efficiently in the rural areas of India, its movement from rural areas to urban markets, where demand was high, was difficult. As a result of this private dairying had picked up in urban areas and the urban periphery, but this production method proved troublesome, unhygienic and inefficient. Seeing the opportunity, a private dairy at Anand in Gujarat state, Polsons, developed a business of milk procurement from the rural areas in the Kaira district through middlemen, for its processing and transport to Bombay some 425 km away (Korten, 1981).

In the mid-1940s, however, in the face of Polsons' exploitative practices and resentment towards its middlemen, the milk producers/farmers of Kaira district went on strike, refusing to supply to Polsons. On the advice of a prominent leader of India's independence movement, Sardar Vallabhbhai Patel, they decided to come together

to form a cooperative body of their own. This body later became the Kaira District Cooperative Milk Producers' Union, popularly known as AMUL (based on its original name of Anand Milk Union Limited). The cooperative union started procuring milk through affiliated village milk cooperative societies, processing it, and sending it by its own means to Bombay. The model and its methods were perfected by the cooperative under the leadership of its enlightened chairman, Tribhuvandas Patel, and its competent professional manager, Dr Varghese Kurien. It has grown enormously over the years, spawning other district unions and becoming a state cooperative federation that now markets milk products across the whole country (Table 9.3).

TABLE 9.3
AMUL at a glance

Members:	15 District Cooperative Milk Producers' Unions	
No. of producer members:	2.7 million	
No. of village societies:	13 141	
Total milk handling capacity:	10.21 million litres per day	
Milk collection (total 2007–08):	2.69 billion litres	
Milk collection (daily average 2007–08):	7.4 million litres	
Milk drying capacity:	626 metric tonnes per day	
Cattle feed manufacturing capacity:	3 090 metric tonnes per day	
Sales turnover	Rs. (millions)	US\$ (millions)
1996–97	15 540	450
1997–98	18 840	455
1998–99	22 192	493
1999–00	22 185	493
2000–01	22 588	500
2001–02	23 365	500
2002–03	27 457	575
2003–04	28 941	616
2004–05	29 225	672
2005–06	37 736	850
2006–07	42 778	1 050
2007–08	52 554	1 325

Source: <http://www.AMUL.com/business.com>.

AMUL's structure

In this model, ownership rests with the farmers on a cooperative basis. It has a three-tier organizational structure, with primary cooperatives at the village level, a cooperative union at the district level, and a cooperative federation at the state level. Broadly, the village cooperatives take responsibility for procurement of the produce from the farmers, the district union is responsible for transportation and processing, and the federation is responsible for marketing and strategic planning and investment. The cooperatives are governed by a rotating board of farmer-elected directors, but the management is carried out by professional managers who are properly empowered and largely independent. Apart from the agro-industrial activity of the dairy business, the cooperative undertakes substantial developmental, agricultural, and dairy extension activities, and provides veterinary, breeding and other services.

The primary level under the three-tier structure is the Village Cooperative Society. Its membership consists of village milk producers (usually 200 or more members per village) and is governed by an elected Managing Committee consisting of 9 to 12 elected representatives of the members. The Managing Committee elects a Chairman and appoints a Secretary and staff. The main function of this cooperative society is to collect milk from the milk producers of the village and make payments based on quantity and quality. It also provides support services to the members such as veterinary first aid, an artificial insemination breeding service, sale of cattle-feed, mineral mixtures, and fodder seeds, and training on animal husbandry and dairying.

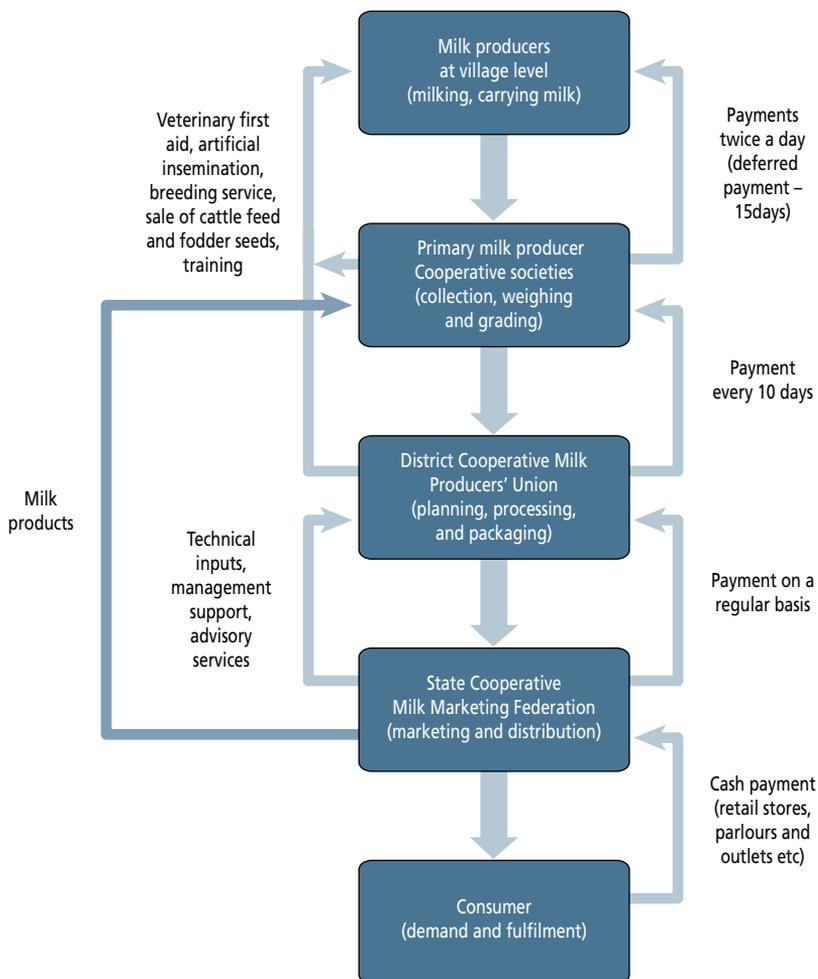
The district-level Milk Union is the second tier under the three-tier structure. Its membership consists of Village Societies of the district through their Chairmen, and is governed by an elected Board of Directors consisting of 9 to 18 elected representatives from among the Village Society Chairmen. The Board of Directors elect a Chairman and appoint a professional Managing Director and staff. The main function of the Milk Union is to procure raw milk from the Village Societies of the district, transport it from the villages to the Milk Union owned dairy plant, and process it into pasteurized milk and other milk products. It also offers significant supporting activities such as veterinary services, breeding services, cattle feed and other inputs for the village societies and producers, and undertakes initiation, training and supervision of the village level societies.

The State-level Federation is the apex tier under the three-tier structure. Its membership consists of Milk Unions of the State through their Chairmen, and is governed by an elected Board of Directors from among the Chairmen of Milk Unions. It elects a Chairman and appoints a professional Managing Director and staff. The main function of the Federation is the marketing of the milk and milk products manufactured by Milk Unions. The Federation manages the distribution network for marketing of milk and milk products and maintains the supply chain network. It also provides support services to the Milk Unions such as technical inputs, management

support and advisory services. The structure and services of the model are outlined in Figure 9.1.

Though not as significant at the national level, the National Cooperative Dairy Federation of India (NCDFI), is another national body that formulates, promotes and lobbies for policies and programmes to help safeguard the interests of milk producers.

FIGURE 9.1 Outline of the structure and functioning of the AMUL model



Source: based on Sridhar and Ballabh (2006).

Political functioning

At the village level, a Dairy Cooperative Society is formed with primary milk producers. A milk producer becomes a member by paying an entrance fee and buying a share of the Society. A farmer producer becomes eligible for a voting right in the Society if she/he is a member and supplies at least 700 litres of milk per year, with 180 days of supply in a year. The allocation of voting rights is by 'one member one vote'. Members of the Society elect a managing committee as per the by-laws, and the committee elects its Chairman. Committee members are honorary and their role is restricted to policy formulation and overseeing the programme. The Society undertakes a few critical functions like collecting milk (twice a day), making regular payments to milk supplier members, and providing cattle feed, fodder, animal breeding and health care services to members.

Member producers bring milk to the Society every morning and evening. Initially, the Union provides each Society with a fat testing machine free of charge. The quality (i.e. fat content) and quantity are assessed, and the amount payable to each producer is worked out. When the producer comes to the centre in the evening, she/he is paid for the morning delivery; for the milk delivered in the evening, money is paid the next morning. Apart from the daily cash income, members also receive bonuses and a difference in price at the end of the year. The amount of the bonus is pro rata to the value of milk supplied by the producers at the Society. The Society also makes profit on the milk it sells to the Union and receives the difference in price. The entire profit of the Society is generally not distributed to member producers. A part is allotted for developmental activities within the village and maintenance of the Society. Societies also act as disseminators for various activities of the Union such as member education and production enhancement. The staff at the Societies are also trained to undertake veterinary first aid and artificial insemination.

The Cooperative Union is the representative of all the Village Societies located at the district level and is governed by a Board of Directors made up of representatives from village societies, financial institutions, the State cooperative department, dairy experts, the Federation, government nominees, and the Managing Director of the Union. The Board elects a Chairman and Vice Chairman and appoints a Managing Director who in turn appoints supporting staff. The Board is responsible for policy formulation and the staff are responsible for looking after the day to day operations. One-third of the village representatives on the Board retire every year and the vacancies are filled by election. The Chairman is elected every year.

Practical functioning

Given the perishable nature of milk, it was imperative for the Cooperative to devise ways and means of transporting the milk procured from distant villages in the shortest possible time, and under refrigerated conditions to the processing units. Hence, milk transportation routes are designed in a manner that all villages are covered in the shortest possible time and in a cost-effective manner.

Bulk cooling units and chilling centres are often set up along these milk routes. Milk is collected by unions from villages twice a day with the help of contracted private transport vehicles. Milk from the Society is measured for its quantity and quality (Fat and SNF, i.e. 'Solids Not Fat') and is paid for on this basis. Payments to the Societies are made every 10 days. Cooperative Unions also provide many services to their farmer members. The Union runs mobile veterinary dispensaries to provide veterinary care free or at a small charge to the members, runs semen production centres for breeding, trains the Society staff in artificial insemination (AI), and conducts various technical extension programmes for increasing the production of milk.

The Gujarat Cooperative Milk Marketing Federation (GCMMF) is the sole marketing agency for the products produced by different cooperative unions, under the popular brand names 'AMUL' and 'Sagar' (Kurien, 2003) and has a network covering over 3 500 dealers and 500 000 outlets (Subramanyam, 2004). There are 47 depots with dry and cold warehouses to carry inventory of the entire range of products. The distribution network comprises 300 stock keeping units, 46 sales offices, 3 000 distributors, 100 000 retailers with refrigerators, an 18 000-strong cold chain, and 500 000 non-refrigerated retail outlets. Products marketed include fresh milk, UHT milk, brown beverage milk drink, infant milk, milk powders, sweetened condensed milk, butter, cheese, ghee, yogurt/curd, breads, pizza, *mithaae* (ethnic sweets), icecreams, chocolate and confectionery. The network follows an umbrella branding strategy. AMUL is the common brand for most product categories produced by various unions. By insisting on an umbrella brand, GCMMF avoids interunion conflicts and creates opportunity for the union members to cooperate in developing products.

GCMMF's technology initiatives include development of new products, processing technology, measures to enhance milk production and quality, and e-commerce. Village societies are encouraged through subsidies to install chilling units. Automation in processing and packaging areas is adopted, as is Hazard Analysis and Critical Control Points (HACCP) certification. GCMMF actively pursues development of embryo transfer and cattle breeding in order to improve cattle quality and increase milk yields. Another initiative underway is to provide farmers with access to information relating to markets, technology and best practices in the dairy industry, through Internet-enabled kiosks in the villages. GCMMF has also implemented a Geographical Information System (GIS) at both ends of the supply chain, i.e. milk collection as well as the marketing process.

Conclusions

AMUL represents a methodology of building and sustaining an economic enterprise and has ensured high levels of patronage, cohesiveness, governance and operational effectiveness (Shah, 1996). The cooperative model benefits from commitment from the farmers, and cost-efficiency in raw material production and procurement. It also extensively engages with small farmers as well as the landless rural poor, who despite their impoverished state may keep 1–2 animals, and is reported to contribute significantly to rural incomes and employment through its

three-tier organization. However, its drawbacks include its need for enlightened and committed leadership (through its governing board), and capable management, which is sometimes difficult to ensure. The board is elected and may become politicized, detracting from sound cooperative and business practices. Further, antiquated laws governing cooperatives invite government interference and prevent use of financial markets for raising equity capital, thereby constraining expansion and growth to some extent.

9.4.2 Model 2: The Nandini model

Another similar agro-industry model on cooperative lines is 'Nandini' of the Karnataka Cooperative Milk Producers' Federation Limited (KMF). KMF is the Apex Body of dairy farmers' cooperatives in Karnataka state in south India, and is the third largest dairy cooperative in the country. In south India it stands first in terms of procurement as well as sales. The brand 'Nandini' is a household name in Karnataka state for pure and fresh milk and milk products. KMF has 13 milk Unions throughout Karnataka state that procure milk from primary dairy cooperative societies, and distribute it to consumers in various cities, towns and rural markets in Karnataka. The district milk producer unions receive milk from 11 000 primary dairy cooperative societies which are at the *taluka* (sub-district) and village levels. About two million dairy farmers in Karnataka state are covered. The growth of KMF over the years is summarized in Table 9.4.

The cooperative evolved under a dairy development programme in Karnataka begun in 1974 with financial assistance from the World Bank under Operation Flood II and III national dairy development programmes. Village dairy cooperatives were promoted

TABLE 9.4
Growth of Nandini

		1976–1977	2007–2008
Dairy cooperatives	Numbers	416	11 063
Membership	Numbers	37 000	1 956 163
Milk procurement	Kgs/day	50 000	3 025 940
Milk sales	Litres/day	95 050	2 129 790
Cattle feed consumed	kg/DCS*	220	3 010
Daily payment to farmers	Rs. 100 000s	0.90	342
Turnover	Rs. billions		27.07

Source: <http://www.kmfndini.coop/>

* DCS means District Cooperative Society. There are currently 13 such unions and the statistic are average per union.

in the AMUL style, in a three-tier structure with the village level dairy cooperatives forming the base level, the district level milk unions the middle level to take care of procurement, processing and marketing, and the State milk federation as the apex body to coordinate at the State level. Coordination of activities among the Unions and developing markets for milk and milk products is the responsibility of KMF. However, unlike AMUL, the marketing of milk in the district jurisdiction is organized by the respective milk unions. The surplus or deficit of liquid milk among the member unions is monitored by the federation. All the milk and milk products are sold under a common brand name, Nandini.

The milk unions also provide the following technical inputs at subsidized rates or free of charge to their members:

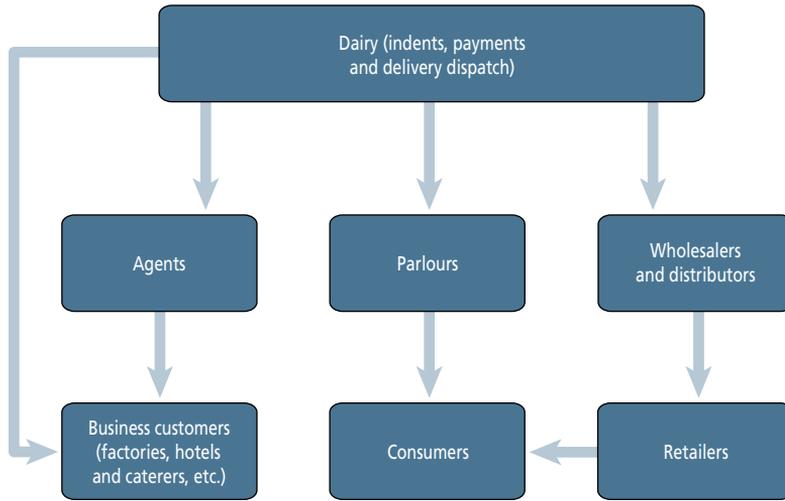
- ▶ veterinary emergency services round the clock at the milk producer's door step;
- ▶ free animal health camps conducted by veterinary staff at village level;
- ▶ provision of animal feed and planting material to grow fodder crops;
- ▶ artificial insemination (AI) services to crossbreed animals, and free infertility camps at village level;
- ▶ free vaccination to protect animals against diseases like Foot and Mouth, Theileriasis etc;
- ▶ free training for milk producers and District Cooperative Society (DCS) staff;
- ▶ empowerment programmes for women in association with the Government of India (GOI) by forming women's cooperatives governed by women;
- ▶ on the death of a milk producer, payment by the Union of Rs. 10 000 to next-of-kin through dairy farmers' welfare trusts, providing scholarships and fellowships for the education of the milk producer's children.

KMF supports the livelihoods of around 1.95 million dairy cooperative members through over 11 000 dairy cooperative societies. KMF has become the second largest milk-procuring organization in the cooperative sector, with daily milk procurement of 3.02 million litres. This has resulted in a 'white revolution' in Karnataka: milk procurement has increased 2.5 times in the last 10 years; the sale of milk per day has reached 1.7 million litres, increasing by 1.4 times; milk procurement is growing at 9.65 percent annually against the national average growth of 4.8 percent. Improved technical inputs such as animal health care, artificial insemination services and cattle feed supply have made a significant contribution to this trend. The surplus milk is sold to neighbouring milk deficit states such as Kerala, Andhra Pradesh, Goa, Maharashtra and Pondicherry, and the rest is converted into products. The Nandini product family consists of 35 products and new products are frequently added after market research. The marketing system and network are outlined in Figure 9.2(a).

The major challenges facing the Nandini model are:

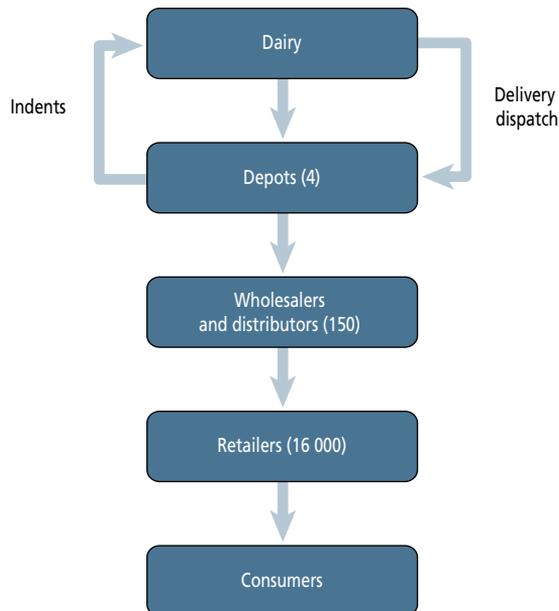
- ▶ inadequate processing facilities;
- ▶ difficulties in maintaining the quality of raw milk under the prevailing conditions;

FIGURE 9.2(a) Milk distribution network of Nandini



Source: Based on Revanna (2006).

FIGURE 9.2(b) Milk products supply chain of Nandini



Source: Based on Revanna (2006).

- ▶ increasing costs of transportation and processing;
- ▶ unhealthy competition from private dairies in procurement;
- ▶ inadequate roads and power infrastructure.

Some of these problems seem to stem from a relatively limited role of the Federation (compared with AMUL), and as a result, inadequate scale economies and lack of support in larger roles such as marketing, investment and logistics.

9.4.3 Model 3: The Nestlé model

Nestlé is the largest food and beverages company in the world. The company uses the milk district model for its agro-industrial activity in India. Nestlé India started its operation in the Moga district of Punjab in 1961 by setting up its first milk factory in India. The factory produces milk powders, infant products and condensed milk. The annual fresh milk intake of the Moga factory rose from less than 12 000 tonnes in 1970 to 240 000 tonnes in 2003, obtained from 85 000 farmers. By 2008, it covered 100 000 farmers and had an intake of 1.25 million litres milk/day. Nestlé India states that it supports a system of sustainable dairy farming with regular milk payments and sustainable methods, and claims that it has a positive impact on the community and rural economy of Moga as a whole.

Setting up a milk district involved:

- ▶ negotiating agreements with farmers for twice-daily collection of their milk;
- ▶ installing chilling centres at larger community and collection points or adapting existing collection infrastructure;
- ▶ arranging transportation from collection centres to the district's factory;
- ▶ implementing a programme to improve milk quality.

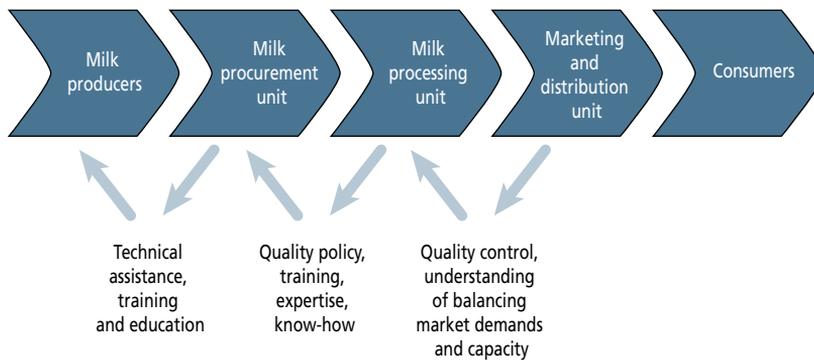
Nestlé India has its milk processing factory in the town of Moga and sources raw milk from the districts of Moga, Ludhiana, Sangrur, Mukatsar, Ferozepur and Faridkot. These districts have been collectively referred to as 'Moga Milk District'.

Selecting a location for collection points is based on several factors:

- ▶ present milk production and the potential of the area based on available fodder resources, agricultural land, and farmers' interest in dairying;
- ▶ present milk production costs and milk prices in the area;
- ▶ the income farmers could earn from fresh milk versus the income from alternative (i.e. not supplementary) crops;
- ▶ present milk collection systems (if any), the presence of competitors, present milk quality and the potential to achieve the required quality.

To ensure quality, Nestlé undertakes training and has manuals detailing good farm practices for each district. The farms are audited regularly to make sure the right practices are followed. The company provides technical support to farmers to guide them in reaching the quality standards. Testing is done at the collection centres and cooling centres (Goldberg, 2006). Surpluses present a challenge for Nestlé and the farmer: the company tries to offset the expense of buying up surplus in the spring season against the security of a steady supply at a stable price throughout the entire year. The chain structure is outlined in Figure 9.3.

FIGURE 9.3 Nestlé's milk value chain



Source: Nestlé.

Some 64 320 dairy farmers supply milk under contract and the company maintains their records. The company has stringent quality specifications. Nestlé staff members regularly monitor milk quality and performance *vis-à-vis* contractual obligations, and the farmers obtain feedback on milk quality at the collection points. Company technologists determine quality in laboratories with samples being taken in the presence both of the farmers and the company representatives. Nestlé is not obliged to collect milk that does not meet the quality standards specified in the contract. The contract also allows the technologists to penalise the producer with a 30-day ban; if antibiotics are found, the price of milk is reduced by 15 percent. Repetition of any discrepancy is considered a serious breach of contract. Farmers have the right to complain through registers located at each collection point if they believe there is a problem. The system still works because it provides an assured market for the farmers at remunerative prices for the milk.

Nestlé states that the milk district model has changed the lives of farmers and also boosted the company's bottomline. The small township of Moga in Punjab is today on the world dairy map. Moga processes over 1 million litres of milk every day, twice the amount processed in the rest of Punjab. The company procures over 1.1 million kg of milk per day from the states of Punjab and Haryana during the peak season, covering 14 000 square kilometres and 98 000 dairy farmers through an efficient milk collection system, with a network of 2 240 milk agencies, and 698 milk cooling centres. It also provides farmers with training and advice on correct dairy farming practices. A news report indicates that covering even 90 000 farmers and ensuring timely payment, linked to both quantity as well as quality for the milk supplied, is no small task. It is certainly something that very few private corporates have attempted and actually succeeded in doing (*Business Line*, 9 December, 2001).

Comparison of the Nestlé model with the AMUL model

In the 'Anand model' run by AMUL, the primary milk collection centre is the village cooperative society, an elected body that is owned and directly accountable to the dairy farmers themselves. In the 'Moga model', the job of sourcing milk from farmers is carried out not by a cooperative society, but a private commission agent appointed by the company. Nestlé operates a network of 1 100 agents who receive a 2.3 percent commission on the value of the milk supplied to the dairy. The agent and the farmers are paid on a consolidated fortnightly basis, unlike the system of daily milk payments to farmers used by AMUL.

In terms of scale and reach, Nestlé's milk procurement pales in comparison with that of AMUL. During 2000–2001, AMUL's unions procured an average of 4 576 million kg of milk per day from over 2 million farmer-members in Gujarat. The unions procured 31.4 percent of Gujarat's estimated milk production of 5 313 million tonnes in that year, implying that almost every third litre leaving a milch animal's udders in the State ended up being collected by societies affiliated to AMUL. Meanwhile Nestlé's operations are much smaller and confined to districts around Moga. The company's average procurement of 0.65 million kg per day covers barely 3 percent of Punjab's annual milk output of 8 million tonnes. The average Nestlé farmer pours about 7.25 kg of milk per day, whereas the corresponding figure for AMUL is slightly over 2 kg per day, indicating that the latter's reach perhaps extends to small/marginal farmers and landless farm labourers who may own only 1–2 milch animals (*Business Line*, op. cit.).

With respect to price, Nestlé in 2000–2001 paid an average price of Rs. 9.84 per kg, lower than the Rs. 13–14 per kg that AMUL paid to its farmers. However, about 45 percent of Nestlé's procurement is cow milk with fat content of about 3.5 percent, as against the bulk of AMUL's procurement being buffalo milk with a fat content of about 6.5 percent or more. Adjusting for this, there is little difference between the farm gate prices paid by Nestlé and AMUL. This would be also be offset by the higher productivity of the animals – especially cross-bred cows – that enables the Nestlé farmer to deliver more than three times the quantity of milk that an average AMUL farmer pours (*Business Line*, op. cit.).

In 2000–2001, Nestlé’s payments to Moga’s farmers for procurement of milk amounted to nearly Rs. 1 950 million. If one adds to this the value of various developmental inputs provided by the company – free veterinary aid, breed improvement and extension services, subsidies on installation of farm cooling tanks, etc – the amount paid to farmers would be around Rs. 2 040 million. This amounts to almost 47 percent of the value of the company’s sales of milk products. In comparison, this proportion for AMUL and its unions is over 80 percent. As part of the equation it must be noted that Nestlé is a company accountable to its shareholders and investors, while AMUL is an entity accountable to and owned by the farmers themselves (*Business Line*, op. cit.).

9.4.4 Model 4: Heritage Foods

The Heritage Group based in Andhra Pradesh was founded in 1992 by Chandra Babu Naidu, the former Chief Minister of Andhra Pradesh. It is a fast-growing private enterprise with three business divisions, dairy, retail and agri, under its flagship company Heritage Foods (India) Limited (HFIL). Heritage’s milk products have a market presence in the states of Andhra Pradesh, Karnataka, Kerala, Tamil Nadu and Maharashtra, and it has retail stores in the cities of Hyderabad, Bangalore, and Chennai. Integrated operations in Chittoor and Medak districts form the backbone of the retail operations. Heritage is considered a successful dairy enterprise and is known for its high quality standards and premium range of milk and milk products. It follows international standards in manufacturing, packing and distribution practices and has become an ISO 22000 certified company. Heritage has 12 packing stations and 74 chilling centres/bulk coolers with operationally-safe processing equipment. The products are sold under the brand ‘Heritage’.

The company covers about 200 000 farmers and has the capacity to process 1.5 million litres of milk per day. Products include full cream milk, toned milk, double-toned milk, cow milk, UHT milk (tetra pack), cow ghee, buffalo ghee, cooking butter, fresh cream, skimmed milk powder, curd (cup and pouch), flavoured milk in bottles and tetra packs of butter, milk lassi, paneer doodh peda, ice cream and bread cookies. The annual turnover reached Rs. 34.7 million in 2006–2007.

Heritage has established a supply chain which procures milk from farmers in rural areas, mainly in Andhra Pradesh and some parts of Karnataka, Maharashtra and Tamil Nadu. The Heritage model’s starting point involves harnessing the current milk collection centres – which are also rural retail points – and thus use them to penetrate the rural market. Two-way or reverse logistics are used to transfer and sell goods from the urban markets to rural markets, and through this direct retail presence also mobilize milk procurement. This enables economies of scale in supply chain costs, serves both the rural customer and producer, and improves penetration in the rural areas.

It connects to consumers through representatives – who are also milk collection representatives of Heritage – that sell consumer goods. This provides opportunities

for Heritage to launch its private labels in rural markets. The company's rural retail network has increased to 1 515 stores with 13 distribution centres. A typical rural store is about 10 square metres in size and is based on a franchise model to cater to villages with a population of less than 5 000. The objective is to deliver popular fast-moving consumer goods (FMCG) products and quality groceries at affordable prices to interior villages across South India, leveraging the milk procurement network. Apart from milk, vegetables and seasonal fruits are also produced and procured through contract farmers and reach pack houses via collection centres strategically located in identified villages. The collection centres undertake washing, sorting, grading and packing and dispatch to retail stores through distribution centres. Other features of the model include:

- ▶ promotion of an annual crop calendar of sourcing that seeks to ensure higher annual income per unit area;
- ▶ technical guidance – agri-advisory services, regular training of farmers, credit linkage and input supply;
- ▶ a package of improved farm practices for better productivity and quality;
- ▶ an assured market at the doorstep;
- ▶ assured timely payments;
- ▶ transparency in operations.

The Heritage model provides an example of using the existing marketing points and chains for the purpose of agro-industry rather than building new/dedicated chains. This may achieve faster roll-out and reach. It also provides an example of using two-way or reverse logistics for improving the efficiency and economics of the supply chain. Both these methods are not seen in the AMUL, Nandini or Nestlé models.

9.4.5 Model 5: Mother Dairy

Mother Dairy (Delhi) was set up by the National Dairy Development Board (NDDB) under the first phase of the Operation Flood Programme in 1974, with the objective of improving the availability of liquid milk to city consumers. Mother Dairy is a subsidiary of the NDDB. Even though Mother Dairy is not owned by the farmers, it is associated with the Anand Model cooperative set-up. Given the potential markets for liquid milk in the big cities, entities like Mother Dairy were established in all the four major Indian metros – Mumbai, Kolkata, Chennai and Delhi – and were also set up in all state capitals. The objective was to help those cooperatives who needed help to process and market the milk.

It is estimated that Mother Dairy Delhi commands 40 percent market share in the organized liquid milk sector in and around Delhi. The Mother Dairy brand name is used for distributing milk in the Delhi national capital region. In Delhi and at national level, Mother Dairy also markets dairy products such as ice creams, flavoured milk, dahi, lassi, mishti doi, ghee, butter, cheese, dairy whitener, the Dhara range of edible oils, the Safal range of fresh fruit and vegetables, frozen vegetables and fruit juices.

Mother Dairy sources its entire requirement of liquid milk from dairy cooperatives – it buys the liquid milk from state federations. Because it runs on the principle that the landed price of milk at Delhi should be the same for all, only state federations near Delhi supply milk to Mother Dairy. Profitability is not the core motive and procurement is done more or less at the market price. Marketing is mainly carried out through bulk vending machines, apart from 12 packaging stations for polypack preparation that are outsourced from the state federations. The costs of the processing units are borne by the federations whereas those of the distribution centres are borne by Mother Dairy.

Mother Dairy pays almost 70 percent of the market price to the milk suppliers. The payment is made through cheques and the milk suppliers receive the payment within 10 days. The surplus from the remaining amount is shared among Mother Dairy, state federations, district unions, and the village-level societies. For the procurement of fruit and vegetables, the grower associations are paid a commission of 1.75 percent to meet the expenses of running the association.

The annual turnover of liquid milk distribution is about Rs. 12–13 billion and the total turnover of Mother Dairy is Rs. 27 billion. Bulk vending milk sales are growing at 3–4 percent per annum, whereas polypack milk sales are growing at 12–13 percent.

Mother Dairy brought significant benefits to the farmers by assisting in the marketing of the dairy cooperative's milk. Recently, Mother Dairy has been facing competition from other organized retailers, and maintaining quality is also a major challenge. The reach of the Mother Dairy model to farmers depends substantially on the efficiency and the effectiveness of the cooperatives, given that it does not connect with the farmers directly. On the other hand it assists the farmer bodies to market the milk in the vast markets of the major urban areas – a capability many of them lack. It also undertakes the necessary investments for processing and distribution which are difficult for some of the farmer bodies to carry out.

TABLE 9.5

Mother Dairy daily milk sales – July 2007 (litres)

Variant	Milk shop	Retail	Total
Bulk vending milk	646 854	189 849	836 703
Polypack milk	333 781	1 075 149	1 408 930
Total	980 635	1 264 998	2 245 633

Source: <http://www.motherdairy.com/>

9.4.6 Model 6: Suguna Poultry

India has a rapidly growing poultry market and its size is now estimated to be around Rs. 12 billion (Business Standard, July 2008). However, the poultry industry is highly fragmented and disorganized. In this sector, Suguna Poultry is one of the largest organized players and is believed to rank among the top ten poultry companies worldwide. The company is based in Coimbatore, Tamil Nadu state, and has operations in 11 states in India, offering a range of poultry products and services. Suguna Poultry started its operations in 1984. The company pioneered contract farming in the poultry industry in India and sources its products through 12 000 contract farmers across different states.

In the Indian market, consumers used to prefer live birds to frozen chicken. Suguna came into the unorganized market with the concept of branding chicken. It has been able to create a space for itself and was able to make its brand prominent in this market, becoming a part of the growing frozen poultry sector. Suguna had a turnover of Rs. 11 billion in 2005–2006 and a 14 percent share in the Rs. 80 billion broiler market. By 2010, Suguna had risen to be a leader in the broiler market in India and among the top ten poultry companies worldwide. By 2010–11, it had a sales turnover of Rs. 32 billion with over 20 percent market share in India. Interestingly, it did so without owning a single poultry farm: by 2007, the company had sold live birds and eggs worth Rs. 20.2 billion without owning a single farm. Its fully integrated operations extend from broiler and layer farming to hatcheries, feed mills, processing plants, vaccines and exports. Suguna sells live broiler chicken, value added eggs and frozen chicken, and has set up a chain of modern retail outlets aiming to provide consumers with fresh, clean and hygienic packed chicken.

In 1993 Suguna set up a 'parent farm' where the parent breed was reared. Day-old chicks hatched by these birds are sent to the contract farmers. In 2000, the company began to directly import 'grandparent chicks' from the UK – these have the best genetic make-up for breeding broilers – and set up a 'grandparent farm'. The company also forayed into the layer (egg) segment of the poultry business in 2007, and grabbed a 6.6 percent market share in the first year. Venkateshwara Hatcheries (90 percent market share) is the dominant player in the layer segment.

Suguna's operations are divided into 13 regions, each under the charge of a manager who has independence to decide on issues in his region. Products include Suguna Chicken, Suguna Anytime (frozen chicken), Suguna Daily Fresh, Suguna Home Bites, Suguna Value Added Eggs. The company collaborates with leading international companies to bring the latest technology and practices to service its massive base of 15 000 farms and has invested in sophisticated technology and infrastructure. This includes:

- ▶ state-of-the-art hatcheries
- ▶ an advanced R and D centre
- ▶ feedmills

- ▷ veterinarians
- ▷ scientists
- ▷ other professionals.

Through this set-up, quality end products are assured through a production chain that can count on the best quality chicks, feed and professional care. Suguna's scientists and employees train the farmers in GMP (Good Management Practices). Through these, Suguna brings substantial value to the industry as well as its farmers, who on their own may not have been able to gain access to these technologies and services. Quality products result from stringent processes and ultra-hygienic rearing methods that are accepted worldwide. Suguna's presence is now established in 11 states across the country and it has obtained ISO certification, further proof of its commitment to quality. It has also implemented the Hazard Analysis and Critical Control Points (HACCP) system and is well prepared with its state-of-the-art processing plant to meet growing demand.

Suguna's business model can be called 'contract broiler farming', a form of franchise farming, and was introduced in 1991. Farmers who own land and have access to resources such as water, electricity and labour can become growers of Suguna's Ross breed of chicks. All the required inputs – day old chicks (DOCs), feed, medicines and expertise – are provided by Suguna, which has successfully reduced middlemen in the poultry chain from 14 to 4. The process of growing the chicks is standardized and must conform to the exacting standards laid down by the company; quality control checks are carried out by company staff to ensure the norms are being met. The broilers are procured by Suguna as long as they comply with established quality norms, and the farmer is paid a 'growing' commission or charge. On average, a typical farmer franchisee can earn Rs. 10 000 monthly for breeding broiler chickens on their farm.

If a farmer does not comply with procedures as laid down in the breeding manual, or sells chickens to another party, this is considered a breach of trust and the contract is unlikely to be renewed. Suguna also provides farmer franchisees with a safety net: not only does the company bear production and market risks, it also shoulders the responsibility for any damage from a change in the market environment. For instance, a rise in feed prices would not affect contract farmers because they are supplied with feed directly by Suguna. Similarly, when an attack of bird flu occurred, Suguna took on the financial losses suffered by the farmers. Farmers deal only with the company and receive assured returns. Regardless of the market price, the farmers still receive the assured growing charge/cost, and incentives.

Suguna has been able to prove that every state in India is fit for poultry operations with its presence in 11 states. It has benefited large numbers of rural households, improving their lives with its innovative business model. Seeing the impact of Suguna's initiatives on rural development, Chief Ministers of other States such as Andhra Pradesh, West Bengal, Punjab and Jharkand have invited the company to set up operations in their States. The model has also attracted visitors from across

borders that are keen to learn from Suguna's initiatives and success and to adopt the same model in their countries.

This model protects the interests both of the farmer and the integrator (Suguna). The integrator takes responsibility for providing day old chicks, feed, medicines and supervision to the farmers. In addition, the integrator brings GMPs and technical know-how that leads to higher productivity. In the absence of these, independent farmers required heavy investments, multiple interactions, and had poor yields overall. Farmers who follow the practices are assured of good earnings in the integrated/contract farming model. The Suguna model offers fast scalability because the company does not have to buy or lease farms. It keeps costs low, and offers economies of scale including in buying raw materials, feed and medicines.

9.4.7 Model 7: The NDDB Safal Auction Market

The NDDB's Safal Auction Market was set up in Bangalore in 2003 as a highly modern market for the marketing of fruits and vegetables. To enable the National Dairy Development Board (NDDB) to set up this market outside the market yards governed by the Agricultural Produce Market Committee (APMC), the Karnataka state government passed a special amendment to the APMC Act. This Rs. 1 500 million auction market is on the outskirts of Bangalore on 60 acres of land, and has a state-of-the-art marketing infrastructure:

- ▶ It has separate auction rooms for fruits and for vegetables which have electronic display boards and electronic auction equipment.
- ▶ The auction is conducted by the staff and there is a viewing gallery for farmers witnessing it.
- ▶ There are no commission agents, and no commission is required to be paid by the farmers, although there is a service charge that they need to pay.
- ▶ There are storage facilities for farmers and traders including cold storage and ripening chambers.

The supply chain is simple and direct. The farmers may either bring the produce directly to the Safal Auction Market with their own or hired transport, or take the produce to the closest Safal Growers' Association. In the latter case, a round of grading is carried out before the produce is sent to the market in the Association's transport. If the produce is brought directly by the farmers, grading takes place at the auction centre before the auction. The produce usually arrives in the evening of the day before. Farmers may come along with their produce to view the auction. Buyers are required to pay a deposit to participate in the auction; afterwards, the produce is transported out by the buyer/trader, including to markets in other States.

Despite the world-class facilities that indicate efficiency and hygiene, the Safal Auction Market, even after five years, is operating at only 15–20 percent capacity. Officials hope

the market will operate at full capacity after another five years or so. The main reason they cite for the current situation is the boycott of the facilities by the wholesalers; these and also some retailers indicate that the main drawback is the lack of product choice. Officials also state that the dependence of farmers on the commission agent for credit discourages them from coming to this facility. Nevertheless, some farmers and consolidators make use of the cold storage and ripening chambers available at the market, even if they do not sell their produce at the auction.

9.4.8 Model 8: HPMC

Himachal Pradesh Horticultural Produce Marketing and Processing Corporation (HPMC) is a government owned and managed organization for the processing and marketing of horticultural produce, especially apples, grown in the State of Himachal Pradesh. The produce is purchased by HPMC from the farmers at announced prices. It is then stored, processed and marketed nationally by the corporation. HPMC has set up processing facilities and infrastructure including produce collection centres, warehouses, cold storage facilities and processing plants in Himachal Pradesh, principally for apples: two collection centres, ten packing/grading houses, three warehouses, and five cold storages. It has also set up cold storage in the metropolitan cities of Delhi, Mumbai, and Chennai.

HPMC was established in 1974 as a government undertaking with the objective of marketing fresh fruits and processing surplus fruits. HPMC provides various services to the State's fruit growers for the processing and marketing of fruits. The corporation has set up two modern fruit processing plants that can make a range of processed products. Between 1974 and 1982, HPMC established pre- and post-harvest infrastructure, comprising a network of mechanically-operated pack houses, cold storage facilities, trans-shipment centres and fruit processing plants, besides a network of sales offices in the terminal markets. The infrastructure for grading/packing, pre-cooling and cold storage was established in rural areas to provide pre- and post-harvest facilities to farmers close to their farms. HPMC produces a variety of processed products including apple juice concentrate, concentrate of orange, pear, plum, and strawberry, and pulps of all the above fruits. It also produces fruit juices in tetra packs, natural and blended juices, squashes, jams, canned products, apple cider, cider vinegar, apple and plum wine, baby corn, mushroom in brine and varieties of pickles.

HPMC seeks to bring remunerative returns to fruit growers and nutritive quality products at a reasonable price to consumers. During the year 2005–2006, HPMC sold processed products worth Rs. 117.7 million in markets across the country. It signed a memorandum of understanding with the Agri-Business Information Centre of the Federation of Indian Chambers of Commerce and Industry (FICCI), which now provides services and information to HPMC for marketing its products in the domestic and international markets. HPMC is supplying its products to

Indian Airlines, Alliance Air India and Indian Railways, earning Rs. 2.1 billion revenue annually. It also supplied products, worth Rs. 13.7 million in 2005–2006, to private companies such as Heinz, Parle, Mohan Meakin and Britannia. To export apples, HPMC has signed a memorandum of understanding with the private company India Tobacco Company Limited (ITC), under which HPMC helped ITC procure 10 000 boxes of apples worth Rs. 4.7 million and HPMC extended its storage and packing facilities to ITC in 2008. Under the Market Intervention Scheme (MIS) of the government, the corporation procured 0.4 million metric tonnes of apples in 2010–11.

HPMC procures some fruits such as apples under the government's MIS, which helps support prices, preventing them from crashing. The efforts made by the corporation have resulted in a stabilization of the prices of fruits in the market. Apart from procuring under MIS, HPMC also directly procures other fruits such as peaches, pears, plums, lychee and almonds grown in the State, for marketing and processing under hygienic conditions in its processing plants. This helps increase the capacity utilization of the plants and assists farmers in receiving additional returns for their produce.

HPMC did well in the beginning but subsequently could not perform in the active market. Producers did not bring apples in sufficient quantities to HPMC on account of their scattered, hilly and distant producing locations, which made transportation from the producing areas expensive. Bringing produce from a producing area to the grading and packing centres was time consuming and they had to wait a long time for their turn to get the produce graded. Because the apple season is very short, the producers preferred to send the produce immediately to the terminal markets to avoid losses and get better returns. Cold storage facilities were often not fully utilized and HPMC therefore needed to divert its utilization to mushroom cultivation, after modifications (Dhankar and Rai, 2002).

When HPMC found it difficult to process the fruit procured, it sent it to markets for sale in fresh form. This affected the market and prices for fresh fruits: for example, good quality apple prices crashed when HPMC took such steps. Though the corporation has experience in the post-harvest management of fruits, it lacks in business skills and capabilities. There has been a gradual decrease in its activities and an increase in its losses. The capacity utilization of grading and packing houses has become very low. HPMC attributes this low utilization to the removal of free transport facilities that were previously available to growers through HPMC (Dhankar and Rai, 2002).

As indicated, even though HPMC was fairly successful at one time, reports show that it has not been able to sustain the performance (Vaidya, 1996; Gandhi *et al.*, 2001). It has been unable either to attract enough farmer suppliers or expand distribution beyond its own outlets. While government-owned agro-industries are well funded as far as investment in infrastructure and technology are concerned, they also depend on bureaucrats for management, and these individuals often have limited business skills. Managers are frequently transferred to other areas at the

whim of changing governments and are accountable primarily to their superiors, not to the farmers or consumers. They are unable to sustain a commitment to procure from small farmers on the one hand, and to meet dynamic marketing demands on the other, thwarting the long-term performance of the enterprise.

9.4.9 Model 9: PepsiCo India

PepsiCo has been working with farmers in Punjab since the 1980s, starting with procuring tomatoes from farmers and producing tomato pulp, as an initial pre-condition for obtaining government permission to produce and sell its soft drinks in India. In the operation, PepsiCo introduced new tomato varieties that helped boost the state's tomato crop from 18 000 tonnes in 1988 to 300 000 tonnes in 2006–07. PepsiCo's involvement in Indian agriculture also stems from its aim of creating a cost-effective, localized agri-base in India, and in return for this, providing farmers with exposure and access to world class agricultural practices. The company has worked with farmers and State Governments to improve agricultural sustainability, crop diversification and raise farmer incomes. PepsiCo helped farmers refine their techniques and increase productivity by offering customized solutions to suit specific geographies and locations.

In 1989 PepsiCo had launched a joint initiative with Punjab Agriculture University (PAU), Ludhiana and Punjab Agro Industries Corporation (PAIC), Chandigarh, for the production, procurement and processing of tomato. This model involved backward integration by a private company with strong marketing capabilities and established products and brands. The initiative led to Pepsi Foods setting up a tomato processing plant at Zahura in Hoshiarpur district, Punjab, in 1989. By 1994, 350 farmers over an area of 2 700 acres were covered and 650 tonnes of tomato were processed every day (Gulati *et al.*, 1994). Under this model contracts for production and procurement of tomatoes were made with small farmers – the contracts were moral in reality, rather than legal. The company invested in building relationships of trust with farmers through their commitment to providing extension services and production inputs. PepsiCo brought in experts and promoted the use of appropriate farm technology and varieties, bringing to bear research and know-how available worldwide. Seedlings were provided to the farmers and planting was scheduled and programmed using computers. The best available technology was used in processing and the company applied its strong marketing capabilities and networks in selling the quality end products.

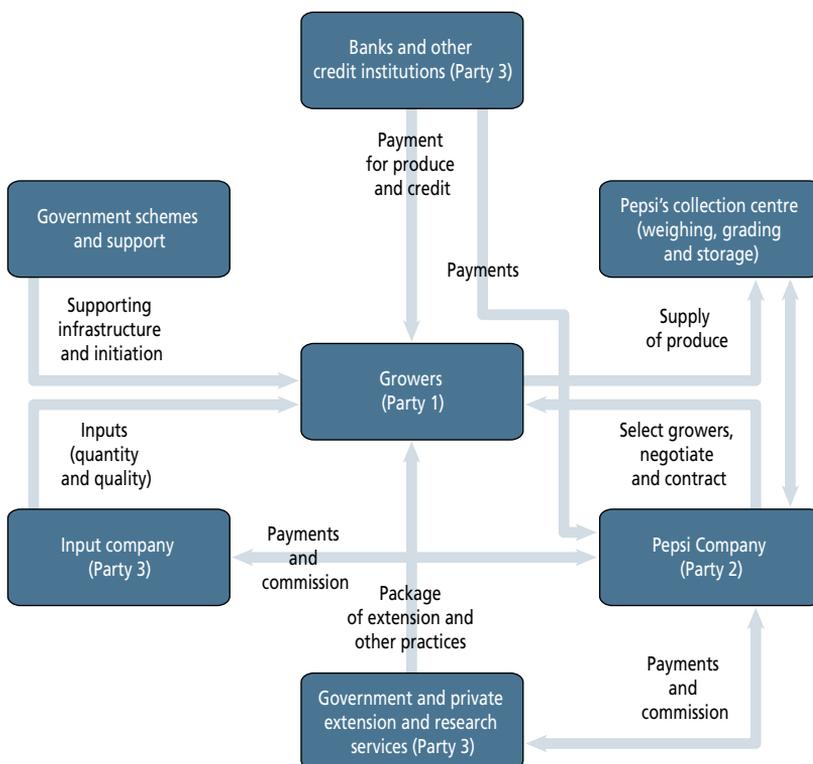
More recently, a similar initiative has been launched for potato. The initiative has sought to improving agricultural practices substantially and help Punjab farmers produce internationally competitive products. PepsiCo used contract farming under which the company transferred agricultural best practices and technologies, and procured the produce at a guaranteed price – see Figure 9.4.

To support the initiative, PepsiCo also set up a 27-acre research and demonstration farm in Punjab to conduct farm trials for new varieties of tomato, potato and other crops. They have evaluated more than 100 varieties and hybrids of tomato, more than 200 varieties and hybrids of chilli, 25 varieties and hybrids of corn, more than 60 varieties of peanut and several varieties of basmati rice.

The quality parameters put in place through the chain are driven by the specific needs of processing, and buyer requirements. Processing requires potatoes with low sugar content (0 percent) and high solids content (between 15 to 20 percent). Apart from this, because the company is also HACCP and ISO certified, stringent quality control is required at all levels in the chain. Specific requirements are met by ensuring quality compliance at every stage: RandD, farming, storing, processing, and packaging (Punjabi, 2008).

Before introducing the varieties to farmers, extensive trials are undertaken and a package of agronomic practices suitable to the local agro-climatic conditions are developed by

FIGURE 9.4 Tripartite model of PepsiCo India



Source: Based on Singh, 2007.

PepsiCo in collaboration with Central Potato Research Institute (CPRI). The package includes specific fertilizer recommendations and spraying schedules (Punjabi, 2008). The company ensures availability of inputs to farmers working in the area, and seed potatoes of specific varieties for processing are also provided by the company. The 'vendor' in the region ensures that farmers falling under their supervision have all the required inputs at the right time. If the company is providing inputs, the costs are deducted during buy back of potatoes. Apart from ensuring inputs, the company had also introduced crop insurance under the auspices of the Agricultural Insurance Company (AIC), and weather insurance from ICICI Lombard. In Karnataka, PepsiCo created an institutional framework roping in the Central Potato Research Institute (CPRI), agrochemical giant Du Pont and the ICICI Lombard General Insurance company.

For producing specific varieties and enhancing productivity, PepsiCo is very closely involved with its contract farmers in potato production. The company has employed teams of agricultural graduates who work with the farmers to provide technical input and to monitor production in their specified area. One technical expert deals with approximately 100 farmers. As a result, farmers reported that because of the technical information provided by company agronomists, the use of chemicals and fertilizers is much more timely and effective (Punjabi, 2008). The agronomists regularly monitor the fields at the time of planting, spraying, harvesting etc; if there is expectation of an outbreak of any disease or pest, they inform the farmers about timely spraying. Any major problems are attended to in consultation with the company researchers if necessary. Apart from PepsiCo's contract farmers, all potato growers benefit from early detection of diseases as a 'positive externality' of the company's operations (Punjabi, 2008).

To emphasize the care required in post-harvest management, the company agronomists often transmit messages such as 'Handle potatoes like eggs not like stones' (Punjabi, 2008). Traditionally, jute bags have been used for packaging potatoes. Instead of these the company has propagated the use of plastic bags for packaging because this ensures better storage. At the company's unloading dock, the potatoes are mechanically graded for size and potatoes that are too small for processing are separated. A visual inspection for damaged potatoes is also carried out, and a test for sugar content is undertaken by frying a small sample from the lot. Sample tests are also undertaken for solid content; potatoes that do not meet all the requirements are rejected. The potatoes are stored at 12 degrees to regulate conversion of sugar to starch; at this temperature they can be stored for up to 4 months. They are also treated to limit sprouting.

Selected potatoes are taken to the processing plant. They are washed and peeled and inspected for physical damage and discolouration, are run through rotating slicers, and are deep fried. Rice bran oil is used for frying because it has a low saturated fat content, and the fried chips are optically tested for colour. Finally, the chips are mixed with spices and packed. The plant has a well-equipped quality testing lab and thorough testing of inputs and packaging materials is also conducted.

New tomato varieties are said to have contributed to an increase in annual tomato production from 28 000 tonnes to over 200 000 tonnes in Punjab (Punjabi, 2008), and yields have increased from 16 tonnes to 54 tonnes per hectare. Many high quality, high yield potato varieties have also been introduced; these have helped increase farm incomes and have enabled PepsiCo to procure world class chip-grade potatoes for its Frito Lay snacks division. The company has partnered with more than 10 000 farmers working over 10 000 acres of potato across Punjab, Uttar Pradesh, Karnataka, Jharkhand West Bengal, Kashmir and Maharashtra.

This model involves more than simple procurement or contract farming, by developing a mutually beneficial partnership between the agro-industry and the farmers. The process may entail substantial financial losses in the initial years, but is expected to be followed by profitability thereafter. The model can result in excellent benefits for small farmers perhaps in a limited area, but it requires a long-term view and commitment from the company and a willingness by the enterprise to absorb substantial start-up costs and initial losses (Gandhi *et al.*, 2001).

Singh and Bhagat (2004) analysed the PepsiCo model and concluded that, though it is a better model of contract farming as compared with Hindustan Lever Limited (HLL) and Nijjer, there are various operational problems in the functioning of contract farming practices. The authors indicate that many farmers rate the PepsiCo experiment with contract farming as a better model. But in the larger sense, PepsiCo has treated farmers as their supply base and had worked only with the intention of creating sustainable supply bases. As the acreage under tomato crop increases, production also increases and the open market prices may fall. The company then may base its price paid or contract price on this low open market price. Farmers in Sangrur, as well as Ganganagar, indicated that PepsiCo had started paying them as low a price as Rs. 1.50 per kg (Singh and Bhagat, 2004). At times, as reported in *Dainik Bhaskar* (2nd September, 2000), they have also failed to fulfil their contract.

The same authors indicate that such a wonderful agreement can go haywire if PepsiCo does not learn to care for the farmers. PepsiCo must fulfil commitments and should enter into an option contract with farmers group, i.e. when open market prices are higher than the contract price they should pay open market prices, and vice versa. They should learn from the experiences of HLL that contract farming without building mutual trust with supply chain partners might be problematic for the company itself. PepsiCo should treat farmers as partners and pass on benefits to them, thereby creating a long-term and sustainable relationship for a sustainable business. Singh and Bhagat (2004) indicate that PepsiCo needs to share its benefits to gain the trust of the farmers. Indian firms need to partner with Indian farmers to bring about an agricultural revolution that will lead to a win-win situation for both the farmers and corporates.

9.4.10 Model 10: ITC *e-Choupal*

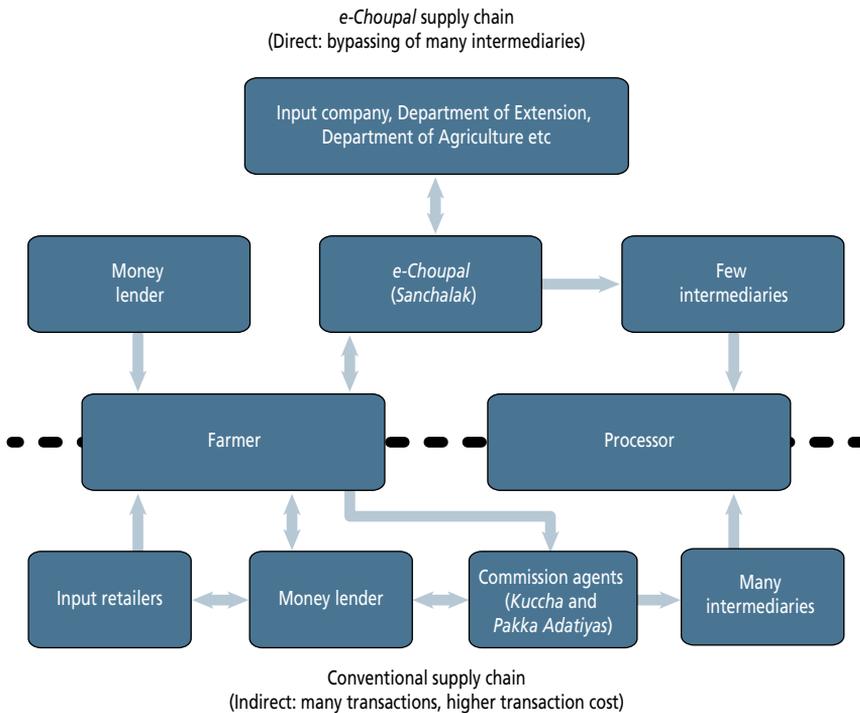
ITC is a large corporate group in India. Through its International Business Division (IBD) it undertakes procurement, processing and export of agricultural commodities such as soybean, wheat, shrimp and coffee. Over the past few years ITC-IBD has developed a unique IT-enabled procurement, information and marketing channel in rural areas, through village centres called *e-Choupals* that cover a huge number of villages. This model has been used to increase efficiency in the procurement of agricultural commodities, resulting in value creation for both the company and the farmer. In addition, the model has created value by taking Internet penetration to remote villages, making global commercial contact possible where infrastructural, economic and social limitations had previously rendered this impossible.

The project was launched in June 2000 in the villages of Madhya Pradesh (see, for example, <http://www.soyachoupal.com>). ITC had opened three soya processing and collection centres and then started the first six village *e-Choupals* in June 2000. Soon, this model became rural India's largest Internet-based initiative. The re-engineered supply chain of *e-Choupal* looks very different from the existing marketing system and has several components (Bowonder, Gupta and Singh, 2002). The company first looked for a farmer from each village around the collection centre to head the village *e-Choupal*. This person was called the *sanchalak* and would become the trained village individual in operating and coordinating the activities in the *e-Choupal*. After selection of the *sanchalak*, a personal computer was installed in his house and he was given training in using it (Bowonder, Gupta and Singh, 2002). The computer had back-up power and was connected to the Internet via telephone as well as satellite. The *sanchalak* helps the farmer in using the system by guiding him in seeing the prevailing prices and other related information on the PC. The *sanchalaks* is paid 0.5 percent of the procurement price for each tonne of soya procured by ITC from their *e-Choupal*. Before implementing any new initiatives, ITC consults its *sanchalaks*, and regular *e-Choupal* meets are held. This not only provides the company with feedback from the farmer but also generates new ideas.

By May 2007, *e-Choupal* services reached more than four million farmers in about 40 000 villages through more than 6 500 *e-Choupals* in Uttar Pradesh, Madhya Pradesh, Rajasthan, Maharashtra, Karnataka, Andhra Pradesh and Kerala. ITC is extending its business model to other Indian States including West Bengal, Himachal Pradesh, Punjab and Haryana. The digital infrastructure at the village is complemented and completed with a physical infrastructure in the form of choupal saagars. These choupal saagars offer multiple services under one roof: a marketing platform, a shop for agri-equipment and personal consumer products, insurance counters, a pharmacy and health centre, an agri-extension clinic, a fuel station and a food court. The ITC *e-Choupal* model is shown in Figure 9.5.

For smooth functioning of its project, ITC could not totally ignore the commission agents, who naturally would resist any change. Therefore, the company devised a new role for them and called them *samyojkas*. The *samyojkas* were responsible for

FIGURE 9.5 Model of ITC e-Choupal supply chain



Source: Based on Bowonder, Gupta and Singh (2002).

collecting the produce from villages that were located far away from the processing centres and bringing it to the ITC centres. The *samyojka* was paid a 1 percent commission for his service.

According to Bowonder, Gupta and Singh (2002), the previous day's *mandi* closing price is used to determine the benchmark Fair Average Quality (FAQ) price at the *e-Choupal*. The benchmark price is fixed for a given day. This information and the previous day's *mandi* prices are communicated to the *sanchalak* through the *e-Choupal* portal, i.e. <http://www.itcibd.com>. The commission agents at the *mandis* are responsible for entering daily *mandi* prices into the *e-Choupal* system. If and when the Internet connection fails, the *sanchalak* calls an ITC field representative to obtain the information.

To initiate a sale, the farmer brings a sample of his produce to the *e-Choupal*. The *sanchalak* inspects the produce and based on his assessment of the quality, makes

appropriate deductions (if any) to the benchmark price and gives the farmer a conditional quote. The *sanchalak* performs the quality tests in the farmer's presence and must justify any deductions to the farmer. If the farmer chooses to sell his soy to ITC, the *sanchalak* gives him a note with his name, his village, particulars about the quality tests (foreign matter and moisture content), approximate quantity and conditional price.

The farmer takes the note from the *sanchalak* and proceeds with his produce to the nearest ITC procurement hub, ITC's point for collection of produce and distribution of inputs. At the ITC procurement hub, a sample of the farmer's produce is taken and set aside for laboratory tests. A chemist visually inspects the soybean and verifies the assessment of the *sanchalak*. Laboratory testing of the sample for oil content is performed after the sale and does not alter the price. Therefore pricing is based solely upon tests that can be understood by the farmer. The farmer accepts foreign matter deductions for the presence of stones or hay, based upon the visual comparison of his produce with his neighbour's. After the inspection, the farmer's produce is weighed on an electronic weighbridge. When the inspection and weighing are complete, the farmer then collects his payment in full at the payment counter. The farmer is also reimbursed for transporting his crop to the procurement hub. Every stage of the process is accompanied by appropriate documentation. The farmer is given a copy of lab reports, agreed rates, and receipts for his records. At the end of the year, farmers can redeem their accumulated bonus points through the *e-Choupal* for farm inputs, or contributions toward insurance premiums.

The transaction at the ITC hub is faster than at the *mandi*, usually taking no more than two or three hours. ITC's electronic weighing scales are accurate and not susceptible to sleight of hand like the manual weighing system at the *mandi*. The system also does not require produce to be bagged; this avoids the associated loss of produce. The *e-Choupal* allows the farmer daily access to prices at several nearby *mandis* and can make better decisions about when and where to sell his crop. Thus, *e-Choupal* attempts to provide farmers with a better price for their crops. The incremental income from a more efficient marketing system is estimated to be US\$6 per tonne on average, or an increase of about 2.5 percent over the *mandi* system.

Farmers can also make use of the information available to them through the *e-Choupal* to improve yields. Seed, fertilizer and consumer products are offered to them through *e-Choupals* cost less than through other local sources such as village traders. Thus there are other economic benefits to farmers. It is reported that in areas covered by *e-Choupals*, the percentage of farmers planting soy has increased dramatically, from 50 to 90 percent in some regions, while the volume of soy marketed through *mandis* has dropped by as much as 50 percent.

A major impact of the *e-Choupal* system is in bridging the information and service gap of rural India. Information and services provided by the *e-Choupal* Web site and e-commerce system include:

- ▶ *weather* – The availability of accurate rain information may cut losses due to weather by more than half.
- ▶ *agricultural best practices* – Information on scientific practices is available on the Web site. Additional questions can be answered through FAQs and access to experts by e-mail.
- ▶ *customized quality solutions* – Farmers are given customized feedback on how they can improve crop quality and yield.
- ▶ *product deployment* – Inputs such as fertilizers and pesticides are supplied along with recommendations and services such as soil testing.

Singh and Bhagat (2004) find that most farmers did not agree with the ITC claim that farmers have been getting better prices for their produce, and that in reality there are only minor benefits like de-bagging expenses etc. Farmers also indicated that the company does not pay the price agreed by the *sanchalaks*. Sometimes, quality is downgraded and farmer income is reduced. One significant advantage however is correct weight, which had been a major worry in traditional *mandi*.

The authors found that the portal did not have the requisite richness for it to become an information and knowledge dissemination kiosk. The information as regards best practices, integrated crop production, inputs, fertilizer and seeds, was of poor quality. Information was not customized to the farming needs of these agroclimatic regions. In all these villages, the only information disseminated was the prices and weather conditions.

The authors find that as regards selling pesticides and fertilizers and seeds, ITC has not taken care to see that there is acceptability of input trading by its *e-Choupals*. Selling the inputs of another company does not take the business relationships into account, and proper partnerships with these companies are often absent.

9.4.11 Model 11: McCain India

The McCain Foods subsidiary, Canada-McCain Foods India (Private) Ltd, was established in 1997 and its potato processing plant in Gujarat (Mehsana) became operational in 2007, with a processing capacity of 30 000 metric tonnes per annum or 4 metric tonnes per hour. The plant aims to produce french fries and other potato products such as flakes, patties, mashed potatoes, *aloo tikki* and wedges for retail and food service businesses across the Indian subcontinent. It will employ 100 and 125 people at full capacity. It will also create indirect employment in storage, supply chains and outsourced services.

McCain has been buying its potato stock for processing via contracts, of which 85 percent were in Gujarat and 15 percent in Punjab. McCain has a choice of three types of contracts with the farmers: fixed, flexible and open. In fixed contracts the price is fixed and the transaction at harvest at that price is guaranteed, irrespective

of the market price. In a flexible contract a range is fixed within which the deal will be settled finally. If prices at the time of harvesting are more than the upper boundary then the farmer is bound by the upper price. In case prices are below the lower boundary, the company is obliged to pay the lower price. In the open contract, both parties are free to transact or not too. Another type of contract may involve a mix of two of the three kinds just described, in some agreed monetary proportion.

Comparison of McCain and PepsiCo (Frito Lay)

Both McCain and Frito Lay contract directly from the growers, specifying clear quality parameters. Both shifted from acreage contracts to combination acreage/quantity contracts that specified the minimum quantity to be delivered per unit area. The firms require delivery at a specified place, with growers bearing the delivery costs. However, there are differences: McCain had a smaller area of operation and a more specialized market for its products. While Frito Lay paid market prices, McCain offered a range of pricing options to its growers.

Frito Lay contracts offered only one price for all rejected chip-grade potatoes and could reject produce at its own discretion, buying it at the lower price stipulated for rejected produce. The final quality tests were carried out at the factory at Channo and undersized potatoes were not returned to the farmer (Singh, 2007). The McCain contract specified that if there was a deviation of more than 2 percent in some quality parameters (size, machine damage, mixing of varieties, presence of solid matter), the company could reduce the prices paid by an unspecified amount. Thus, there was uncertainty and risk for growers resulting from information asymmetry and lower bargaining power.

Both company's contract documents were replete with various obligations on the part of the farmer as regards quality maintenance, quantity, cultivation practices, post-harvest care of the produce, etc, but with very little obligation on the part of the company. All production risks were borne by the farmers and neither firm provided any reprieve to a contract farmer in case of crop failure. Even having entered into a contract and followed all instructions, there was uncertainty about whether the producer would have a market, because neither firm's contract obliged the company to buy the produce (Singh, 2007).

The cost of production for McCain potato contract growers was found to be slightly lower than the McCain non-contract growers, but much higher than those selling at the APMC (Agricultural Product Market Committee) or at farm-gate. The yield and marketing costs for McCain contract growers were higher than any other channel. Marketing costs were higher for growers involved with McCain than they were for the APMC alternative, while net income from McCain was higher compared with income from alternative channels. Variation in net income between growers in the same category was much lower in the case of contract growers because of set prices. The McCain growers found that the

use of sprinklers rather than flood irrigation reduced their labour requirements, improved soil quality, increased potato yields and quality, and also saved water and extraction costs (Singh, 2007).

In the case of Frito Lay, the cost of production was higher and transaction costs somewhat lower than for APMC and farm-gate growers, despite the fact that contract growers had to deliver to the factory. Gross and net income was lower than that of growers using other channels due to lower yields; contract prices for high quality produce and rejected produce were lower than post-harvest and off-season prices. The trend was for farmers directly supplying the companies to have higher production costs, regardless of whether a contract was involved, than those selling to other market outlets.

9.4.12 Model 12: Desai Fruits and Vegetables (Desai Cold Storage)

The large scale production of fruits and vegetables in the south Gujarat area gave two families the idea of starting a cold storage facility, in 2001. There were two partners in this venture. Mr Ajitbhai Desai was the active partner while the other partner was associated with a sugar mill in the area. The construction of the cold storage was begun in 2001 and was completed in 2002. In venturing into this business the main intention was to help other traders and farmers to keep their produce for a longer time. But no suitable enquiry was carried out as to the extent the facility would be used; in the end, no such service was provided to any customer. The facility is now used only by the partners themselves, and they do not keep any of their products in cold storage for very long. Nevertheless, they have developed a highly-successful business mainly trading in fruits and vegetables, not only locally but also nationally and internationally. It is this business, initially named Desai Cold Storage, that we will assess in this section.

The major problem the partners encountered at the outset was convincing farmers to sell their produce to them. To overcome this, they devised a number of activities to create awareness among farmers in their area about the facilities they were offering. In 2001 Desai organized a number of face-to-face meetings with farmers in different villages. To attract farmers they offered integrated pest management (IPM) without any charge. They also offered the harvesting and handling technology through which farmers could save labour and obtain higher quality produce. Some of the other benefits offered were:

- ① waiver of any commission on the transactions (normal market charges amount to about 10 percent)
- ② assurance of 100 percent buying
- ③ quality based pricing – higher than the prevailing market price
- ④ direct buying from the farm gate
- ⑤ an assured minimum price. The minimum price would be calculated on the

basis of the production cost and harvest labour cost, with a margin for the farmers added in. Through this mechanism, even if the market price crashed the farmers would receive the pre-determined minimum price agreed upon. If market prices increased, then the transactions would be carried out at the prevailing market price.

Desai began trading only in mangoes. During the first year of operation in 2002, with the help of traders from Canada, France, the Netherlands and other countries, they exported 600 tonnes of the fruit; in 2003 this increased to 1 200 tonnes, again with the help of merchant traders. In 2002 they also tried to sell in the domestic market through some super market chains in major cities, and to the system run by NDDDB Mother Dairy. But this experience was disappointing: the response from consumers was not as expected and the venture did not work. By 2004 they were exporting 17 000 tonnes of mangoes. The main destinations for these were the Middle East and the UK. They also continued to sell locally on a minor scale through merchants and Mother Dairy on a demand basis. Though the mangoes business is its major one, Desai also exports banana, papaya and pomegranate. It has now succeeded in expanding its export destinations to include China and Australia; the required approvals/contracts have already been signed.

The mango season in India is spread over a period of about eight months. It can start as early as January or February in Kerala, moving up to Andhra Pradesh and the Konkan region of Karnataka as the year progresses, then further north to Maharashtra, Valsad and the Saurashtra region in Gujarat, ending during August in Uttar Pradesh and Bihar. As such, Desai can expect to have a viable mango business for about eight months per year. To meet the requirements of expanding the business into an eight-month operation, Desai are buying in local markets in Gujarat and are carrying out improvements and value additions to the produce at their present unit. In the future the company plans to implement the procurement system it has already developed at Gujarat in other states and areas. Desai has already contacted with farmers in some of the above mentioned regions, who have been guaranteed the benefits and facilities offered to producers in Gujarat. The state governments of Andhra Pradesh and Maharashtra have also started some processing units to help the farmers.

Desai has noticed that during the initial 2–3 months of the season they will not have any competitors from any Asia region countries; hence their business can have a major competitive advantage during this period. Major competition comes from Pakistan but only towards the end of the season (July–August), when the *Chosa* varieties of mango from Uttar Pradesh and Bihar are available.

To improve and maintain quality and prevent deterioration in exports, certain processing and handling measures are followed stringently in the cold storage premises. These include:

- ▶ *deshaping*: The raw mangoes brought from the farm first undergo deshaping. In this process the extra length of the stem is cut uniformly (to about one inch length) to avoid damage that may result from the acidic discharge;
- ▶ *hot water treatment*: After deshaping the mangoes are put through an automatic hot water treatment plant to remove and destroy fruit fly eggs;
- ▶ *fungicide treatment*: After the hot water treatment, the lot goes for fungicide treatment, which extends the shelf life of the product;
- ▶ *grading*: The produce is then passed through an automatic grading machine. In this process the mangoes are sorted into different lots according to the weight of each fruit;
- ▶ *washing/waxing*: As per the requirements of the buyers, washing and waxing services are carried out on selected lots;
- ▶ *packing*: This is carried out according to weight of fruits and the buyer's requirements *vis-à-vis* the number of mangoes in a carton;
- ▶ *pre-cooling*: The entire lot is then moved to a pre-cooling treatment plant. Pre-cooling brings the fruits at a uniform temperature before they move to the cold storage shelves;
- ▶ *storing*: After pre-cooling the packages are moved to specified locations in the cold storage facility;
- ▶ *loading*: When an export or domestic order is received the lots are loaded into containers for transportation to their destinations.

To expand into the banana business, Desai is planning to import modern technology in all aspects of its operation, including farming, handling and processing; the company plans to spend about Rs. 5 million for this purpose. Large-scale banana farmers around Navsari and in nearby areas of Gujarat have already been contacted and offered the same benefits and guarantees as the mango farmers. Contact meetings with these farmers have already taken place at different locations.

Since inception Desai has also been dealing in green vegetables, the main ones being lady finger (okra), bitter gourd, bottle gourd, and other minor interests such as chilly and lemon. During the first year of this operation (2002) the company bought this produce on the market but also purchased from farmers around the cold storage facility. As with the mangoes, vegetable exports were also initially distributed via merchant traders. Desai exported about 40 percent of its procured produce through these traders and sold the remainder in the domestic market. Here Mother Dairy was the major purchaser.

In this initial period the company convinced farmers to tie-up directly with them on the same lines as with the mango farmers. Slowly, direct input arrivals have picked up. Farmers are required to sort their produce into A, B and C quality categories before delivery, and this is taken into consideration in deciding prices. The purchase prices of vegetables are fixed slightly higher than the Surat APMC daily market price. The payment is made to farmers the next day, after the exact market prices of Surat APMC have been ascertained. In 2003 Desai started direct export of vegetables to the UK and Middle Eastern countries. In addition to this they are still keeping up their export business through merchant traders and in the domestic market through Mother Dairy.

To maintain the quality of the produce, Desai has devised a plan that also benefits the farmers significantly. Typically, small and marginal farmers had been exploited by retailers in the supply of inputs such as seeds, pesticides and fertilizers. These farmers had also been exploited in selling their output to traders and commission agents. To liberate farmers who agreed to supply the company with produce, Desai devised an innovative idea. Inputs such as seeds, pesticides and fertilizers are procured in bulk and are supplied to farmers without any margin and on credit, free of any interest. The cost is then taken into account against payment for supply of the output.

In 2004 Desai distributed about 3 000 kg of lady's finger seeds (okra). By supplying this to its farmers, as well as bottle gourd and bitter gourd, the company ensured that the output would be of the same good variety and quality. For lemon, chilly, beans and other vegetables, Desai did not provide seeds but a bulk purchase agreement was signed. In chilly alone, the 2004 business amounted to more than 500 tonnes, while the weekly procurement of lemon was as much as 15 tonnes.

Contract Farming India (CFI) AG, a company based in Zug, Switzerland, has made significant investments in Desai Fruits and Vegetables (DFV) – the new name for Desai Cold Storage since April 2006 – to enhance its financial, operational and management capabilities. DFV has since created multiple integrated pack houses for bananas and continues to invest in creating facilities at the farm and village levels. Since its inception the company has invested in RandD for agricultural practices and in developing long-distance transport protocols. These initiatives have helped Desai emerge as one of the leading exporters of high quality fruits and vegetables in India. It now supplies a wide range of high quality tropical products: the portfolio includes over 10 types of fruits and 30 types of vegetables. However, the key focus over the years has been on four fruits – mangoes, bananas, pomegranates and grapes. This flagship produce makes up over 90 percent of total sales.

Over 2 500 small and medium-sized farmers supply to Desai. The company has a unique contract farming mechanism by which it controls the inorganic inputs,

technology and work practices at the farm level to ensure that the product is absolutely natural and safe. The model has been so successful that Desai has a waiting list of over 800 farmers wishing to be included in its programme. The company works with its customers to create specialized, customized solutions in order to deliver quality at a reasonable cost. It ensures the quality of every product that it supplies by controlling every step involved in the production process, from land preparation to logistics. The quality assurance system is based on the following principles:

- ▶ *process control* – achieved through contract farming and technical control;
- ▶ *farm approval system* – extensive checks are conducted for work practices, use of chemicals and quality of products, before any farm is approved for procurement;
- ▶ *traceability* – of the farm, inputs used, processing location and transportation;
- ▶ *quality checks* – a Desai product passes through a stringent quality assurance process:
 - o quality control by a supervisor at the point of procurement from farmer;
 - o quality checks at the point of packing;
 - o random checks of consignments;
 - o random sampling at laboratories for residue analysis.

Desai has been conscious of the importance of superior infrastructure from its inception. As a result, one of the most modern and state-of-the-art packhouses has been developed, innovative trailer designs have been created for smooth transportation, reefer vans have been bought, and pre-cooling, cold storage and processing facilities have been enhanced.

9.5 Comparison and evaluation of different models

How do the different models compare *vis-à-vis* the institutional performance of agro-industries in developing countries, as discussed above? Table 9.6 provides a broad comparison; this is followed by a more in-depth discussion.

TABLE 9.6

Broad comparison of different models on institutional performance parameters

Agro-industry model	Reaching large numbers of small farmers	Ensuring adoption of suitable technology and practices by farmers	Use of modern processing technology and meeting capital costs	Delivering a strong marketing effort	Effective management and control to meet the needs of all stakeholders
AMUL	Strong	Limited	Strong	Strong	Strong
Nandini	Good	Limited	Limited	Reasonable	Reasonable
Nestlé	Limited	Strong	Strong	Strong	Limited
Heritage	Good	Limited	Good	Good	Limited
Mother Dairy	Limited	Good	Good	Good	Reasonable
Suguna	Strong	Strong	Strong	Strong	Strong
Safal Market	Limited	Limited	Good	Limited	Limited
HPMC	Limited	Limited	Good	Poor	Poor
Pepsi	Limited	Strong	Strong	Strong	Limited
ITC e-Choupal	Strong	Limited	Strong	Strong	Limited
McCain	Limited	Strong	Strong	Strong	Limited
Desai Cold Storage	Reasonable	Good	Good	Strong	Reasonable

9.6 Production and procurement from small farmers by different models

9.6.1 Do different models reach out well to large numbers of small farmers?

Access or reach to large numbers of small farmers is a major problem for most models and is very important for cost effectiveness, quality and development impact. Small farmers often do not have the ability to connect on their own with the main stream of agro-industry development initiatives. On account of its huge membership of village cooperative societies, the AMUL model is able to cover a very large number of small farmers: it is able to collect milk even from farmers who only keep a single animal. The Suguna model is also able to reach out to a large number

of small farmers, mainly because of its low capital requirements; the farmers only have to feed and rear the chicks until they grow. ITC *e-Choupal* also reaches a large number of farmers even in remote villages through the Internet, and by setting up web-linked *e-Choupals* run by local operators or *sanchalaks*. The Nandini model, another cooperative model like AMUL, also has a substantial reach but not as deep as that of AMUL. Heritage foods has developed a good presence in some rural areas by using the existing retail network for FMCG goods, but is a little constrained because it does not directly count on farmers' involvement. Desai Fruits and Vegetables has achieved good reach with small farmers in a small area of operation.

By contrast, other models such as Nestlé, Mother Dairy, Safal, HPMC, PepsiCo and McCain, though successful in other aspects, are generally unable to connect with a large number of small farmers and expand their reach, even though they may often suggest that they contribute substantially to their development. In the cases of Nestlé and McCain, this may be explained by their stringent quality requirements and limited quantity requirements.

9.6.2 Do the different models try to organize production of raw material from small farmers?

AMUL leaves milk production to the farmers but it promotes the organization of farmers into cooperatives for the collection and marketing of milk. It also helps the farmers in milk production through the supply of nutritious cattle feed, fodder seed, veterinary services, vaccination, artificial insemination services, and extension. Suguna leaves rearing of poultry birds to its farmers but provides large-scale technical inputs, including the best breeds of day-old-chicks, quality feed, veterinary care, and extension guidance. The PepsiCo model also works extensively with small farmers so that they use the best technology and achieve the quality and quantity required by the company, making good profits. McCain too follows this approach in alternative ways. PepsiCo and McCain give technological advice and offer inputs to the growers. PepsiCo has collaborative tri-party agreements with farmers and input companies as partners. McCain provides diggers, planters, advisory services and extension services to its growers. ITC has *sanchalaks* and a web portal to give advice. Desai also provides inputs and advisory services to its members. HPMC, Nandini, Heritage Foods, Mother Dairy and Nestlé provide some extension services, albeit in a limited role.

9.6.3 Is the procurement activity organized efficiently? If so, how?

Three critical aspects of performance are quantity, quality and cost. AMUL stands out in quantity and cost. This is because it uses a cooperative model to access remote sources and shares the costs with the farmers through the village

and district cooperatives. Nandini takes a similar approach but is not as efficient. Mother Dairy is not owned by the farmers and therefore is unable to fully leverage this model. However, it helps the cooperatives in distribution and marketing so that they can become more viable. Heritage achieves good efficiency in procurement by using the existing retail network for consumer goods, achieving a two way flow of goods. Suguna organizes procurement efficiently via a contracting arrangement with the farmers in which costs and risks are shared. ITC leverages the Internet to organize its procurement efficiently. PepsiCo and McCain are not able to be as efficient on this count as they have a relatively loose link with the farmers.

9.7 Adoption of appropriate technology and practices by farmers and performance on quantity and quality

9.7.1 Are the various models able to adopt appropriate technology and practices through the farmers?

Private players such as Nestlé, PepsiCo, McCain and Suguna, which are demand or market-driven, seem to do comparatively better in ensuring the adoption of good technology and practices by farmers. This appears to be because they are especially concerned about selling quality products, given the fierce competition: ensuring quality in the raw material is critical to their operations. Because of this they make special efforts to push the adoption of appropriate technology by farmers, and they enforce this discipline through strict quality control in purchasing from the farmers. Desai is also focused on adopting the right technology because it is privately run and is engaged in export, and therefore needs to comply with high international quality standards.

Farmer or supply driven models such as AMUL and Nandini are often not able to do as well in ensuring the adoption of appropriate technology and practices by farmers. This issue does not garner as much importance because the inclination is to accept the farmers' produce, given that they are ultimately the owners of the enterprise. However, to achieve success, these models cannot ignore market requirements. ITC *e-Choupal* needs to focus on the adoption of appropriate technology, but its link with farmers is more remote – for example, extension knowledge is sent through the Internet only – and hence it cannot exert the required pressure as effectively. However, the price paid and the acceptance of the produce is linked strongly to quality, and this serves as a signal of what is required from the farmers. Heritage Foods, working through retail outlets, is able to do little for adoption of technology; Safal and HPMC are also not able to play much of a role.

9.7.2 Are the models able to procure a high quantity and quality of output from the farmers?

AMUL does very well on quantity criteria; it procures 7.4 million litres of milk per day from the farmers. It also maintains basic quality through local quality testing automated by milk testers, weighing machines and computers widely distributed to the village cooperatives. The model is able to achieve high quantity output and satisfactory quality.

Nestlé on the other hand procures much less at 1.1 million kg of milk per day (1 kg is slightly more than a litre for milk) during the peak season, but pushes very strongly for high quality through various measures such as training on good farm practices, auditing of farms, technical support to farmers to help them reach quality standards, and strict testing/ acceptance policies at the collection centres. This is driven by Nestlé's high quality standards and requirements.

Suguna has achieved notable success in both quantity and quality. The company does business worth Rs. 20.2 billion (2007) in live broiler chicken, frozen chicken and eggs, by sourcing its products through 12 000 contract farmers on 15 000 farms across 11 states. It has reduced middlemen in the poultry chain from 14 to 4. It aims for a turnover of Rs. 30 billion by 2010 and a 20 percent market share in the Indian poultry industry. It maintains high quality through importation of breeds, state of the art hatcheries, an advanced RandD centre, feedmills, veterinarians, scientists and other expert professionals, assuring farmers the best quality chicks, feed and professional care. Its scientists and employees train the farmers in good management practices. The system results in the production of high quality poultry birds in the quantities demanded by the market.

For its limited quantity requirements, PepsiCo works closely with its contract farmers to produce the specific varieties of produce needed and enhance productivity. It employs a team of agricultural graduates to provide technical input and monitor the farmers in their specified area. McCain also works in a similar way to generate high productivity and quality raw materials for its processing requirements.

ITC depends on its Internet enabled *e-Choupal* network to obtain the quantities of produce it needs from the farmers. It does well on reaching out widely and achieving the volumes it desires. However, where quality issues are concerned, it only works indirectly with farmers by making available high quality agri-inputs at reasonable prices, and providing information about best agronomic practices through its web portals.

9.7.3 How cost effective are different models in procuring from the farmers?

A major strength of the AMUL model is the cost effectiveness of its procurement. AMUL has shortened the milk supply chain and has made it very financially viable. Moreover, AMUL passes on the benefits of this cost-effectiveness to the farmers, who if linked to AMUL receive about 80 percent of what the consumer pays. The ITC *e-Choupal* is also highly cost effective because it uses the Internet very effectively, thus reducing transaction costs substantially. The incremental income to ITC from the more efficient marketing process is about US\$6 per tonne, which is about 2.5 percent over the *mandi* system. Suguna is also cost effective, mainly because of its efficient contracting arrangements and achievement of scale economies in technology and technical services. The PepsiCo model and McCain models are also more efficient than alternative channels and provide more margins to farmers as compared with traditional potato growing. But their high procurement costs prevent them from expanding widely. This is also true for Nestlé. Besides, gains in procurement efficiencies would mainly go to the companies in the Nestlé, PepsiCo, McCain and ITC models. HPMC, Safal Market and Mother Dairy lack cost effective procurement processes.

9.8 Processing technology and capital requirements

9.8.1 Are the models successful in using or promoting good processing technology?

AMUL has a good record of using modern state-of-the-art processing technology and adopting it innovatively to local needs and conditions. This is mainly because its leaders have always believed in employing professional management that is highly empowered. A highly efficient procurement system and the need to find a market for the growing milk production of members has propelled the use of good technology. Private players like Nestlé, PepsiCo, McCain, ITC and Suguna all have a good record of excellent processing technology, and this has been driven largely by internal standards and markets. PepsiCo and McCain have world class processing facilities for making various products such as chips and french fries. Desai uses good processing technology because its produce must meet high export standards. HPMC and Nandini have not done so well on this count. HPMC plants work at only 15–20 percent of their capacity which perhaps prevents them from upgrading much. They are neither highly market oriented nor highly farmer oriented, and have less pressure for generating a return on investment.

9.8.2 Are the models able to meet the high capital requirements of agro-industry?

AMUL has been able to meet the high capital requirements of its dairy plants and processing technology because of its sound management, particularly its cost effective procurement and strong marketing. It has made use of credit which it could easily obtain, as well as government assistance and international aid, given that it was a cooperative of farmers serving high priority development objectives. ITC could tap the resources of its highly diversified and profitable parent businesses, PepsiCo and McCain, its multinational parent organization. The capital resources available to Nandini, Desai and Suguna were more limited. HPMC and Mother Dairy could tap government resources.

AMUL could meet part of its working capital requirements by delaying the payments for milk. The district milk unions pay the village milk societies after 10 days. In the McCain model farmers are paid for their produce 7–17 days after the procurements. This provides some working capital for the model. In the cases of ITC and PepsiCo, payments are delayed by some days and help meet the requirements of working capital. Some working capital management is built into contracts in the case of Suguna. Additional requirements in all these cases need to be met through bank credits, for which the basic soundness of business models is very important.

9.9 Marketing and product innovation

9.9.1 Are the different models able to deliver a strong marketing effort?

AMUL, Nestlé, Suguna, ITC *e-Choupal*, PepsiCo, McCain and Desai all demonstrate strong marketing performance, while Mother Dairy and Heritage foods can be rated as good. Nandini's marketing performance can be rated as reasonable while the marketing performance of NDDDB's Safal is limited. HPMC is not very effective in marketing.

The top tier of AMUL's three-tier structure, i.e. the state federation, focuses on the marketing of milk and milk products. By insisting on an umbrella brand, AMUL skilfully avoided interunion conflicts and also created an opportunity for union members to cooperate in developing products. Nandini is not so effective in this regard because much of its marketing is done by the district unions themselves and not by the state federation. AMUL products are available in over 500 000 retail outlets across India through its network of over 3 500 distributors. AMUL has used very simple but highly effective advertising campaigns as compared with the star-studded campaigns of PepsiCo and Nestlé. It is fair to conclude that AMUL, PepsiCo, ITC and Nestlé are highly successful in marketing their produce.

PepsiCo has a strong soft drinks marketing network and the agribusiness division uses the same network to market its products under the brand name Frito Lays. ITC uses marketing channels and the marketing experience of its FMCG divisions to good effect. McCain Foods India has strong institutional buyers such as McDonald's, KFC and Pizza Hut. Suguna has also developed strong marketing with substantial retail reach. HPMC's marketing, though initially successful has not been sustainable, perhaps explained by its non-market orientation.

9.9.2 Are the different models able to develop new innovative products?

AMUL initially was making only a few milk products and mainly concentrated on liquid milk, butter and milk powder. But it is now producing a whole range of products such as ice cream, srikhand, dahi, chaas, chocolates, flavoured milks and more. PepsiCo is continuously innovating and has a huge number of products. McCain, ITC, Suguna and Desai are adding to their product ranges. The private players are generally at the forefront of creating innovative products, barring exceptions such as AMUL. Private models are more proactive in creating niches and innovative products, and develop the necessary technology that goes with this. Suguna has launched a new category of home meal replacements – Suguna Home Bites and Suguna Anytime – a range of ready-to-eat chicken products. Nestlé, PepsiCo, McCain and ITC invest large sums of money on research and development to bring out innovative new ranges. Most cooperative and government-run models are less market oriented, perhaps as a result of bureaucratic and structural bottlenecks.

9.10 Ownership and control

9.10.1 Who are the major owners in the model and how does this affect performance?

AMUL and Nandini are owned by the farmers. The farmers elect the top management – managing committees or boards of directors of the village cooperatives, district unions and state federations – on a representative basis. This ensures that the concerns and needs of farmers are given high priority, and also brings loyalty and commitment on the part of the farmers to supply good produce. However, particularly in the case of AMUL, professional management is appointed below this level and empowered to handle the strategic and operational management. This helps to ensure that excellent strategic and operational decisions are made, giving a business edge to the organization. Because of farmer ownership the organization continues to reinvest in the business and offer a variety of necessary goods and services to the farmers.

In private models such as Nestlé, PepsiCo, McCain, ITC, Heritage Foods and Suguna, the ownership and control remains with the private company which reports to its shareholders. The private profit motive and generating shareholder value will naturally dominate. In the cases of PepsiCo, McCain and Suguna, a partnering approach through, for example, contract farming models has been developed with the producers, thereby recognizing their critical role in production and supply. In this way producer concerns can be taken into consideration. However, in the case of ITC and Heritage, partnering is not explicitly developed and the relationship continues to be based mainly on procurement. In the government-driven models of HPMC, Mother Dairy and Safal, the ownership and control remains with the State, which helps bring in substantial state capital and government support. But performance remains dependent on government management and commitment, with varying degrees of success.

9.10.2 Is the management of the model professionalized?

Professional management is very important to the success of most models. The top management of AMUL is largely not professional and consists of elected farmers' representatives. However, strategic and operational management have been strictly professional to date. This may be somewhat less so in the more decentralized Nandini model, and this may account for its more limited success. In the government-owned models of HPMC, Mother Dairy and Safal, administrative management is appointed by the government and may or may not consist of suitable professions, who in turn may tend to report more to the government bureaucracy rather than producers, consumers or shareholders. Private models such as Nestlé, PepsiCo, McCain and ITC do very well in hiring highly-qualified professional management and have the capacity to pay for such management. To economize, ITC also uses local non-professional *sanchalaks* and *samyojaks* after training. Other private players such as Heritage and Suguna employ professional management too, but may not be able to pay as well and therefore may not attract the best talent.

9.11 Addressing the interests of various stakeholders: producers, consumers, investors and government

9.11.1 Producers

The AMUL model, given its ownership by producers and strong professional management, is perhaps best able to meet the interests of farmers. In recent years, with significant market share and power in its hands, AMUL appears to have enhanced the bargaining power of the producers, often allowing it to raise consumer

prices in the interests of its farmers. Suguna, PepsiCo and McCain also claim to meet the interests of producers through win–win contracting models. The Nestlé, ITC and Heritage models appear to be focused more on reducing procurement and supply chain costs to the companies; they share benefits with the producers to a limited extent but claim to provide them with a better marketing channel.

9.11.2 Consumers

Nestlé, PepsiCo and McCain are focused entirely on consumers and aim to provide best quality products to their customers, who are the *raison d'être* of their business. Suguna also tries to do the same and AMUL is not far behind. These two organizations naturally seek markets for the increasing supply of produce from their farmers, and therefore need to deliver high quality to their customers, serve them well, and keep offering new products which consumers will want. Government-run models such as HPMC, Mother Dairy and Safal often lack this fundamental customer-oriented philosophy.

9.11.3 Investors

Given that cooperative shares such as AMUL are not traded and therefore do not have a market value, there is no outside investor interest in such 'shares', though of course, the farmer owners are interested parties and therefore are themselves investors of sorts. AMUL profits are often shared through their distribution as price bonuses at year-end. By contrast, private models such as Nestlé, PepsiCo, McCain and Heritage naturally try to maximize benefits to shareholder investors through increases in share value. As such, they are ideal vehicles for all kinds of investors who may, for example, see agri-industry as a 'safe bet' in difficult economic times. Government-run models such as HPMC and Safal are usually not concerned with share values; however, in the present economic environment, the Government does not tolerate loss-making enterprises either, and as such may be an active and interested investor.

9.11.4 Government

The Government gets involved in these enterprises mainly for social objectives. These are served well by AMUL because its activities substantially benefit a large number of producers, all rural people, and their well-being is a high priority for the Government. The Government is also behind other initiatives such as HPMC, Mother Dairy and Safal, given that these engage in critical activities which are ignored by the private sector. However, if they fail, they become a burden on the Government. Meanwhile if private models are successful in contributing to agricultural and rural

development, they are also doing the Government and the nation a service. In a more extensive way, ITC and Suguna seem to have demonstrated such an impact. Nestlé, PepsiCo and McCain too have contributed, but in limited areas and to limited numbers of people compared to models such as AMUL and Suguna.

9.12 Conclusions

Agro-industries have been given significant priority in the economic development of India. Mahatma Gandhi's emphasis on developing village-based agro-industries in the movement for independence marked the beginning of this strategic view. Is the priority given to agro-industries justified today? This analysis finds that the agro-industrial sector in India contributes significantly to employment in industry, as well as to value addition and income generation. Its continued role in promoting development and reducing poverty will depend on its capacity to contribute to small farm incomes and rural employment, particularly among the landless poor.

Managerially, one of the major challenges lies in organizing sustained production and procurement from large numbers of small farmers. A partnering approach appears to be most promising in overcoming multiple constraints. It can be implemented either through building cooperative organizations, or by building confidence and trust through a mutually beneficial business relationship involving private enterprise and farmers. In both cases, and with other successful models, the government must play a facilitating role through enabling policies, regulations, financing options and research and development.

If the development objectives of agro-industrial growth are to be served, small farmers must benefit from this growth, and the landless should at least benefit indirectly. However, this depends substantially on the nature of the organization and the commitment of the agro-industry to their involvement as partners. It also depends on the bargaining power of the small farmers within the models and structures that are created. Cooperatives have often done better in bringing benefits to the rural poor, sometimes with the assistance of NGOs as intermediaries. Supply contracts with small farmers are rarely formal and are therefore mostly non-enforceable in India – as elsewhere in developing countries – remaining agreements that are only morally-based. In order to make contract farming successful, much depends on the development of longer-term relationships between agro-industries and farmers through transparent contract terms, fair pricing, effective extension, and good marketing. This is possible for private agro-industry firms, as shown by the PepsiCo model.

There is a need for new indigenous models to emerge for the organization of agro-industries. Government models alone do not demonstrate a good record of performance. The AMUL cooperative model is one promising approach that brings

benefits to small farmers and gives them ownership of the enterprise. However, it needs to overcome political, legal and managerial limitations. The PepsiCo model, involving cogent backward integration with farmers by a private company based on a strong product market, offers another alternative. However, it requires long-term commitment and financial strength with limited scope for benefiting large numbers of rural poor. It is critical that alternative agro-industrial models are encouraged and receive strong government backing, especially those models which contribute positively to rural employment, poverty alleviation and sustainable development.

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CHAPTER 10

Linking farmers to market through processing: The role of agro-industry clusters with special reference to mango in south India

MYSORE SUDHA AND FROUKJE KRUIJSSEN

10.1 Introduction

In recent times, world markets have become truly globalized. World exports have increased and commercial stakeholders from across the globe are now able to participate in trade at the global level. This trend is true for agricultural/horticultural crop-based products as much as any other good. It is becoming increasingly important that all participants along agrifood value chains are effectively organized to be competitive globally. Yet, value addition in the globally competitive production process will only be effective if the final consumer price is fairly distributed to all actors along the supply chain (FAO, 1997). The effectiveness and smooth functioning of such supply chains is also dependent on access to market information, which in turn depends on factors such as technology, infrastructure, institutional policy and financial resources, as well as market forces. The goal of global competitiveness is especially challenging in supply chains involving highly perishable commodities like horticultural products. Cross border supply chains involving horticultural products have proven to be instruments that stimulate the development of local agro-industry, generate employment and improve access to technology, if the connection between producers and the different actors across the chain is well managed (Roedel *et al.*, 2002).

India, with its strong horticultural crop production base, appears to have huge untapped potential to be a global competitor for a number of horticultural products. Mango and mango-based products constitute an important segment of India's agrifood economy. The country is the world's largest producer of mango, accounting for about 40 percent of global output (Hanemann, 2006). Although less than 5 percent of this production is processed into mango pulp, this is the main export product, both in terms of value and volume (Babitha, 2009). The Chittoor district of

Andhra Pradesh is the main supply base for mango pulp (Mehta and George, 2003) in the country, followed by the Krishnagiri district of Tamil Nadu state. Both are located in Southern India, where a nascent agro-industry cluster for the supply of mango pulp has been in operation for a long time. This agro-industry cluster is rather dynamic, yet still inefficient for want of appropriate institutional support. Realizing the untapped potential of this sector for supplying processed products and generating income and employment, strong policy support for developing infrastructure and logistics support began to receive higher priority from the Government in recent years.

The creation of a separate Ministry of Food Processing Industries, as well as the enhancement of the installed capacity of the industry and the liberalization of the policy of importing modernizing technology, are a few of the recent government initiatives aimed at uplifting the processed product sector. The installed capacity of the food processing sector more than doubled within one decade, from a mere 1 108 000 million tonnes (MT) in 1993/94 to over 2 774 000 MT in 2006/07. In the 2006/07 budget, the food processing sector was declared a priority area for bank credit and a refinancing window, with an allotment of some US\$2 billion, especially for agro-processing infrastructure and market development.

One of the main objectives of this drive has been to improve the linkage of farmers with the market through value addition and processing, a goal whose accomplishment continues to be far off. This is especially so with regard to the *totapuri* mango agro-industry sector, given its persisting domination by market intermediaries such as the pre-harvest contractors and commission agents. While several models of effective linkages between farmers and markets through processing, including public-private partnerships, have been initiated successfully, they could not be sustained for long. In a highly competitive and mature market, initiating and sustaining a market linkage requires special efforts. This chapter presents an analysis of the agro-industry cluster of *totapuri* mango in Southern India, from the point of view of cluster development, distribution of margins, changing partnership patterns, government policies and initiatives and supply chain management.

The authors' analysis uses data from both primary and secondary sources. The primary data has been collected from a sample of over 50 producers, processors and other stakeholders involved in *totapuri* mango in Chittoor district of Andhra Pradesh. The secondary data has been drawn from various sources. Discussions with key stakeholders complement the information sources utilized. The data pertains to agricultural years 2006/2007 and 2007/2008.

The chapter is organized into three sections. Section 2 outlines the status and performance of the *totapuri* mango agro-industry cluster and the existing pattern of margin distribution along the supply chain. Section 3 provides a discussion on the agro-marketing clusters, including various models of linkage involving horticultural crops. Section 4 highlights the uniqueness of the *totapuri* mango cluster and makes suggestions for improving this agro-industry cluster's performance.

10.2 Status of processed mango in south India

The Indian agricultural export basket, which comprises both fresh and processed products, is traditionally dominated by mango (*Mangifera indica*) despite efforts at diversification. The processed product sector is especially dominated by the semi-processed form of mango – the mango pulp – making up around 43 percent of the export of processed fruits and vegetables and over 80 percent of all mango products (Agricultural and Processed Food Products Export Development Authority, APEDA, 2008). As the world's largest mango producer, India accounts for approximately 40 percent of world mango production and is a natural home for over 1 000 varieties of this species, with around 20 varieties being traded commercially. *Alphonso* (from the western parts of India) and *totapuri* (from the south) are the two varieties which cater to the domestic and export demand for processed mango. Nearly 80 percent of *totapuri* produced in the south is processed into mango pulp, much of which is exported, while around 20 percent is used domestically for the manufacturing of juices, jams and other mango products. The fact that semi-processed mango from the Chittoor region has been the main source of mango pulp export from India for over two decades highlights the comparative advantage this region has for the production of *totapuri* mango.

10.2.1 The *totapuri* agro-industry cluster

The South Indian state of Andhra Pradesh accounts for over 29 percent of the country's mango area and contributes around 39 percent of production, with a productivity of around 8 tonnes per ha. Chittoor district, with an area of over 59 380 ha under mango cultivation, is the main mango belt, contributing about 12 percent of the region's mango production (Government of Andhra Pradesh, 2008 – Annex 1).

A typical mango orchard in this region houses over ten varieties, each catering to a specific market demand, of which *totapuri* is the main mango variety used exclusively for processing purposes. *Totapuri* mango production in Chittoor district represents a typical agro-industry cluster for processed pulp, which emerged due to the agroclimatic suitability of the region for mango cultivation. The cluster houses a widely spread and vibrant mango production base, plus a few semi-processing units that operate for four months annually during the mango season. These have been converting *totapuri* mango into pulp for several years now. Within the last decade, the number of semi-processing units operating in this region grew to around 50, with varying levels of investment in processing infrastructure. These are spread out over a radius of 50 km around the production base, forming the main players of the agro-industry cluster in Chittoor.

Estimates indicate that the region produces around 4 157 928 tonnes of mango, within which 70–75 percent is the *totapuri* variety (Ministry of Food Processing Industries, 2008. <http://mofpi.nic.in/>). In terms of financial value, Chittoor exported around

Rupees (Rs.) 1 416.3 million (US\$29.63 million) of mango pulp from the agro-industry cluster (Department of commerce, 2007). The region also houses a wholesale market exclusively for mango trade and has good access to an international airport, about 180 km away in Bangalore. The processing units, being located close to the production centre, give the producer the option of supplying directly for processing into pulp.

10.2.2 The *totapuri* mango supply chain in Chittoor

The supply chain of *totapuri* mango is characterized by a large number of stakeholders and chain actors, who operate without any formal written supply agreements or pre-fixed price contracts. These include producers, suppliers, market intermediaries, processors and consumers. The *totapuri* mango cluster in Chittoor is one of the largest supply belts, with over 8 500 mango growers and over 1 000 pre-harvest contractors, traders and other market intermediaries.

Producers and production

Mango in Chittoor is usually produced in a mixed commercial orchard maintaining a number of varieties and trees of different ages. The orchards in this region are mainly large farms of over 10 hectares each, although farm size varies from less than one hectare to over twenty hectares. Because they constitute an important source of farm income, mango orchards in the region are usually well maintained. Annual application of farm yard manure, and occasional application of fertilizer and irrigation, are undertaken as part of regular agricultural practices. Annual average maintenance costs range from Rs. 5 000 (US\$125) to Rs. 35 000 (US\$830) per ha, depending on the bearing age of the orchard.

Mango trees come to bear from the fourth year after planting and continue to yield for up to 60 years. However, the economic benefits are most apparent in years 8 to 40. A fully grown mango tree in full bearing can yield up to 60 kg. But mango cultivation is constrained by biennial bearing, i.e. years with high and low yields alternately. This specific characteristic of mango trees requires appropriate strategies to deal with the instability in production, such as diversification in age and varieties.

Suppliers

Irrespective of the variety or orchard type, mango is mainly sold through pre-harvest contractors (PHCs), with few undertaking self-marketing. The PHC enters into a contract with a farmer three to four months prior to the harvest season, based on the flowering of the orchard. The PHC will also undertake some of the maintenance of the orchard, plus the harvest of the produce and its transfer to the market or processing unit at his cost. By entering into a contract with the PHCs, farmers transfer their production and marketing risks down the market chain. The specific characteristics of mango production and sale – such as biennial bearing of mango trees, high transaction costs and a lack of access to credit – can force producers

into distress sales to PHCs; thus the price paid by the PHC is often lower than that prevailing at the wholesale market at any given time. Since the PHC enters into such a contract with a number of producers, he undertakes the transfer function and makes his margin through bulking and economies of scale. Despite efforts at creating marketing infrastructure such as markets closer to production centres, the dominance of PHCs still persists in mango marketing.

Market intermediaries: wholesalers/commission agents and retailers

The farmer or PHC transports the harvested mango to the wholesale market, a specialized market solely trading in mango with a large number of auction lots, where it is auctioned by a wholesale or commission agent. The commission agent rents the auction lot during the period of the mango season or buys it and auctions to processors, retailers and petty vendors. For this transaction a commission is charged to both the seller and the buyer. The wholesaler or commission agent then sells the mango to retailers or processors within the same market or by transporting the produce to distant destinations. Direct sale to processors is common, especially in the case of *totapuri*, though this involves a few large-scale farmers only.

Processors

Processors form an important market intermediary in the *totapuri* mango marketing network, as much of the produce is converted to a value added intermediary product, the pulp. Chittoor hosts around 50 mango processing units that operate during the mango season for three to four months, from May through August every year. Most of these processing units are small-scale canning units, with investments of up to Rs. 2 million (US\$47 620), with a capacity of 10 tonnes per hour (India Ministry of Agriculture, 2008). There are four units with state-of-the-art technology for undertaking aseptic packaging, involving an investment of over Rs. 5 million (US\$120 000). In contrast with the typical processing plants of the region, these have a 5 tonne per hour capacity only, as aseptic packaging takes longer for processing.

The processing units undertake custom processing based on the orders from exporters. The raw material and the packing material (tin cans) are supplied by the exporter, while the semi-processing units simply convert the fruit into pulp using the available infrastructure and labour. The amount paid to the processor to conduct this activity is Rs. 3 500 (US\$85) per tonne of pulp. A few of the processing units also undertake their own processing, procuring the raw fruit from the market, involving a working capital of over Rs. 200 000 (US\$ 4 750) per export container (of 6 000 cans or 18.6 tonnes of pulp).

The final product of this processing stage is a semi-processed product, mango pulp, which is usually canned or in some cases packed in aseptic packaging. The exporter bears the costs of transporting the pulp to the port and exports to different destinations by sea. The pulp thus sold is repacked to serve the domestic and export demand for fresh juice and other mango based products, such as jams, jellies and thandra.

Exporters

Nearly 80 percent of the mango pulp is exported to different destinations based on prior orders. Mango exporters are generally the large industrial groups that are already into export business or individual entrepreneurs who act as agents for foreign buyers. Much of the mango pulp from India is exported to the Middle East, Europe and USA.

10.2.3 Value addition and margins along the supply chain

In a market chain, each market intermediary performs a specific transfer function or value addition, in anticipation of a remuneration that is directly proportional to the quality of service rendered. However, when power in the chain is not fairly distributed among the chain actors, there will be no equitable division of value added in the chain. The concentration of power with a specific market intermediary may stem from their access to market information and their ability and capacity to take higher risks (Preckel *et al.*, 2004). This can lead to differences in margins among the chain actors.

The role played by each of the market intermediaries, and the costs incurred and margins earned along the fresh and processed mango value chains, are discussed next. The market chain of processed *totapuri* is analysed up to the level of export; therefore the semi-processor's sales and margins are also calculated as a share of the export price.

In Figures 10.1 and 10.2 an overview of the costs and margins of fresh and semi-processed *totapuri* mango is presented, taking into account all the marketing channels and the most popular market channel adopted by the producer.

FIGURE 10.1 Market chain and sale price for fresh mango sale (domestic market)
(The highlighted channel is the focus of this analysis)

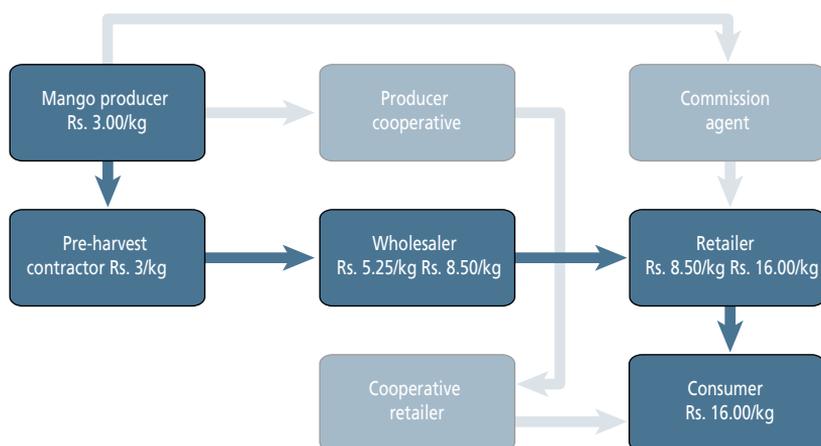
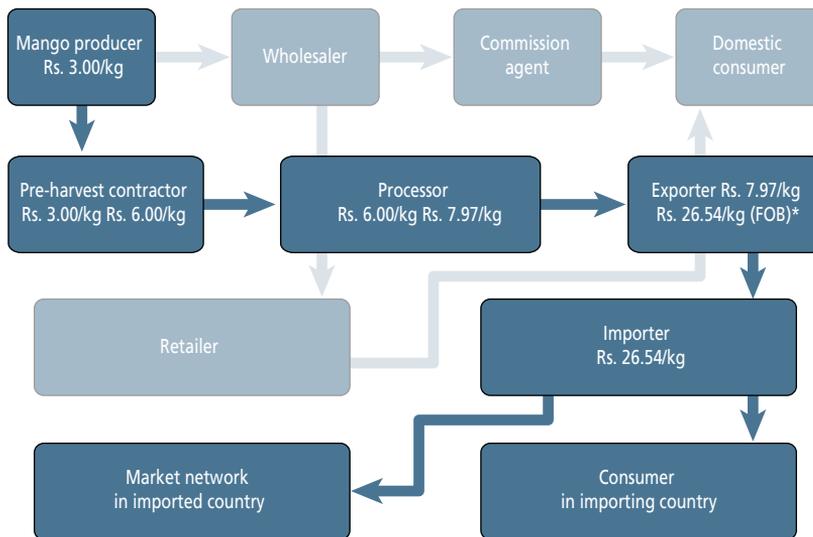


FIGURE 10.2 Market chain and sale price for processed mango sale (export market)
(The highlighted channel is the focus of this analysis)

*FOB: Free On Board.

The producer contracts to the pre-harvest contractor, who transports the produce to the nearest wholesale market and auctions it. The retailer purchases and sells to domestic consumers.

The highest margin in the fresh *totapuri* mango chain is earned by the retailer (28 percent), followed by the wholesaler (16 percent), farmer (10 percent) and lastly the PHC (9 percent). In the processed chain the exporter receives the highest share (17 percent). The PHC is better off in this chain than in the fresh one (11 percent) and is then followed by the processor (7 percent) and finally the farmer (6 percent). In real (rupee) terms, there is no price difference for the farmer; the PHC, however, is able to increase the margin in real terms because of the elimination of the commission agent from the chain. Some large-scale producers that are located in the vicinity of the processing units are able to make direct deliveries to the processing units, thereby substantially increasing the margin they receive.

The processor's margin reflects the level of risk undertaken by this chain actor. The work is contracted and own investments are therefore limited, resulting in a relatively low level of risk. Along the market chain, the material is increasingly bulked, given a concentration of the produce with a reducing number of players at each stage; this implies that income in real terms will also increase significantly along the chain.

The difference between the price paid by the ultimate consumer and the price realized by the producer is the price spread. In the case of fresh and processed *totapuri* mango this is Rs. 14.37 and Rs. 24.91 per kg respectively (Table 10.1). Although the price spread is significantly different in the two chains, because of the high differences in costs involved in processing this is not reflected in the margins earned in real terms. (Sudha and Kruijssen, 2008). The flow of market information along the chain is limited; this is shown by a lack of differentiation at farmer level in terms of *totapuri* mango production.

Further, the exact terms and conditions of the contract between the exporter and the importer are not clearly known. The price spread and market margins will reduce substantially if the final price paid by the consumer at the importing country is taken into account. In a typical export transaction of mango pulp following the standard marketing channel, the proportion of consumer's price received by the producer does not show any difference from what it is when obtained in the market for fresh product. The exporter's share is improved, but the advantage of a higher export price is not distributed to all the other players along the chain. The 'fag end' player, like the exporter who has access to market information, improves his margin from the export of mango pulp. It is here that the *totapuri* agro-industry cluster fails to coordinate a fair distribution of the market margins, unlike in the case of other export-oriented market linkages.

TABLE 10.1
Price spread along the *totapuri* mango supply chain (Rs./kg)

	Sale price	Fresh	Proportion of consumer's price (%)	Processed mango pulp	Proportion of consumer's price (%) [*]	Proportion of consumer's price (%) ^{**}
Farmer's sale price		3	18.75	3	18.75	6.67
PHC's sale price		5.25	32.81	6	37.5	13.33
Wholesaler's/processor's price		8.5	53.13	7.97	49.81	17.71
Retailer's/exporters price		16	100.00	26.54	100.00	58.98
Final consumer's price (Europe)				45		100.00
Price spread (up to exporter's price)		14.37		24.91		
Price spread (export sale price)				42		

Table based on authors' own calculations and Europe mango price.

* Proportion based on exporter's price.

** Proportion based on price paid by the final consumer in the imported country.

Source: Authors' own data, compiled from sample collected.

10.2.4 Income and employment generation along the supply chain in the *totapuri* mango agro-industry

An analysis of the *totapuri* agro-industry cluster's performance is incomplete if an assessment of the livelihood support that it provides to several stakeholders along the market chain is not carried out. Besides the prominent actors in the chain such as the PHC, the wholesaler/commission agent, the retailer, the processor and the exporter, others also play an important role in the mango supply chain. Employment is provided to a large number of people that are involved in odd jobs such as loading, unloading, sorting and grading at the market yard, and also in sorting, cleaning, cutting and packing at the processing units. Transport at all stages in the chain also provides employment for many.

During the mango season, families temporarily migrate to the market yard in the urban area or the processing units to earn a living, from as far as 200 km away. In the years when quantity is high, it is not uncommon that some of the migrants also act as small (on the spot) retailers. Nearly 150 days of employment is generated at each processing unit during the mango processing season, as each one of the transformation units processes over 500 tonnes of fresh mangoes annually. The Chittoor mango cluster could be generating employment to over 1 000 000 man days during the 3 to 4 month mango season annually. Yet, the jobs performed at the processing level are under threat from the increase in automated machinery that is required for the aseptic packing.

TABLE 10.2

Income distribution and risk borne

SI No	Name of the market intermediary	Function performed	Risk involved	Proportion of mango handled along the market chain (% share)	Proportion of value realized (% share)
1	Producer	produces	production risks – low	1	2
2	PHC	collects and transports	shares much of the producer's risk	4	7
3	Wholesaler	arbitration	moderate	27	42
4	Handler	transfers	low	53	10
5	Transporter	transfer	low	3	8
6	Processor	value addition	low	6	9
7	Exporter	exports	high	7	22

Source: Authors' own data, compiled from sample data.

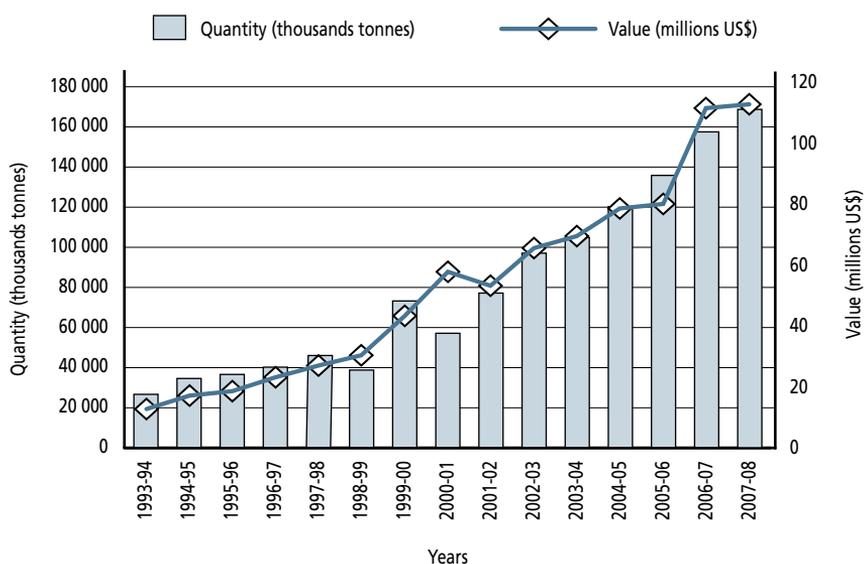
With regard to income, the proportion earned in the different supply chain echelons seems directly proportional to the risk borne at each stage. Table 10.2 outlines the role played by each of the market intermediaries, the perceived risk borne and the proportion of income earned.

While the high proportion of income earned by the exporter is justified given the level of risk borne for processed mango, the proportion of income earned and the risk taken by the wholesaler, either for fresh or for processed mango, is not justified by the amount of risk taken. The wholesaler primarily helps in arbitration and collects a market fee from both the seller and purchaser, taking away a major chunk of the margin merely from bulking products.

10.2.5 Export trade of mango pulp

Mango pulp is one of the most important commodities traded internationally in the processed fruits and vegetables market. India is the largest exporter followed by Mexico. India controls nearly 63 percent of the world market and nearly 70 percent of its exports go to the Middle East, while 12 percent are shipped to Europe and 5 percent to the USA. Estimates show that over Rs. 7 000 million (US\$54 million) are earned annually from mango pulp exports from India. Of this total, *totapuri* mango accounts for more than 50 percent (Figure 10.3). The major Indian and overseas players in the food processing industry, and especially in mango processing, are Indian Tobacco Company Limited (ITC) and Hindustan Unilever Limited (EMC, 2009). Hindustan Unilever Limited, a subsidiary of Unilever, has a

FIGURE 10.3 Export trend of mango pulp from India (1993–1994 to 2007–2008)



large market and considerable bargaining power, and has its own division for food and beverage exports (HUL, 2009). ITC Limited is the market leader in agro-exports (ITC, 2009). Besides these 'big two' are hundreds of small-scale exporters (APEDA, 2009). According to a recent study, aseptic packed *totapuri* mango pulp with 14 brix fetches around US\$850/MT, equal to Rs. 45/kg. The producer receives only about 2–5 percent of this price, suggesting inequitable distribution of margins in the export-oriented supply chains.

10.2.6 Efforts and innovations that lead to the current status of the *totapuri* mango supply chain

The *totapuri* mango agro-industry cluster is probably among the oldest market networks that have been in operation in India. The cluster as it stands today is a result of several favourable policies and innovative efforts. These include government policy and investment initiatives by the chain actors themselves.

Government export promotion initiatives

A series of policy initiatives and institutional support from the Government have impacted the *totapuri* mango market chain over the years.

- (a) **APEDA:** Setting up of the Agricultural Produce Export Promotion and Development Agency (APEDA) in 1984 provided a boost for export promotion of horticultural produce in India. Most of the export houses benefit from the services rendered by APEDA to its members, including market information services, export infrastructure credits, periodic assessment of consumer preferences from importing countries, and adjusted terms and conditions for export to different destinations. In keeping with the changes in the post World Trade Organization (WTO) period, APEDA also initiated efforts at implementation of HACCP¹ standards, with partial financial assistance from the Ministry of Food Processing Industries, covering a total of 24 mango processing units based at Chittoor and Krishnagiri districts in a phased manner. These units have also been assessed and certified by the International Standards Certification (ISC) South Asia Pvt. Ltd. in 1998/1999. The National Sanitation Foundation (NSF) has also certified the same. Compliance with the Minimum Residue Level (MRL) for several pesticides and fungicides is not a problem for mango exporters, given that mango cultivation in this region is largely organic, with very limited dosage of chemicals being used for spray and other purposes.
- (b) **AEZs:** Product-specific exclusive production regions were identified as Agricultural Export Zones (AEZs) during 2000 by the Government of India, which helped to create export and processing infrastructure specific to different crops closer to production centres. The idea was to provide focused attention on the problems faced by the growers in these specific regions.

1 Hazard Analysis Critical Control Points (HACCP).

- (c) **Liberalization of import policy:** This was one of the most important policy initiatives that enhanced private sector participation in Indian agriculture and allied sectors. Prior to 1997, imports of fresh and dried fruits were prohibited with the exception of dates and figs. Following the liberalization of trade in agricultural commodities, imports of all fresh fruit (except citrus, grapes and lychees) have been permitted generally on an Open General License (OGL) basis. In the case of countries belonging to the South Asian Association for Regional Cooperation (SAARC), an import tax of 44 percent *ad valorem* is levied, while for other countries it is set at 45.6 percent. There are no reported export duties on fruits from India. With additional facilities such as duty draw back, export market promotion concessions have helped growers gearing up for export oriented production. However, liberalized import policies helped foster the importing of state of the art technology for processing and packaging, including that for mango pulping and aseptic packaging.
- (d) **State-of-the-art aseptic packaging facility:** As a result of the increased attention given to food safety standards in the post WTO period, the demand for aseptic packaging of pulp for export markets is increasing. This type of process requires substantial investments in sterile processing and packing technology and material and lab testing facilities. Two such facilities have been set up exclusively for mango processing and packaging in south India, one of them at Chittoor and one in Bangalore. The daily requirement of raw material for these units is around 160 tonnes of fresh mango – for 24 hours after which the process is interrupted by a sterilization process required for production according to HACCP standards – hence sourcing of raw material in the appropriate quantity, maturity and price is a crucial constraint in the process. With the high level of fixed investment involved, it is essential for processors to utilize the unit at full capacity at all times during the mango season.

Initiatives for market integration

Several attempts have been made to attain and sustain vertical integration across the marketing network and supply chain of fresh and processed mango. One of the most significant attempts and by far the earliest was an intervention within the existing chain, initiated by a large private sector exporter. A state-of-the-art processing infrastructure for large-scale export was established closer to the production centres, with the primary objective of reducing transit times and post-harvest losses, thereby strengthening the link between producers and processors. With a pre-determined price, the set-up entered into contractual agreements with producers or PHC for the supply of raw material, fresh *totapuri* mangoes. Though the attempt succeeded initially, the advantage of 'price information' did not trickle down to the base level player, the producer (ITC Model)². As a counter to this attempt, soon a number of semi-processing units sprung up in the region, most of them being small-scale units

2 A model established by the Indian Tobacco Company during 1990s.

with a crushing capacity of around 10 tonnes per hour/day. These processing units started forming cartels during the season, allowing them to control the market price, nullifying the specific advantage of the processing infrastructure that was created.

In yet another attempt, an effort has been made by the State Government to promote the establishment of technology parks. These provide centralized facilities at reduced rates for processing and packing to producers or semi-processors that wish to set up a processing centre, thereby allowing them to enjoy these benefits, given that fixed investments and overheads are reduced. In addition, the central unit also provides market information on quality parameters, standards, arrivals and prices in different export destinations, in order to assist entrepreneurs to benefit from trade (TIP)³. It is important to ensure that the price advantage realized by an effective market information system is distributed along the market chain. However, this second effort also did not achieve the vertical integration that was anticipated. A few large farmers dominate the mango processing segment by acquiring the units of other small-scale players operating on job work or custom processing. In a more recent attempt under a public–private partnership model, an effort has been initiated with farmers cooperatives in order to assure the supply of mango for processing purposes⁴. Most of the efforts at creating horizontal linkages through cooperatives have not been successful in the past, given the administrative bottlenecks the cooperatives typically become entangled in.

10.3 Agro-industry clusters of horticultural crops in India

This section provides a discussion of the problems and prospects of agro-industry clusters and also considers other important Indian crops, relating the observations to the special features of the *totapuri* agro-industry cluster.

10.3.1 Efforts at linking farmers to markets

Being highly seasonal and perishable, horticultural crops are also capital and labour intensive and need care in handling and transportation. Their bulkiness makes handling and transportation a difficult task, leading to huge post-harvest losses which are estimated at around Rs. 230 billion, or nearly 35 percent of the total annual production (CII, McKinsey, 1997). Their seasonal production pattern results in

3 Technology Infrastructure Park (TIP), 1999.

4 There have been some attempts at creating horizontal linkages across the chain actors by creating cooperatives among producers with the goal of empowering them. Notable among these are the efforts initiated by AgriTerra of the Netherlands, through the Food and Agriculture Organization of the United Nations (FAO), Federation of Farmers Associations (FFA) and the Horticulture Department of Andhra Pradesh. This project, helping farmers to develop these cooperatives, has been implemented since 2007–2008.

frequent market gluts and associated price risk, thereby forcing farmers into distress sales to pre-harvest contractors and commission agents. A typical marketing channel of a horticultural crop thus involves a number of intermediaries like the pre-harvest contractor, commission agent, wholesaler and retailer, all operating between the producer and the final consumer. Each of these market intermediaries performs a specific market function that involves a cost to them, thereby yielding a share in the market margin. Some economic theories suggest that an efficient market provides for the distribution of market margins in proportion to the aggregation of utility performed by each market intermediary; however, market failures might distort the chain margin structure. In a market function, the physical movement of the produce occurs from farm to market along the chain, while the monetary and information flows happen in the reverse direction. The asymmetric access to information tends to empower market intermediaries and give them a stronger bargaining position, thus allowing them to secure higher shares in the chain's marketing margin (FAO, 1997).

Fostering coordinated linkages of farmers to traders and processors has been a recognized means to reduce seasonal gluts and associated price crashes, especially for perishables (Eaton & Shepherd, 2001; Subrahmanyam, 2000; Sudha and Gajanana, 2001). However, the linkage between producers and processors is rather weak under Indian conditions, given reasons such as high processing costs, inadequate supply of the right quantity of raw material for processing, dual taxation policies, and inconsistent demand for the processed produce. Efforts have constantly been made to link farmers to markets, so that the marketing channels and the role played by different market intermediaries are better coordinated. These efforts include the creation of alternate marketing channels that provide better pricing policies and reduce the margins, the promotion of contract farming for assured buy-back and corollary assured prices, and the development of streamlined supply chains to create and sustain value addition for some commodities (Dileep *et al.*, 2002).

Contract farming

Contract farming is one of the most accepted forms of integrating producers with industry through value addition. Several forms of contracting have been successfully implemented in horticultural crops. Some of these models, such as the one adopted by Pepsi or Hindusthan Lever for tomato and potato in India, are worth mentioning (Singh, 2000). These contracts seem to have worked well, but the inclusion of small farmers and the benefits to them are debatable (Dileep *et al.*, 2002). However, evidence points towards the positive impact of cross-border contract production of fresh vegetables for supermarkets involving a large number of small farmers. In this global supply chain, small farmers' microcontracts are combined with extensive farm assistance and supervision programmes to fulfil the complex quality requirements and phyto-sanitary standards of supermarkets. Small farmers that participate in these contracts enjoy higher welfare gains, more income stability and shorter loan periods (Minten *et al.*, 2005).

Cooperatives for domestic market linkages

The cooperative structure is the most common and rather overstressed organization model for the marketing of horticultural crops in India. Banana cooperatives from the Jalgoan region of Maharashtra have shown the way forward in accessing distant domestic markets, by pooling and thereby cutting down transport costs. Most of these cooperatives seem to work well in marketing fresh horticultural produce. One of most popular and successful cooperative marketing initiatives is that of milk and sugar rather than for horticultural crops. Having said this, successful value chain coordination through processing cooperatives has been reported for mango in Tamil Nadu. This model includes a hierarchy coordination involving 600 mango growers for *totapuri* mango (Aharam, 2009). However, the cooperative model has not been sustainable, given the administrative and legislative bottlenecks that are embedded in the cooperative legislation.

Linkages involving export-oriented production

There have been other innovative models integrating production to markets through value addition in horticultural crops, such as the export-oriented production of fresh grapes, plus the cases of coffee and tea.

Grape: One of the more recent accounts of a successful agro-industry cluster is that of a fresh grape export production group based in Narayana Gao, Pune district, Maharashtra. Popularly known as the Abhinav export group, this is a farmer's association set up in 2002 by a group of 110 grape growers, bringing about horizontal integration among the supply group for export-oriented production. Each farmer enrolls in the society as a member through a nominal payment (in the range of Rs. 5 000/farmer). The group plans the annual export-oriented production among the members. The infrastructure facilities for pre-cooling, cold storage and packing have been provided by APEDA and the State Government. The association ensures the timely supply of inputs and also provides technical expertise for export-oriented production, including clean cultivation practices and other HACCAP standards. The association invites buyers from across different destinations, provides them with information on cultivation practices and thus ensures they achieve a collective bargaining power. Within a short span of five years, the association has been able to export over 100 tonnes of fresh grape to different European countries. The model thereby helps farmers overcome the problem of distress sales to PHCs, prolonging the marketing season and creating access to alternate and distant markets where higher prices may be reaped. The benefit of higher export prices realized by farmers is distributed across the chain players equitably. The model also eliminates a number of market intermediaries and helps producers gain higher market share. Through collective action, farmers are also able to import better technical know-how for value addition on-farm. The model provides for horizontal integration and value addition through improved packaging, but is available only to a small set of grape growers.

Coffee and Tea: The export market linkage models existing for coffee and tea provide insights into a comprehensive linkage scheme, where even a small grower is able to realize the benefits of quality-based export market prices for his produce. The fact that the prices of these commodities are internationally established provides an opportunity for producers to benefit from a quality-based pricing system. These commodity groups provide an example of how an internationally-determined competitive price is effectively transmitted to the farthest upstream players along the supply chain. Effective institutional support and strong producer collectives can be identified as the most critical factors responsible for the success of these initiatives. The case of Darjeeling tea is an example of chain empowerment channeled through Mercy Corps and its local partner, Darjeeling Earth Group. This linkage arrangement gave farmers the right to sell directly to tea estates and realize higher prices than when selling to middlemen.

Most of these experiences or models do not seem to apply directly to the mango supply chain, given the sheer size of the cluster and also because of its unique characteristics. Section 4 examines these features and makes inferences and suggestions for the future.

10.4 Feasibility of standardizing supply chains for *totapuri* mango pulp

Taking on board the lessons from the examples of other crops, this section aims to assess the feasibility of emulating a similar effort for *totapuri* mango pulp from Chittoor. At the outset, it is important to understand the unique characteristics of the *totapuri* mango agro-industry cluster in comparison with other crops and clusters.

The *totapuri* mango agro-industry cluster is one of the oldest naturally-formed clusters that emerged from the comparative advantage of *totapuri* production in the region. It also represents a highly dynamic market network that is mature yet fiercely competitive. In a typical agro-industry cluster of this nature there are no written agreements nor pre-determined price supports. Entry barriers are low, competition is fierce and the market is mature. The *totapuri* mango cluster focuses on a processed product, distinct from others such as grape which is for fresh consumption. Though both are seasonal crops they differ with regard to capital and labour requirements. Its capital-intensive nature makes grape a highly commercial crop through which producers are keen to gain high returns.

In the case of *totapuri* mango the crop is the most convenient farm enterprise option available to the producer, given the limited rainfall and other agro-climatic conditions in the region. The area's hilly landscape actually saves the producers several costs, such as those stemming from watch-and-ward needs and from

wind-induced damage to the mango crop. This comparative advantage and low cost of establishment and maintenance makes the production base highly differentiated in terms of holding size; this is not the case with other perennial fruits.

Another feature unique to mango is the biennial nature of its cultivation cycle, which means that not all the trees in an orchard will bear fruit every year. Growers therefore maintain orchards involving different varieties and different age groups, such that overall, the orchard sustains itself through income from one or other variety every year. These unique features of mango differentiate it from other fruit trees and make it difficult to maintain any regular farmer group. The grape model highlights the scope for organising growers into fewer and smaller groups of farmers sharing common interests. Such associations develop uniform practices and allow the formation of a regular supply base.

Since the mango industry is based on a highly-differentiated production base, any effort aimed at market intervention seems to have sparked off market expansion through additional processing infrastructure. The fact that the *totapuri* mango cluster has been expanding continuously is an indication of the growing and sustainable profitability of the commodity in domestic and export markets. Most of the earlier efforts initiated by the Government to create infrastructure and facilitate smooth functioning of the value addition chain have been successfully countered by alternate efforts from private owners and growers themselves. Despite this there has not been a decline in the revenues earned or quantity traded.

The impact of Government policy in terms of dissemination of market information by APEDA, infrastructure creation through the National Bank for Agriculture and Rural Development (NABARD), and a drive towards refinancing and promotion of liberalized exports, can be seen in the expansion of the agro-industry cluster and the subsequent enhanced exports of mango pulp from the region. Now that mango pulp has been standardized as an internationally-traded commodity, there is a need to put in place a mechanism for price determination in the free market that can be passed along the chain to the lowest level player. The most critical point in the mango pulp cluster is that the margin involved in converting fresh mango into pulp is rather small. A number of players along the chain, including the processor, earn their profits from bulking. It is here that supply chain management needs to pay special attention to avoid the smallest player in the chain, the grower, suffering the consequences of unfair trade practices. The chain model needs to be developed so that the cluster incorporates a safety mechanism to safeguard the interests of the smallest link in the supply chain. The model adopted by Darjeeling tea, discussed earlier, seems to offer a suitable approach in this respect.

Furthermore, there is a need to address the problem of non-competitive behaviour, which appears to characterize the actions of market chain players such as wholesalers or commission agents. While these market intermediaries retain nearly half of the producers' share from the consumers' rupee, there are no indications that the

functions they perform would justify the margins observed. Indeed, there is evidence that suggests the failure of markets to disseminate price information effectively across the different players in the chain, thus creating asymmetries to the detriment of the growers. As such, a key function of any attempt at market organization for the cluster should ensure that market price information is effectively disseminated along the chain. Similarly, redundant and non-essential market intermediation should be minimized. Being a processed commodity, *totapuri* mango could be marketed through direct links set up between growers and processing companies. Since *totapuri* mango pulp is an internationally-recognized commodity that can be measured on standard brix and the international price is directly proportional to the brix, there is scope for setting up an efficient price information system.

10.5 Suggestions and policy implications

Creating a commodity board, or a similar chain coordination mechanism exclusively for mango pulp, appears to be a tangible solution for linking producers to markets. The primary objective of the board or association would be to facilitate a process through which mango producers are empowered to participate in the market and benefit from the international trade of the processed product. As has been discussed earlier, ample examples are available for creating and sustaining such commodity boards or associations. An effort of this nature would require the creation of a 'brand name', bringing all the producers and processors under one banner, ensuring uniform quality of the finished product from the region, and guaranteeing a more uniform benefit-sharing mechanism, irrespective of the size of the operating unit. Because the product from the region is unique, it is also possible to obtain a 'geographic indication' for the produce, create a brand name, trademark the logo, and bring all the producers and processors under one umbrella through a franchise scheme. One of the prerequisites for this is the standardization of the end product, the mango pulp. Since mango pulp and the specific case of *totapuri* mango pulp are already standardized and internationally traded, all these steps are feasible with appropriate institutional support.

At this juncture, it is imperative that the requisite interventions are actioned at international level. Since mango pulp is a homogenous, standardized commodity that can be traded internationally, an organization of international repute such as FAO could play a significant role in initiating and sustaining such an initiative. The primary objective of such an initiative would be to assist the process of 'price discovery' and dissemination to the lowest players along the supply chain.

Apart from the interventions required at processing level to ensure uniform quality, efforts are also needed to increase competition at the wholesaler level of the chain. This would require collective action in a three-tier structure, grouping farmers at community level into self-help groups, identifying processors at district level who procure fresh material directly from these groups, and who in turn are integrated with exporters to export the semi-processed pulp under one brand name. Obstacles that have to be overcome for such an intervention to succeed are manifold and include: inconsistencies in export demand; lack of transparency and information sharing in the market in terms of price, quantity and quality; a lack of trust among the chain actors; difficult and cumbersome taxation policies; the absence of initiatives to build brand names. The commodity board or association would be expected to address most of these issues.

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Annex 1:

Trend of mango area and production in Chittoor, Andhra Pradesh

Table 10.3

Trend of mango area and production in Chittoor, Andhra Pradesh

	Chittoor Area (ha)	State total area (ha)	% of total State area	Chittoor production (tonnes)	State total production (tonnes)	% of total State production
1998-99	33 032	281 914	11.72	106 785	2 269 571	4.71
1999-00	42 766	297 449	14.38	342 128	2 379 592	14.38
2000-01	45 077	306 192	14.72	360 161	2 449 536	14.70
2001-02	45 559	341 191	13.35	368 912	2 445 824	15.08
2002-03	47 834	370 267	12.92	382 672	2 962 136	12.92
2003-04	52 721	402 154	13.11	421 768	3 217 232	13.11
2004-05	48 913	391 896	12.48	391 304	3 135 168	12.48
2005-06	59 155	459 713	12.87	391 304	3 306 032	11.84
2006-07	59 380	471 367	12.60	486 916	3 865 209	12.60
2007-08	59 380	483 480	12.28	510 668	4 157 928	12.28

Source: Statistical data of Government of Andhra Pradesh.

Annex 2:

Marketing margins and price spread along the supply chain for *totapuri* mango

Table 10.4

Marketing margins and price spread along the supply chain for *totapuri* mango

	Fresh			Processed	
	Value (Rs./tonne)	% of total		Value (Rs./tonne)	% of total
Farmer			Farmer		
Net price	1 630	10.19	Net price	1 630	6.14
PHC			PHC		
Buying price	3 000	18.75	Buying price	3 000	11.30
Costs			Costs		
<i>Transport</i>	120	0.75	<i>Transport</i>	10	0.04
<i>Handling</i>			<i>Handling</i>		
<i>Commission</i>	420	2.63	<i>Commission</i>	10	0.04
Margin	1 410	8.81	Margin	2 970	11.19
Wholesaler			Processor		
Buying price	5 250	32.81	Buying price	6 000	22.61
Costs	650	4.06	Costs	60	0.23
Margin	2 600	16.25	Margin	1 910	7.20

Annex 10.4 (Continued)

 Marketing margins and price spread along the supply chain for *totapuri* mango

	Fresh			Processed	
	Value (Rs./tonne)	% of total		Value (Rs./tonne)	% of total
Retailer			Exporter		
Buying price	8 500	53.13	Buying price	7 970	30.03
Costs			Costs		
<i>Transport</i>	2 500	15.63	<i>Cans</i>	3 330	12.55
<i>Handling</i>	500	3.13	<i>Reforming and filling</i>	1 670	6.29
Margin	4 500	28.13	<i>Packing</i>	20	0.08
			<i>Transport to port</i>	250	0.94
			<i>Sea freight</i>	2 530	9.53
			<i>Commission</i>	640	2.41
			<i>License</i>	5 560	20.95
			Margin	4 570	17.22
Consumer price	16 000	100.00	Export price	26 540	100.00
Price spread	14 370		Price spread	24 910	

Source: Author's own calculations based on sample data.

CHAPTER 11

Process and product innovations in the cassava agro-industrial sectors in Africa: The stimulating effect of presidential initiatives

LATEEF O. SANNI

11.1 Introduction

The production, processing and marketing of cassava provides a major source of income for about 450 million people, often women and low-income earners, in sub-Saharan Africa (FAO, 2004). Cassava is not only strategically important as a food source and famine reserve. Combining high calorific efficiency with versatile/low cost input and reliable and flexible production, it is now seen as a pro-poor vehicle for economic development (NEPAD, 2004). The New Partnership for African Development (NEPAD) hence adopted the slogan 'Cassava: A Powerful Poverty Fighter in Africa' for its Pan African Cassava Initiative (Whingwiri, 2004).

Nweke *et al.* (2002) classified cassava development in Africa into five stages. In the first stage, cassava is considered a famine reserve crop, especially in areas where rural consumption is based on cereals. In such dry regions of Kenya, Malawi, Tanzania, Mozambique, and Zambia, as well as in the northern Saharan zones of most countries in West Africa, cassava is a famine reserve crop during periods of scarcity and drought.

In the second stage, cassava is considered a rural food crop because it is the main source of calories in the diets of rural consumers. Although cassava has this important role, farmers only use local varieties and traditional technology, largely because of the limited market incentives to adopt new varieties and improved technology. As a result, farm output is relatively low and cassava is mainly consumed on the farm. This type of production is often found in remote areas of the cassava belt in sub-Saharan Africa (SSA).

In the third stage, cassava is considered a food and cash crop, based on traditional technology and traditional low-yield varieties. Average yields are 7–10 tonnes/ha and manual processing is very common. Cassava is a basic rural and urban food staple; a significant part of the harvest is sold in processed form. This type of production is found in regions with market access in the coastal, forest and savannah zones of some countries in western and central Africa: examples include Nigeria, Democratic Republic of Congo, Cameroon, Guinea.

The fourth stage is when cassava is considered a food and cash crop based on improved technology, involving a broad adoption of high yielding varieties and mechanization of certain processing stages (grating, pressing, frying and milling). At this stage cassava is both a rural and urban food crop. Examples abound in Nigeria and Ghana as a consequence of presidential initiatives.

At the fifth stage cassava also becomes an industrial crop, providing raw material for starch, ethanol, flour, and the livestock feed industries. At this stage, less than 75 percent of the total cassava output is devoted to direct human consumption in both rural and urban areas. A significant number of cassava growers in Nigeria have made the transition to the fourth stage (high yielding varieties and mechanized processing), even though farmers have not yet attained the desired technical efficiency in cassava production. This low efficiency results from a lack of knowledge of the latest available technology in cassava cultivation and other improved inputs such as fertilizers and herbicides. However, the wide-scale adoption of high yielding varieties and the resulting increase in yields from 11 tonnes/ha to 40 tonnes/ha have shifted the problem of the cassava sector from supply issues (production) to demand issues, such as finding new uses and markets for cassava.

11.2 Presidential Initiatives on Cassava (PIC)

According to Tonah (2006), the development of the cassava sub-sector is emerging as a key component of a regionally strong and diversified economy able to generate employment, contribute to food security, and sustain incomes for the populations of sub-Saharan Africa. To achieve these potentials, however, it is necessary to put in place mechanisms and policies that guarantee a regular supply of good quality cassava.

To this end a number of SSA countries, especially Ghana and Nigeria in West Africa, have launched Presidential Initiatives on Cassava (PICs) as part of elaborate economic reform programmes aimed at promoting the diversification of the foreign exchange earnings base for these countries. The PIC policies were expected to encourage public–private partnership by creating, through well-designed intervention mechanisms, a practical enabling environment for

competitively advantageous industries identified as having the potential for fast growth and demand from export markets.

The Ghanaian Presidential Special Initiative (PSI) on cassava began in 2001, as part of the Government's policy of transforming cassava production from its subsistence nature into a commercially viable agribusiness that can generate substantial revenue locally and through exports. The specific objectives of the PSI on cassava were to: (1) transform the cassava industry into a major growth area; (2) establish 10 cassava starch processing plants; and (3) generate annual export revenues of US\$100 million by the end of 2006. In addition the initiative aimed to ensure that 50 percent of farmers participating in the project should be women.

Although the Ghanaian Government is the main sponsor of the PSI, the project was to be executed through a farmer-ownership scheme called the Corporate Village Enterprise (COVE). The COVE model seeks to bring rural communities into mainstream economic activity by establishing large-scale export-oriented enterprises, which will be owned by farmers themselves but managed by professionals with industrial experience who are engaged on performance contracts. In line with this policy, farmers were encouraged to form cooperatives. Members of the cooperatives were expected to grow the crop on their individually-owned farms and then be assisted by the Government to own a starch processing plant collectively, established by the government to process cassava into starch (Tonah, 2006).

The Government and its development partners were expected to complement the efforts of the private entrepreneurs by supporting the project with infrastructure facilities: construction and upgrading of access roads, provision of communication facilities, adequate power for the processing plant, and potable water for the factory as well as the surrounding communities. Advocacy structures were also set up using project field staff (with the assistance of the Ministry of Food and Agriculture) to inform the farmers about the impending project and the roles expected of farmers and the Government in the project. They also needed to convince rural farmers about the benefits of cassava production and the readiness of the produce market to receive their output.

In July 2002, a year and a half after the launch of the PSI in Ghana, the President of the Federal Republic of Nigeria announced a similar initiative. This aimed to create awareness among farmers about the opportunities that exist in the cassava market through expanded cassava utilization and primary processing. To this end, actions were taken to increase productivity and expand annual cassava production in order to achieve global competitiveness, while integrating the rural poor (especially women and young people) into the mainstream of Nigeria's national economic development. Furthermore, new market opportunities were identified and developed to stimulate increased private sector investment in the establishment of export-oriented cassava industries (FNG and UNIDO, 2006; Knipscheer *et al.*, 2007; Ezedinma *et al.*, 2007).

The specific objectives of the Nigerian presidential initiative on cassava (PIC), which was to be achieved by 2007, included:

1. Enhance the productivity and production of cassava by increasing the area cultivated to 5 million ha, with the hope of harvesting 150 million tonnes of fresh cassava tuber annually.
2. Produce 37.5 million tonnes of processed cassava products (i.e. *gari*, HQCF (high quality cassava flour), pellets, chips, starch and ethanol) for local and export markets.
3. Organize the export of cassava and processed-cassava products as a revenue-generating project.
4. Earn about US\$5 billion annually from exporting value-added cassava products.

According to the United Nations Industrial Development Organization (UNIDO, 2006), existing and new policies aimed at supporting investment and market development in the cassava industry in Nigeria include:

- ▶ **Policy on national strategic food reserve.** The food reserve policy was aimed at ensuring food security, guaranteeing food and industrial raw materials and providing employment opportunities for the rural labour force. *Gari*, the most produced and traded cassava product, has recently been added to the list of products. This should stimulate the *gari* production industry, creating more cassava plantations, essential for the growth of the overall cassava industry.
- ▶ **Policy on Pioneer Status Investment Incentives:** Companies can obtain pioneer status in several ways: if they produce products declared 'pioneer products' under the Industrial Development (Income Tax Relief) Act No. 22 of 1971 as amended in 1998; if the Nigerian Investment Promotion Council (NIPC) has declared it a deserving enterprise; if the company is located in an 'economically disadvantaged' area. Pioneer status provides a five-year tax holiday to qualified investors, with a two-year extension for those located in economically disadvantaged areas. These areas are defined in the NIPC guidelines for investment incentives in Nigeria (NIPC, 1998). However, it must be noted that pioneer status is not automatic and must be applied for; even with pioneer status such companies must report taxes to the Federal Inland Revenue Service (FIRS) even though the tax is not taken from the company.
- ▶ **Policies on export incentives for non oil sector:** These include (a) a 10 percent tax concession for five years for industries exporting no less than 60 percent of their products; (b) retention of export proceeds in foreign currency; (c) an Export Development Fund (EDF) that provides financial assistance to private sector exporting companies; (d) an Export Grant Fund Scheme (EGFS) that provides cash inducements for exporters that have exported a minimum of ₦50 000¹ worth of semi-manufactured products; (e) a duty drawback/suspension and manufacture-in-bond scheme; (f) an export adjustment fund scheme providing supplementary export subsidies to compensate exporters for the high cost of local

1 ₦ = Nigerian naira.

production arising mainly from infrastructure deficiencies and other negative factors beyond the control of the exporter; (g) Nigeria Export/Import (NEXIM) Bank Foreign Exchange facilities; (h) a capital assets depreciation allowance, which is an annual allowance of five percent on plants and machinery to manufacturing exporters who export at least 50 percent of their annual turnover, provided that the product has at least 40 percent local materials content or 35 percent value added.

All of these incentives are also applicable to cassava-based industries (e.g. starch or ethanol) that are produced for export purposes.

- ▶ **Policy on the provision of credit loans for agriculture producers** through specialized banks like the Nigerian Agriculture, Credit, and Rural Development Bank (NACRDB).
- ▶ **Policy on mandatory substitution of 10 percent wheat flour with high quality cassava flour** in the flour mill industry. This policy will link high quality cassava flour processors to large-scale wheat flour millers in Nigeria, and consequently create the desired jobs.
- ▶ **Policy on provision of gainful employment** for the country's population. The present government of Nigeria strongly supports a growth-oriented economy with the capacity to create jobs.
- ▶ **Policy on blending of 10 percent Ethanol in fuel.** The Nigerian government as part of its commitment to the 2000 Kyoto Agreement has decided to implement a policy of blending fuel with 10 percent ethanol. Ethanol blended fuels will lower the emission of carbon monoxide into the atmosphere.

Nigeria's PIC was to have been implemented during the period 2002–2007. To achieve these objectives, there was a need to develop the domestic market and create national policies in order to promote cassava development in the country.

11.2.1 Stimulating effect of Presidential Initiatives

These Presidential initiatives on cassava generated great excitement and hope, and greater expectations on the part of relevant stakeholders, contributing to the achievement of the United Nations' Millennium Development Goals as explained in Table 11.1.

In general, the PICs have helped create awareness about the multiple uses of cassava to produce value-added products such as flour, starch, cassava chips, glucose syrup, animal feed, ethanol, and composite (cassava–wheat) baking flour. Both the public and private sectors have been giving increasing attention to the cassava sub-sector. In Nigeria, the PIC has stimulated an increase in cassava production and processing activities. The promotion of HQCF in the baking and confectionary industries was given further political support to enhance public and industrial acceptance. With strong advocacy at all levels there was support for processing and export.

TABLE 11.1

Millennium Development Goals and the roles of PICs and other parties

Millennium Development Goal	Roles of PICs and others
Eradicate extreme poverty	Cassava is a secure source of food and nutrients. Post-harvest processing adds value and enables farm-gate businesses to boost farmers' incomes.
Promote gender equality	Women benefited especially from improved cassava farming and processing activities. Women's participation in cassava initiatives increased their knowledge and skills, and enable them to make better enterprise decisions.
Reduce child mortality	PICs have contributed to this goal by reducing hunger and raising farmer-processors' standards of living.
Improve maternal health	Through better nourishment, PICs directly improved the health of women and their unborn children.
Develop a global partnership	More partners involved in cassava for development.

A policy was promoted to add 10 percent of cassava flour to the wheat flour used in bread, to open additional market opportunities for smallholder farmers. The growth in demand activated the industrial scale-up of HQCF and starch processing by about 48 percent (Maziya-Dixon and Onadipe, 2007). The awareness created greater interest and increased investment in the industry by foreign and local investors. During the period, private sector participants established over 500 microprocessing centres (MPCs) and 100 small- and medium-sized enterprises (SMEs) for the production of intermediate cassava products. The enterprises provided substantial job opportunities for the young, technicians, professionals and artisans (Sanni *et al.*, 2006). There were substantial investments in new factories for the manufacture of glucose syrup, starch and HQCF. Such factories include Ekha Agro Farms, Ogun State, a glucose syrup factory built in 2007; Dutch Agricultural Development Company Nigeria Ltd, Benue State, an automated HQCF factory built in 2006; and Matna Foods, Ondo State, a cassava starch factory built in 2005. The market for HQCF in Ghana is already established with the Plywood manufacturers and the biscuit factories (Piccadilly Biscuits and Parle Biscuits). There is also instant *fufu* being manufactured and available on the market. Finally, a company named Lee Chemicals that is chiefly into export trade also purchases HQCF.

Some companies attempted regional marketing of cassava starch, e.g. Matna Starch Industry exported cassava starch through Nestle Plc to Cote d'Ivoire, while Ayensu Starch Mills, Ghana, attempted to enter the Nigerian market. There was a policy on 5 percent inclusion of HQCF in bread, but it has not been passed into law as the bill had not gone through parliamentary scrutiny. The Ghana Agro-Food Company

(GAFCO) had a significant interest in HQCF, provided that the other two flour millers (Irani Brothers Flour Mills and Takoradi Flour Mills) would be willing to use it in the production of composite flour.

The Nigerian PIC rested its success more on strong financial support to relevant institutions, most especially the International Institute of Tropical Agriculture (IITA), the National Root Crops Research Institute (NRCRI), the Raw Materials Research Development Council (RMRDC) and the Root & Tuber Expansion Programme (RTEP), towards the achievement of the objectives of the initiative.

The period between 2007 and the present day has seen a new outlook in liberalization of food trade, including cassava products. Unlike previous regimes, African leaders are decreasing trade barriers on flour products, including cassava. This conflicts with research findings that suggest nationals made more money in local substitution with high tariffs on importation of food products. Today, Africa is lacking in the area of reliable and sustainable policy implementation on trade liberalization.

Various reports (mainly in the news media in Nigeria) and an impact study published in Ghana (Tonah, 2006) have been highlighting difficulties in their implementation. For example, processors failed to meet the deadline of January 2005 related to government policy on 10 percent cassava flour inclusion in bread making in Nigeria. In Ghana, Tonah (2006) found that farmers were unhappy with low prices paid by the processors who, in turn, complain about insufficient supply of raw cassava roots.

The coordinating Government Ministries in Nigeria (Federal Ministry of Agriculture and Water Resources, FMAWR, and Federal Ministry of Commerce and Industry, FMCI) failed to provide strong influence to ensure early commencement of the initiative. There were also conflicting positions as regards the implementation of PIC, which shows a serious lack of monitoring and evaluation; this problem is still lingering.

Price has always been the bone of contention among all stakeholders in the cassava sector. Farmers complain of the prices offered for the cassava roots by processors, while processors in turn complain of the prices that major end users are offering to purchase their finished products. Furthermore, Nigerian processors were unable to sell high quality cassava flour (HQCF) to flour milling industries because of a price disagreement. At present, HQCF is sold at ₦65 000 (US\$439) per tonne in Nigeria while processors are clamouring for ₦90 000 (US\$608) per tonne. There are two types of HQCF available in the Ghanaian market – the food grade HQCF, which sells for Gh₵700/tonne, and the other grade for the plywood industry, which sells for Gh₵600/tonne. Kokorte sells for Gh₵400/tonne. Price is greatly affected by seasonal differences in this part of the world.

The perceived challenge at present is that ongoing efforts are not adequate and that the cassava sub-sector needs a further push for it to play a leading role in

the agricultural and economic development of SSA countries. To this end, African leaders made a call, through the New Partnership for Africa's Development (NEPAD), to give priority to cassava in regional agricultural development strategies. This led to the creation of the NEPAD Pan African Cassava Initiative (NPACI), a strategic institutional arrangement that is aimed at linking national agricultural research and extension systems to regional initiatives on cassava, in order to ensure food security and income generation in Africa.

Changes in successive governments and leaders have been a bane in sustainable agro-based industrialization in sub-Saharan African countries. Incentives that opened windows of market opportunity based on paradigm shifts from production to market-oriented approaches are easily withdrawn, simply because of changes in leadership, without any policy dialogue involving the stakeholders. This has implications for product and process innovations that can enhance agro-industrial development. It is pertinent to note that the sustainable and stimulating effect of a cassava diversification policy in Africa rests heavily on supportive and amiable approaches, continuous political will, constant dialogue with stakeholders and collaboration by development partners. This has been exemplified by South American countries such as Brazil and Colombia, which have advanced cassava development systems that play a vital role in their successful industrialization. With 70 percent of South American market share, these two nations, especially Brazil, have become leading world producers, processors and marketeers of cassava and its corollary products (UNIDO, 2006).

11.3 Influence of Presidential Special Initiatives on product innovations

Efforts made so far towards improving the quality and safety of fermented cassava products (*gari*, *attieke*, instant *fufu* flour, *agbelima*) based on Presidential Initiatives in Nigeria and Ghana are presented as case studies. Advances made in the local substitution, fortification of traditional and new products are presented.

Findings from the Collaborative Study of Cassava in Africa indicated that the majority of cassava consumed on the continent is fermented (Nweke, 2003; Tanya *et al.*, 2006). These include *fufu*, *gari* (Figure 11.1), *eba*, *attieke*, *kokonte*, *chikwangue*, *placani*, cassava beer, fermented boiled cassava, etc (Kuye and Sanni, 1999). In many African countries, age-old traditional methods were employed before the presidential initiatives in traditional fermentation processes.

Pilot initiatives in 2002–2006 undertaken by Natural Resources Institute (UK) and its partners in Ghana demonstrated the technical and commercial feasibility of producing new/improved cassava products such as instant *fufu* (Figure 11.2), instant *agbelima*, and improved *kokonte* in Ghana and Nigeria, applying the HACCP principle (Hazard Analysis and Critical Control Point) (Johnson *et al.*, 2006; Tomlins *et al.*, 2007).

FIGURE 11.1 Gari Market, Edo State, Nigeria, 2005



FIGURE 11.2 Instant fufu flour



11.4 Process innovations

According to Nweke *et al.* (2002), there are three types of cassava-processing machines in use in Africa: graters, pressers, and mills. Mechanized graters were first introduced in the Republic of Benin by the French in the 1930s, and were modified in Nigerian in the 1940s by welders and mechanics, using local materials such as old automobile motors and scrap metal. The mechanized graters are owned by village entrepreneurs, who provide grating services to farmers. In Nigeria, the PICs encouraged remarkable modifications with technical backstopping from the International Institute of Tropical Agriculture (IITA) in cassava processing techniques, and equipment manufacturing for peeling, grating, drying, frying and milling (Sanni *et al.*, 2006a,b).

Local (mainstream) manufacturers have come up with diverse forms of innovation and improvements to enable processors to overcome some of their limitations. The locally adapted post-harvest technologies were introduced by the IITA-implemented cassava enterprise development project (CEDP) in support of the PIC (Sanni *et al.*, 2005, 2006, 2007). These machineries include mobile graters, flash dryers, pulverizers, centrifuges and plate mills. Other low cost innovations suitable for micro-processing included: the improvement of the cassava presser from screws to hydraulic mechanism; the design of a mobile grater; improvement in cassava sieves; the development of a low cost cassava dryer that can use charcoals and kerosene (for drying of cassava chips and pellets); the integration of the cassava grater, cassava press, cassava sieve and *gari* fryer in a single package.

The development of peeling machines in Nigeria began in the 1980s (Olukunle *et al.*, 2006). IITA, in collaboration with the African Regional Centre for Equipment Development and Management (ARCEDEM), the A & H Engineering Construction Company (Iwo), Fataroy Steel Industry (Ibadan), and other engineers from public institutions in Nigeria commenced modification of cassava peelers in 2005. Based on the assessment, minimum peel retentions were 5.7 percent, 6 percent, 11 percent, 0 percent and 0 percent respectively for A&H, FUTA, FATAROY, Hand Fed Model and manual method,

with capacities of 0.25 tonnes/ha and 1 tonne/ha. Various suggestions were discussed and manufacturers were encouraged to improve on their designs. Consequently, ARCEDEM produced a prototype peeler in collaboration with IITA (Sanni *et al.*, 2006b).

A recent field visit by engineers from the National Centre for Agricultural Mechanization (NCAM) to A & H Engineering revealed some improvement in innovative cassava peelers (Olowonibi *et al.*, 2009). The peeling machine comprises three cylindrical rotating rollers with a crest of about 0.5-inches and 2 mm mild steel wound round the rollers, which serves as the peeling blade. The blade winds round the top left and wooden rollers anticlockwise while the top right roller blade winds clockwise. There is a stationary hollow cylindrical galvanized pipe positioned exactly at the top downroller; the three rollers connect together with a chain via sprockets. The machine has an efficiency of 85–90 percent with small cassava roots and 90–95 percent with large roots. Processors (Cottage to SMEs) in other parts of Africa are still using manual peeling, which is laborious. It is only Ayensu Starch Mill that uses mechanical peelers, which are not accessible for use by a critical mass of processors in Ghana. Some SMEs are currently testing using ARCEDEM-WABAMACO, Fataroy and A&H peelers, with some degree of success. However, there is still a need for further collaboration in the development and perfection of cassava peeling machines before they may be usefully integrated into cassava processing methods by other end users in Africa.

Based on considerable demand from vulnerable groups and processors in remote areas of Nigeria, a mobile grater was designed and manufactured by engineers from the International Institute of Tropical Agriculture, the Federal Institute of Industrial Research, State Agricultural Development, and manufacturers (Sanni *et al.*, 2007). The best version was produced by the Scientific Equipment Development Institute (SEDI) – a Government-owned engineering centre in Enugu, Nigeria. The mobile grater has the following features: a stainless steel hopper/delivery chute, a 7 HP (Horsepower) diesel engine prime mover, a steel chassis, a motorcycle wheel that supports and reduces vibrations, a push handle, and a rest/support metal frame.

This initiative resulted in the large-scale commercialization of the production of cassava derivatives such as *gari*, which culminated in the shift from the use of local roasters to stainless steel double roasters and automatic roasters.

Cassava processors in particular have perceived that the PIC has improved their access to improved processing technologies that reduce drudgery and facilitate the processing of high quality cassava products. They also believe that these technologies have enhanced their opportunities to earn income (Sanogo and Adetunji, 2008).

One notable benefit of process innovation from PIC was the positive collaboration from 2006 to 2008 between the IITA and other public agencies (e.g. the International Fund for Agricultural Development (IFAD)-sponsored Root and Tuber Expansion Programme (RTEP)) and in Godilogo farms, Obudu, Cross River State, on the design and manufacture of more efficient flash dryers. The new flash dryer installed

at Godilogo was commissioned in August 2008 with financial support from the IITA, the International Fund for Agricultural Development (IFAD)-Root and Tuber Expansion Programme (RTEP), Godilogo farms, and the Raw Material Research and Development Council (RMRDC) under the Federal Ministry of Science and Technology. It is an impressive machine that can produce 250 kg/hour of cassava flour (Kuye *et al.*, 2008).

11.5 Institutional support for cassava agro-enterprise development in Africa

Emphasis by the Global Cassava Development Strategy (GCDS) to turn cassava as an engine for industrial development in Africa spurred greater understandings of national and global cassava markets (FAO, 2001; UNIDO, 2006). The GCDS has influenced a number of larger initiatives including NEPAD's Pan-African Cassava Initiative, PICs in Nigeria and Ghana, and International initiatives (Table 11.2).

A major conceptual approach for these initiatives is to link activities that reduce production risks and costs (e.g. improved and disease resistance varieties), create reliable supply (agronomy and adoption), add value, and create reliable demand. The international, regional and national institutions played active roles to foster positive policy thrusts as a vehicle to promote employment generation, earning of foreign exchange, and encourage new investors in cassava enterprises.

Some of the major actors involved in the implementation of the initiatives are presented next, with a brief description of their main roles and responsibilities in the execution of the programme, especially as regards product and process innovations in Nigeria and Ghana (Sanogo and Adetunji, 2008).

11.5.1 Government agencies as stakeholders

The initial design and planning of the structure and objectives of the PIC in Nigeria were coordinated by the Federal Ministry of Agriculture, in collaboration with the Federal Ministry of Commerce and Industries. Most of the activities were implemented by national agencies such as the National Root Crop Research Institute (NRCRI), the Raw Materials Research and Development Council (RMRDC), the Federal Institute of Industrial Research at Oshodi (FIRO), the Scientific and Equipment Development Institute at Enugu (SEDI), the Nigerian Stored Products Research Institute (NSPRI), the Standards Organization of Nigeria (SON), the Nigerian Export Promotion Council (NEPC), the IFAD-sponsored Root and Tuber Expansion Programme (RTEP), as well as other institutions. Meanwhile in Ghana the secretariat of the Presidential Special Initiative (PSI) on cassava coordinates all aspects of the design, planning and implementation of the PSI on cassava with the following government institutions: the Ministry of Food and Agriculture (MOFA), the Crops Research Institute (CRI) at Kumasi, the Roots and Tuber Improvement Project (RTIP), and the Ayensu Starch Company Limited (ASCO).

TABLE 11.2
 GCDS-related initiatives

Name of initiative (funder)	Countries	Achievements/Impacts/Scalable innovations
1. Development of cassava chips and flour for commercial uses. An NRI/FRI research project funded by DFID. Beneficiary farmers (8 000) involved at the level of validation of technologies.	Ghana	Processing options developed and tested to produce HQCF which could be used directly by plywood and food industries or used as a feedstock for the manufacture of paperboard adhesive, glucose syrup and industrial and potable alcohol. The HQCF was used at levels of 10–35 percent in bakery products. HQCF was used for complete substitution of wheat flour as an extender in urea and phenol formaldehyde resin plywood adhesives. HQCF was used to produce Bauer-type paperboard adhesive that could completely replace imported starch-based materials. A controlled process was developed for conversion of HQCF into a range of sugar syrups for different end uses. Developed concept of commercial processors (SMEs) acting as market intermediary between the farmers and the end users.
2. Development of high quality cassava products (DfID and the EC-funded CASSAVA-SMES projects). A NRI/FRI/UNAAB research project funded by the EU, working with more than 10 000 farmers through a number of NGOs involved in validation exercises. Main focus on SMEs	Nigeria Ghana	The approach adopted of getting groups of poor local processors to supply cassava mash to the cassava processing plants (SMEs) has made them the net beneficiary (in terms of higher patronage) in this intervention (Adebayo <i>et al.</i> , 2004). The outputs of the project (dried <i>fufu</i> and HQCF, drying technology and market linkages) are currently being used in 11 SMEs in Nigeria and five medium-scale companies in Ghana. On a technical level the project has developed dried <i>fufu</i> (fermented – Nigeria) and instant <i>fufu</i> (unfermented – Ghana) as products and specific processing technologies. Also the approach of linking farmers to markets through SMEs acting as market intermediaries was refined further.
3. Development of small-scale cassava chip production in the Lake Zone (DfID).	Tanzania	Developed chip-based flour processing using non-motorized equipment to enable poor farmers to access supermarket chain outlets, addressing issues such as access to machinery and access to finance.
4. Small-scale cassava processing and vertical integration of the cassava subsector in southern and eastern Africa (funded by CFC/SARRNET/EARRNET/NRI/FOODNET and implemented by IITA and five national institutions).	Uganda Tanzania (other countries in region)	Developed and tested new technological and management innovations offering significant potential for the commercialization of small-scale cassava producers. Results of the project turned out to justify the original assumption of the existence of a large unexploited market for high quality cassava products and the high positive potential impact on poor households. The outcomes of the project imply that any public–private partnership aimed at promoting higher scale application of the tested modern processing technologies and management approaches can ensure that the full benefits of cassava can be derived more quickly, by increasing demand for cassava and the incomes of more smallholder cassava producers. Poverty can be reduced through accelerated growth of rural value-addition enterprises, creating job opportunities and reducing the cost of food and other consumer goods for rural and urban consumers.

TABLE 11.2 (Continued)
GCDS-related initiatives

Name of initiative (funder)	Countries	Achievements/Impacts/Scalable innovations
5. Integrated Cassava Project hosted by IITA in south and southeast Nigeria, with funding from USAID and the Shell Petroleum Development Company, the Nigerian Federal Government Presidential Initiative on Cassava, the Niger Delta Development Commission, the Nigerian National Petroleum Corporation, and 12 State Governments.	Nigeria	<p>This project has facilitated the establishment of additional processing centres in the following states: Abia, Akwa Ibom, Bayelsa, Ebonyi, Edo, Enugu and Rivers. The project strategies include the distribution of mobile graters and assistance to existing enterprises by providing machinery based on need.</p> <p>As at March 2007, Over US\$21 million revenue had been generated from gross sales of cassava products.</p> <ul style="list-style-type: none"> • 463 processing enterprises established and over 1 000 new jobs created. • More than 5 000 persons trained on cassava post-harvest techniques. <p>Cassava products are sold in wet and dry forms such as mash, <i>gari</i>, <i>fufu</i> flour, HQCF, cassava chips and starch. Other products produced and sold, especially by SMEs, include bread and plantain flour.</p>
6. 'Cassava: Adding Value for Africa' hosted by NRI, UK sponsored by Bill & Melinda Gates Foundation (2008 to date)	Nigeria Ghana Uganda Tanzania Malawi	<p>C:AVA is developing value chains for HQCF in Ghana, Tanzania, Uganda, Nigeria and Malawi to improve the livelihoods and incomes of at least 90 000 smallholder households as direct beneficiaries, including women and disadvantaged groups. The project is focusing on three potent intervention points: (i) ensuring a consistent supply of raw materials; (ii) developing viable intermediaries acting as secondary processors or bulking agents in value chains, and (iii) driving market demand and building market share (in, for example, the bakery industry, components of traditional foods or plywood/paperboard applications).</p>
7. 'Great Lakes Cassava Initiatives' hosted by Catholic Relief Services sponsored by Bill & Melinda Gates Foundation (2008 to date)	Tanzania Uganda Malawi DRC Kenya Rwanda	<p>This project aims to achieve a level of 50 percent penetration of new disease resistant cassava varieties into the farming systems of cassava-based poor farming households.</p>
8. Cassava Value Chain Development in West Africa hosted by IITA, sponsored by Common Fund for Commodities, The Netherlands (2008 to date)	Nigeria Benin Republic of Sierra Leone	<p>CFC West African Cassava Value Chain Development project is strengthening the capacity of rural enterprises on supply lines, upgrading traditional processing technologies and products and creating sustainable markets with the deployment of superior cassava varieties, high capacity processing machines and workable business plans in 12 locations in project countries.</p>

11.5.2 Primary actors of the cassava value chain

The Presidential Initiatives on Cassava (PIC) strengthened the rapid formation and contribution of cassava growers' associations, cassava processors (medium-scale processors and microprocessors), equipment manufacturers, cassava traders, transporters, master bakers and NGOs. The roles performed by some of the NGOs, such as the Farmers' Organization Network of Ghana (FONG) and the Cassava Growers' Association of Nigeria, included the multiplication and distribution of cassava planting materials to farmers (in collaboration with the Root and Tuber Improvement Programme (RTIP) in Ghana and the Roots and Tuber Expansion Programme (RTEP) in Nigeria), capacity strengthening of local processors to produce cassava starch using traditional processing technologies, and the coordination and technical backstopping of farmers' groups.

The RTEP contributed positively to the promotion of cassava production and marketing in Nigeria. With funding from IFAD, the RTEP coordinated a cassava multiplication programme with farmers; this was followed by the release of the ten best improved cassava varieties. The implementation of the cassava developments in Nigeria was centred on the active participation of RTEP, the National Root Crop Research Institute (NRCRI), and the International Institute of Tropical Agriculture, as well as other public and private actors.

11.5.3 Support institutions

International Institute of Tropical Agriculture (IITA)

Since its foundation in 1967, IITA has worked with the national agricultural research system as well as agricultural development organizations on the improvement of cassava and the dissemination of improved varieties. More recently, IITA worked on the expansion of cassava enterprise in Nigeria. The implementation of the PIC in Nigeria has been built largely on the achievements of IITA's research activities. The Institute prepared a research report entitled *Opportunities in the industrial cassava market in Nigeria* that was made available to the Government of Nigeria and other stakeholders in 2002/2003 in support of the PIC. IITA is currently collaborating with national and international agencies to back up the PIC on cassava by promoting innovative technologies for the development of industrial utilization of cassava in Nigeria.

In addition, the Cassava Enterprise Development Project (CEDP), which supports the PIC on cassava, is being implemented through IITA as a lead institution. This project is a public-private partnership between the USAID and the Shell Petroleum Development Company, aiming to support the development of the cassava sector over five years (2004/05 to 2008/09). It has the global objective of increasing economic opportunities through sustainable and competitive cassava production, and marketing and agro-enterprise development in selected communities of the South-South and South-East States of Nigeria. Under the CEDP, IITA strengthened the human and

institutional capacity of producers, processors, commodity traders and manufacturers to produce, process and market cassava efficiently, as well as foster increasing private sector investment in the production, processing, storage and marketing of the product.

The implementation of the PSI on cassava in Ghana had also built greatly on the cassava improvement research at IITA. The three major cassava varieties with good starch content (*afisiafi*, *doku duade* and *agbelefi*) deployed on the implementation of the PSI were all developed at IITA, Ibadan, Nigeria. IITA's links with national systems are of great importance to the realization of common goals. IITA has been active in maintaining and further improving linkages between the cassava programme and the national root crops programmes in Ghana and other African countries.

NEPAD Pan African Cassava Initiative (NPACI) Secretariat

NPACI's Secretariat worked with actors in the Federal Government of Nigeria on the conceptualization and development of the objectives of the PIC. The Secretariat has been collaborating with all relevant partners to ensure the successful implementation of the programme. It assists with the organization of workshops and fora for the planning, funding allocation and execution of PIC's activities.

11.5.4 Global support

Over the years there have been agro-industrial initiatives from various national, regional and international institutions, as well as donor agencies. The Global Cassava Development Strategy (GCDS) provided a recent additional approach to intervention in the cassava sub-sector. It was endorsed at an international forum in Rome in 2000 attended by FAO, the International Institute of Tropical Agriculture (IITA), the International Center for Tropical Agriculture (CIAT), Agricultural Research for Development (CIRAD), the Natural Resources Institute (NRI), and the International Fund for Agricultural Development (IFAD). It promotes an approach to "spur rural industrial development and raise incomes for producers, processors, and traders, and contribute to the food security status of its producing and consuming households". The key to the approach is that it is market driven, i.e. driven by demand. The idea is that groups or individuals use an 'industry analysis based approach' to improve their techniques by adopting the following principles:

- ◉ regarding stakeholders as equal partners;
- ◉ building a practical, shared vision;
- ◉ helping to make action plans for industry;
- ◉ building better linkages with private sector organizations;
- ◉ building better links with and among public sector institutions;
- ◉ ensuring co-stewardship of research and service outputs with users;
- ◉ facilitating the rapid introduction of high-impact technologies through public and private sector partnerships.

At the FAO/GFAR (Global Forum for Agricultural Research) conference 'Global Initiative on Post-Harvest Technology, Phase 1', held in Entebbe, Uganda, 17–19 September 2001, two strategies for promoting the post-harvest sector were developed by the participants. One was based on the existing post-harvest system and traditional commodities. It suggested upgrading products and processes, and improving value addition and quality, thereby allowing the products to enter higher value urban and regional markets. This strategy also encompassed storage of traditional commodities, for on-farm use or to take advantage of higher prices in the off-season. The second strategy focused on the development of novel or non-traditional export commodities/products, aimed at both regional and global markets, including products with large volumes and those with a niche but higher unit-value market.

The African Agricultural Technology Foundation (AATF)–IITA Ibadan Strategic Plan of 2005 encouraged the industrialization of cassava in Africa based on available resources, a global competitive framework, and vertically-integrated agricultural business ventures. The UNIDO Abuja 2006 Master Plan declaration promoted domestic, regional, and international market strategies for the cassava sub-sector, in line with the FAO Entebbe 2001 action plans for the cassava agro-industrialization system in Africa. Meanwhile IFAD's cassava processing and marketing regional initiative workshop – the Accra declaration of March 2006 – also affirmed previous action plans with the private sector as the key driver. Various action plans went in tandem with the FAO Entebbe plans and the Commission for Africa initiatives. The Commission for Africa was set up by Tony Blair in early 2004. It recognized that everyone would benefit from – and has a role in creating – a strong and prosperous Africa using commodities like cassava.

The action plan proposed a commodity chain approach, which is by definition a pragmatic, results-oriented approach. A commodity chain describes the full range of activities required to bring a product (e.g. fresh cassava) from its conception (e.g. production) throughout all intermediary phases, transformation (e.g. processing) and delivery (e.g. marketing) to its final consumers.

11.6 Dissemination of strategies for successful and appropriate processing systems

Successes recorded in the development of appropriate processing systems through the implementation of cassava initiatives, especially in Nigeria and Ghana, need further dissemination to African manufacturers and processors. Most of the sound innovations on appropriate processing systems are still limited to one part of the African region. There is a need for project implementers to harmonize their implementations and release information through documentation, peer learning workshops, study tours, and regional 'train the trainer' workshops. National, regional and international exchanges of experiences, skills and technologies also need to be encouraged.

11.7 Conclusions

There have been noticeably successful outcomes to the introduction of cassava presidential initiatives in Africa, with sound process and product innovations in the cassava agro-industrial sector. The technologies and machinery involved, particularly for mobile graters, peeling, drying etc, are still not well known in many African countries. An effective and complete cassava production–utilization system in Africa requires a coalition of private–public partnerships, with the private sector investing in market development and procuring the machinery required. Clear and effective policies that cover the influence of presidential initiatives on trade liberalisation, access to markets, equitable distribution of benefits, gender, environment, credit, infrastructure, taxes, legal requirements, grades and standards need to be embarked upon. The examples outlined in this chapter show that through political will and appropriate policy incentives, much can be accomplished in the promotion of agro-industrial development. The lessons learned from these examples, and some critical success strategies for cassava development that have emerged, are summarized as follows:

Lessons learned from the PICs:

- ▶ The right policy environment is critical to attracting adequate investment and stimulating growth in Africa.
- ▶ Without legislated policy support, gains in cassava development will not be sustained.
- ▶ Access to long-term investment finance at low (single digit) interest rates continues to be a major bottleneck that denies African private sector operators the ability to respond to new market opportunities.

Strategies that will enhance proper legislation for the advancement of commercially-driven cassava sectors in Africa include:

- ▶ increased 'research for development' efforts and investment in the area of cassava innovations;
- ▶ initial substantial investment by government for the establishment of farm gate processing centres;
- ▶ joint partnerships between entrepreneurs and foreign investors for the successful provision and operation of adapted and efficient processing units;
- ▶ formal legislation and enforcement to facilitate the compliance of relevant implementing actors for the successful achievement of PIC objectives, such as the inclusion of cassava in baking (composite) flour;
- ▶ promoting the establishment of a cassava development commission;
- ▶ provision of basic infrastructure by the Government, especially energy sources at affordable rates for cottage industries in rural and semi-urban areas;
- ▶ provision of tax-free regimes for SMEs in their first 5–7 years of operation.

Various issues for sustaining cassava equipment development in Africa, such as intellectual property rights, the technical know-how of manufacturers, environmental risks (renewable vs. non-renewable energy sources), gender influence and flexibility of equipment use, adoption rates (viability and durability of equipment), and quality hazards, are becoming more important and must be addressed for sustainable technology transfer.

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CHAPTER 12

Transiting cassava into an urban food and industrial commodity through agro-processing and market driven approaches: Lessons from Africa

ADEBAYO B. ABASS, MPOKO BOKANGA, ALFRED DIXON AND PAULA BRAMEL

12.1 Introduction

Sub-Saharan Africa (SSA) has the largest population of poor people in the world (World Bank 2009). Agriculture accounts for 70 percent of the labour force and as such is very important for economic growth, but productivity for many agricultural commodities is low. Rapid urbanization, food aid, and an increased taste for cheap foreign foods, are all contributing to significant food import expenditure in sub-Saharan Africa. In 1995, *per capita* importation of wheat into Africa was estimated at 8.25 kg/year. African farmers are not able to supply agricultural products to both the local and export markets, partly because of tough price competition in the world market. African markets are therefore flooded with surplus food products from other markets where farming is probably subsidized (IITA, 1999). Graffham *et al.* (1999) observed that fluctuations in wheat flour prices suggest that the wheat flour market was likely influenced by the political wish to keep prices of food staples low. Such low prices increase the access of low income families to cheap food, but they also create negative impacts on the rural poor because farmers have no incentive to increase production of local crops. The lack of technologies to transform crop produce into higher-value products further exacerbates the problem. Rural populations responsible for the processing of staple foods at village level – particularly women – are unable to increase the quantity and improve the quality of their outputs because of limited access to labour- and energy-efficient processing machinery. Excess production therefore leads to huge spoilage and loss of incomes.

Scott *et al.* (2000) showed that the production of the most important root and tuber staples of sub-Saharan Africa – cassava, yams and sweet potato – has been increasing since 1968 and will continue to increase till 2020. The production

increases can be explained by an increase in the area cultivated and the introduction of high yielding, disease-free and pest-resistant cultivars. However, demand issues and uncertain markets remain major constraints to the development of the crops. According to Hartmann (2004), cassava is one of the most consumed staple food crops in sub-Saharan Africa; the *per capita* consumption (kg/year) is 103, followed by maize (40), banana/plantain (28), yam (28), sorghum (23), and millet (17). Although cassava, maize, banana, yam, sweet potato, beans, sorghum and millet form the bulk of what the rural poor in SSA produce and rely on for food security, the markets for these crops are seriously under-developed. The efforts concentrated on the development of markets for traditional export crops such as coffee, tea and cotton is disproportionate when judged on the basis of the values of trade involved. The annual value of staple food crops in Africa exceeds US\$150 billion, compared with the gross value of the traditional export crops which stands at around US\$8.5 billion/year, and non-traditional export crops (especially horticulture and fish) which stands at around US\$7.8 billion/year (Adesina, 2008). Therefore, processing and value-addition to staple food crops in sub-Saharan Africa can improve market opportunities for African farmers, who may thereby gain the full benefits of new production technologies (Abass *et al.*, 2009).

The cassava subsector in Africa is largely subsistent and rudimentary. Smallholder farmers are dispersed over large areas and there is little coordination of production, processing and marketing activities. Average farm holdings in many countries are less than 0.5 ha; the farmers operate using low input technologies and lack mechanization. Yields are very low, typically 10 tonnes/ha compared with 25–40 tonnes/ha in India, Thailand, Brazil, and Colombia. Farm holdings and yields can vary considerably from location to location in the same country. While the average farm holding in the major cassava growing areas of Nigeria is 0.75 ha/farmer, it is 0.43 ha in the moderate growing areas. Although root yields are determined by ecological factors, cassava production is more strongly determined by the availability of labour-saving technologies for production and processing than ecological factors (Ugwu, 1996). Plant population density is often low in many countries where cassava is considered a subsistence crop; this contributes to the low yields per hectare.

In high production countries such as Nigeria, cassava production exhibits high levels of variability and cyclical gluts, mainly because of the inability of markets to absorb supplies. As a result, prices decline sharply and production levels reduce in succeeding years before picking up again. Most of the poorest of the poor in Africa depend on cassava, and are therefore vulnerable to such adverse short-term supply and price fluctuations (Scott *et al.*, 2000), significantly increasing their income risk. This can result in more people becoming poorer and farmers being discouraged from taking up improved production technologies. Insufficient processing options for cassava, inadequate marketing channels, and a lack of linkages between producers and end users are other factors preventing higher production and greater profitability for producers and processors.

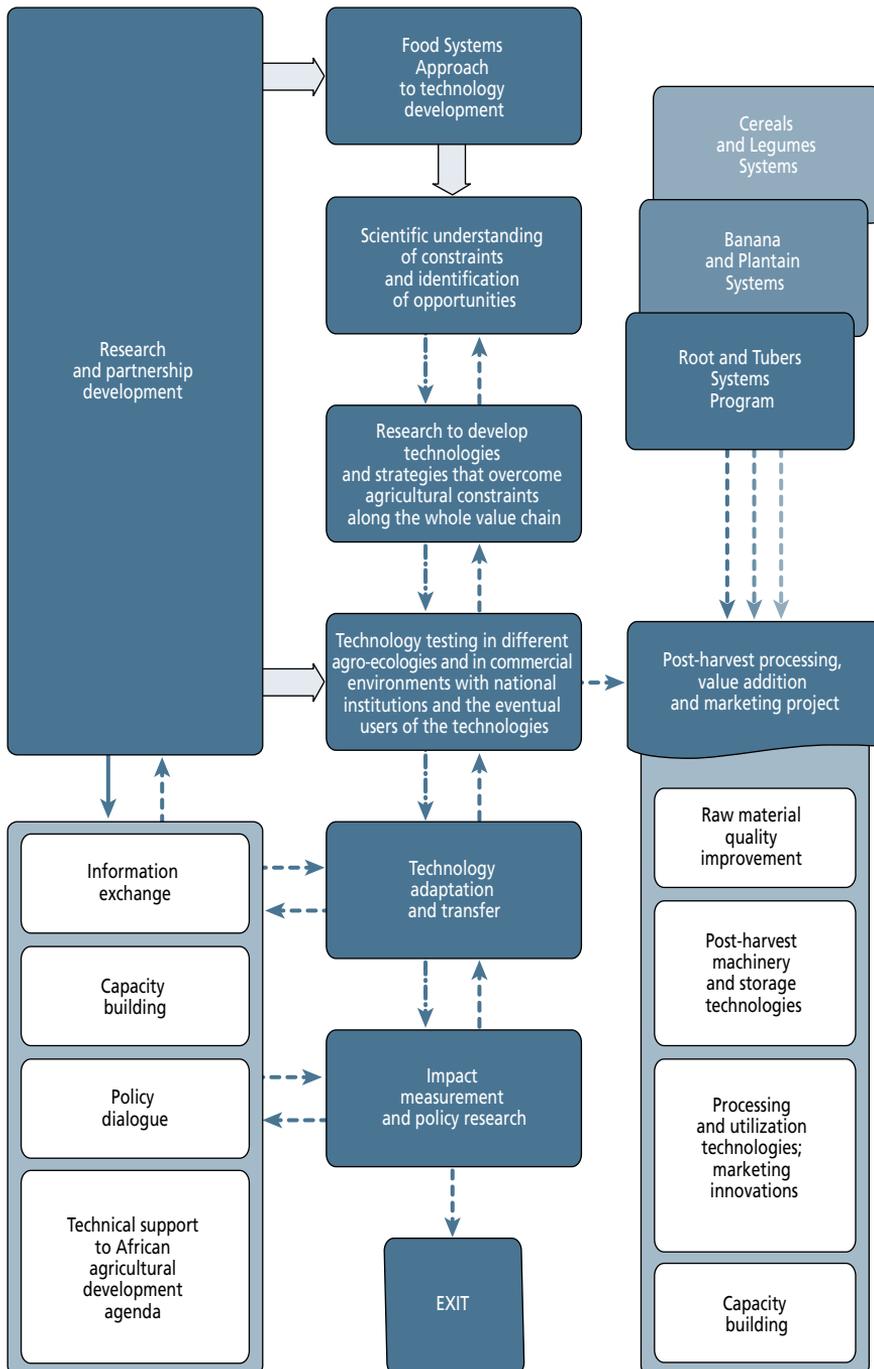
To resolve these problems, the International Institute of Tropical Agriculture (IITA) and national institutions in SSA have, since 1974, continued to invest in the development of technologies and innovations that improve the productivity and tradability of cassava and other crops. A holistic value chain or food systems approach is used to develop proven agricultural technologies that address the constraints of African farmers from input supply to production and marketing. This is combined with a concurrent delivery of technologies to national institutions, capacity building, information exchange, policy dialogue and technical support to the agricultural development agendas of various African governments (Figure 12.1). The research for development activities was redesignated as 'root and tuber systems' which became one of the seven medium-term programs that have been recently integrated into the consultative group on international agriculture research programs (CRPs). These measures in total constitute the IITA Research for Development (R4D) approach to enhance food security and improve livelihoods of smallholders in Africa.

The model is implemented through development platforms that use long-term agricultural development needs of Africa for designing research and choosing partners. It involves a process of mid-term research outcome, impact and exit strategy (<http://www.iita.org/what-we-do>). This approach contributes to the development of agro-industries, and supports a more commercially-based farming system compared with the conventional production-based research strategy. The combined efforts of IITA, other international research centres and international and bilateral development agencies, have contributed to the change in status of cassava from a 'poor man's crop' to a commodity with high potential for industrial use. Although cassava commercialization is spreading across Africa, faster advances have been made in Nigeria and Ghana than in other countries. Yet, cassava commercialization still faces major problems arising from the high cost of primary production that makes cassava products less competitive in some cases. Processing infrastructure in many countries (except Nigeria and Ghana) is poor; institutional support for mobilizing investment and use of modern technologies is low; implementation of policy instruments that support cassava-based agro-industrial processing is weak.

12.2 The integrated food systems approach

According to Nweke *et al.* (2002), African policy-makers and members of the international donor agencies and NGOs are searching for a solution to Africa's food production crisis. However, solutions are difficult to offer because statistics and other information on the economics of production, processing, and marketing of most crops, including cassava, are unavailable. In the past, increasing food security in Africa was tackled via a single-step approach: increasing productivity. Plant-breeding research was carried out with little knowledge of the agronomic, processing, and marketing problems faced by small-scale cassava farmers and traders (Nweke *et al.*, 2002). This approach did not achieve the desired success because the application of a single

FIGURE 12.1 The IITA R4D approach to cassava development



solution to a specific problem in the 'food pipeline' without considering the upstream and downstream problems leads to a blockage in the food supply system. It makes the continual supply of adequate food unachievable.

The integrated food systems approach at IITA involves investigating the problems faced and the development needs of the smallholder farmer, including poor rural dwellers, and designing agricultural research to tackle those problems. The development needs are identified through diagnostic surveys, stakeholder consultations and participatory identification of challenges and opportunities (Robert Asiedu, personal communication). The Collaborative Study of Cassava in Africa (COSCA study) implemented between 1989 and 1997 demonstrates the procedure used to identify research and development needs, on the basis of which strategic research at IITA is designed. During the COSCA study, researchers collected primary data on cassava in the main cassava producing countries of Africa, namely the Democratic Republic of Congo, Côte d'Ivoire, Ghana, Nigeria, Tanzania, and Uganda. These data included cassava production systems, processing and food preparation methods, markets and consumption patterns. The information was subsequently used in the food systems approach to research, design, develop and extend programmes and policies for reducing food insecurity and poverty in many African countries (Nweke *et al.*, 2002).

The food systems approach focuses on the poor, the markets for their commodities, and the profits involved in marketing a crop. It uses new approaches to improve traditional production and processing methods and to develop new market opportunities (IITA, 1999). The approach has been implemented through structured multidisciplinary research projects or programmes at IITA; these are either based on themes or are focused on specific production systems. Currently the main IITA research programmes are: Agriculture and Health, Agrobiodiversity, Banana and Plantain Systems, Cereals and Legumes Systems, Horticulture and Tree Systems, Root and Tubers Systems, Opportunities and Threats. The Institute also hosts the System-wide Program on Integrated Pest Management (SP-IPM) of the Consultative Group on International Agricultural Research.

Many projects dealing with different aspects of the food system, such as inputs, production, post-harvest and other issues are carried out within most of these programmes. The 'Improving post-harvest systems' project adopted in 1994 was part of the food systems approach. It involved post-harvest processing, value addition and marketing research. It emphasized the links between crop characteristics, farmers' resources, cropping systems, commodity handling and storage problems, processing requirements, food quality characteristics and consumption patterns, seasonal and special price variability, and the movement of agricultural products between rural and urban areas. The emphases were meant to improve food availability, increase accessibility by consumers, and raise the income of small-scale farmers and processors (IITA, 1999). Four main

areas were involved: raw material quality, post-harvest machinery and storage, processing, utilization and marketing, and capacity building and information exchange (IITA, 1999).

12.2.1 Raw material

The quality of fresh roots in terms of storability, processing characteristics, palatability and the safety of food products are critical factors to enhance market prices and rate of adoption of improved varieties by farming communities (IITA 1997). The cassava breeding research is focused on incorporating market quality requirements in new varieties in addition to the usual breeding for high yield and disease resistance.

New technologies and improved practices have been developed in partnership with other international and African institutions to limit or manage the major production constraints such as poor soils and agronomic practices, and devastating cassava diseases and pests. Between 1987 and 1996, new varieties were tested through on-farm adaptive research involving farmers in many agro-ecologies of Nigeria in collaboration with the National Root Crop Research Institute (NRCRI), the National Seed Service (NSS) Nationally Coordinated Research Project, and large-scale agricultural extension programmes such as the National Accelerated Food Production Project (NAFPP) and Agricultural Development Project (ADP). Six IITA-improved varieties (Tropical Manioc Selection or TMS series) were released through the National Variety Release Committee (NVRC) and some were given new names: TMS 50395, TMS 91934, TMS 63397, TMS 30555, TMS 4(2)1425 (Nigerian Cassava: Savanna), and TMS 30572 (Nigeria Cassava Idioshe). The National Variety Release Committee (NVRC) later released an additional 17 varieties for cultivation. The national research and extension institutions also engaged in very elaborate multiplication and distribution of planting materials of the TMS series of IITA-improved varieties in Nigeria (Nweke *et al.*, 1999). The well coordinated activities of the various extension programmes – with support from private companies such as Shell BP, Texaco Agro industries Limited, and Nigeria Agip Oil Company Limited – in the multiplication, promotion, and distribution of the improved cassava varieties, contributed to their rapid spread in Nigeria. By the end of 1990, planting materials of improved varieties for 9 130 ha at the rate of 10 000 planting stakes/ha had been provided to the state agricultural development programmes (ADPs) while 400 demonstration plots were completed by the ADPs and the National Seeds Service of Nigeria (NSS) (Nweke *et al.*, 1999). The collaboration and support given to the Nigerian National Agricultural Research and Extension Systems (NARES) contributed immensely to the increase in production of cassava from 1991. The existence of improved processing technologies in Nigeria acted as a catalyst to increased production through an upward pull effect on the market demand for cassava (IFAD and FAO, 2005).

The increased demand and increased production of cassava contributed to a reduction in poverty and hunger because the cash income for cassava-dependent farmers increased, while more food products were available at lower costs (Nweke *et al.* 2002).

Collaboration, capacity building and support to national root and tuber programmes in many African countries were further strengthened for the transfer, testing and selection of new varieties adapted to their specific agro-ecologies. In 1993, Ghana officially released three improved varieties (TMS 4(2)1425 (Abasa Fitaa), TMS 50395 (Glemo Duade), and TMS 30572 (Afsiafi). In 1994, Uganda officially released three varieties TMS 60142 (Nase 1), TMS 30337 (Nase 2), and TMS 30572 (Migyera). Additionally, six improved and disease resistant varieties of IITA origin were released in Uganda in 1999. These improved varieties later contributed to the improvement of yields and the slow-down or control of major disease epidemics that threatened the food security of millions of the poorest farmers in some African countries such as Nigeria, Ghana and Uganda (IITA, 1986; IFAD and FAO, 2005a). Major achievements in the development of additional varieties have been made since then, with hundreds of those new varieties currently being tested by many national programmes.

12.2.2 Post-harvest machinery

Grating and milling machines were already in commercial use in most Nigerian villages before the post-harvest activities started at IITA. From 1988 to 1998, collaboration and knowledge from many research and development institutions such as the International Centre for Tropical Agriculture (CIAT), the Federal Institute of Industrial Research Oshodi (FIRO), the Nigerian Stored Product Research Institute (NISPRI), and the Rural Agro-Industrial Development Service of the Nigeria Ministry of Agriculture and Natural Resources (RAIDS), among others, led to the introduction of some modifications that further reduced labour input to cassava processing (IITA, 1998a and b). Added to the existing and well-used machinery and tools such as graters, wet grinders, dry grinders etc, were trailer-type field carts, modified wheel barrows, double screw presses, manual chippers, power chippers (with 3.5 HP petrol engines), combined grating-chipping machines (with 5.0 HP petrol engines), peeling bays and tools, fermentation racks, drying racks with trays and stoves, double-stage frying stoves, agricultural waste-fired stoves, kerosene burners, and bucket-type starch sifters. When tested, the processing machines were found to reduce labour input and post-harvest losses, and increase product output, quality and safety (Figure 12.2). The output products were of higher quality and output volume had increased. The use of improved processing technologies increased the relative importance of cassava in many villages and contributed to the overall increase in utilization of cassava in Nigeria (Nweke *et al.*, 1999). Cassava field areas were found to be higher in villages where farmers had access to mechanical grating systems than in villages where they did not. In addition, high root yields achieved with the

adoption of improved cassava varieties did not bring substantial cost-saving benefits to farmers without the use of mechanical processing machines (Nweke *et al.*, 1999).

12.2.3 Processing, utilization and marketing

From 1976 to 1985, a combination of increased urbanization, rising incomes, market promotions and specific policy decisions favoured the importation of large amounts of wheat into Nigeria. The annual average import of rice per person in Nigeria also increased more than 1 500 percent between 1960 and 1987 (Nweke *et al.*, 1999). In addition, Nigeria became the largest importer of wheat in Africa with imports totaling US\$37 million representing 2.2 percent of the nation's foreign exchange earnings in 1985. Manufacturers of a diverse range of products such as soft drinks, confectionery, automotive/dry cell batteries, paints, textiles, pharmaceuticals, iron ore, paper, soap, detergent, packaging, and cosmetics, all depended on imported syrup concentrates and starch (Abass and Shiwachi 2003a).

Following the adoption of a structural adjustment programme in Nigeria in 1985, the government banned the importation of certain foods and industrial raw materials in December of that year, notably wheat, rice and maize. The government was looking for ways to reduce expenditure on imports and develop markets for local raw materials. Various national institutions such as the Federal Institute of Industrial Research (FIRO) and the National Cereal Research Institute (NCRI) were mandated to investigate the suitability of locally-sourced raw materials for use in industrial baking processes, to modify such processes to suit local conditions, and to seek solutions to the basic technical problems of bakers in the use of locally-sourced raw materials. Although in 1985 cassava was not considered an import substitution crop, the ban on wheat imports presented an opportunity to develop flour from locally-grown grains, roots and tubers, as well as other crops.

In collaboration with many advanced research centres such as the Katholieke Universiteit Leuven (KULeuven) under the 'Cassava for Bread project', funded by the Belgian Administration for Development (BADDC), research efforts at IITA led to the development of the high quality unfermented cassava flour technology (from here referred to as high quality cassava flour, or HQCF) in 1985 (Figure 12.3). The method required the use of cassava processing equipment already in common use in Nigeria for preparation of *gari*, and thereby minimized the requirement for capital investment (Onabolu and Bokanga, 1995; Abass and Shiwachi, 2003a; Abass, 2006). This new technique was quick and effective for making large volumes of processed cassava flour. Recipes were developed for the use of HQCF in baked and fried foods and for various industrial applications. The recipes for making convenience food products such as composite bread (20 percent HQCF and 80 percent wheat flour), meat pies, sausage rolls, cakes, cookies/biscuits, doughnuts and chinchin were developed and popularized at this time (Onabolu *et al.* 1998).

FIGURE 12.2 Effects of mechanization and improved processing techniques on food losses, labour input to processing enterprises and output products

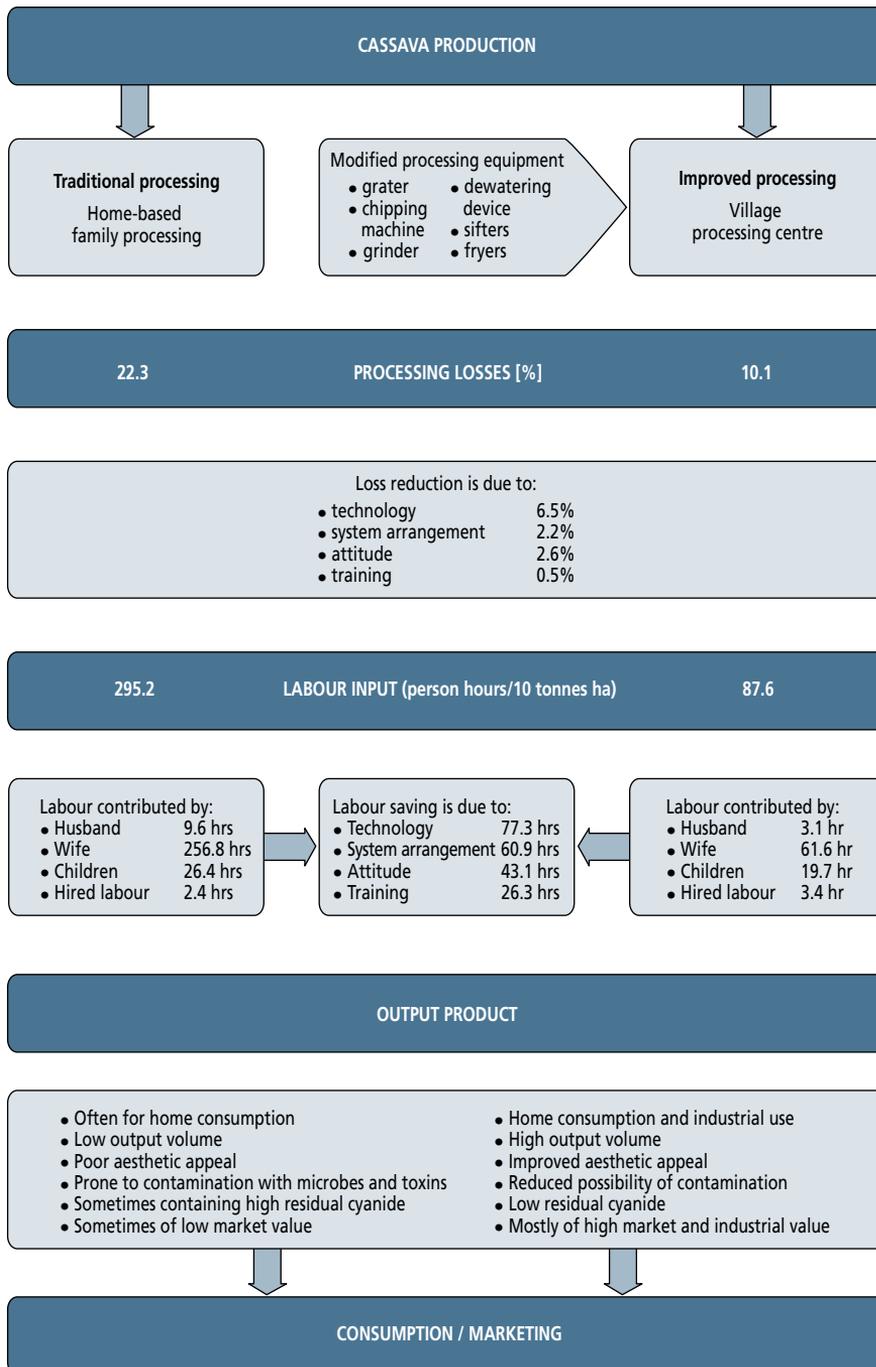
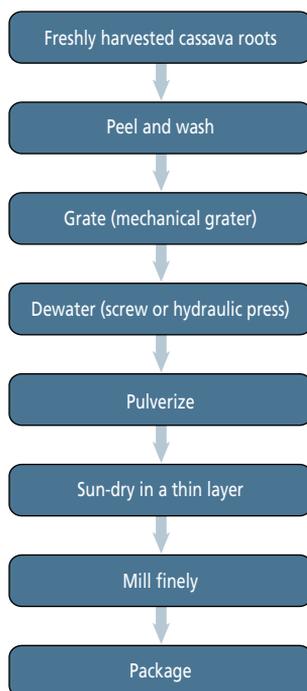


FIGURE 12.3 High quality cassava flour processing (HQCF) technology



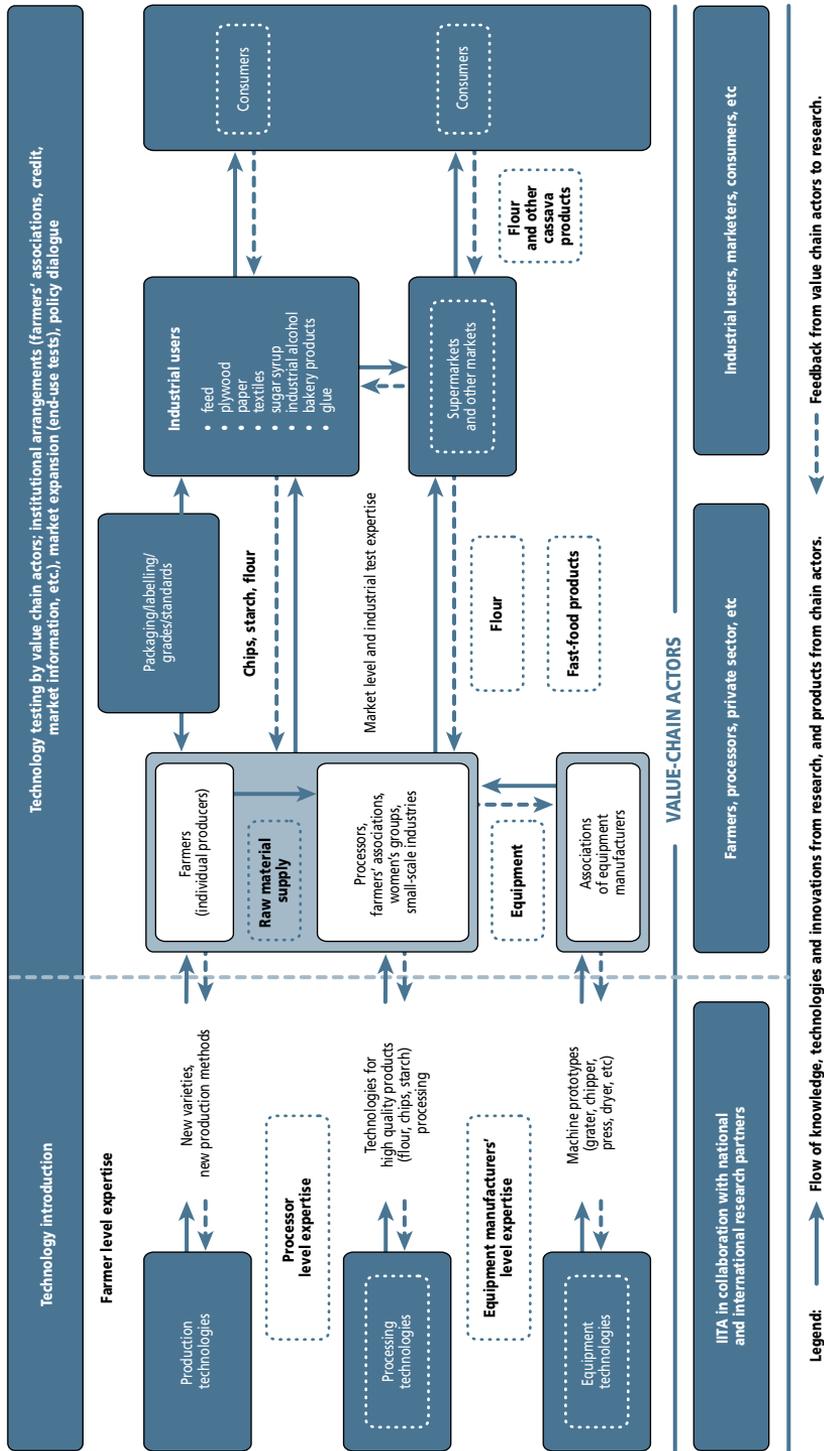
Source: Onabolu *et al.* 1998.

12.2.4 Capacity building and information exchange

As with all new products, there are barriers to the adoption of new technologies, particularly among low-income groups who are averse to risk, have poor access to capital, lack information, and may have limited business skills (IITA, 1997). To overcome these problems, testing of agroprocessing technologies was carried out under pilot systems in different locations to develop the value chain for cassava, while simultaneously developing manpower and mentoring of stakeholders. Capacity building for all categories of stakeholders was promoted through university degree training, short courses or workshops.

Pilot operations for value chain development involved the integration of available technologies along the cassava value chain and pilot testing with farmers, processors, and industrial end users in selected locations. The framework for pilot testing and transfer of new technologies is shown in Figure 12.4.

FIGURE 12.4 Framework for value chain development at pilot scale



The sequence of actions involved in pilot testing included:

- ▶ Identifying cassava products for which there were promising markets; identifying key stakeholders, their ways of operation and constraints.
- ▶ Selecting the sites and the participating groups or cooperatives of smallholder processors and end users; developing market strategies for the most promising cassava products.
- ▶ Training farmers/processors in the new processing technologies for making cassava products with the required quality characteristics.
- ▶ Producing and supplying cassava product(s) to end users, or urban-based supermarkets near the pilot locations.
- ▶ Training potential end user industries to adopt the new products as raw materials in their recipes or processes.
- ▶ Use of suitable improved varieties and agronomic practices to ensure sufficient and timely supply of raw materials for processing.

Pilot operations also involved training, information exchange and technology refining. During pilot operations experiences were shared on the performance of the technologies and other innovations being tested. The approach emphasized the collection of feedback along the 'research to development' continuum, during the field or pilot tests, during adaptation by national institutions, and from higher levels of policy-makers. Corrective actions were taken by designing new research activities based on the feedback.

Technologies and innovations are refined based on feedback from value chain actors during pilot testing. For example, previous knowledge before the development of high quality cassava flour technology in 1995 suggested that fermentation was critical to removing cyanide from cassava, so that flours to replace wheat flour could be made from certain cassava varieties. However, the products made from the fermented flours deteriorated rapidly (IITA, 1988) because of spoiling microorganisms in the fermented flour. It therefore became necessary to develop a new technique for processing cassava to flour with suitable baking properties. The refining of this technology led to the current HQCF processing method.

Pilot testing of HQCF technology was carried out in Nigeria from 1995 to 1998. The merits of using HQCF were demonstrated to potential user factories (biscuits and noodles) in Ogun, Oyo and Lagos states. A client-supplier relationship was developed between HQCF producers and user factories. National research institutes and state agricultural development projects (ADPs), local NGOs and a credit institution (the Farmers Development Union), community-based organizations, farmers' associations, as well as the private sector, were all involved. Smallholder processors and entrepreneurs were supported with respect to cassava value addition, agro-enterprise development, and marketing activities emphasizing better organization, collective action, better marketing, and private sector participation through investment. The farmers or their local government authorities provided farmer-level infrastructure, including the pilot processing buildings used for technology testing.

Capacity building through group and individual training

Capacity building and transfer of technology were achieved through degree and non-degree training, international training workshops for the demonstration of the technologies, participation in exhibitions and agricultural trade fairs. Selected countries were grouped into two zones: West and Central Africa (WCA), and East and Southern Africa (ESA). Countries in WCA included Benin, Congo (DR), Côte d'Ivoire, Ghana, and Togo; in ESA they included Kenya, Madagascar, Tanzania, Uganda and Zimbabwe. In each country, interdisciplinary and interinstitutional groups of project personnel responsible for coordinating the dissemination of cassava technologies were trained in the design and execution of pilot projects for promoting cassava processing and utilization. In addition to these, equipment manufacturers were trained in Ghana, Nigeria, Benin, Tanzania, Uganda, Cameroon, etc., on equipment design, building and servicing.

Information exchange

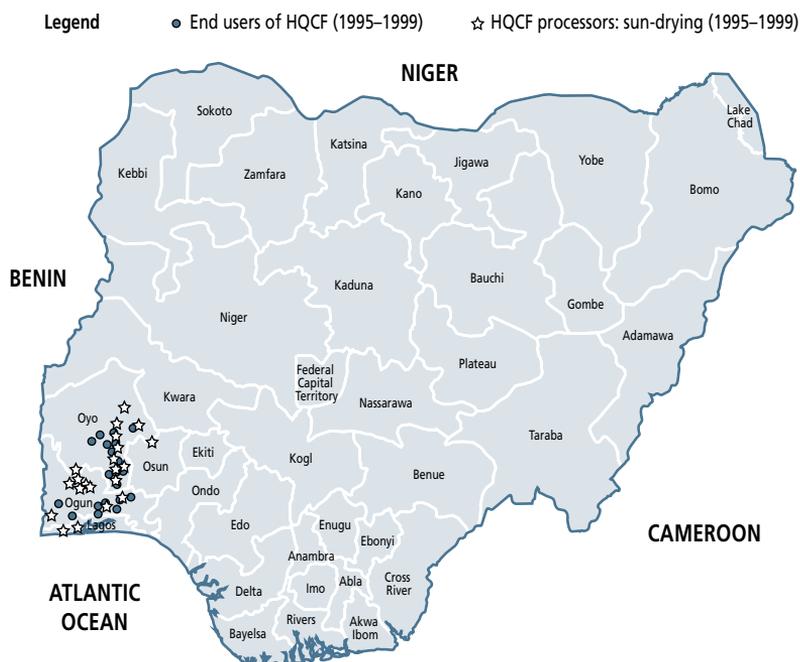
Market information service (MIS) was designed to benefit farmers, traders and consumers. MIS was initiated first in Uganda, by the Post-harvest and Marketing Research Network for Eastern and Central Africa (FoodNET). Market data were collected on current prices of agricultural commodities and products in different markets, including the variation in prices due to season or qualities. These were disseminated through radio broadcasts, newspapers, e-mail, fax, or post office couriers (IITA 1999). Access to market information helped farmers to better negotiate prices of their products based on current market prices, instead of accepting prices offered by traders or local marketing agents. It enabled farmers to take decisions on the need to bulk their produce for higher value in times of best market prices.

12.3 Selected cases and outcomes of capacity building through pilot tests, and training on agroprocessing technologies

Pilot tests in West Africa

Before 1994, there was no producer or user of HQCF in Nigeria whatsoever. By 1999, after four years of pilot testing in Nigeria, 25 to 30 groups of HQCF producers were involved in regular processing and trading of cassava flour at commercial or household levels. Demonstration of the use of HQCF to potential end user industries led to the use of HQCF in 1995 by three biscuit factories and the only noodle factory in Nigeria. By 1999, the number of industrial users increased to 11 while 9 small-scale bakers and caterers were using HQCF for baking bread and making other snack foods (Figure 12.5).

HQCF was used in about 18 brands of biscuits (10–50 percent of the country's total biscuit output) and in a brand of noodles amounting to about 10 percent of the

FIGURE 12.5 Nigeria, showing locations of HQCF processors and end users during the pilot phase


country's output. Home caterers used 10 to 100 percent HQCF depending on the products they made, e.g. cake, pies, chinchin or buns. The products were sold freely in Nigerian markets. According to the end users, the benefits of HQCF included increased profits as a result of the lower cost of HQCF compared with wheat, and increased product quality and yield. To maintain product quality, users of HQCF set quality specifications for screening HQCF before purchase (Abass *et al.*, 2001).

The main factor that favoured the use of HQCF as wheat flour replacement in Nigeria was its lower cost compared with wheat flour. The price of HQCF was about 55 percent of the price of wheat flour delivered at bread bakeries (Abass *et al.*, 2001). Processors also maintained that the HQCF processing enterprises were profitable. However, the cost of fresh cassava constituted a very high percentage of the total cost of HQCF processing (Table 12.1). Although the use of cassava flour in the baking industry proved to be technically possible and appeared economically beneficial to processors, farmers, and users alike, its production and use were hindered by the disorganized state of its marketing structure (Abass *et al.*, 2001). Due to the small-scale processing method, which was based on sun-drying, production capacity in the dry season by processors (2.5 tonnes/week) was reduced to nearly 1.0 tonne during the rainy season.

TABLE 12.1

Some cost parameters of cassava flour production by small-scale processors during the pilot phase

Parameters	1996	1998
Cost of fresh cassava roots (US\$/tonne)	54	32
Cost of transporting fresh cassava from the farm to the processing centre (US\$/tonne)	8	8
Cost of production (US\$/tonne)	256	209
Selling price, delivered at end user's gate (US\$/tonne)	291	314
Cost of production attributable to fresh cassava (%)	81	57
Cost of production attributable to labour and other inputs (%)	19	43
Wheat flour price, delivered at end user's gate (US\$/tonne)	538.9	570.8
HQCF to wheat flour price ratio	0.55	0.54

Source: Abass et al. 2001

It became obvious that the use of better drying technologies for HQCF processing, better organization of the market and targeted national policies were needed to help expand the market for cassava, increase farmers' incomes, and create jobs for more people, especially women, who are the majority involved in cassava production and processing. In 2000, a flash dryer owned by Femtex Starch factory in Lagos was tested for drying HQCF. The result of the test was encouraging and it was subsequently proposed that flash drying technology needed to be promoted for HQCF processing to elevate the scale of processing and to resolve the drying dilemma once and for all (Abass *et al.* 2001). By 2002, a partnership with the Raw Material and Development Council of Nigeria was initiated to develop flash drying technology in Nigeria. Overall the results of pilot testing showed that, while the use of intermediate cassava products by industries provided the opportunity to reduce the cost of raw material importation, it also proved to be a successful approach to developing markets for smallholder farmers.

The replication of the Nigerian experience then began in Ghana and Benin. The pilot testing of HQCF processing was carried out in the Oueme and Mono regions of Benin by the Departement de Nutrition et Sciences Alimentaires, Université Nationale du Bénin and the Laboratoire de Technologie Alimentaire, Institut Nationale de Recherches Agronomiques du Bénin. The project staff had earlier received training on product development from IITA in 1998. Results in Benin showed that substituting starch with HQCF in biscuits and 'galettes', and substituting wheat with HQCF in 'atchonmon' improved the quality of the traditional products. Incorporation of HQCF

as a 15 percent substitute for wheat in bread loaf and French baguette produced products with 100 comparative quality *vis-à-vis* wheat bread (IITA, 1999).

A study on expanded markets for locally-produced cassava flours and starches in Ghana funded by the United Kingdom's Department for International Development (DfID) was carried out in the 1990s by the Natural Resources Institute, Food Research Institute (FRI), University of Ghana and the Forestry Research Institute of Ghana (FORIG). A marketing sample survey conducted in 1997 by the team clearly showed that composite flour with a 20 percent cassava inclusion rate was widely accepted by the Ghanaian public as comparable to 100 percent wheat flour. This was then followed up by FRI demonstrating HQCF processing technology, the production of various new convenience foods from HQCF, and the adoption new techniques for using HQCF in plywood (IFAD and FAO, 2005c).

The market potential of HQCF as a partial or total replacement for wheat in food, and for the manufacture of plywood and paperboard, began to increase significantly in Ghana (Day *et al.*, 1996). The increase in cost of wheat flour in Ghana in the late 1990s increased the potential to use HQCF, which was cheaper. While the cost of producing HQCF was between US\$0.13/kg and US\$0.22/kg, the wheat flour price was US\$1.30/kg. Bakers were able to save 32 percent of the cost of flour when HQCF was used to substitute 35 percent of the wheat flour, and the replacement of wheat flour with HQCF in adhesive formulations led to a reduction in the cost of adhesive extenders (Graffham *et al.*, 1999). The application of HQCF for partial replacement (20 percent) of imported wheat flour (2 500 to 300 000 tonnes/year) and imported industrial starch (about 2 500 tonnes/year) in Ghana therefore proved to be technically feasible and economically competitive (Graffham *et al.* 1999). It was evident that an expanded use of HQCF for food and non food industries in Ghana would reduce the dependency on imported raw materials for these industries (Abass and Shiwachi 2003b).

Pilot tests in East and Southern Africa

In East and Southern Africa (ESA) from 2000, pilot activities were supported by more NGOs, FoodNET, bilateral development agencies and others, for the development of agroprocessing and markets for cassava. These activities helped in the transfer of the agroprocessing technologies for transforming cassava into intermediate shelf-stable industrial raw materials (HQCF, chips, pellets and starch), and refined food items such as *rale* or *gari*, biscuits, noodles, and bread. From 2003, the IITA small-scale cassava processing project funded by the Common Fund for Commodities (CFC) adapted the IITA pilot testing approach to Tanzania, Uganda, Zambia, Mozambique, and Madagascar. Results from the pilot activities in the five countries suggested that processing of cassava to high quality industrial raw materials such as HQCF, chips and starch provided opportunities for smallholder farmers to access more profitable markets (Mbabaali and Abass, 2008). Tests by industrial users showed that the intermediate cassava products (e.g. HQCF, chips and starch) were suitable for various industrial applications (paper, biscuits, etc).

End user industries were therefore encouraged to try out the use of the products. Estimates of market opportunities for cassava products, particularly HQCF, showed that there were significant opportunities for increasing the production and supply of fresh cassava by primary producers of cassava.

In Madagascar, end users such as bread and biscuit factories expressed the need to expand the processing capacity for making HQCF to meet growing demand. As of 2005, the demand for HQCF by eight bread bakers in Antananarivo was 425 tonnes/year, while the demand by makers of pastries was estimated at 1 000 tonnes/year. In Tanzania, two supermarkets, six food processing factories and two textile manufacturers that tested cassava in 2005 demanded 95 tonnes of HQCF and 42 tonnes of cassava starch per month. The annual market opportunity for fresh cassava created by these ten end users was 4 500 tonnes of fresh cassava (Mbabaali and Abass, 2008).

In 2004 Tanzania imported about 10 484 tonnes of starch at the rate of US\$400/tonne, and 730 000 tonnes of wheat at US\$168/tonne, an expenditure of over US\$124 million. Assuming 10 percent of the imported wheat was replaced with HQCF (the rate could be much more for biscuits, bread, etc), the demand for fresh roots would have been about 297 000 tonnes. Up to 1 240 small agroprocessing industries would have been required to supply HQCF and at least US\$12.5 million foreign exchange expenditure would have been saved. The amount would be distributed among the farmers, processors and other people who are involved in ancillary activities such as harvesting, transportation, bulking and marketing activities in the agroprocessing industry. While the price of wheat flour was US\$164/tonne in 2005, operators of supermarkets in Dar es Salaam offered higher prices for HQCF, between US\$169 and US\$253 per tonne. Textile factories that import starch at US\$400/tonne offered US\$350/tonne for HQCF.

In Zambia, seven end users requested 505 tonnes/year of HQCF for the production of various items such as biscuits, paper, and packaging materials, providing an opportunity for smallholder farmers to supply about 2000 tonnes of fresh cassava annually (Mbabaali and Abass, 2008).

However, in terms of HQCF processing, small-scale operations with sun-drying were again found to be a major constraint, as previously reported in West Africa (Abass *et al.* 2001, 2009). Output volumes were low, supply to end users by small-scale processors was irregular, and product quality was inconsistent. The uncertainties about the available volume of products of acceptable quality to meet end user requirements, the poor image of cassava, the widespread belief that cassava is a food security crop, and the lack of policy support for the use of cassava in the industry, continued to hinder its wide adoption as a reliable raw material. The opinion of a few policy-makers in the ESA region is that the use of cassava in large volumes in the industrial sector might disrupt food supply systems. They are therefore reluctant to support or promote industrial utilization of cassava. The successes in Nigeria

and Ghana, however, have shown that this view is questionable. A detailed analysis of the profitability of processing enterprises (for starch, HQCF and chips) and the factors that influenced the overall success of such enterprises in Tanzania has been investigated (Abass *et al.*, 2009a). The factors identified include:

- ▶ The low ability of smallholder processors or farmers to operate the processing plants at optimum processing capacity for a significant number of days per year. Village processors did not ensure that the output volumes of the plants exceeded the break-even volumes. The potential to achieve this was found to be affected by the length of the rainy season and the time farmers spent on other farming activities.
- ▶ Efficient use of inputs such as labour and access to water. Such inputs are often limiting in many rural villages where cassava processing occurs, and therefore affect efficiencies.
- ▶ Ability of the processors to maintain the quality of products. Quality was also affected by insufficient supply of water and dependence on sun-drying. These made it difficult to avoid fermentation, contamination and spoilage during the rainy season.
- ▶ Availability of sufficient raw material at low cost. Insufficient raw material was found to be a major issue in ESA villages, unlike the West African countries of Nigeria and Ghana. Most cassava farmers in ESA are not yet market oriented; they produce mostly for subsistence and have little or no excess cassava to sell to processing plants.
- ▶ Access to a product market was poor. Most rural farmers/processors shy away from getting their products to end users in the cities; transacting business or negotiating prices with urban-based factory owners was difficult for most rural-based farmers. The processors resorted to selling the processed products to traders who buy at lower prices than those offered by the end user industries.
- ▶ Managerial skills were not good enough.
- ▶ Support infrastructure such as electricity, water, roads and affordable transport systems are generally inadequate in rural areas and affected the enterprises negatively.

Training

Between 1996 and 2001, during the implementation of the 'Cassava for Bread Project' alone, more than 550 trainees from national research and extension agencies in 25 African countries were trained on cassava processing and utilization (Table 12.2). Over 350 Nigerians (farmers, processors, caterers, bread bakers, biscuit manufacturers, etc) received classroom and practical skills enhancement during the training of trainers. The project helped in the development of researchers, extension officers and university scientists from more than 40 partner institutions in the 25 African countries. In addition, other units and programmes of IITA such as the post-harvest engineering project, the East African Root Crops Research Network (EARRNET), the Southern African Root Crops Research Network (SARRNET),

and the Post-harvest and Marketing Research Network for Eastern and Central Africa (FOODNET), conducted similar training sessions in Central, East, Southern, and West Africa. Performance testing of small machines, and training of equipment manufacturers on the design, operation, and maintenance of post-harvest tools and equipment was carried out in collaboration with other agencies such as FAO, national cassava programmes, post-harvest programmes, and roots and tubers (RandT) programmes of Central, East, Southern, and West African countries (IITA, 1999). About 9 000 people were trained from 2003 to 2008 during the IITA-led Preemptive Management of virulent CMD (cassava mosaic disease) in the south-south and south-east of Nigeria (the CMD Project), and the Cassava Enterprise Development Project (CEDP) implemented in Nigeria.

The results of the pilot tests improved knowledge of the constraints against the cassava agroprocessing sector in ESA, and were bases for additional research to improve the sector through additional out-scaling and up-scaling programmes and projects. In 2008 and 2009 the Common Fund for Commodities provided additional funding to IITA to adopt lessons from the past pilot projects and test a higher-scale technology for HQCF processing. This occurred with farmers and local entrepreneurs in Tanzania, Madagascar and Zambia, ensuring that the entrepreneurs participated as constructively as possible by taking a 'business outlook'. The United States Agency for International Development (USAID) also provided funds to IITA to apply the approach in Nigeria, Ghana, Democratic Republic of Congo, Sierra Leone, Malawi, Mozambique and Tanzania. The government of Italy through FAO and the Ministry of Agriculture and Cooperative (MACO) is replicating the approach in Zambia and Malawi. Similarly, the Bill and Melinda Gates Foundation (BMGF) provided funds to the Natural Resources Institute (NRI) to implement a value-addition project on cassava ('Cassava: Adding Value to Africa', or CAVA), focusing specifically on the processing of HQCF in Nigeria, Ghana, Uganda, Tanzania, and Malawi. The NRI selected IITA to participate in the project to provide both production and post-harvest support. Several organizations and governments are currently involved in the development of the cassava sector and there are many on-going projects or programmes through which the pilot tests are carried out in many countries. The next sections will explain how multi-country investments on cassava have had positive effects on the development of cassava-based agro-industries in ESA.

Having acquired the necessary expertise on cassava processing and product development, national institutions took on the dissemination of the new processing technologies to the wider public at national and regional levels during meetings, trade shows, etc. End users were made aware of the possibility of using cassava flour in their products and processes. The recipes and baking techniques developed by IITA were adapted to the food tastes and preferences of consumers in different countries (Gensi *et al.*, 1998; Mlingi *et al.*, 1998; Sanni *et al.*, 2006). The development of more expertise for cassava processing, product development, and use of HQCF is an ongoing activity in various African countries and is now undertaken by previous

TABLE 12.2
Trainees during 'Cassava for Bread' Project, 1996-2001, IITA

Country	Total	% Female	NARES Affiliation
<i>International training</i>			
Benin	7	57	Laboratoire de Technologie Alimentaire; Institut Nationale des Recherches Agricoles du Benin
Burkina Faso	2	50	Institut de Recherche en Science Appliquée et Technologie
Cameroon	2	100	University of Maryland
Chad	1	100	Ministère de l'Agriculture
Congo	1	0	Institut Nationale d'Etudes et de Recherches Agronomiques
Gambia	3	67	Gambia Food and Nutrition Association; National Agricultural Research Institute
Ghana	51	29	Food Research Institute; Ministry of Food and Agriculture; Sasakawa Africa Association; University of Science and Technology; Crops Research Institute
Guinea	2	50	Institut de la Recherche Agronomique de Guinée
Kenya	13	100	Kenya Agricultural Research Institute; Ministry of Agriculture, Livestock Development and Marketing; Kenya Industrial Research and Development Institute
Madagascar	6	33	Centre Nationale de la Recherche Appliqué au Développement Rural; Cité Universitaire Ankatso
Malawi	1	0	Private
Mali	1	100	Institut d'Economie Rural
Mozambique	1	100	Southern Africa Root Crop Research Network

TABLE 12.2 (continued)
Trainees during 'Cassava for Bread' Project, 1996–2001, IITA

Country	Total	% Female	MARES Affiliation
Netherlands	2	0	Private
Niger	2	0	Institut National de Recherche Agronomique du Niger
Nigeria	18	67	Federal Institute of Industrial Research; Institute for Agricultural Research; National Root Crops Research Institute; Shell Petroleum Development Corporation; Technoserve Nigeria; University of Ibadan
Portugal	1	100	Southern Africa Root Crop Research Network
Rwanda	2	50	Institut des Sciences Agronomique du Rwanda
Senegal	3	33	Institut de Technologie Alimentaire
Switzerland	2	50	Private
Tanzania	2	50	Agricultural Research Institute; Sugarcane Research Institute
Togo	5	20	Institut Togolais de Recherche Agronomique; Institut Togolais de Recherche Agricole
Uganda	6	0	Kawanda Agricultural Research Institute; Ministry of Agriculture, Animal Industry and Fisheries; National Agricultural Research Organization;
Zaire	2	50	Institut National d'Etudes et de Recherches Agronomiques
Zimbabwe	3	67	Private
<i>Local training in Nigeria</i>			
Nigeria	415	61.9	Small-scale cassava processors and farmers, staff of the only noodle factory in Nigeria, and bread and biscuit bakers involved in the initial pilot testing activities
Total	554	57.9	

trainees who apply the knowledge acquired to the implementation of new projects in various countries. For example, two metal manufacturers in ESA – Tonnet Enterprises in Uganda and Intermech Engineering in Tanzania – provide training services to other manufacturers in the region. They also provide appropriate and affordable equipment to farmers, processors and investors.

12.4 Policy dialogue

The safety and quality of processed cassava products for domestic and export markets are essential to establish confidence in consumers and importers and to ensure their long-term willingness to purchase. Assurance of quality may also contribute to price premiums and consumer brand loyalty. Many national institutions face the challenge of developing cassava-based food quality standards, and management systems that cassava processors can implement easily and cost-effectively. End users often avoid using cassava in their products for a number of reasons, including the lack of approved standards, lack of required knowledge for using cassava, and the uncertainty of obtaining product certification from relevant regulatory agencies. Of course, an unfavourable policy environment also constrains the commercialization of cassava. Experience from Nigeria suggests that fiscal policies that effect increases in the domestic prices of rice, wheat and maize, also lead to increases in the demand for cassava and cassava products. Similarly, in Tanzania, shortages in the supply of cereal crops resulting from natural disasters such as droughts have also lead to a rise in the domestic price of cassava. In these situations, political leaders often encourage farmers to grow more cassava to fill the gap in food supply; farmers usually respond by increasing production. Unfortunately, reversals of such policies in ways that depressed cereal prices after farmers had increased production have in the past caused major financial losses to farmers. Adoption of food importation as a quick fix, without any supportive systems of marketing the surplus cassava already produced by farmers, have often led to a drop both in the demand for and the price of cassava. Such serious inconsistencies discourage farmers from cassava production and may be contributing to their reluctance to adopt new technologies that enhance productivity. IITA and the national institutions engage in policy dialogue and information exchange with political leaders on ways to achieve economic growth and food security without resorting to arbitrary policy measures that further worsen the farmers' situations.

12.4.1 Some selected cases and outcomes of policy dialogue

Nigeria

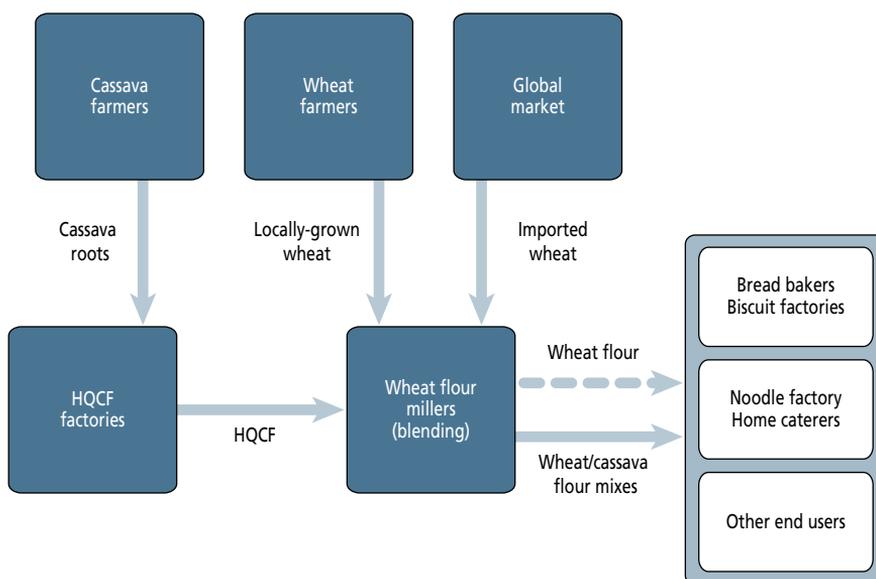
Following the evident enthusiasm of the Government of Nigeria to acquire knowledge and develop suitable policies to move the cassava industry forward,

an international workshop on 'Cassava Competitiveness in Nigeria' was held in 2002 in collaboration with national institutions, such as the Raw Materials and Research Development Council (RMRDC), the Federal Ministry of Agriculture and Natural Resources (FMANR), the United Nations Industrial Development Organization (UNIDO), the National Seeds Service (NSS), the Nigeria Chamber of Commerce, and private sector companies such as AGIP Oil. Various recommendations were proposed for improving the competitiveness of the Nigerian cassava sector. For example, three areas of policy intervention for the development of cassava markets and agro-industry for poverty reduction were proposed by Abass (2002):

- ◉ A composite flour policy: a five-year development plan to make all flour mills include 10 percent cassava flour in baking flour.
- ◉ A national ethanol production policy: alcohol distilleries should derive 80 percent of their ethanol from cassava in order to progressively reduce importation of (crude) ethanol.
- ◉ A national starch-use policy: a phased development plan for industries such as confectionery, textiles, paper, gum, to source their starch requirements locally, with the aim of meeting 70–100 percent starch-based raw material needs in the food, pharmaceutical, oil drilling and textile industries from internal sources.

A conceptual framework for the implementation of the HQCF policy was proposed (Abass, 2002). It was suggested that the implementation should involve direct blending of locally-sourced wheat, HQCF, and imported wheat by flour millers before marketing to bread bakers and other users (Figure 12.6). Direct blending by the flour millers was expected to reduce problems associated with irregular quality, low supply volume, fear by cassava users of sanctions from regulatory agencies, and possible negative consumer reaction to these cassava-containing products. It was projected that the policies would open significant market opportunities for smallholder farmers and reduce poverty and hunger, given that more industries would be required to use secondary cassava products – such as chips, baking flour and ethanol – as raw materials. The potential benefits of implementing the policy proposals from IITA were further discussed by the Federal Institute of Industrial Research (FIRO) Oshodi-Lagos with the Nigerian Government in 2004.

In 2005, the Nigerian Government finally announced its intention to implement a policy on mandatory inclusion of 10 percent locally-sourced flour in bakers' flour. This was followed by the approval of a Biofuel Policy by the Nigeria legislature in 2007; the policy aimed to integrate the agricultural sector with the downstream petroleum sector. The policy made special reference to the use of cassava, sugar cane, oil palm and other crops as biofuel feed stocks. In addition, the policy also identified the National Root Crop Research Institute (NRCRI), the Root and Tubers Expansion Program (RTEP) and the IITA as some of the institutions charged with the responsibility of developing biofuel feedstock in Nigeria (FGN, 2007). Further policy dialogues were carried out with relevant Government agencies and policy-makers at two levels to support cassava development programmes. Discussions were

FIGURE 12.6 Conceptual framework for the import substitution policy in Nigeria


Source: Abass, 2002.

held with technocrats such as agricultural and marketing extension experts at the 36 State and Federal levels and in Abuja, and also with the programme managers of all the agricultural development projects (ADPs). Discussions were then also held with high-level policy-makers including State Commissioners, the Ministers of relevant Ministries, and the Presidency.

Development of quality standards to strengthen the cassava industry in other countries

Through the Common Fund for Commodities (CFC), the CMD and the CEDP projects, SARRNET and EARRNET, IITA established partnerships with standards bureaus in many countries, as well as other organizations such as the Eastern and Central Africa Program for Agricultural Policy (ECAPAPA), concerning the analysis of cassava food safety and quality and the drafting of standards for cassava products. From 2004, countries such as Tanzania, Zambia, Madagascar, Malawi, Nigeria and Ghana have either revised old standards or drafted and approved new standards for cassava products in food, feed or other industrial applications (HQCF, edible cassava flour, cassava starch, chips, *gari*, *rale* etc). In many cases, IITA representatives and lead experts on post-harvest issues in partner institutions served in the technical committees for standards development and other committees for preparing cassava development programmes in the various countries. Nigeria, Tanzania, Zambia

and Madagascar are some of the countries where such collaborative activities are strong. In Tanzania, IITA serves as a member of the technical committee of the bureau that developed the standards for cassava products (starch, HQCF, chips). It was represented in the committees of the Commission for Science and Technology (COSTEC), and the Ministry of Agriculture and Food Security and Cooperatives (MAFSC), responsible for cassava sector development, including a programme on the development of composite flour technology. The national institutions responsible for the coordination of the 'IITA small-scale cassava processing project' – Centre National de Recherche Appliquée au Développement Rural (FOFIFA) in Madagascar and the Zambian Agricultural Research Institute (ZARI) – are members of the technical committees of the standards bureaus that developed the standards for cassava products – starch, edible cassava flour, chips – in the two countries.

12.5 Technical support for the African agricultural development agenda

IITA partners with national institutions, the private sector, NGOs and other participants in the agricultural sector of many African countries to apply available technologies in their agricultural programmes. Most technologies relate to the areas of production, processing and marketing, with the aim of developing staple food crops as a remedy for hunger, poverty and the underdevelopment of agro-industry in Africa.

12.5.1 Support for national cassava initiatives¹

The government of Ghana announced a Special Presidential Initiative (SPI) on cassava in 2001. The idea was to transform cassava production from its subsistence nature into a commercially-viable agribusiness that can generate revenue through exports. The SPI planned to establish ten cassava starch processing plants under the farmer-ownership scheme called Corporate Village Enterprises (COVE). The ten starch plants to be installed by the International Starch Institute would be owned by farmers, as a means of bringing rural communities and cooperatives of farmers into mainstream economic activity. Revenue was expected to be earned through the export of starch from the starch plants. Farmers, particularly women farmers, were to supply cassava roots to the processing plants established with government-backed funding from three banks.

1 Further information on these initiatives is provided in Chapter 11.

The processing plants were to be managed by management professionals. The project started with the establishment of the Ayensu starch plant and the distribution of high yielding varieties to farmers. Some of these high-yielding cassava varieties were from the TMS series, e.g. *Afisiafi* (TMS 30572), *Doku Duade*, and *Agbelefa*. Through its links with the Root and Tuber Improvement Program (RTIP) and the National Root crops programme, IITA contributed to the SPI through capacity building previously provided to most of the institutions involved in the SPI. Some of the processing experts went through degree training or group training previously organized by IITA both in Ghana and in Nigeria. IITA has also been providing backstopping support to the RTIP since the 1990s. Extensive analysis of the outcome and constraints of the SPI have been well documented (Tonah, 2006; Sanogo and Olanrewaju, 2008).

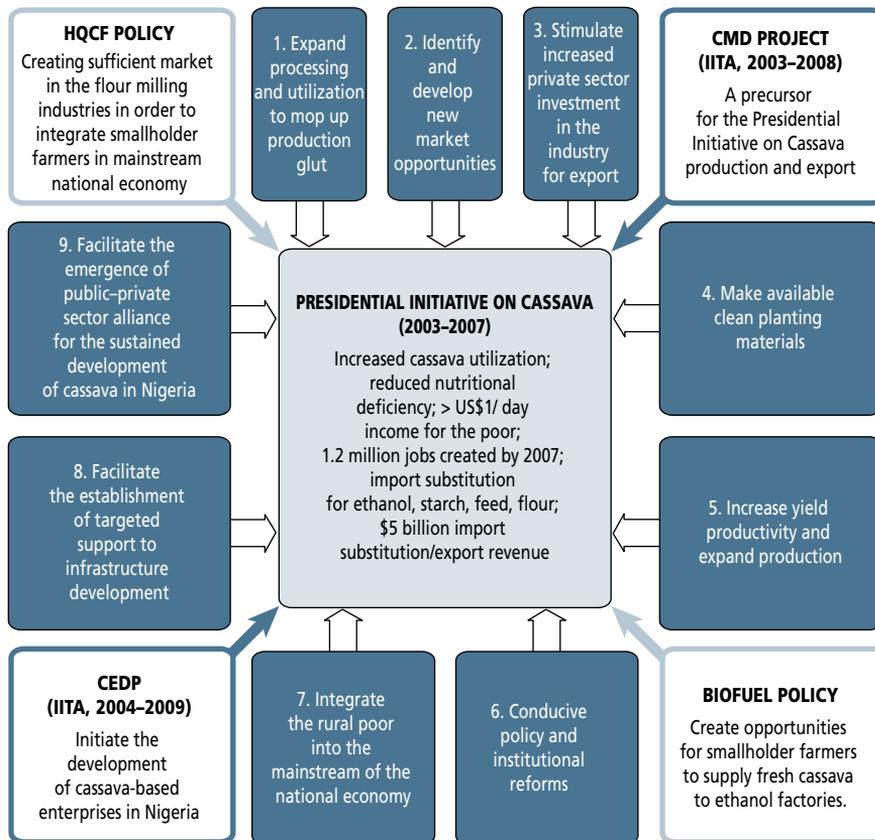
The Presidential Initiative on Cassava (PIC) was announced by the Government of Nigeria in August 2005. PIC was a three-year initiative (2004–2007) to increase the contribution of cassava as an engine of economic transformation, to spur rural industrial development, to generate employment, to reduce poverty, to ensure food security, and to generate and conserve foreign exchange through exports and import substitution. It aimed to enhance the productivity and production of cassava by increasing the area cultivated to 5 million ha – with a target yield of 30 tonnes/ha – in order to produce 37.5 million tonnes/year of products for local and export markets.

The PIC was designed to involve a coordinated set of activities that would promote a competitive cassava production, processing and marketing system, and generate revenue of about US\$5 billion annually. The PIC was implemented through two policy initiatives – one on composite flour and the other on biofuel production – with eight major output targets. Complementary to these, two major cassava value chain development projects were implemented as precursors to the PIC. The two projects, led by IITA, formed extensive partnerships with national institutions to deliver cassava technologies and marketing innovations to all actors in the Nigerian value chain, to develop institutional arrangements, and to facilitate the development of the cassava industry. The projects were:

- ▶ the preemptive management of virulent CMD in the south-south and south-east of Nigeria (the CMD Project);
- ▶ the Cassava Enterprise Development Project (CEDP), funded by the Government of Nigeria and Petroleum companies (Figure 12.7).

Technologies that addressed multiple cassava constraints from production to consumption were introduced to farmers, processors and other stakeholders using the commodity chain approach. Production technologies were integrated with value-adding post-harvest processing and storage technologies, microenterprise and market development, the development of supply-chain structures and management, the promotion of agro-inputs and service delivery systems, and the enhancement of farmers' access to credits. They also improved the links between producers/processors and end users.

FIGURE 12.7 Presidential Initiative on Cassava (PIC) showing the nine component parts, the two precursor projects and the two policy drives



Close partnerships were maintained with a wide range of stakeholders from both public and private sector institutions: the Root and Tuber Expansion Project (RTEP), the National Root Crops Research Institute (NRCRI), Agricultural Development Projects (ADPs), strategic private industries, NGOs and individuals, CIAT, the Latin American Consortium for Cassava Research and Development (CLAYUCA), and the private sector in Brazil. These led to the introduction of wide range of technologies, including new designs and higher scale machinery for cassava processing.

The machinery designs introduced provided opportunities for equipment manufacturers in Nigeria to improve on the efficiency and cost-effectiveness of local machinery, and also to acquire additional expertise in the manufacture of

a wider range of new machinery with the higher capacity needed to support the emerging cassava agro-industry. In addition to the previously existing cassava-based associations such as the Root and Tuber Growers Association of Nigeria (RATGAN), new associations such as the Nigeria Cassava Processors and Marketers Association (NICAPMA) and the Agricultural Machinery and Equipment Fabricators Association of Nigeria (AMAEFAN) have emerged, and are currently driving commercial activity in the cassava sector.

12.5.2 Support for regional cassava initiatives

Through the East and Southern African Root Crops Research Network (ESARRN), the East African Root Crops Research Network (EARRNET) and the Southern African Root Crops Research Network (SARRNET), IITA supported links between national programmes in ten countries, provided access to suitable varieties and integrated pest management (IPM) technologies for major pests and diseases, improved cassava post-harvest techniques, and helped develop the NARES human resource capacity (IFAD and FAO, 2005). In addition, IITA and the root crops networks, SARRNET and EARRNET, support the NEPAD (New Partnership for Africa's Development) Pan-African Cassava Initiative (NPACI) to tap the potential of cassava to work for food security and income generation, via a transformation strategy that emphasizes expanding markets, better organization of producers for collective action, and increased private sector investment. IITA provides both secretariat and leadership in research on specific issues related to NPACI and supports NPACI's efforts to promote best practices for cassava development. NPACI provides suitable information on models for energizing the cassava sector and agro-industry development in cassava growing nations. Such information is needed in countries such as Tanzania, Mozambique, Madagascar, Zambia, Bénin, Gabon and Sierra Leone, where there are ongoing discussions on how to formulate national initiatives and policies on cassava development. Mozambique, Ghana and Sierra Leone are also currently discussing modalities for the blending of HQCF with wheat flour, while Tanzania and Zambia have national committees developing strategies for the expansion of cassava utilization, and the possible blending of cassava with other flours such as wheat or sorghum².

12.5.3 Support for global initiatives

The vision of the Global Cassava Development Strategy (GCDS) as described in 2001 is that "cassava will spur rural industrial development and raise incomes for producers, processors and traders, and will contribute to the food security status of its producing

² Available at: <http://allafrica.com/stories/200709181014.html>.

and consuming households". The spread of cassava technologies has been possible through collaborations with the network of NARES, Root and Tuber Crop networks, regional projects on cassava, the International Fund for Agricultural Development (IFAD), the private sector, NGOs, and policy-makers. So far the technologies have made it possible for the private sector to invest in cassava production, processing, and marketing of high-value cassava-based products.

12.6 Transformation of research outcomes to development impact

As part of the IITA R4D approach, the research outputs used by research and development partners to achieve outcomes are further made available to a broader number of partners including the ultimate end users of the technologies – farmers, NGOs, the private sector, policy-makers and other development agents – for out-scaling and up-scaling to generate the desired development impacts. The involvement of IITA in the process fosters the analysis of the evolving benefits of the new technologies being used, through measurement of their impact on their ultimate beneficiaries. Such analysis helps in the detection of new challenges emerging in the process of creating positive developmental impacts.

12.6.1 The outcome of the use of new cassava varieties and HQCF technology in Africa

According to Nweke *et al.* (2002) and Nweke (2003), there are four stages to cassava transformation, based on the role cassava plays in a county's economy or food system. The stages have been classified as: famine reserve (stage I), rural food staple (stage II), urban food staple (stage III), raw material for food, feed and industry (stage IV). Since the 1990s the increased activities on cassava development by national and international research centres, multilateral development institutions, NGOs and others, have helped many countries progress on the cassava transformation ladder. In the past 12 years, organizations such as IITA, CIAT, SARRNET, EARRNET, NRI, FAO and NGOs, have collaborated with the NARES in ESA countries, particularly the cassava programmes, on implementation of cassava research and development activities. These activities have included testing and disseminating market-oriented cassava processing technologies.

In Zambia, the Program Against Malnutrition (PAM) has been involved in the distribution of planting material in many parts of the country. In 2004, the Zambia Agricultural Research Institute in collaboration with IITA established the first HQCF pilot plant in Mansa, Zambia. The capacity of processor groups was enhanced to supply HQCF to paper, cardboard and food factories in the copper belt area of Zambia.

Compared with traditional cassava products, the significant improvement in the quality of cassava produce supplied to the industries using the new IITA processing methods and machinery led to an increase in industrial demand for new cassava products. Subsequently, the PAM, the Ministry of Agriculture and Cooperatives (MACO), FAO and some NGOs, collaborated to out-scale the cassava processing technologies through testing and adaptation with more smallholder farmers and processors in other locations in Zambia. Presently the CFC, FAO, International Trade Centre (ITC), United Nations Conference on Trade and Development (UNCTAD) and the World Bank (WB) are collaborating in the implementation of value chain development activities in Zambia.

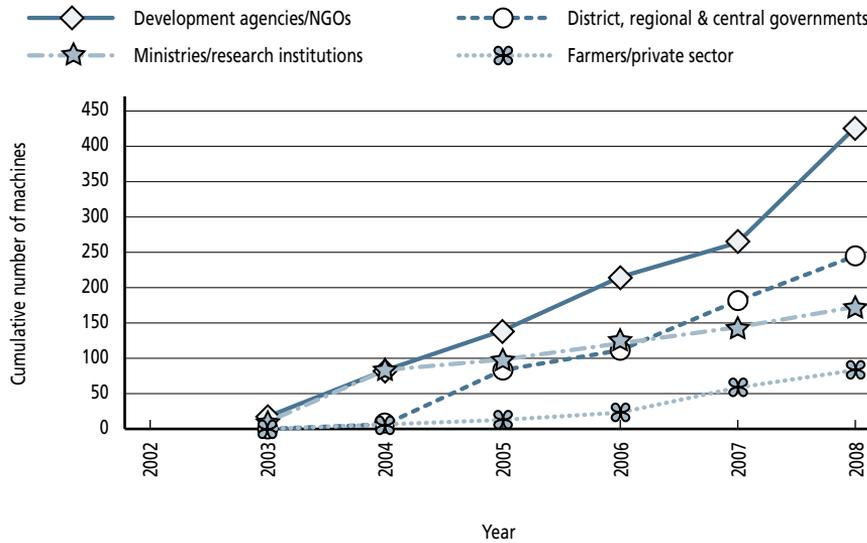
In Tanzania, collaborations between the Root and Tuber Programs on the mainland and Zanzibar, IITA, SARRNET, district and regional governments and the prison service, have improved the availability of new high-yielding disease-tolerant cassava varieties with acceptable food quality traits. Pilot cassava processing plants were established in collaboration with the Tanzania Food and Nutrition Centre (TFNC) and MAFSC, e.g. a CFC-funded project on small-scale cassava processing, a CIAT–IITA starch processing project, and the Livelihood project funded by the USAID 'Initiative to End Hunger in Africa' programme. Subsequently, many district and regional governments and NGOs became active in the formation of farmers' and processors' groups to take up and outscale the new processing technologies. There has been a significant demand for HQCF, starch and chips from industrial users. However, the private sector is yet to invest in cassava agroprocessing (Abass, 2008). Most investment was carried out by the public sector and NGOs to promote processing technologies and enhance food security (Figure 12.8). Consequently, industrial demands for cassava products have not been met by the small-scale processing groups, although consumption of cassava flour by the urban middle class has been on the increase since 2004/2005.

The sale of cassava flour in Tanzania's city supermarkets has increased. In addition, the consumption of fresh cassava as a snack has been on the rise in the cities. Public opinion seems to suggest that the high energy content and the lower glycaemic response properties of cassava are contributing to increased consumption. The activities of national and international research and bilateral institutions, NGOs and local governments, combined with the increased demand for cassava roots and products, indicate a growing recognition of cassava as an urban food and industrial raw material in Tanzania. The cassava sector in Tanzania appears to have transformed from the rural staple stage of the 1990s to the urban staple stage.

The increased demand has influenced production; cassava cultivation in villages around major cities has increased. These factors may have contributed to increases in cassava yield and total production in Tanzania. Statistics from FAO (Figure 12.9) show that for the first time in over ten years, cassava yields and production have both increased consistently for four years.

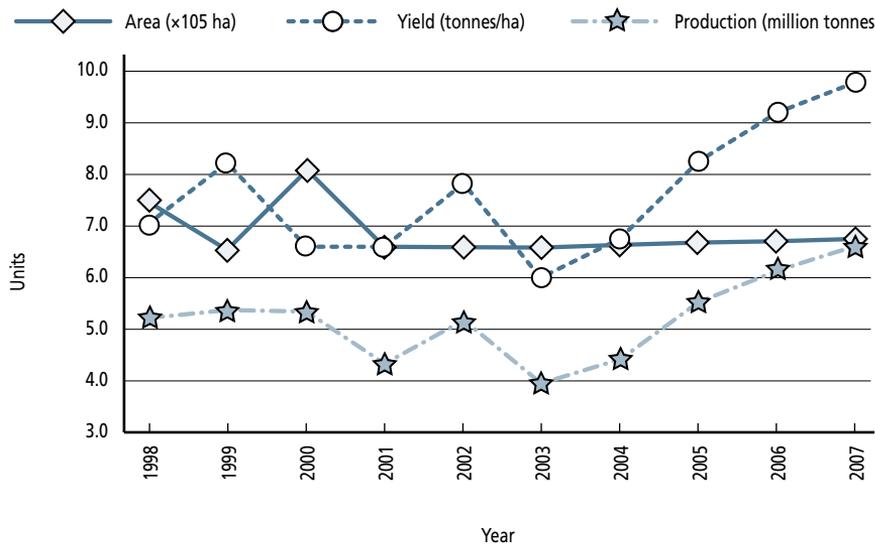
Transiting cassava into an urban food and industrial commodity through agro-processing and market driven approaches: Lessons from Africa

FIGURE 12.8 Trends in supply of cassava machinery by Intermech Engineering Ltd and Tonnet Enterprises to Burundi, Rwanda, Malawi, Tanzania, Uganda and Zambia



Source: Sales records of Intermech Engineering Ltd (Tanzania) and Tonnet Enterprises (Uganda).

FIGURE 12.9 Cassava production, area planted and yield in Tanzania, 1998–2007



Source: FAOSTAT 2009.

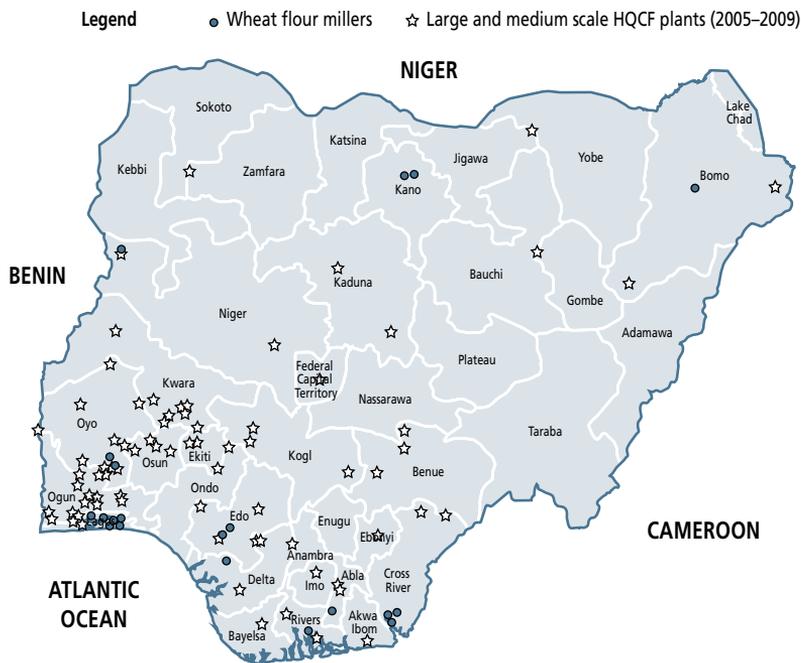
12.6.2 Assessing the impact: case studies of Ghana and Nigeria

In Ghana, the SPI energized further investment by the private sector. Additional medium- and large-scale cassava-based commercial enterprises are beginning to emerge in Ghana. These include Amasa Agro-processing Limited (Amasa) and Caltech Venture Limited (CVL). Amasa has been involved in the processing of fermented cassava foods for many years. The company has recently developed a new investment plan to install a flash dryer for the manufacture of HQCF. CVL was established in 2006 with the objective of producing ethanol, starch, and HQCF. The company started its operation with the supply of cassava roots to the SPI's Ayensu starch plant. Since the closure of Ayensu, CVL has installed medium-scale cabinets and flash dryers for making HQCF and is currently selling to the plywood industry in Ghana. The current plant capacity is 3.5 tonnes of HQCF per day. CVL adopted 5–8 TMS varieties, and uses the rapid multiplication technique on its current 500 ha cassava plantation, which the company plans to expand to 2 000 ha.

One of the varieties, *Afisiafi*, yields at least 25 tonnes/ha without the use of fertilizer at the CVL farm; in comparison, smallholder farmers in Ghana did not achieve more than 10 tonnes/ha yield with the same variety. Similarly, commercial farmers in Nigeria are also achieving 25–40 tonnes/ha with the Nigerian varieties. The higher yields have clearly come about because of good production practices, which smallholder farmers often do not give much priority. Without a doubt, good management practices can improve the competitiveness of cassava, whether with the existing high yielding varieties such as *Afisiafi* or the other IITA–TMS varieties grown by farmers. Smallholder farmers seem to lose the financial and competitiveness benefits of the new high varieties because they lack knowledge of good production techniques. It would therefore be necessary for the new R4D agenda to include the demonstration of best production practices through 'cluster systems' in a manner similar to how the 'pilot processing system' was used to transfer the HQCF technology across Africa.

During the PIC in Nigeria, significant manpower development was achieved through a series of training sessions and distribution of training manuals. Model cassava processing plants were built in nearly all the states that participated in the two precursor projects (Sanogo and Olanrewaju, 2008). Before 2003, limited success was achieved in the mechanization of harvesting, peeling, pelletizing and frying of *gari* at small- and medium-scales (Nweke, 2003). Starting from 2005, collaboration between machinery manufacturers (e.g. Fataroy Enterprises, Niji Lukas Nigeria Limited, Nobex Technical Company Limited, Peak Precision Products Nigeria Limited, Adebash, etc), many national institutions and universities, CIAT, CLAYUCA and IITA led to the development of new or higher capacity labour-saving machinery through hybridization of the local techniques and with designs from Brazil, Germany, and other countries. New designs and higher capacities were realized for peelers, dryers, pellet-making machines, hydraulic presses, and fryers for *gari*. For example, a new design of cassava peeler suitable for medium-scale enterprises emerged, and it is now on commercial sale for the

FIGURE 12.10 Nigeria, showing location of wheat flour mills and the medium- and large-scale cassava plants processing HQCF during the commercial phase



first time in Nigeria. In addition, a larger capacity flash dryer with a higher fuel efficiency and double output was designed, tested and commercialized. A major scaling-up of capacity and more advanced mechanization in terms of unit operations of the cassava processing industry was thereby achieved. This achievement was recognized with an award by the CGIAR (Consultative Group on International Agricultural Research) for an outstanding example of agricultural technology in SSA in 2008. Following the CGIAR award, doubts about the need for agroprocessing and value-addition research – which form part of the IITA R4D approach – seems to have been resolved and the Science Council of the CGIAR finally adopted the R4D approach in 2008.

The combined effects of the nine aspects of the PIC, two policy plans, and the two IITA-led projects, jump started the establishment of several medium-scale cassava processing enterprises between 2005 and 2008. By 2009, the number of companies and entrepreneurs that had invested in flash dryers for HQCF or starch production had increased to circa 140–150, from a mere six or so in the year 2000 (Figure 12.10).

Nearly 95 percent of the enterprises were for HQCF processing with additional facilities for making traditional products such as *gari* and *fufu*. These include the model processing plants established under the CMD and CEDP projects. The capacity that existed for processing HQCF with mechanical flash dryers increased

from near zero in 2003 to about 85 000 tonnes per year in 2009. The production of higher volumes of HQCF at consistent quality, even during the rainy season, was made possible. This represents a major achievement compared with the situation during the pilot testing stage in Nigeria, when groups of 14 small-scale processors dried HQCF by sun-drying (Abass *et al.*, 2001). At the medium scale, the cost of the machinery for HQCF processing and the daily output volumes were much higher than obtained during the piloting stage (Table 12.3).

In addition, new factories were established for the production of ethanol and glucose syrup. The demand for the intermediate cassava products increased – HQCF, starch, and glucose syrup – and came from wheat flour mills, textile factories and multinational food factories such as Cadbury and Nestlé. Farmers responded to the demands for cassava roots by increasing production. Total production in Nigeria increased from 34.1 million tonnes in 2002 to 45.7 million tonnes in 2006, and farm-gate prices also increased (Figures 12.11 and 12.12). Average farm size increased and truly commercial cassava farms emerged. The increases in the price of

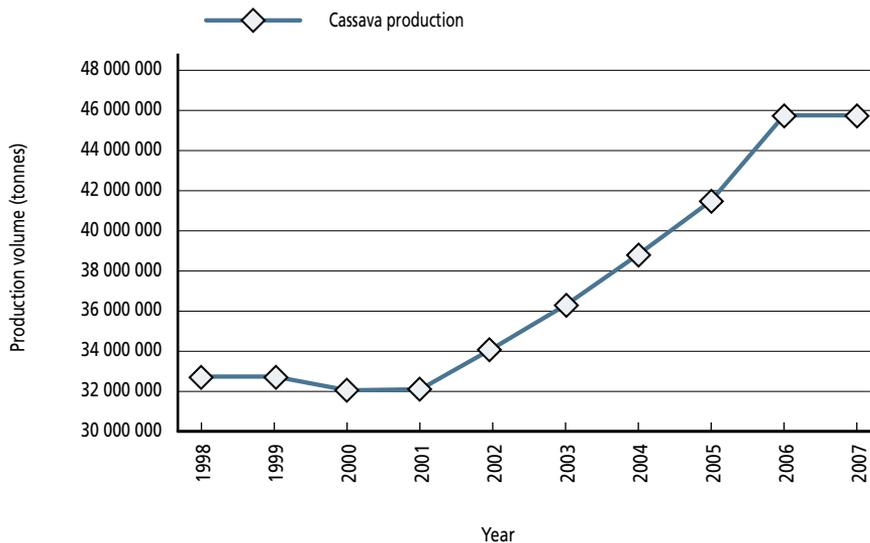
TABLE 12.3

Equipment required for production of HQCF during pilot and commercial phases

Item	Pilot phase (1995–1998)		Commercial phase (2005–2008)	
	Capacity	Cost (US\$)	Capacity	Cost (US\$)
Mechanical peeler			0.6–0.8 tonnes fresh roots/hour; 60–90% peel removal	2 966
Mechanical grater (two required for commercial processing)	0.3–0.5 tonnes fresh roots/hour	870	2.0–3.0 tonnes fresh roots/hour (two units/plant)	4 237
Double screw press	0.05–0.10 tonnes fresh roots/hour	300		
Twin basket hydraulic press (Brazilian design)			8 tonnes fresh roots/day (two units/plant)	11 017
Filter bag (used with twin basket hydraulic press)			20 pieces/day	424
Wooden drying racks (sun-drying)	Set (15)	30		
Flash dryer			4 tonnes flour/day	33 898
Hammer mill	0.25–0.40 tonnes flour/hour	1 550	5.0 tonnes flour/day	5 508
Total per processing plant	129–153 tonnes flour/year	2 750	960 tonnes flour/year	55 085

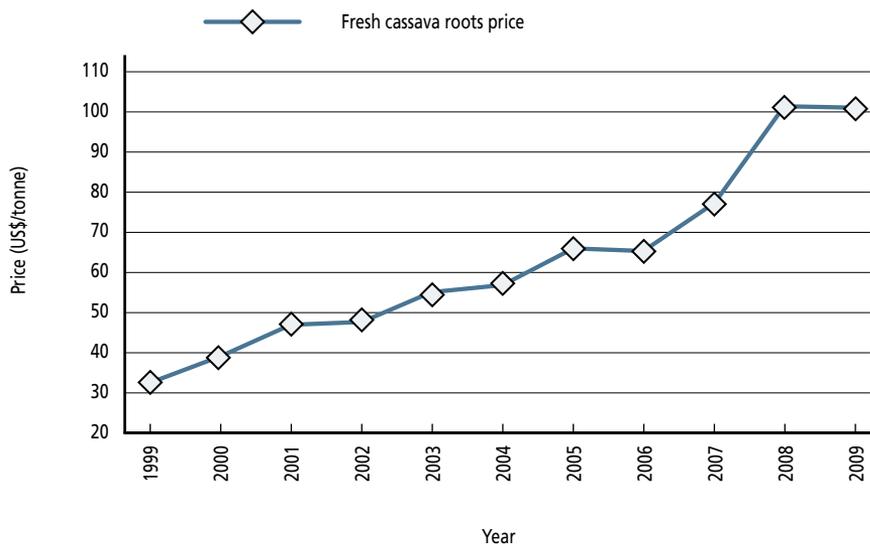
Source: Abass *et al.* 2001, SIS Engineering Ghana Limited, Niji Lukas Nigeria Limited, Nobex Technical Company Limited, and Fataroy Enterprises.

FIGURE 12.11 Cassava production trend in Nigeria before, during and after the PIC



Source: FAOSTAT 2009.

FIGURE 12.12 Trend of fresh cassava root prices in Nigeria before, during and after the PIC



Source: HQCF processors, and Agroprocessing Unit, Ogun State ADP.

fresh cassava during the years of increased production signify a reversal of the usual price collapse following production increases for an African crop.

The purpose of expanding market opportunities for cassava was to increase farmers' incomes. Such increases helped Nigeria to reduce rural poverty in the 1990s (Nweke, 2003). Many smallholder farmers in Nigeria benefited from the recent increases in prices, between 2006 and 2008, at the same time as they increased production. However, raising smallholder farmers' incomes through significant reductions in the cost of production is more desirable than increasing incomes from higher prices of cassava or land expansion. Reductions in the cost of production will make cassava and its products more competitive, both in the domestic and international markets.

12.6.3 Assessing new challenges in the development process: the case of the HQCF industry in Nigeria

The R4D approach requires assessment of new challenges arising from the development impacts of the use of IITA technologies by partners.

A recent assessment of the emerging challenges of the HQCF industry, following the impact being generated in Nigeria, showed that the major challenge in the cassava products market is the cheaper prices of imported substitutes. A high cost of cassava production translates into a high cost of cassava products and uncompetitive prices. At the same time, lower prices of imported substitutes reduce the market opportunities for cassava products because most consumers buy cheaper items. Farmers are then discouraged and drop out of the market; import volumes and national import expenditure grow once the local farmers are forced out of the market (World Bank, 2009). Such situations have often been followed by increases in the prices of the imported items already dominating the market.

According to the United States Department of Agriculture (USDA), Nigeria imports up to 85 percent of the wheat it consumes from the USA (USDA, 2009). About 3.2 million tonnes of wheat was imported in the 2008/2009 season; part of this may have been traded in the regional market. The milling capacity in Nigeria grew from 1.2 million tonnes per year in 1985 to about 6.2 million tonnes per year in 2008. According to USDA (2009) only about 52 percent of the 2008 milling capacity was utilized. It is estimated that the average import price of wheat into Nigeria during the 2008/2009 season was around US\$395.3/tonne. This implies that Nigeria's expenditure on wheat imports alone in 2008/2009 was about US\$1.3 billion (Table 12.4). The substitution of 10 percent of this with HQCF would save Nigeria US\$130 million yearly. Meanwhile over US\$49 million can be injected into the rural economy through the purchase of fresh cassava from farmers and to engage thousands of unemployed youths in the production, processing, transportation and marketing of the HQCF (Table 12.5). The possibility of achieving this depends on the competitiveness of HQCF compared with wheat, corn starch and maize, to which the price of HQCF is strongly linked.

TABLE 12.4

Summary of indicative cost of cassava production under traditional and modern methods in Uganda, 2007

Cost item/activity	Traditional production	Improved varieties and production methods
Yield (Fresh, tonnes/ha)	10	25
Unit cost of production (US\$/tonne)	6.74	7.11
Current farm gate price for fresh roots market (US\$/tonne)		19.13
Most probable farm gate price for processing plants; high volume or high turnover opportunity for farmers (US\$/tonne)		15.30
Gross value of output (current, US\$/ha)	191	478
Net income (US\$/ha)	124	300
Net income (US\$/tonne)	12	12
Net income ratio (Improved production method to traditional production method)		2.43 : 1

Source: Starcas Ltd, Uganda.

The price of HQCF in Nigeria has risen gradually from the time of pilot testing in 1995–1998. Although HQCF has more added value in terms of its stage of processing compared with imported wheat, processors and end users often settle for about 75 percent of the on-going price of imported wheat for HQCF. The HQCF price was about US\$290/tonne in 2000, and was traded at US\$609/tonne in 2007 when the implementation of the mandatory inclusion of 10 percent HQCF in wheat flour was implemented (Figure 12.13). This relatively high price was also influenced by the recent global food price crisis caused by low global wheat stock and general high prices of food items. By 2008, the imported price of wheat in Nigeria decreased from the US\$450–550/tonne in 2007 to about US\$280–510/tonne (Figure 12.14). Wheat flour millers became reluctant to buy HQCF at the 2007 price. The price was not acceptable to the majority of HQCF processors, particularly those that adopted flash drying technology, who argued that the price of fresh cassava was high and the profit margin was too low.

TABLE 12.5

Analysis of the potential benefits of the HQCF use in Nigeria

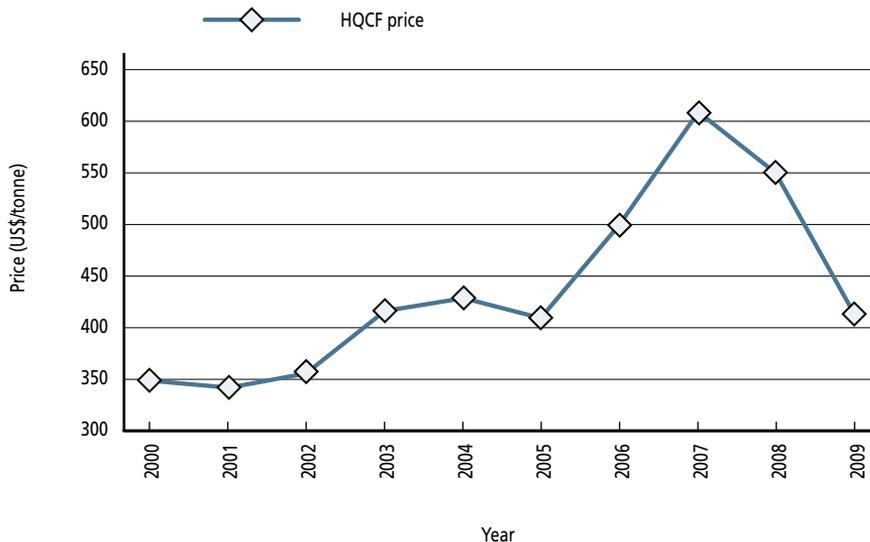
Wheat use and HQCF development in Nigeria	Estimates
Installed capacity of flour mills in Nigeria (tonnes/year)*	6 200 000
Estimated annual volume of wheat importation into Nigeria (based on 2008/2009 season, tonnes/year)*	3 200 000
Current capacity utilization of wheat flour mills in Nigeria (%)	52
Estimated price of imported wheat (estimates for 2008/2009 season, US\$/tonne)*	385.3
Estimated value of wheat imports by Nigeria (based on 2008/2009 season costs, US\$)	1 232 960 000
HQCF needed to meet national target based on 10 percent substitution set by the Presidential Initiative on Cassava (tonnes/year)	320 000
Estimated processing days per year	240
Number of HQCF processing plants needed (based on 2.5 tonnes HQCF/plant/day)	533
Estimated number of existing HQCF processing plants	140
Average installed capacity of existing HQCF plants (tonnes/plant)**	2.5
Estimated existing HQCF flash drying capacity (tonnes/year)	84 000
Potential annual savings from import substitution which could be saved from export to boost the internal economy had the 10 percent substitution been achieved (US\$, based on 2008/2009 season)	123 296 000
Estimated amount from import saving that could be injected annually into the rural economy through the purchase of fresh cassava from farmers, based on 40 percent value of savings from import (US\$/year)	49 318 400

* USDA, 2009; ** Data supplied by Nigerian flash dryer manufacturers.

Yet, wheat millers pointed out that the price was acceptable to HQCF processors located in semi-arid or dry regions of Nigeria who are using sun-drying. The cost of HQCF processing was cheaper when sun-drying was used, although the method can lead to supplies of low quality and inconsistent volume during the rainy season. The safety of the sun-dried HQCF may be easily compromised and could cause serious financial losses to wheat flour mills and bread bakers who use the composite flour (Abass *et al.*, 2001, 2009).

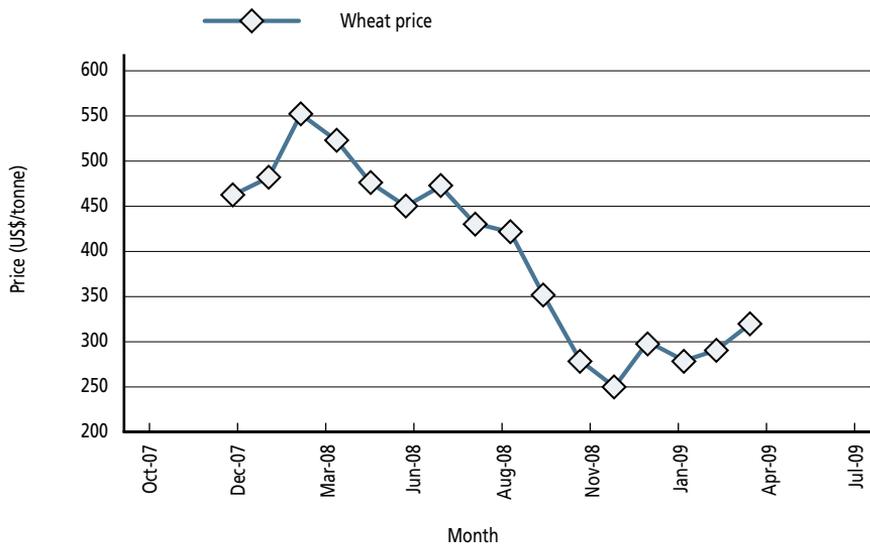
According to some of the processors the purchase price of HQCF should be at par with – if not more than – the factory gate price of wheat grains. HQCF is of higher added-value than whole wheat grains in terms of the extent of processing and readiness for bagging and marketing. There were no additional milling costs incurred by wheat flour mills for the use of 10 percent HQCF, given that HQCF enters the flour

FIGURE 12.13 HQCF price trend in Nigeria



Source: HQCF processors, and Agroprocessing Unit, Ogun State ADP.

FIGURE 12.14 World wheat price trend



Source: USDA 2009.

milling process at the final sifting, blending, and bagging stages. The HQCF processors observed that there was no evidence that the reduction in the price of imported wheat since 2008 resulted in any commensurate reduction in the price – US\$835–848/tonne – which bread bakers pay for the wheat flour. In addition, consumers were observed not to have benefited from the reduction in import price for wheat because the prices of loaves of bread did not reduce proportionately. Processors therefore argued that the savings gained by using HQCF and the substantial reduction in the price of imported wheat in 2008/2009 have both been to the almost exclusive benefit of wheat flour millers. Field data has shown that for an efficient HQCF processing plant, the profit margin would be near US\$47/tonne (Table 12.6).

A model of marketing margins also showed that smallholder cassava farmers, HQCF processors using flash drying technology, HQCF distributors, and bread bakers, can achieve additional benefits of US\$14.92, US\$14.92, US\$4.47 and US\$48.47 respectively for every tonne of HQCF sold for bread baking, and this including the potential for reduction in prices of food items, particularly bread. Clearly the current price formation model in the HQCF industry is not understood very well by all the stakeholders, particularly farmers, processors and users. This evident disorganized state of the market is a major factor slowing down progress in HQCF development in Nigeria. A similar situation was observed in 1996–1998 during the pilot phase

TABLE 12.6

Some cost parameters of HQCF production by medium-scale processors in Nigeria during the commercial phase

Costs	HQCF	US\$/tonne
Fresh cassava		203
Peeling labour		34
Washing labour		8
Permanent staff costs/ tonne		34
Diesel (15 litres/ hour)		85
Electricity		8
Cost of equipment		42
Overhead costs		21
Packaging/ Transportation		42
Contingency (5%)		24
TOTAL		503

Source: HQCF processors, 2009.

(Abass *et al.*, 2001). Nearly 96 percent of the HQCF plants in Nigeria are now idle because of these pricing problems. It is therefore necessary that marketing margins are discussed by all stakeholders to improve confidence and business cooperation in the Nigerian HQCF industry.

The existing HQCF plants in Nigeria are constrained by the unreliable supply of electricity. The processing enterprises rely on fuel-operated electricity generators that make the processing operations expensive. Nigeria often experiences chronic shortages of fuel, especially diesel, which results in a complete shutdown of processing operations. If the current state of infrastructure and inputs permits it is advisable for idle HQCF plants in Nigeria to diversify into drying of other products, such as plantain flour, *ogi*, *fufu*, and soy flour. Although the composite flour policy of the Government of Nigeria seems to be slowing down as a result of the confusing pricing situation resulting from the disorganized marketing structure, wheat flour millers are aware that the Government could sanction erring flour mills, as occurred in 2007 when many of the flour mills did not comply with the requirement (USDA, 2009). The huge capacity of wheat flour millers and the implementation of the policy on 10 percent import substitution provide an opportunity for agricultural growth and poverty reduction in Nigeria. The capacity to grow wheat (if possible) and to produce and use HQCF will need to be developed and sustained (Abass, 2002). The competitiveness of HQCF as an import substitute in the medium to long term depends on the possibility of reducing the production cost of fresh cassava. However, organization and training of the entrepreneurs who have invested in the HQCF plants will facilitate proper management or optimization of the drying operations, which appear to be inefficient at the moment. The Nigerian cassava industry needs a robust price formation strategy to ensure a fair distribution of profits and benefits along the whole chain. The stakeholders – cassava farmers, processors, wheat millers, bread bakers and other players – need mentoring in developing good business relations.

12.6.4 Translating new challenges to development interventions: the case of HQCF plants in Nigeria

The new challenges identified in the HQCF industry in Nigeria require development intervention, particularly in the area of infrastructure development and policy interventions.

However, the stakeholders at the cassava competitiveness workshop held at IITA (Nigeria) in 2002 before the announcement of the import substitution policy by the government of Nigeria in 2005, had cautioned that there were no 'quick fixes' for achieving economic growth and poverty alleviation. A deliberate, strategic and sustained set of actions were recommended for a private-sector-led agricultural transformation and long-term commitment (e.g. for 15 to 25 years) to invest in

market-oriented strategies, with an emphasis on value addition and productivity enhancement along the entire cassava value chain. The provision of an enabling environment for the adoption of modern techniques by stakeholders will make cassava competitive within and outside the country. The focus for the immediate development of the cassava sector should be the sale of cassava products in the domestic and regional markets, rather than export out of Africa. African countries need to make the foods they want from what they grow, and grow what they eat to feed themselves sufficiently before considering exporting food. As such, success in providing market opportunities for African farmers in the immediate and medium term would depend on good strategies and policies that encourage internal use of secondary processed cassava products as food, feed, and industrial raw materials. Export does not seem to provide an immediate competitive advantage to African cassava farmers because of the high cost of production, and poorly organized or expensive logistics of production and marketing activities. Improvement in the marketing structure of cassava products can be achieved with an efficient real-time national and regional market information system (MIS) with readily available disaggregated price data. The MIS would allow comparisons of volumes, prices, seasonality of supply, and evaluations of opportunities in the domestic and export cassava markets. It would also assist existing and potential investors to make informed decisions on how, where and when to invest in the cassava industry, and would help to attract more investments in the cassava sub-sector.

Recently, consumers in Nigeria seem to have accepted the inclusion of cassava in bread and other food items. Consumer rejection can no longer be a reason for the baking industry not to use HQCF: the public perception of cassava is better in Nigeria than in any other African country. New market outlets for HQCF can be created through product development research and promotion activities. For example, the promotion of a maize–cassava flour blend for home consumption might be considered. Such products may be less affected by the fluctuating prices of imported food items and could stabilize the price of HQCF. This strategy will work even better for ESA countries where there are larger populations dependent on moisture-sensitive crops (such as maize or rice) as staple foods. Most of these countries are prone to droughts that cause frequent food shortages and food price instability. These often lead to frequent reliance on food aid and cheap food imports that make it even more difficult for smallholder farmers to compete, thereby destabilizing agricultural growth. Some millers have suggested tax concessions for wheat millers who use a set minimum quantity of HQCF, or other incentives similar to the vitamin and iodine supplementation strategies used in some countries. Millers in Nigeria also noted that 10 percent inclusion was difficult to achieve, particularly at the beginning, since the HQCF plants were few and did not have the capacity to supply the required volume of HQCF. A gradual increase from 3 percent inclusion rate to 10 percent over a period of 5–8 years is proposed for Nigeria, and Ghana is currently developing its own composite flour strategy.

Other countries such as Madagascar, Mozambique, Tanzania and Zambia, all of which are hoping to transform their cassava industries, may adopt a similar approach. The experiences and labour-saving technologies developed in Nigeria can help these countries in their transformation processes. Deliberate efforts should be made to tap into the Nigerian experience and technologies through international collaboration. It is proposed that African governments planning to implement composite flour policies should ensure that HQCF is not a burden, but rather an acceptable and positive input for millers in terms of the quality, quantity and competitiveness of their businesses.

12.6.5 Transfer of roles from the IITA to national institutions

IITA facilitates the building of partnerships with national and international institutions in the development of technologies based on the specific development objectives in each sub-Saharan African country. In general terms, partnerships are formed from the point of identification of agricultural constraints. Solutions to these constraints are developed together with the national and international institutions in specific research locations; the results are widely applied by the partners and other beneficiaries, e.g. small farmers or processors, to achieve desired outcomes. This approach contributes to the development of institutional capacity, since national institutions are often able to take over the adaptation and application of the research results to achieve impacts after IITA's exit. IITA's role reduces to the level of monitoring and evaluation of the impacts on the beneficiaries, and the identification of further development needs³. This transfer of responsibility to the national institutions and the private sector ensures sustainability of development programmes on agriculture in the various sub-Saharan African countries, such as is presently occurring in Nigeria and Ghana for the development of the HQCF industry.

12.7 Conclusion

The IITA R4D approach emphasizes the development of technologies that solve the problems of African farmers along the whole value chain of each mandated crop, from input supply to consumption. The technologies are designed to reduce risk and generate income for poor farmers. The application of a holistic value chain or food systems approach is working: in partnership with national and international research partners, in the development of proven agricultural technologies that address the constraints of African crops, combined with a concurrent delivery of these technologies to the national institutions, capacity building, and technical support to the agricultural development agendas of various African governments.

3 Available at: http://www.iita.org/cms/details/research_summary.aspx?a=1570andz=63.

The continuous interaction of partners along the research to development continuum, and the development of the capacity of NARES to adapt technologies to their specific needs, are an important factor for the spread of technologies and their eventual impact. The engagement in policy dialogue with various governments helps to ensure that favourable economic and policy environments are created for the application of the technologies to benefit smallholder farmers and help the development of national economies.

This approach played a significant role in the cassava transformation that occurred in Nigeria from the 1960s to the 1990s because of the spread of high-yielding cassava varieties and the availability of processing technologies. The investment and policy initiatives adopted by Ghana and Nigeria from 2001–2007, aimed at commercializing the HQCF technology developed by IITA, have enhanced the acceptance of cassava as an urban food and as an industrial raw material. The level of processing and marketing activities by the private sector in the two countries during the period represents a shift to the industrialization step on the cassava transformation ladder. However, those development activities have led to new challenges that need to be addressed. Nonetheless, the experiences of IITA applying the R4D approach on cassava in Africa have proven to be successful, and to the greatest extent in Nigeria and Ghana.

Acknowledgements

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CHAPTER 13

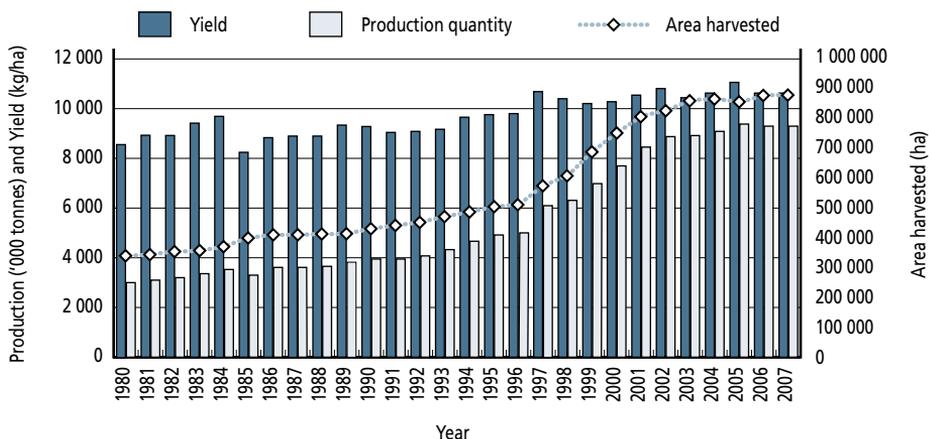
Development and diffusion of vegetable post-harvest and processing technologies in the Greater Mekong subregion of Asia

KATINKA WEINBERGER AND ANTONIO L. ACEDO JR.

13.1 Introduction

Cambodia, Laos and Viet Nam have experienced sustained growth in vegetable production, from about 2.9 million tonnes in 1980 to 9.3 million tonnes in 2007 (Figure 13.1) (FAOSTAT, 2008). Harvested acreage also increased by approximately threefold, from 337 850 ha to 875 400 ha. In Viet Nam, widespread vegetable production and commercialization has been observed even in the most impoverished communities of the northern uplands (International Food Policy Research Institute, IFPRI, 2002).

FIGURE 13.1 Vegetable production area, volume and average yield, in Cambodia, Laos and Viet Nam, 1980–2007



Source: FAOSTAT (2008).

Post-harvest losses negatively impact on the economic benefits derived from vegetable production. They are usually high in developing countries such as those in the Greater Mekong subregion – Cambodia, China's Yunnan Province, Laos, Myanmar, Thailand and Viet Nam – where a lack of knowledge, skills, technologies, techniques and facilities for produce handling and processing are compounded by the perishable nature of most vegetables and the region's hot and humid climate. The loss of food and economic opportunities contributes to the persistent problems of poverty, unemployment and malnutrition in the region. Reducing post-harvest losses through the proper application of appropriate post-harvest technologies has far-reaching benefits. It improves the incomes of farmers and marketers, makes diversification into vegetable production less risky and more attractive, creates rural employment and income generation opportunities through value-added activities and post-harvest enterprises, enhances productivity and competitiveness in vegetable industries, increases opportunities for export, and sustains economic growth (Jaffee and Gordon, 1993). As the world economy becomes more integrated, post-harvest technologies could enable developing countries to position their agricultural produce more effectively in domestic and export markets at competitive quality and prices. Post-harvest industries contribute to greater gender equality and empowerment of women, who often play an important role in post-harvest activities for fresh and processed vegetables (Jaffee and Morton, 1995).

Recently, AVRDC – The World Vegetable Centre – launched an initiative to strengthen the vegetable industry and advance economic growth and food security in Southeast Asia. The initiative aims to provide the groundwork and direction for future development activities within a supply chain setting, to improve the well-being of disadvantaged actors in Southeast Asia's vegetable industry, particularly in Cambodia, Laos, and Viet Nam.

In this chapter the approaches used will be described; these included an assessment of post-harvest losses of vegetables along various points in the supply chain, an overview of the technologies developed, and an assessment of how adoption of post-harvest technologies improves the livelihoods of the rural poor, including some of the factors that contributed to adoption and uptake. The relevant methodologies applied will be discussed under each section. The chapter will conclude by discussing the major achievements of the project, and will offer recommendations for the replication of models that aim to support the rural poor by providing access to post-harvest technologies.

13.2 Post-harvest loss in vegetables

Post-harvest loss adversely affects the profitability and efficiency of supply chains. Reports on post-harvest losses in vegetables vary considerably, with studies reporting losses in developing countries of 50 percent or even higher.

Field observations have reported that 40–50 percent of horticultural crops produced are lost before they can be consumed, mainly as a result of high rates of bruising, water loss and decay during post-harvest handling (Kader, 2003). Poor post-harvest handling and storage can also lead to loss in nutritional quality, because of loss of vitamins and the potential for development of health hazards (e.g. mycotoxins in dried chili). Post-harvest related losses in quality also reduce opportunities for export and export revenues (Weinberger and Lumpkin, 2007). Typically, post-harvest losses vary greatly between different vegetable types, production areas and seasons. The magnitude of the losses and their impact on farm incomes can be difficult to calculate because the post-harvest handling chain includes all the steps between harvesting and consumption, including sorting, cleaning, packing, cooling, storage, transport and processing.

Reducing post-harvest losses for fresh produce has been shown to be an important part of sustainable agricultural development efforts whose aims are to increase food availability, but which usually attract little funding (Kader, 2005; Weinberger *et al.*, 2009). During the past 30 years, less than 5 percent of the funding provided globally for horticultural development efforts has been directed at the post-harvest phase (FAO, 2004).

Reasons for high post-harvest loss can include poor pre-harvesting and harvesting practices (e.g. harvesting leafy vegetables during the hottest time of the day), inappropriate post-harvest handling and packaging (e.g. packing tomatoes in woven bamboo baskets that can be crushed when stacked), post-harvest pests and diseases, and lack of storage, cooling and cold chains (e.g. the transport of tomatoes over long distances on the top of trucks and tankers). Knowing where loss occurs along the chain is essential to identify appropriate research strategies and training programmes. Thus, an initial activity during the AVRDC project assessed and quantified post-harvest loss in Cambodia, Laos and Viet Nam for priority vegetables – including chili, tomato, yard-long bean, cucumber, and Chinese kale – and, according to production quantities and sales, identified critical technological entry points for reduction of post-harvest loss. Based on the outcomes of the study, subsequent research focused on certain areas and crops to reduce post-harvest loss.

To analyse the supply chains and post-harvest loss for vegetables, detailed interviews were conducted with actors at various points in the supply chain using a structured questionnaire. Three types of questionnaires were developed to gather general and specific information from supply chain actors. The generic information sought included: socio-demographic data, post-harvest loss estimates, trading information, marketing information (e.g. the monthly volume of produce purchased and sold, the prices achieved, the main trading partners, the monthly turnover of the entire business), and attitudes towards post-harvest loss. For farmers, details about production and harvesting practices were obtained based on the past year's production cycles. An upstream interview approach (retailers to farmers) was applied. Through proportionate sampling the objective was to ensure equal

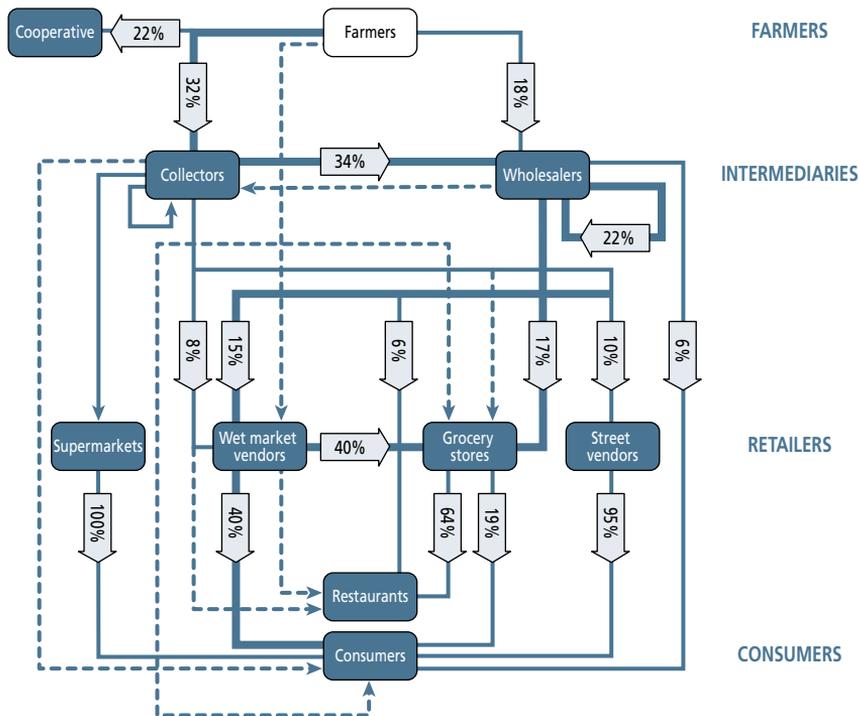
representation of retailers, intermediaries (collectors and wholesalers) and farmers, all from important production areas serving the larger cities of the countries involved. All actors were required to identify their main sources of the crop in question. After establishing the different forms of retail outlets for vegetables and their approximate share of total vegetable sales based on interviews with the key informant, the sample size of supermarkets, wet market vendors, small grocery stores and street vendors was determined. The initial respondents were selected at random from a list of retailers in two major cities in each country. At the conclusion of the retailer interview, intermediaries were selected based on the list of names provided by retailers; farmers were chosen from the list furnished by intermediaries. The sample included retailers, intermediaries and farmers. The number of actors surveyed was approximately equal: 190 retailers, 181 intermediaries and 187 farmers, for a total of 558 respondents in the three countries.

In the study, loss referred to produce unfit for human consumption, and excluded produce of lower quality that was still saleable. For farmers, post-harvest loss was quantified in absolute terms for produce lost *after* harvest, and then calculated as a percentage based on total harvested quantity. For intermediaries and retailers, loss was estimated as the difference between quantity purchased and quantity sold¹. To obtain a monetary value of the loss experienced, actual loss in kilograms (kg) was multiplied by the average selling price achieved in each month or harvest. This value was divided by the total amount of vegetables produced or purchased by each actor (kg) to obtain a value of loss based on a uniform denominator; the value was then added across all actors in the supply chain. The total number of observations used for collectors, wholesalers and retailers was the monthly observations collected for the entire year. For farmers, the total number of observations amounted to the past year's production cycles (a maximum of three production cycles in each country with one wet and two dry seasons). The data presented are a summary for wet and dry seasons. Data for post-harvest loss by individual actors along the chain was aggregated to obtain the total loss along the chain.

Figure 13.2 maps out the flow of fresh vegetables from the producer to the consumer level. Supply chain channels are similar across the various crops. Respondents were asked to identify the main actor they sold their produce to, and to estimate the share of produce sold. The percentages in green arrows represent the shares of vegetables that suppliers at different levels sold to their main trading partners as a share of total produce sold. Dotted lines represent minimal transactions by the actors (less than 5 percent). Where our analysis generated missing links between actors and their main buyers, the main sources of their vegetable produce, represented by solid lines with no percentage value, were added into the flow chart to obtain a complete picture of the demand and supply side of vegetable transactions in each country.

1 This approach may include small errors due to personal consumption.

FIGURE 13.2 Overview of the supply chain for fresh vegetables



Source: Weinberger et al. (2008).

The main flow of vegetables is highlighted by the thick black line and usually moves from farmers to collectors and wholesalers. Wholesalers either resell the produce to other wholesalers who distribute the product to other regions, or sell to grocery stores and wet market vendors who then sell vegetables to final consumers.

Table 13.1 provides an overview of the post-harvest loss situation across crops as perceived by various actors in the supply chain. Post-harvest loss was incurred by most supply chain actors, with 94 percent of farmers, 93 percent of intermediaries and 87 percent of retailers experiencing vegetable losses. The volume of loss per million tonnes of produce harvested or sold was highest for farmers, slightly higher than intermediaries and about 30 percent higher than that of retailers. Seasonal effects escalated the problem, especially among farmers, where losses increased by 20 percent during the wet season compared with other actors. The median of loss was lower than the average value for all actors, but still substantial, indicating that

TABLE 13.1
Post-harvest loss estimates in the vegetable supply chain

Parameter	Farmer	Intermediary	Retailer
Number of respondents (N)	187	181	190
Percentage share with loss	94.0	93.4	86.8
<i>Loss values</i>			
kg per million tonnes	64.8	61.1	43.0
US\$ per million tonnes	13.4	18.6	21.9
<i>Percentage loss</i>			
Dry season	6.0	5.9	4.2
Wet season	7.2	6.2	4.4
Average	6.4	6.0	4.3
Median	5.0	3.9	3.0
Maximum	50.0	90.8	69.4

Source: Weinberger et al. (2008).

most supply chain actors were affected by post-harvest loss. The maximum loss that a single supply chain actor experienced was 50 percent for farmers, 91 percent for intermediaries, and 69 percent for retailers.

Table 13.2 shows the accumulated loss values for specific vegetables in the supply chain per country. Tomato was the only crop surveyed in the three countries and had the highest physical loss – amounting to about 20 percent of production (205 kg per million tonnes) – of all the crops covered. The monetary value of loss was highest for chili, at about US\$75 per million tonnes. Cambodia had the highest post-harvest loss among the three countries. Factors that contributed to the high loss in Cambodia may have included relatively complex supply chains² – with more backward and forward linkages than in Laos – and lack of technological expertise in post-harvest handling and processing compared with Viet Nam. Across crops and countries, the average loss throughout the supply chain was about 17 percent.

2 The vegetable supply chain in Laos was rather short and direct. In contrast, there was a higher retailer participation in Cambodia and Viet Nam, i.e. supermarkets, wet market vendors, grocery stores and street vendors. In addition to final consumers, wet market vendors also cater to restaurants and grocery stores. A certain contingent of vegetables was supplied by importing suppliers and there was evidence that during certain months when local production was low, the share of imports to domestic supply was substantial.

TABLE 13.2

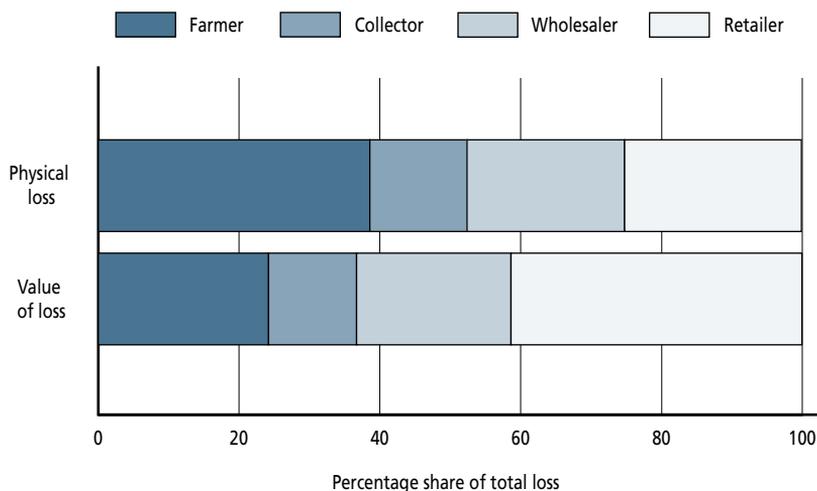
Total value of post-harvest losses in the vegetable supply chain by crop and country

Country		Tomato	Yard-long bean	Cucumber	Chinese kale	Chili	Average
Cambodia	N	50	50	50	50		200
	Kg/MT*	245.7	217.9	197.1	163.9		207.6
	US\$/MT	56.8	57.9	28.5	59.3		51.4
Laos	N	31	69	27		73	200
	Kg/MT	169	122.4	87.1		107.1	123.9
	US\$/MT	84.2	48.5	12.8		88.2	64.2
Viet Nam	N	105				53	158
	Kg/MT	191.2				168.7	184.5
	US\$/MT	35.3				60.1	43.1
Average	N	186	119	77	50	126	558
	Kg/MT	204.6	167.0	146.8	163.9	126.1	168.9
	US\$/MT	49.1	54.2	21.8	59.3	75.2	53.9

*MT = million tonnes. Source: Weinberger *et al.* (2008).

In terms of loss distribution, farmers incurred the highest physical loss of produce, estimated at nearly 40 percent of the total quantity lost in the entire supply chain, with a monetary value of about 25 percent of the total value of loss (Figure 13.3). The case is reversed for retailers, where the monetary value of loss was estimated at more than 40 percent and physical loss was only about 26 percent. These differences in physical and monetary values of loss at the farm and retail levels can be explained by the retail–farm price margins. Both physical and monetary values of loss were lowest for collectors, given that they merely transport the produce and have limited involvement in other value-adding activities such as re-packing.

The results showed that concentrating efforts only at the farm level to try to reduce post-harvest loss is not sufficient, and that losses further down the supply chain are relevant and large. The monetary value of loss and the consequent loss of economic opportunities is enormous. In 2005, the combined total vegetable production in the three countries was 8.5 million tonnes, worth US\$2 612.3 million (FAOSTAT, 2006). Assuming that 17 percent of this was completely wasted after harvest, this means a loss of 1.5 million tonnes of produce, worth US\$461 million. The loss quantified

FIGURE 13.3 Distribution of loss along the vegetable supply chain


Source: Weinberger *et al.* (2008).

would be even larger if the loss caused by reduced quality (qualitative loss), which always reduces product prices, and the loss of nutrients (nutritional loss) were also factored in.

13.3 Technological options developed

Supply chain actors provided information on various causes of loss that required technological and non-technological interventions. Some technological interventions had already been established (e.g. time and method of harvesting), and thus were directly available to overcome certain problems. Other technologies underwent research for adaptation and optimization to local conditions. Technology verification is important because a technology proven effective elsewhere may or may not work in another location, given a number of varying factors such as crop variety and growing conditions. Other technologies may not be practical in certain countries or localities, and may need to be modified using available resources.

Technology development under this post-harvest research and development programme addressed fresh produce handling and processing. Results of the supply chain surveys were validated and priority setting for research and development (RandD) to develop selected technologies was carried out during workshops.

RandD programmes initially focused on tomato and chili. Before undertaking these programmes, however, capacity building was critical because post-harvest RandD in vegetables was new to Cambodia and Laos partners, and the capacity of Viet Nam partners required upgrading. Post-harvest laboratories with basic facilities were established in Cambodia and Laos, the post-harvest laboratory in Viet Nam acquired new equipment, and training on post-harvest research and technology development was conducted with a component workshop to develop the RandD plan. A training manual incorporating a review of post-harvest techniques based on simple and low-cost technologies that should be adapted and optimized was selected for use in the workshops (Acedo and Weinberger, 2006b). Later, leafy vegetables were included and a workshop attended by GMS (Greater Mekong Subregion) network members was conducted to review the best practices in post-harvest management of leafy vegetables (Acedo and Weinberger, 2007), determine priorities, and plan for RandD programmes.

A series of post-harvest trials was conducted following standard experimental procedures. For tomato and chili, the AVRDC lines and commercial varieties used included those identified as having a good yield, and good shipping and processing qualities in on-station and on-farm variety trials in each country. For leafy vegetables (cabbage, Chinese/green mustard, Chinese kale, aromatic mustard, and kangkong or *Ipomoea aquatica*), commercial varieties were used. Brief descriptions of the research that took place to identify the most promising technologies are now outlined.

13.3.1 Cooling

Precooling

It was thought that rapid removal of product heat by precooling could improve the storability of tomato. A simple, portable, knockdown-type hydrocooler was developed (Acedo *et al.*, 2008b). Water was cooled using ice to 10 °C, monitored with an ordinary bulb thermometer, and the fruit was dipped for 4–12 minutes before storage at ambient or chilling temperature (10 °C). Hydrocooling for 12 minutes proved to be the most promising: it retarded fruit reddening and maintained high soluble solids at both storage temperatures. It also slowed the rate of acidity loss and reduced chilling injury at 10 °C.

Evaporative cooling storage

Evaporative coolers usually create slightly reduced temperatures but provide higher relative humidity (RH) than that at ambient temperature, which could be effective in improving shelf-life of fresh produce. Three simple evaporative coolers were developed: a brick-walled cooler with moistened sawdust (type 1) or moistened sand (type 2) as wall insulation, and a box-type cooler (type 3) covered with moistened jute sacking sewn to fit the structure (Acedo *et al.* 2009c; Vandy *et al.*, 2008a; Vandy *et al.*, 2008c). The vegetables were placed in trays inside the storage chamber. During storage, the evaporative cooler temperature and RH

were about 1–10 °C lower and 10–25 percent higher than at ambient temperature: 22.5–42 °C and 32–89 percent RH, respectively. As a result, weight loss decreased and shelf-life increased.

13.3.2 Packaging

Modified atmosphere packaging

Keeping produce in polymeric films creates low oxygen, high carbon dioxide, and high humidity conditions that retard quality deterioration. Modified atmosphere packaging (MAP) trials were conducted using three commercially available plastic films: low-density polyethylene (LDPE), high-density polyethylene (HDPE) and polypropylene (PP) of different thicknesses (25–75 microns) with and without perforations as vents (Acedo *et al.*, 2009b. Acedo *et al.*, 2008d; Chanthasombath *et al.*, 2008; Vanndy *et al.*, 2008b; Vanndy *et al.*, 2008d). Storage was at ambient temperature. The inclusion of an ethylene scrubber sachet (0.1–0.4 percent potassium permanganate) in MAP-wrapped leafy vegetables for control of yellowing was tried and in some trials, storage at ambient temperature and in a cold chamber (10–13 °C) was compared (Acedo *et al.*, 2009a). Cost-benefit analysis by partial budgeting showed that the techniques are potentially profitable.

TABLE 13.3

Technical and monetary benefits of using grid-polystyrene crate with paper shreds in reducing fruit damage of different tomato varieties relative to the use of carton box

Harvest maturity	Variety	Fruit damage reduction (%)	Net returns* (US\$/kg)
Breaker fruit	CLN2123A (AVRDC)	13	0.03
	CLN2498E (AVRDC)	18	0.05
	Perfect 89 (Syngenta)	18	0.05
Turning fruit	FM1080 (local)	11	0.02
	CLN2123A (AVRDC)	13	0.03
	CLN2498E (AVRDC)	18	0.05
	Perfect 89 (Syngenta)	15	0.04
	FM1080 (local)	11	0.02

* Calculated as the difference between the monetary saving attributable to damage reduction, and the added cost of using grid-polystyrene crate with paper shreds over the cost of carton box. Cost of 25 kg carton box (used only once) = US\$1; 25 kg grid-polystyrene crate (assumed to be used 3 times) = US\$3; paper shreds = US\$0.2/kg (1 kg/container); labour = US\$3.5/person-day (1 crate packed in 5 mins). Price of tomato = US\$0.5/kg.

TABLE 13.4

Tomato fruit decay reduction using 2 percent bicarbonate washing prior to storage in evaporative cooler (EC) and its monetary return based on partial budget analysis.

Tomato variety	Decay incidence (%)		Net return* (US\$/kg)
	With bicarbonate wash	Water wash (control)	
CLN1462A (AVRDC)	14	18	0.26
TLCV15 (AVRDC)	9	27	0.40
T56 (local)	4	37	0.33
TMK1 (local)	0	15	0.31

* Calculated as the difference between the monetary saving due to decay reduction and shelf-life improvement and added cost of bicarbonate wash and EC storage over that of water wash and ambient storage. Costs per 1000 kg tomato per year: baking soda = US\$2; EC annual depreciation = US\$100 (EC used 10 times/year); labour = US\$5; water (4 m³/year) = US\$2. Price of tomato = US\$0.5/kg.

Packaging system

Different packaging methods for tomato in Viet Nam (a 25 kg carton box and grid-polystyrene crate with and without paper shreds as cushioning material) were evaluated for reducing physical damage through simulations of handling hazards by drop test (Thanh *et al.*, 2008). The use of grid-polystyrene crates with paper shreds was the most promising and its financial return was estimated by partial budget analysis (Table 13.3).

13.3.3 Commodity treatments

Tomato decay control

Tomato storage is limited by decay. Pre-storage washes in 1–2 percent bicarbonate solution (prepared using food-grade baking soda) for 2 minutes, or 100–200 ppm chlorine solution (prepared using commercial bleach, 5.25 percent sodium hypochlorite) for 3 minutes, were tried as possible decay control treatments (Acedo *et al.*, 2008a; Acedo *et al.*, 2008c). After washing, the fruit was rinsed in water. Promising results were obtained only with 2 percent bicarbonate wash during storage in the evaporative cooler. The technical and economic benefits are shown in Table 13.4.

Cabbage soft rot control

Bacterial soft rot is the most serious post-harvest problem of cabbages in the humid tropics, causing enormous losses due to trimming after transport and during marketing. As possible control measures, three indigenous and safe treatments were tested: lime paste prepared as 1:1 lime powder and water mixture; 15 percent

TABLE 13.5

Promising treatments for the control of bacterial soft rot in cabbage in Cambodia, Laos, and Viet Nam and monetary return based on partial budget analysis

Country	Treatment	Trimming loss due to soft rot (%)	Net returns* (US\$/kg)
Cambodia	Lime	8.7	0.15
	Alum	20.3	0.09
	Guava leaf extract	7.2	0.15
	Water (control)	44.3	
Laos	Lime	0.0	0.12
	Alum	0.0	0.12
	Guava leaf extract	0.0	0.11
	Water (control)	20.0	
Viet Nam	Lime	0.0	0.16
	Guava leaf extract	2.0	0.14
	Water (control)	33.4	

* Calculated as the difference between the monetary saving due to trimming loss reduction and added cost of the treatment over that of the control. Costs per 1 000 kg cabbage: lime = 1 kg at US\$1; alum = 0.5 kg at US\$1/0.5 kg; mortar and pestle for guava leaf extraction = US\$4 (2 units at 2US\$/unit); labour = 5–7 person-days at US\$3.5–5.0/person-day. Price of cabbage: US\$0.5–0.7/kg.

alum solution (15 g alum granules in 100 mL water); guava leaf extract as 1:1 pure extract and water mixture (Acedo *et al.*, 2009d). These control agents were applied using any suitable applicator (e.g. fine brush, cloth, or cotton) at the cut butt end of the cabbage head where soft rot usually develops. Water served as a control. After air-drying, a paste made from soft-rot affected cabbage butts was spread on the cut surface, simulating possible infection of cabbages during post-harvest handling. Responses were consistent and promising treatments for soft rot control were identified for each country (Table 13.5).

13.3.4 Processing technologies

Solar drying

Dehydration can extend the marketability and usability of vegetables. In developing countries such as Cambodia, Laos and Viet Nam, vegetables are usually sun-dried in the open air, which is slow, weather-dependent, and subject to physiological and

hygiene-related problems. These constraints could be minimized by placing the produce in an enclosed solar drying chamber where it is protected from dust, rain, stray animals, and so on. Simple solar dryers were designed and manufactured in Cambodia (cabinet solar dryer and a solar dryer with heat collector—Royal University of Agriculture, Phnom Penh), Laos (solar dryer – National University of Laos), and Viet Nam (a solar dryer that combined the features of the Cambodia and Laos designs). The solar dryers maintained much higher temperatures and lower RH than those achieved under sun-drying conditions. In Cambodia, drying trials were conducted for chili and cabbage, with the latter first being shredded, mixed with 5 percent salt, and fermented overnight (as in traditional practice) before drying. The two solar dryers accelerated drying to less than 10 percent moisture content in chili in three days instead of six days for sun-drying, and in cabbage to one day instead of two to three days for sun-drying. In the Laos chili drying trials, drying rates differed according to variety, apparently as a result of differences in morpho-anatomical structures. Nevertheless, the solar dryer again accelerated drying of the produce compared with sun-drying (Table 13.6). Dipping in 65 °C water for 3 minutes was included as a pre-drying treatment to preserve the red colour of the fruit. In the Viet Nam trials, the use of the solar dryer similarly resulted in faster drying. Cost and return analysis showed that dried chili production could yield 32.5 percent higher income than fresh chili production.

TABLE 13.6

Days to achieve less than 10 percent moisture content of different varieties of chili dried using a solar dryer and in the sun

Chili variety*	Days to <10% moisture content	
	Solar dryer	Sun-drying
CCA 321 (AVRDC)	2	12
CCA323 (AVRDC)	6	12
PBC142 (AVRDC)	1	6
DemonF1 (commercial variety from Thailand)	6	8
Local variety	2	6

*All varieties belong to *Capsicum annuum*, except the local variety, which is *C. frutescens*.

Paste/sauce processing

Tomato paste and chili-tomato sauce processing trials were conducted. One trial determined the effects of tomato variety on the paste product processed following

the method developed at the Royal University of Agriculture, Phnom Penh. Two AVRDC lines (CLV1462A and TLCV15) and two commercial varieties (T56 from Viet Nam and the local TMK1) were used. The variations in paste quality resulting from different crop varieties provided useful benchmarks for choosing fruit for processing. For example, fresh paste from T56 showed the best quality, mainly on account of the deep red colour of the fruit, while pastes from CLN1462A and TLCV15 had more stable storage quality because colour and flavour was better maintained, especially compared with TMK1. In another trial, different combinations of tomatoes (CLN2498E and CLN2123A from AVRDC, Perfect89 from Syngenta, and FM1080 from the Fruit and Vegetable Research Institute, Hanoi) and chili (9955–15 and CCA321 from AVRDC, and Ox Horn, a local variety) were tested. The sauces were of good sensory quality regardless of chili-tomato variety combination, except for the 9955–15 and FM1080 combination, which had inferior colour, texture, and taste. Dark storage – keeping the bottles of sauce in a closed carton box – maintained better taste quality than storing bottles in the open. Profit analysis calculated the net return of chili-tomato sauce production at US\$0.04 per 250 gram jar and US\$151.5 per million tones of product.

Fermentation

Cabbage and Chinese mustard fermentation was optimized in Viet Nam in winter and summer using different salt concentrations (6–14 percent) and fermentation periods (2–10 days). Cabbage required higher salt concentration (10 percent) than Chinese mustard (8 percent), but the optimum fermentation period for both crops was the same, 4 days in winter and 2 days in summer. The fermented products had better sensory qualities and shelf-life than those produced using other salt levels and fermentation periods. Cost and return analysis for cabbage fermentation revealed that it could realize 23.2 percent higher income than fresh market production. Profit analysis for Chinese mustard fermentation showed a net income of US\$0.09 per 500 g jar and US\$190 per million tonnes of product. The optimized fermentation procedure for cabbage was adopted in Cambodia and for Chinese mustard in Laos; it was compared with traditional methods and those developed by the national universities. In both countries, the Viet Nam process was found to be very desirable for longer shelf-life. However, the products produced by the local methods were more positively appreciated in terms of colour and taste.

13.4 Evaluation of project outcomes

The technologies described above were disseminated to supply chain actors through a series of training programmes. In late 2006 to early 2007, a total of 237 actors along the supply chain in Cambodia, Laos and Viet Nam received training in post-harvest handling and/or processing of vegetables. These training sessions were held to test the approach for large-scale training programmes currently being conducted

with 2 000 supply chain actors in Cambodia, Laos and Viet Nam. Training manuals on post-harvest technologies for tomato, chili and leafy vegetables (Acedo and Weinberger, 2009, 2006a) were developed based on the results of RandD work and other information on best practices from various sources. These were translated to country languages, distributed during training sessions, and for wider dissemination were uploaded to the AVRDC post-harvest web page³. Demonstrations of some technologies were set up prior to the training so that trainees could observe the actual outcomes or results brought about by using the technologies. This increased the credibility of the training programmes and helped to build the trainees' trust and confidence in the training providers.

Monitoring and evaluation are tools to help manage the resources and activities of a project to enhance its impact throughout its term, and beyond. Under this post-harvest project a number of monitoring and evaluation tools were applied. These included regular assessments of training courses by participants, an interim assessment of training impacts, and a formal assessment of the impact of the pilot trainings two years after they were conducted. The evaluation of these pilot trainings is described now.

A questionnaire for the evaluation of the pilot training was distributed to partners for feedback and translation into local languages. Fifteen respondents per country were selected at random, based on the list of training participants available for each country; those unavailable were replaced accordingly. The complete sample included 45 respondents. The questionnaire was organized around ten open-ended questions. These covered aspects such as retention of information, details about the technologies adopted, impact on farm operations and livelihoods, and constraints to adoption. The survey was conducted in early 2009, with the following results.

13.4.1 Adoption of technologies

A very high share of respondents (all but one) in Viet Nam initially adopted one or more of the post-harvest techniques (Table 13.7). The share was lower in Laos and Cambodia. In these two countries, around 50 percent of respondents initially adopted one or more of the technologies covered in the training programmes. Two years later, 60 percent of the respondents in Viet Nam, 40 percent in Laos, and 27 percent in Cambodia still used one or more of the technologies. Of these, one or two respondents in each country modified the technologies and also used them on other crops.

Farmers adopted practices for fresh produce and for processing (Table 13.9). More farmers adopted fresh produce handling technologies (10) than sun-drying technologies (7) or processing technologies (6). Fresh produce handling practices

³ Available at: <http://www.avrdc.org/post-harvest>.

TABLE 13.7
Retention and adoption rates of training participants after two years

Particular	Cambodia		Laos		Viet Nam		All
	N	%	N	%	N	%	%
Adoption of techniques	6	40	8	53	14	93	62
Currently using the techniques	4	27	6	40	9	60	44
Modified the techniques	1	7	1	7	2	13	11
Stopped using the techniques	2	13	2	13	5	33	20

Source: Weinberger *et al.* (2009).

TABLE 13.8
Average number of techniques adopted by respondent

Country	Mean	Number of farmers
Cambodia	1.8	6
Laos	2.4	8
Viet Nam	2.1	14
Total	2.1	28

TABLE 13.9
Overview of post-harvest technologies currently in use

Classification	Share (%)	Specific technique
Fresh produce handling techniques	63	Careful harvesting and harvesting produce with <i>calyx</i> intact
		Careful handling of fresh produce
		Proper storage
Sun drying techniques	37	Chili sun-drying
		Tomato sun-drying
Processing techniques	32	Tomato paste processing
		Chili sauce processing

Average number of technologies adopted by each farmer is two, based on number of farmers (19)
Source: Weinberger *et al.* (2009).

included: harvesting with an intact *calyx* (tomato) and using scissors to cut the fruit from the vine; harvesting at the appropriate stage, i.e. when the fruit turns pink; careful handling of produce after harvest, e.g. using soft leaves or old newspapers to cover baskets before loading; gentle loading into appropriate containers; storage of harvested produce in cool rooms or in the shade; sorting and grading by colour and size; packaging into suitable containers. Farmers who adopted practices for handling fresh produce usually changed a range of practices between harvesting and selling.

The processing technologies that farmers adopted included practices for chili and tomato drying using a simple solar dryer, and for the preparation of chili sauce and tomato paste with improved hygienic standards, by filtering water and boiling glass bottles and lids.

13.4.2 Benefits of using post-harvest technologies

The adoption of the post-harvest technologies presented in the training courses has led to a number of benefits for the trainees (Table 13.10). All adopters in Laos, 86 percent in Viet Nam, and 67 percent in Cambodia, provided specific examples of the benefits they experienced from applying the improved technologies.

The range of benefits includes, among others, the reduction of post-harvest loss and enhanced product quality. Eight out of 24 trainees (33 percent) reported a reduction in post-harvest loss, and eight trainees reported an improvement in produce quality. For example, several farmers in Viet Nam recounted how their losses dropped to as little as 1–2 percent from almost 30 percent before the training.

The results also show that impact on farm profits is large. Around 71 percent (17 of 24) of the adopters reported that their farm profits increased because of higher prices, price differentiation for products of different grades, and being able to sell larger quantities. For example, one trainee reported that her sales of dried chili increased from 1–2 kg/month to 30–40 kg/month after training. Another retailer recounted that, while previous processing of dried chili was for home consumption only, after the training he began selling about 20–30 kg/month. One farmer from Vang Vieng District in Laos, who previously sold approximately 40 kg/year of dried chili for Laotian Kip (K)15 000/kg, was able to increase sales to 100 kg/year for an average price of K20 000/kg, a rise in price of 33 percent, and a 2.5-fold increase in volume. Another farmer was able to obtain a 25 percent higher price for tomatoes as a result of a change in harvesting practices.

The majority (80 percent) also reported an improvement in their buyer-seller relationship. While some farmers were able to find a larger number of buyers, many farmers reported that their buyers were satisfied, and crops could more easily be sold. There were cases in which the number of buyers doubled or even quadrupled after

participation in the training. In one case, a farmer from Hadxayfong District increased the number of trading partners to ten collectors, up from five collectors in 2007. Another farmer reported increasing the number of his buyers to 20, compared with five to seven in the past. Several farmers mentioned that overall it became easier to sell produce.

Other benefits respondents referred to related to enhanced knowledge and increased consumption.

TABLE 13.10
Benefits of using post-harvest technologies

Main benefit	Share (%)	Specific benefit	Share (%)
Buyer network	79	Satisfied buyers	54
		Increased number of buyers	29
		Crops can now be easily sold	29
Farm profit	71	Price differentiation	54
		Higher quantity sold	21
		Product diversification	17
Reduced loss	33	Reduced loss	33
Product quality	29	Better appearance	21
		Tomato paste is guaranteed clean	12
		Longer shelf-life for dried chili	8
Income stability	13	Contract arrangement	4
		Regular income	8
Other benefits	42	Improved knowledge	29
		Higher consumption of tomato paste	8
		Solves the problem caused by overpacking	4
		Time saved	4
		Wastes used as animal feeds	4
		Expanded relationship with neighbours	4

Based on number of farmers (24) Source: Weinberger *et al.* (2009).

13.4.3 Impacts on livelihoods

One important aspect of this evaluation was to assess whether new knowledge and skills acquired through the training programmes made a difference in the livelihoods of respondents. Results show positive impacts on the livelihoods of all the adopters from Laos, and half of those from Cambodia and Viet Nam (Table 13.11). Increased income was used mainly to invest in appliances (e.g. gas cooker, TV), equipment for farm operations (e.g. a generator for an electric pump, a motorbike) and land. In Laos, educational expenses were covered and additional savings were deposited in the bank. One respondent each in Laos and Viet Nam reported opening another business.

One particular trainee from Viet Nam was a remarkable example of the high potential for employment creation in a favourable environment. A former collector from Hai Hau District, Nam Dinh Province, he invested in a processing plant because farmers in his area had expanded vegetable production, on account of the higher income that can be realized compared with producing rice.

There was a surplus of tomato and chili during production peaks. The training course he attended in January 2007 provided him with handling and processing technologies and advice on factory construction and processing equipment. After attending the training course, he borrowed capital from the Viet Nam Bank for Agricultural and Rural Development (AGRIBANK) to invest in land, a building/factory, equipment, and two transport trucks. He started drying tomato and chili in December 2008, and subsequently expanded his drying operations to other products such as Vietnamese palm, onion, pumpkin, ginger and garlic. He reported that for the future he intends to move into producing tomato paste and chili sauce, as well as other processed products such as pickled cucumber and syrups. Currently he employs up to 100 people. This respondent has also initiated discussions with two export companies.

TABLE 13.11
Impact of post-harvest technology adoption on farmers' livelihoods

Impact factor	Share (%)
Increased income	100
Able to purchase other assets (e.g. land, motorbike, TV, etc)	61
Sent children to school	17
Saved money in the bank	17
Opened another business	11
Provided employment to family members	6

Based on number of farmers (18)

Source: Weinberger *et al.* (2009).

13.4.4 Constraints to adoption

Because a relatively large number of farmers in Cambodia chose not to adopt any of the technologies after the training, it is interesting to identify the underlying causes. The largest number of farmers (56 percent) did not adopt any of the technologies because of a lack of time, land or capital. Lack of time may also reflect a lack of interest in the post-harvest technologies. For eight participants, most from Cambodia, the training was irrelevant. The study found a high number of Cambodian respondents who were not (or who are no longer) chili or tomato growers. Six trainees were not interested in the training topics offered and chose not to adopt any of the technologies.

In all three countries, the adoption of processing technologies was less sustainable than fresh produce handling practices. Two farmers (22 percent) in Laos who gave up fresh produce handling technologies did so because they left the farming sector. All other respondents (78 percent) simply stopped using the processing and/or drying techniques because of a lack of time and capital. This highlights the need for access to credit; lack of credit can be a constraint to adoption, especially of processing technologies.

TABLE 13.12
Technologies initially adopted but later discontinued

Technology	Share (%)	Reason for discontinuing use	Share (%)
Tomato paste processing	44	Lack of time to do processing	44
Chili drying	33	Lack of capital and/or machinery	22
Chili sauce processing	33	Stopped collecting/retailing	22
Fresh produce handling technique	22	Only wanted to try and test the technique	11
Tomato sauce processing	11	Chili sauce is readily available in the market	11
		Prefers fresh tomato to tomato paste	11
		Year-round production of tomato: no need for processing	11

Based on number of farmers (9) Source: Weinberger *et al.* (2009).

13.5 Discussion

13.5.1 Relevance of the problem

Nearly all supply chain actors reported that they incurred large volume losses. The average loss of these vegetables along the entire supply chain from farmers to retailers was about 17 percent, but differed by country, type of produce and even growing season. This was anticipated as every country has its own peculiarities in supply chain and handling practices. Different vegetables have different degrees of perishability and susceptibility to hazards in the post-harvest period, during which environmental conditions vary with time of year. It is likely that this loss situation prevails in the entire vegetable industry of the three countries. All actors along the supply chain were affected, indicating that solutions to reduce post-harvest loss must address different stages along the supply chain.

Supply chain actors would have better control over product quality, longevity and marketability through appropriate storage and processing techniques, as well as through better market coordination. Improved market coordination would lessen the oversupply of produce and thus reduce waste. A major component of improved market coordination is market information, yet studies in the region indicate a lack of availability or use of information (Genova *et al.*, 2006a; Genova *et al.*, 2006b; Genova *et al.*, 2006c). Interventions that address the availability of information related to produce volume and quality requirements could help to reduce waste. Another important requisite for ensuring market coordination is the standardization of product quality. Product quality standards serve as the universal language that guides supply chain actors in producing, handling and marketing agricultural produce. Without product quality standards, poor quality produce will be a persistent problem in the supply chain. Poor quality produce was the second leading cause of loss at the retail level, likely caused in part by poor transportation during distribution from the farm or wholesale market to the retail market. An immediate solution to this problem is greater care during harvesting, as well as interventions that address packaging and transport conditions.

13.5.2 Factors that contributed to the successes and failures of the project

Technically and economically feasible packaging systems (e.g. MAP, polystyrene crates) and commodity treatments (e.g. bicarbonate wash for tomato decay control, lime treatment for cabbage soft rot control) were developed that can enhance quality and shelf-life and reduce loss during transport and storage. These and other technologies developed for fresh produce handling (e.g. precooling, evaporative coolers) and processing (e.g. solar dryers, tomato paste and chili-tomato sauce

processing, fermentation of leafy vegetables) provided farmers and other supply chain actors with more alternatives for better control of product quality and marketing, and for generating more income. It is vital that these technologies and other best practices in produce handling and processing reach the users of such technologies. Thus, a training programme was developed to address this need. Careful planning and preparations are essential for successful training, including capacity building of country partners, training teams, and developing the RandD and training master plans.

Adopters of technologies noted the benefits of post-harvest technologies. The majority of the intermediaries had an explicitly positive attitude towards the technology changes because of the positive impact on produce quality. Improved networks, which in turn lead to greater demand for produce from a larger number of buyers, were most important to farmers. In many cases this translated into higher farm profits and profit stability. Farmers reported an increase in price of 25–30 percent, and in many cases, substantial increases in the volume of sales. There were reports that losses had gone down to 2–3 percent, from previous rates of 20–30 percent. Substantial improvements in income were observed for those who adopted the improved post-harvest technologies, ranging from 25–30 percent. Other beneficial impacts at the community level were also reported, and the most striking among these was employment generation.

Fresh produce handling technologies involve little additional effort and investment, therefore adoption rates were high. In contrast, a move to commercial processing requires investment in infrastructure and equipment, which is difficult without access to capital and risky in a situation where small-scale businesses are not supported by the political environment. Adoption rates for processing technologies were lower, therefore.

Because the benefits of fresh produce handling are high and attainable without the need for large investment, it is worth identifying major constraints in the uptake of the technologies. An analysis of non-adopters suggested that careful selection of participants is crucial for the success of future training programmes. Trainers and trainees alike should be selected based on criteria that indicate the likelihood of the respondent to make further use of the technologies. Current involvement in production, handling, and marketing of fresh or processed vegetables is one such indicator. Another approach could be to request that participants make a small contribution to the training programme, perhaps in-kind, e.g. by offering food. As in the past, training programme participants should include all actors along the supply chain, because intermediaries play an important role in the uptake of technologies.

13.5.3 Recommended models of good practice for small scale post-harvest and processing technologies

Overall, the results discussed here indicate that several strategies can contribute to the development of the post-harvest and marketing sector for vegetables, with the objective of enhancing the livelihoods of small and marginal farmers. These strategies include both technological and organizational interventions:

- ▶ To contribute to a reduction of post-harvest loss for farmers, more research is required on pest and disease-resistant varieties and improved production methods. Insect pests and fungal diseases were identified as major reasons for loss.
- ▶ In designing training and other dissemination activities, limited access to credit should be considered. Previous studies indicate that farmers' access to credit is very limited, especially in Cambodia and Laos. NGOs providing microfinance could become involved in training programmes. This may enhance uptake of equipment-intensive processing technologies.
- ▶ Recruiting the most successful trainees to lead future training programmes is one way to expand on experiential learning. The positive experiences of these successful trainees can convince others about the usefulness of the technologies.
- ▶ Processing at farm level is underdeveloped in Laos and Cambodia, and farmers in both countries face high price variations. Farmers also reported a lack of knowledge on how to conduct processing; access to the credit necessary for the procurement of equipment is also a limiting factor. Training in processing technologies may be a viable approach, especially in collaboration with microcredit NGOs.
- ▶ Technologies and varieties that allow year-round production of leafy vegetables – as is occurring in Viet Nam – could help reduce price fluctuations and contribute to year-round income.
- ▶ Encouraging value-addition at farm level should focus on the promotion of grades and standards, especially in Laos and Viet Nam, as these are important for the development of high-value agricultural markets: currently an underdeveloped sector in these two countries.
- ▶ In terms of enhanced efficiency of the supply chain, two areas for intervention deserve attention. More emphasis on collective marketing by farmers can reduce marketing costs and enhance the bargaining power of farmers. Contract farming is another area for development. Currently, very few farmers are engaged in contract farming and opportunities for farmers to become involved in contract production and marketing are limited.

13.6 Conclusion

AVRDC – The World Vegetable Centre – aims to address post-harvest loss in vegetables through a supply chain approach administered through research and development efforts in Cambodia, Laos and Viet Nam. These efforts include studying and quantifying loss in vegetables along the entire chain, identifying appropriate strategies, conducting research for adaptation of available technologies, and developing a training programme for wide dissemination of technologies. The benefits of adopting post-harvest technologies were high and involved improved supply chain networks, higher farm profit, and profit stability. Farmers reported an increase in prices of 25–30 percent, and in many cases substantial increases in the volume of sales. There were reports that losses had gone down to 2–3 percent, from previous rates of 20–30 percent. In future, more emphasis should be placed on developing and disseminating post-harvest handling and processing technologies and facilitating the access of smallholder farmers to these technologies, especially in the upland areas of Cambodia, Laos and Viet Nam. The limited post-harvest and value-adding activities that currently characterize the sector are a positive step towards providing the scope and potential to enhance the livelihoods and well-being of millions of small and poor farm households.

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