Food and Agriculture Organization of the United Nations

Study conducted for the International Congress

SAVE FOOD!

at Interpack2011
Düsseldorf, Germany

APPROPRIATE FOOD PACKAGING SOLUTIONS FOR DEVELOPING COUNTRIES

new edition

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APPROPRIATE FOOD PACKAGING SOLUTIONS FOR DEVELOPING COUNTRIES

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Preface

This publication is based on a study carried out by Ms Nerlita M. Manalili from May 2010 to February 2011, upon a request from the Food and Agriculture Organization of the United Nations (FAO).

The study was undertaken to serve as a basis for the international congress Save Food!, taking place from 16 to 17 May 2011, at the international packaging industry fair Interpack2011 in Düsseldorf, Germany. Save Food! has been co organized by Interpack2011 and FAO, aiming to raise awareness on global food losses and waste. In addition, Save Food! brings to the attention of the international packaging industry the constraints faced by the small- and medium-scale food processing industries in developing countries to obtain access to adequate packaging materials which are economically feasible.

This revised edition, dated 2014, contains a new section on investment opportunities in developing countries (paragraph 3.7).

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Executive summary

The study assesses the state of packaging and packaging technologies in developing countries, with the challenge of global food losses and the potential for agri-food systems as the backdrop. The purpose of the exercise is to identify packaging solutions in developing countries, within the limits of prevailing levels of development and conditions, and in an attempt to make better use of the locally available packaging materials. This is done within the framework of developing countries' role as major supplier to the global food system and, consequently, as contributor to the search for global food loss solutions.

Highlights of the study are as follows:

On the status of packaging industry sectors in developing countries
The food packaging industry sector of developing countries derives its strength from the large volume of agricultural production, the steady growth in food commodities and the continually increasing food demand fuelled by rising incomes. Industry limitations that beset the packaging sector across developing regions include limited packaging solutions to meet international market requirements, and the small size of the domestic demand for packaging materials that consequently leads to low investment by the packaging industry. This, in turn, limits developing countries' ability to enhance product quality to meet standards of increasingly discriminating consumers, both in domestic and international markets.

On the packaging sector's opportunities and potential in developing countries
As many products exported to developed countries are already processed at point of origin, the demand for these to be packaged in retail friendly form is on the rise and this is an opportunity for the developing economies to take advantage of. Of the three subsectors of the packaging industry (manufacturing, machinery and service), there appears greatest potential to develop package manufacturing in developing countries, given the tendency to process nearer to the production source and the availability of paper and paper board packaging materials. As to packaging machinery, creativity in coming up with locally designed equipment suited to local needs and conditions will help propel packaging industry development. While this strategy is in its infancy, developing countries will mainly have to rely on second-hand machines with their lower cost offsetting the cost of maintenance. This is because of the prohibitive cost of brand new ones. Developing the packaging service provision subsector, specifically pre-packing of food products for export, and outsourcing the packaging of food products to specialized companies, will provide a much-needed boost to the packaging industry in developing countries. They will not only lend affordability of packages and packing but will likewise enhance handling and distribution efficiencies to exporters, specifically to SMEs.

On addressing the low investment in packaging industries in developing countries
Initiatives towards growth of packaging industries in developing countries may come either from improving traditional technologies or importing new ones. However, more relevant than the appropriateness and balance of the selected mix of strategies, the success of these initiatives will be contingent on a country's enabling environment, both economic and political. As packaging materials are in short supply in developing countries, relaxing packaging regulations without sacrificing food safety considerations may assist the industry to develop. An example is allowing the use of recycled packaging materials when they pose no problem of contamination (i.e. for use with dried foods). Such relaxation of packaging standards will help increase supply of packaging materials while at the same time addressing food loss concerns. While prospects are bright for the growth of the packaging industry sector, it will be for the good of the industry, the stakeholders comprising it and society at large, if focused packaging solutions, taking into account sustainability concerns, are provided to meet the sector's needs. This will not only bring about cost savings but will likewise be good for the environment.

1. Introduction

About one billion people were living in hunger across the globe in 2009, which was about 100 million people more than the 2008 level (World Summit on Food Security, 2009). While addressing global hunger through further investment in food production is a welcome move, it should be complemented with a food loss reduction strategy, as reducing losses is among the most sustainable alternatives to increasing food production (UNEP/GRID-Arendal, 2010) and is a way to advance food security as well as to feed the hungry.

The large losses from farm to plate are attributed to poor handling, distribution, storage, and purchase/consumption behavior. Huge resources that could otherwise be spent on more productive activities go into producing and transporting goods that only go to waste. Losses at almost every stage of the food chain may be reduced by using appropriate packaging. Packaging is an essential part of a long-term incremental development process to reduce losses, that will have to employ a blend of technologies and processes (Olsmats and Wallteg, 2009). The global food packaging industry has a lot to contribute not only in addressing food losses but also in ensuring food safety as well as enhancing global food trade, which is a key to economic development of varying economies.

Important as it is, packaging has a high cost for users from the farm, processing and distribution sectors. A comprehensive analysis of the true value of packaging and the options available (usually a factor of the demand for commodities requiring packaging, resource availability and innovation capacities, among others), can place the cost of packaging in the right perspective. In fact, views are emerging that in the long run more, but better, packaging rather than less could help address the problem of losses. An increased understanding on the protective and marketing functions of packaging and a better appreciation of the economics of its use can help promote the use of food packaging to reduce food losses. Advances in packaging will not only lead to improved food quality and safety, they will also address an equally important concern in developing countries: that of livelihood enhancement of small producers through enhanced market access and integration into sustainable value chains.

This report briefly introduces the global packaging industry: its size, its structure, and its products. An overview is then provided of the status and trends of food packaging in developing countries, and a SWOT (strengths-weaknesses-opportunities-threats) analysis is carried out. This information is required to arrive at the appropriate solutions for developing countries to address the constraints presently faced by the agro- and food industry in meeting their packaging needs. Finally a set of conclusions and recommendations are presented.

METHODOLOGY

As to focus, the study looked at the value chains of the following five commodity groups and their derived (processed) consumable food products. These were a) cereals; b) roots & tubers; c) oilseeds, pulses, nuts); d) fruits and vegetables ; and e) animal products (milk, eggs, meat, fish). The four sub-regions of 1) sub-Saharan Africa; 2) North Africa and the Middle East; 3) South and Southeast Asia; and 4) Latin America were the study areas.

Cross-regional and country comparisons were undertaken to the extent data and time limitations would allow. As for the study methods, secondary data generated were complemented with key informant interviews. Findings from the combined analysis of primary and secondary sourced information, within the context of value chain analysis, were substantiated with case examples of packaging initiatives that were solicited across regions.

2. The global packaging industry

If there is an industry sector that is equally, if not more dynamic than the food sector, it is none other than the packaging industry. It is undergoing transformation almost every day with new technologies, better than before, taking the place of old ones (Packaging Trend-The Future Outlook, 2010). Consumer behaviour, product demand and the current level of global warming are all going to have a direct impact on the future of packaging, the report stated.

2.1 INDUSTRY COMPOSITION

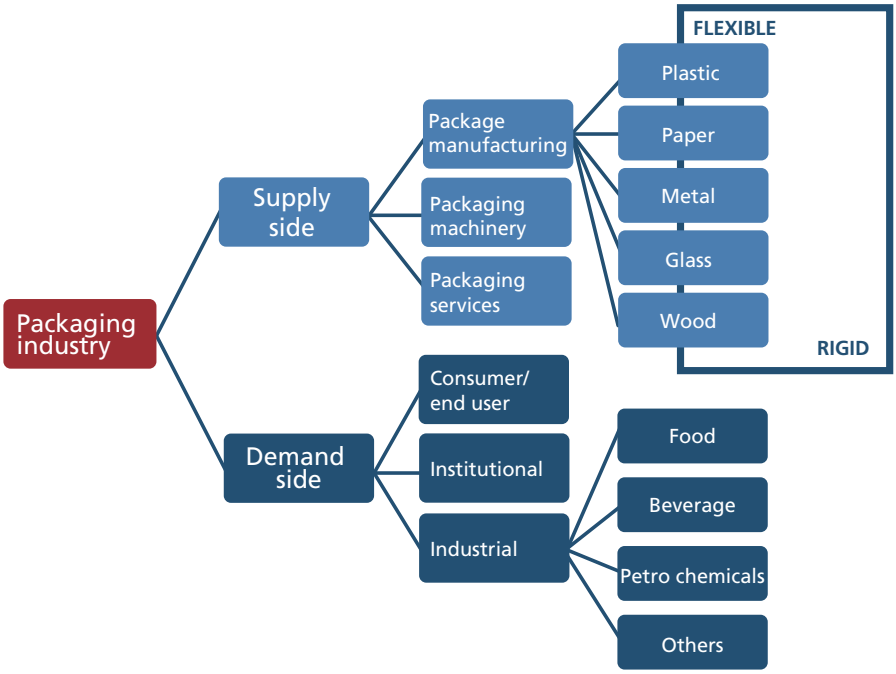
The packaging industry is composed of two major components, namely, the supply side or providers of packaging products and the demand side or end users (Figure 1). Each component's category is characterized by varying investment status and potentials, contingent upon growth stimuli in each sector.

2.2 SUPPLY SIDE – BY NATURE OF END PRODUCT

As for the type of end product, packaging manufacturing has globally the greatest share of the total industry (81%), followed by the packaging service (14%) then by packaging machinery (5%).

Packaging machinery is equipment for uses such as canning; container cleaning, filling, and forming; bagging, packing, unpacking, bottling, sealing and placing of lid; inspection and check weighing; wrapping, shrink film and heat sealing; case forming, labelling and encoding; palletizing and depalletizing, and related uses. (US Dept of Commerce, 2009). The packaging machinery sub-sector is highly globalised, with European countries and the USA dominating the top ten lists of major country producers and exporters. The world production of packaging machinery reached € 22 billion in 2007 (Packaging Gateway, 2010).

Figure 1. The packaging industry



Packaging refers to the technology and material for enclosing or protecting products for distribution, storage, sale, and use (Soroka, 2002). The *packaging manufacturing* sub-sector is not so much globalized, with exports ranging only to a quarter of the total market volume. This is attributed to its general tendency to set up operations nearer to its end market to cut down on variable costs. The sub-sector is likewise comprised largely of small and medium enterprises (SMEs) with a great number falling under the less than 10 employees classification, particularly for the wooden packaging manufacturing.

The *packaging service* sub-sector is comprised of establishments primarily engaged in the packaging and labelling of client-owned materials (such as food products) usually undertaken on a contract or outsource basis. It is important to note that this sub-sector does not include manufacturing of the packaging or the label itself.

2.3 SUPPLY SIDE – BY FORM AND TYPE OF PACKAGING MATERIAL

As for form, packaging can either be flexible or rigid with the former fast replacing the more traditional rigid form, owing to cost and flexibility advantage. Flexible packaging includes materials such as film, foil or paper sheeting. Rigid packaging includes glass, rigid metal, and wood.

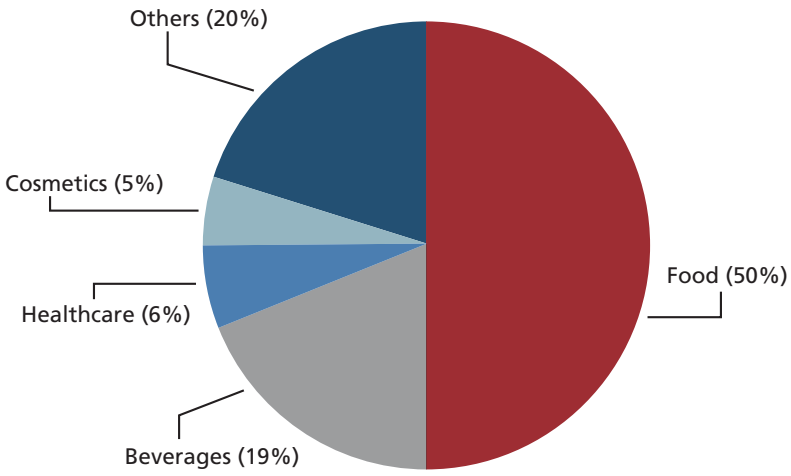
As to the share of the total packaging market, paper (34%) tops the list, followed by rigid plastic (27%), metal (15%), glass (11%), flexible packaging (10%), and others (3%). The flexible packaging market is expected to grow by around 3.2% annually over the next five years with food accounting for 75-80% of the demand. To retain its current share of the market, rigid packaging has to address the cost advantage of its flexible counterpart, while affording flexibility and variety of uses.

2.4 DEMAND SIDE – BY END USER PRODUCT OR INDUSTRY

On the demand side, the packaging industry may be classified in relation to the type of end user, namely: individual consumers, institutional and industrial users with the latter further sub categorized by industry type, namely, food, beverage and petrochemicals.

Food accounts for 50% of the global consumer packaging industry valued at US$ 380 billion as of 2009. If the beverage sector is to be added, that will even increase to 69% (Figure 2). That the food and beverage market accounts for more than half of the packaging market is a worldwide phenomenon. In developing countries the growing demand from the food and beverage market has been instrumental in stimulating the overall growth in the packaging industry (Global Industry Analysts, 2010).

Figure 2. The global consumer packaging industry, by end use, 2009



Source: PIRA International, 2009

3. Food packaging in developing countries – status and trends

3.1 VOLUMES OF TRADE

The packaging industry of developing countries is a market with a value of US$ 15.4 billion t (Table 1). This represents around 27% of the packaging materials that have been exported worldwide in the past five years (2005-2009) and includes glass, paper, plastic, and wood. Import of plastic materials is the highest in terms of value ($ 9.5 billion), followed by paper ($ 4.0 billion), then by glass ($ 1.6 billion), and last is wood materials for packaging at a comparatively low level ($ 0.3 billion).

The value of the contribution of Developed Market Economies (DMEs) on the trade of packaging in Developing Market Economies (DgMEs) is almost the same as that traded among DgME countries for paper, plastic and wood. In the case of glass, the contribution of DgMEs is even higher than that of DMEs. This shows that developing countries are almost on an equal footing with developed economies in terms of value of packaging materials traded globally. This is partly attributable to the fact that most packaging companies of DMEs have country operations in DgMEs. Another possible explanation is that packaging developments in DgMEs is also a reflection of product demand in DMEs as the former supplies the latter, at least in the case of most agricultural produce.

3.2 MEETING THE NEEDS OF COMMODITY CHAINS

Offering instant, ready-to-eat packages for cereals, processing roots and tubers into snack foods are trends that not only expand market opportunities for these commodities, but also for their accompanying packaging as well. The trend towards local processing of traditional export commodities and the introduction of new consumer-packed products from developing countries on the world market will mean that exporters have to pay increased attention to customer requirements in industrialized countries

3.3 MARKET ACCESS AND INTEGRATION INTO SUSTAINABLE VALUE CHAINS

Modern retailers such as supermarkets are increasingly becoming an important feature in urban areas, reflecting an increasing concentration at the retail level. As not all smallholder producers are capable of supplying to the modern retail sectors, their emerging concern is how best to survive in traditional markets that are experiencing the spillover effect of modern retailers. They likewise have to keep up with the increasing level of product quality and packaging needed by the traditional markets, if they are to remain the more sustainable chain option for smallholders.

Table 1. Average import of packaging materials of developing market economies, 2005-2009 (million US dollars). Values in parenthesis are percentages of the packaging materials that have been traded worldwide

Packaging	Exporting region			
	Least developed countries	Developing market economies	Developed market economies	Total
Glass	6 (0.1)	956 (14.6)	590 (9.0)	1,566 (23.8)
Paper	7 (0.0)	1,892 (12.2)	2,048 (13.2)	3,959 (25.4)
Plastic	24 (0.1)	4,670 (13.0)	4,882 (13.6)	9,589 (26.6)
Wood	0 (0.0)	155 (6.6)	123 (5.3)	285 (12.2)
Total	37 (0.2)	7,673 (46.3)	7,643 (40.9)	15,399 (26.5)

3.4 PACKAGING TECHNOLOGY DRIVERS AND TRENDS

The trend to consume more (a reflection of rising incomes) creates a demand that drives producers to offer products in ready-to-go and prolonged shelf-life packages to induce volume purchase. Meal preparation takes time and with the advent of double income households, where women are also preoccupied with activities outside of the home or men are expected to share in food preparation chores, food that comes in easy-to-open and resealable packages is extremely popular.

3.5 REGIONAL DIMENSIONS OF GROWTH

As a demand derived from the products that use it, the state of packaging and its status in developing countries are best deduced from the state of food and food processing industries. A number of factors are contributing to the growth of the packaging industry and they vary by region.

In the case of Asia, for instance, the foremost contributors are the fast-growing economies of China and India, which fuel an increasing demand for food supplies and consequently demand for packaging in the region. In the same manner, the sub-region of Southeast Asia has been experiencing a boost in the processed food industry owing to the modern lifestyle and food needs of its inhabitants.
In Africa, proximity and access to the lucrative US and European markets is triggering the growth of the packaging industry.

Table 2. Selected country food industry SWOT analysis and packaging industry implications, by region

SWOT	WESTERN AFRICA	SUB SAHARA & SOUTH AFRICA		MENA Region
	NIGERIA	SOUTH AFRICA	ZIMBABWE	EGYPT
STRENGTHS				
Strong agricultural and food-processing sectors	Encouraging turnover growth in 2009 despite weak near-term economic outlook	Country striving towards self-sufficiency in agriculture	Climate and topography lends itself well to agricultural production	Largest and most dynamic fast-moving consumer goods market in the Middle East
Geographic advantages	Increasing foreign retailers from neighbouring countries			Favourable access to a number of markets within and beyond the wider Middle East
WEAKNESSES				
Poor infrastructure	Much of rural consumer bases inaccessible to most food companies			Inflates operating costs
Weak economic growth	Per capita food consumption remains very low			
Inadequate facilities and raw materials	Market for white goods held back by lack of refrigeration facilities	Manufacturers held back by the limited supply of raw ingredients/ materials		
OPPORTUNITIES				
Increasing demand for processed and packaged foods	One of the world's largest consumer markets	Rising as lifestyles get busier and the size of the middle class increases	Strong demand from very small percentage of population that can still afford them	Demand for processed food projected to increase
Consumer preferences	Increasing health-consciousness and brand- consciousness			
THREATS				
Political issues	Widespread corruption and unfavourable regulatory environment remain significant investment deterrents			Intellectual property rights issues
Increasing raw material costs	Dependence on inputs from abroad making production costs high			
Effects of globalization	Intense competition from other countries			

Table 2. *(continued)*

	NORTH ASIA	SOUTHEAST ASIA			SOUTH ASIA
	KAZAKHSTAN	**VIETNAM**	**THAILAND**	**MALAYSIA**	
STRENGTHS					
Promising food-processing industry	Industry beginning to attract more investments	Accounts for sizeable proportion of industrial output and GDP	Thailand largest SEA food exporter	Many products catering for a large Muslim population	Consumers welcome new food products and innovations
Improving economic growth	Increased attention given to economic recovery	Economic boom lifting many Vietnamese out of poverty	Increasing tourism levels, sustained economic growth & steady urbanization	Increase in Per capita food consumption levels	
WEAKNESSES					
Underdeveloped agricultural sector	Promising, has yet to develop full potential	Criticized as too slow to adapt to new technologies	Suffers from some structural shortcomings that restrict its potential in export market		
Poor infrastructure	Inadequate roads, railways and ports to cope with the economic growth/ links with the outside world				Suffers from crop losses due to infrastructural inadequacies
Limited facilities and raw materials	Cold storage facilities in short supply	Diminishing profit margins due to increasing cost of raw materials sourcing			
OPPORTUNITIES					
Changing Consumer preference	Increasing demand for processed and packaged foods				
	Alcohol consumption becoming accepted despite Kazakhstan being a predominantly Muslim country	Vietnamese consumers' heightened interest in brands, particularly among the young and affluent	Urbanization and tourism driving demand for processed and packaged food	Increasing demand for processed and packaged halal foods	Lifestyles get busier and eating habits become more Westernized
Investment prospects	Increasing domestic market offering many investment opportunities				
THREATS					
Political issues	Investors deterred by perceived high levels of bureaucracy and corruption		Political turmoil damaging attractiveness to foreign investors		
Globalization & open economy	Smaller companies unable to cope with increased competition				
Increasing raw material costs	Costs cannot easily be passed on to consumers		Rising input costs restrict investment in primary &secondary food production	Manufacturers are highly dependent on imports for ingredients	Rising raw materials drives up prices of products
Environmental issues	Climate change jeopardizes many food-processing industries				

Reduced reliance on their oil industry, coupled with the need to develop other industries for economic survival, is the main factor boosting the Middle East's packaging industry. This is further aided by international trade policies favouring export of Middle East products to developed countries which then translates to increased demand for packaging products and technologies.

For Latin America, its development programme thrusts and internal policies are shaping the growth of the packaging industry such as deregulation of markets and free-trade agreements.

Table 2. *(continued)*

	NORTH AMERICA	SOUTH AMERICA		
	MEXICO	**PERU**	**CHILE**	**ARGENTINA**
STRENGTHS				
Strong food-processing sector	Accounts for sizeable proportion of industrial output and GDP and attracts foreign investors	Significant exporter of agricultural commodities and dairy products		
Domestic consumption	Growing middle class	Economic activity spurred by consumer spending		
WEAKNESSES				
Weak economic growth	Per capita income remains low Unemployment and underemployment concerns Income inequality and large number of people living below poverty line			
Underdeveloped agricultural sector	Poor infrastructures Heavy reliance on imported goods			
OPPORTUNITIES				
Changing demographics	Increasing number of working women fuelling demand for convenience foods			
Consumer preferences	Growing health-consciousness among consumers			
THREATS				
Globalization	Domestic producers unable to compete with imported goods			
Increasing raw material costs	Increase the price of the products that may lead to cutting down on consumer purchases			

Source: Country reports on Food and Drinks, Business Monitor International, 2011.

3.6 THE STATE OF REGIONAL DEVELOPMENT

The state of the packaging industry varies within and across regions as its growth is contingent upon the regional economic development and the production and market potentials of major commodities. The state of the packaging industry (based on selected country samples) is presented in Table 2, highlighting regional differences on the strengths, weaknesses, opportunities, and threats (SWOT) as derived from their respective food industry's status and development. The SWOT analysis shows a relatively young packaging sector that has a strong potential for development, backed up by a promising agricultural sector Though promising, the agricultural sector is generally in an underdeveloped state, often too slow to adapt to new technologies and is suffering from structural shortcomings, thereby restricting its ability to tap into export potentials. Therefore, both the sectors of packaging and agriculture, need strong support on the infrastructure and facilities front, if sustained development is to be pursued.

3.7 INVESTMENT OPPORTUNITIES IN DEVELOPING COUNTRIES

Developing Market Economies (DgMEs) contribute substantially in the production of agricultural foods like cereals, roots and tubers, oilseeds and pulses (including nuts), fruits and vegetables (including bananas), animal products (milk, eggs, meat), as well as fish, contributing 60–80% to the world total production (Figure 3). The large volume of production in the agricultural food sector in DgMEs therefore offers a potentially huge market for investment for the international packaging industry, packaging being a critical component in the complete value chain of agricultural food products.

Aside from the large volume of production, another factor that can further attract investment in packaging is the steady growth in these commodities. Furthermore, in a report, FAO (2009a), has predicted that DgMEs have high growth opportunities in agriculture up to year 2018 (Figure 4), which has in fact already attracted high income countries to invest in DgMEs as supply regions to secure their own long-term food security.

Figure 3. Production percentages of selected commodities per market economy in 2011

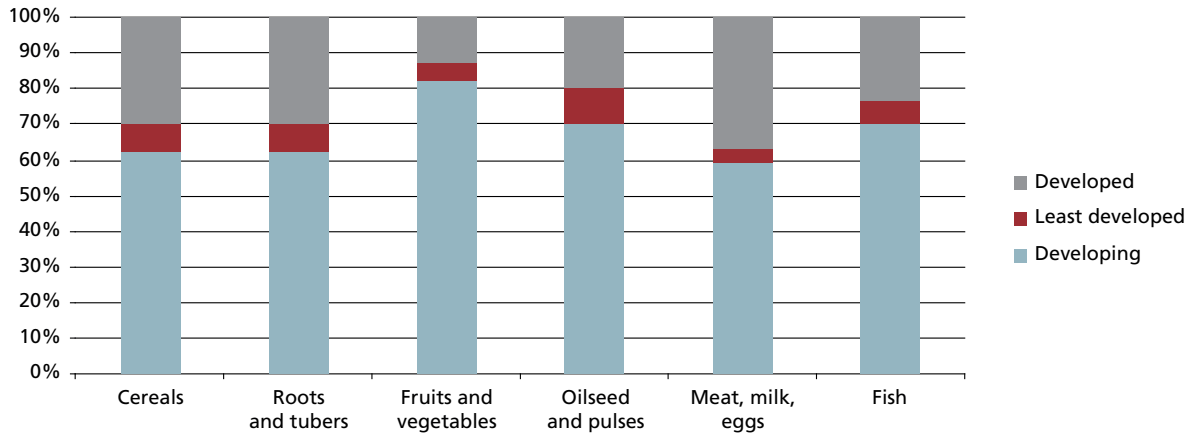


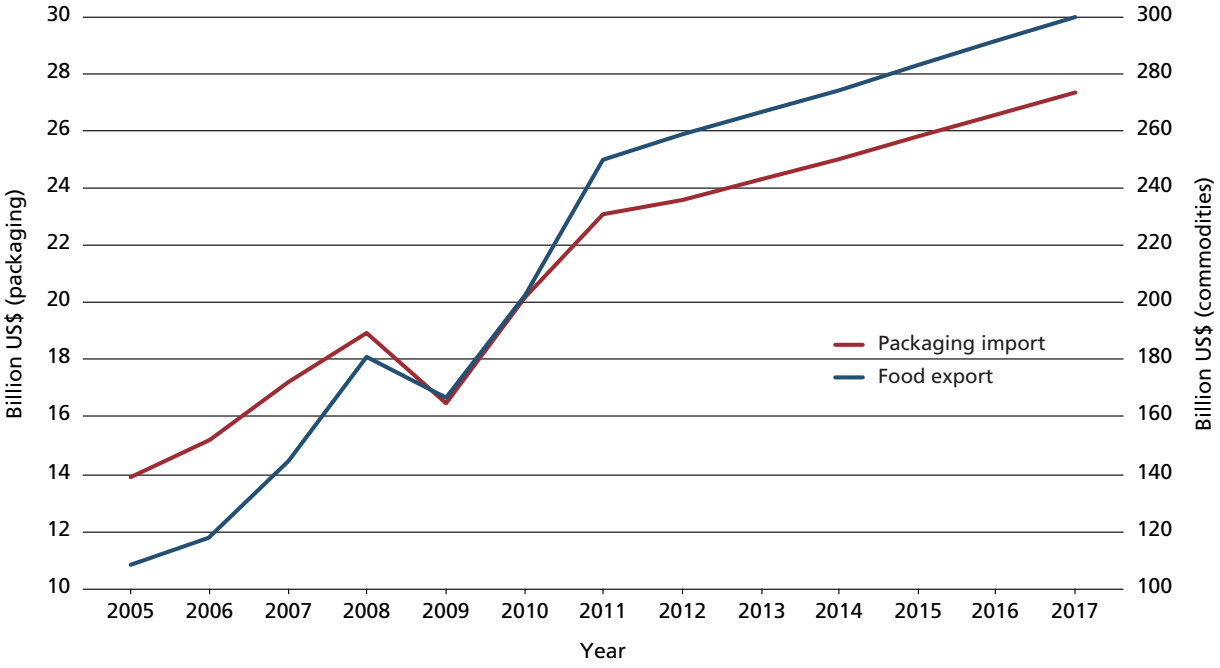
Figure 4. Long-term trends in agricultural production, by region

Source: FAO, 2009a.

The projection on the possible size and opportunities for investment in the packaging needs of Developing Market Economies (DgMEs) is based on (1) the growth in imports of packaging materials, and (2) the growth in exports of food commodities for the period 2005–2012. The data are mainly from the International Trade Centre (ITC, 2012).

In the evaluation of packaging materials, the ITC study followed the grouping which include (1) glass (carboy, bottle and other containers of glass); (2) paper (packing containers of paper, paperboard, cellulose wadding, webs); (3) plastic (plastic packing goods or closures stoppers, lids, caps, closures); and (4) wood (packaging materials of wood). For the evaluation of exports of commodities, the commodities that were included based also on ITC groupings are (1) cereals; (2) dairy products, eggs, honey, edible

Figure 5. Comparison of imports of packaging materials and exports of selected commodities in DgMEs (ITC, 2012), and projection for growth after 2012



animal products; (3) fish, crustaceans, molluscs, aquatic invertebrates; (4) edible fruit, nuts, peel of citrus fruit, melons; (5) meat and edible meat offal; (6) oil seed, oleic fruits, grain, seed, fruit, etc, not elsewhere specified (nes) in the other groupings; and (7) edible vegetables and certain roots and tubers.

An aggregate of the imports of packaging materials and of the exports of selected commodities are shown in Figure 5. The figure shows that the growth in imports of packaging follows the growth in exports of commodities, increasing (positive growth) from 2005 to 2012 with a decline (negative growth) from 2008 to 2009.

In terms of the commodity exports, the global trend is expected to continuously increase up to 2017 with a growth rate of around 3%. This modest growth rate will be used to predict the possible size of market for food packaging materials.

4. Food packaging solutions in developing countries

4.1 ADDRESSING FOOD LOSSES IN THE VALUE CHAINS

Knowing which product group spoils easiest, at what point along the chain they spoil the most, what brings about the food loss and last but not the least, can losses be avoided or not, are specific concerns along the value chain, with high implications on packaging.

Studies have shown that the fresh fruit and vegetables (FFV) are the most perishable food items. FFV account for the highest share of food losses and is usually among the most wasted items, followed by other perishables such as bakery and dairy products, then meat and fish (Thonissen, 2009 as cited in Parfitt, et al., 2010). This information very well supports the earlier claim that moving FFV from the production site to the table in the desired state of freshness poses the biggest challenge to the packaging sector. Considering that fruits and vegetables are a growing component of meals, either out of preference or need to meet nutritional requirements, the FFV cluster offers a lot of opportunities and potentials to the packaging industry.

Knowing when and where the losses occur in the commodity chain helps to pinpoint, not only the food loss hot spots, but also their probable causes, which in turn will be crucial in determining the extent to which they can be avoided or not, and the packaging solutions to best address them.

Within an organization and in a value chain context, there are certain barriers to waste reduction classified either as external (not within control) or internal (within control) (World Economic Forum, 2009). External barriers, on the one hand, include concerns such as infrastructure, regulations, competitive pressures, consumer behaviour, stakeholder relationships and technology. Included in the internal barriers, on the other hand, are again concerns about expertise, infrastructure and technology with the addition of management support, business models and financial resource concerns. Of these barriers, there are those that have a direct or indirect bearing on packaging, either as problems to which packaging can provide solutions or potential support areas to the packaging sector's development. The identification of these areas will help organizations to have effective programmes on food loss reduction.

Within the external barriers, the area on an optimal packaging process under infrastructure is a direct potential for packaging action, while those with indirect potentials fall under consumer behaviour and stakeholder relationships. Under the internal barriers, development in technology, management support, as well as business models are potential grounds which are supportive of packaging development.

Although packaging opportunities abound on the basis of needs and requirements of the food sector (and other sectors as well), the translation of actual demand is contingent on meeting the specific packaging needs of the product. More specifically, this is expressed in terms of the specific packaging solutions offered.

The packaging solutions for reducing the food losses at every stage along the value chain are presented in Table 3. The stages that were included are: production, post-harvest, distribution, processing, wholesale, retail, and consumption. To a certain extent multi-use packaging has an advantage for meeting the requirements of a number of products, but again only to the extent that they cater to the specific requirements as well.

Table 3. Packaging solutions for reducing food waste along the value chain.

Loss situation and causes	Selected packaging solutions
At production stage	
Unnecessary variety of packaging types	- Universal packaging design
High amount of greenhouse gas (GHG) emissions per ton of production	- Modified atmosphere packaging - Integrated materials handling and warehouse management systems
Non-recyclable wax-coated boxes for delicate perishables	- Recyclable packages with excellent moisture barrier - reusable plastic containers
At post harvest stage	
Inefficient product insulation	- Fibre reduction - Microflute technology
Manual case forming and stretch wrapping	- Automated processes reducing labour and material costs
Product spoilage and toxicity	- Anti-microbial packaging
At distribution stage	
damage due to palletizing and strapping	- Slip sheets and stretch wrapping in lieu of pallets and strapping
Damage due to mixed products on pallets	- Cube utilization via 'pin-wheeled' position
At processing stage	
Damage during transport	- Leak-resistant packaging - Tough, tear-resistant packaging
Product spoilage	- Hermetic seals - Vacuum or modified atmosphere packaging
Loss of production	- Efficient equipment systems - System integration and automation
At wholesale stage	
Inappropriate shipping containers	- Optimizing secondary packaging for shipping and shelf impact/appeal
Damage due to high humidity, storage time and stacking height	- Use of new materials with enhanced stacking strength - Modified atmosphere packaging
At retail stage	
In-store preparation losses	- Centralized food preparation - In the bag merchandizing
Product spoilage	- Leak-resistant packaging - Vacuum or modified atmosphere packaging
Passed sale date	- Shelf-life extension - Freshness preservation
At consumption stage	
Too much preparation	- Portion control packs - Ready-to-eat entrees
Spoilage	- Resealable packaging - Vacuum or modified atmosphere packaging
Not consumed prior to expiration date	- Shelf-life extension - Freshness preservation

4.2 TRADE POLICY AND LEGISLATION

While trade without borders is putting pressure on the packaging industries, which in turn respond in terms of fast-changing packaging technologies and practices, national regulatory bodies are not keeping up in pace, thereby limiting trade access specifically of developing countries. Variations as well as constant policy changes, together with the problem of compliance, lead to product damage and even rejection of products already shipped, with the lack of information in terms of policies including packaging requirements being great contributors. These regulations often have packaging component clauses.

Policies and regulations (or the lack of them) impact as well on the introduction and acceptability, more so on the commercialization, of a packing and packaging technology. Box 1 showcases the challenges confronting initiatives of an R&D institution, such as the International Rice Research Institute (IRRI), to introduce appropriate packaging in developing countries. National policies on intellectual property rights (IPR), tax and tax exemptions, when non-existent or have grey areas, serve as disincentives to technology commercialization.

Box 1. R&D Institution generated storage packaging technology: challenges & issues

Training component is critical

- Simple technology but wrong usage renders it non-functional (twisting the end, over filling, etc.).
- Quality aspect is important so as not to be thought of as an extra activity.
- Teach the principle, not the product.

Needs an enabled environment

- While technology is available, issues such as IPR, tax and tax exemption delimit use of technology.
- Conflicting perspective at the national and field level; government claims farmers not storing seeds, but they do.

Takes time for benefits to sink in

- Technology development and transfer takes time, benefits long in coming; business models needed to showcase.

What it is

The International Rice Research Institute (IRRI) bag is a farmer friendly 50 kg storage bag that allows cereal grains to be safely stored for extended period. The super bag fits as a liner inside existing woven jute or polypropylene storage bags presently used by farmers. The bags are made of a tough transparent multi-layer polypropylene material which incorporates a gas barrier that restricts oxygen and water vapour movement.

How does it work?

Sealing the grain inside the super bag stops the uptake of moisture and oxygen from the surrounding air and protects the grain from pests and disease. Respiration by the grain and the insects trapped inside the storage system quickly reduce the inter-granular oxygen levels from 21% to less than 5%. Studies have shown:

- life of seed extended from 6 to 12 months;
- head rice yields improved by 10%
- insect numbers are reduced to less than 1 insect/kg of grain without using insecticides and often within 10 days of sealing.

Contributor:
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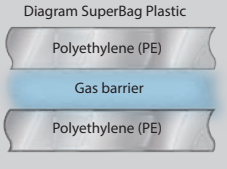
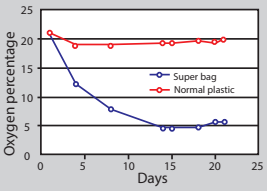
The International Rice Research Institute
Photos are part of the image collection of the International Rice Research Institute (www.irri.org)





SuperBags can be stored as any other storage bag

4.3 TRADE WITH INDUSTRIALIZED REGIONS

While the DgMEs packaging industry's trading performance is on a par with those of the DMEs, the packaging industries in these regions are not without challenges. Industry limitations beset the packaging sector in almost all regions, such as the limited packaging solutions to meet international market requirements, and the smallness of the domestic demand for packaging materials that consequently leads to low investment by the packaging industry. This in turn limits the region's ability to enhance product quality that meets standards of the increasingly discriminating consumers, both with regard to the domestic and international markets. As if competition is not yet a big enough a problem to handle, given the entry of imported products into local markets, the perception that products from the developing regions are inferior (as in the case of Africa and for sure other regions as well) adds to the problem and compounds packaging challenges in the developing regions.

More and more traditional export commodities of DgMEs are now being processed where they are produced and introduced in new consumer-packed products in the world market. The issue here is whether exporters from DgMEs are well abreast of product preferences and packaging requirements of DMEs. In most cases, it will mean marketing directly to consumers in target markets, using their own brand names, and maintaining competitive packaging designs and high quality levels which will present new and often difficult problems for the packaging industry in developing countries, as well as for the exporters. The latter are often unfamiliar with the requirements of supermarket distribution systems, for example, and may have difficulty in understanding the package design needs in their target markets.

4.4 PRODUCT AND TECHNOLOGY DEVELOPMENT

A dual investment scenario has been observed, and both have limiting effects on the growth of the packaging sector. For one, very little investment has been made so far in developing traditional technologies or in applying scientific knowledge in most of the developing countries. There are traditional technologies that are already past being useful as they no longer contribute (if ever they did at all) sufficiently to meeting socioeconomic imperatives. This is true also of those food technologies where many of the processing methods have remained unchanged for centuries and are becoming inadequate to cope with modern needs, because they are too labour-intensive and depend too much on natural environmental conditions. It is now clear that there is a need to lessen the dependence on nature, reduce the drudgery, shorten the time of the work involved and upgrade the preparation, quality, packaging, presentation and shelf life of these traditional foods and their packaging. (Hicks, 2001). It is also being increasingly recognized that the time has come when these traditional technologies must be upgraded through scientific application of packaging principles and then integrated with other functions such as marketing and advertising into country development programmes. Secondly, the more expensive products of imported technologies have further slowed down the development of indigenous technologies specifically those with potentials. Care should be taken that new technologies complement, not slow down, the development of indigenous ones.

4.5 UPGRADING PACKAGING TECHNOLOGY

In developing countries, a number of factors tend to limit the actual adoption of upgraded technologies, which are otherwise readily available. Lack of incentives to upgrade is a major deterrent, as well as inadequate support facilities to sustain usage of upgraded technology. The perceived lack of purchasing power of potential consumers is a good reason for entrepreneurs not to upgrade technology or even produce at all. The same is true for problems related to poor distribution, lack of sales promotion of these technologies or the inability to repair and maintain facilities necessary for their continued adoption. Numerous examples also exist of technically and economically sound upgraded technologies, which were rejected by the target group because they clashed with socio cultural customs and tradition (Hicks, 2001).

Packaging technology upgrading is usually suggested when confronted with problems on product and its marketability enhancements. However, caution is needed considering that social, economic and cultural sensitivities, including gender concerns, come into play when upgrading traditional food and food

Box 2. Cost-effective packaging innovation

Innovative packaging

• Plastic crates
Allow fruits to withstand rough roads when transported from farm to packaging sites, reusable a number of times.

• Collapsible metal crates
Reduces damage during transport, have done away with 10-15% losses of conventional packaging. Save on space when transported back empty after delivery; however, to recover the cost the metal crates have to be used at least 80 times.

• Display ready boxes
Have reduced handling losses on terms of bruises by minimizing points of contact when transferring fruits from conventional packaging to retail displays.

Contributor:
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Proprietor
Robbie Trading –
The Mango Specialist
Cebu City, The Philippines

packaging technologies. Manually-produced food, for instance, when mass produced using upgraded technology, may be unable to maintain product authenticity, flavour and even form. In the same manner, a small enterprise that may seem to be a simple business at the start when operated at a medium sized level (for economies of scale) with technology upgrading may offer greater than expected challenges, oftentimes incompatible with traditions and difficult to handle by small business entrepreneurs. If not appropriately addressed at the onset, this may put a toll on the economic viability of the enterprise and the packaging enterprise deriving its business from it will be likewise affected.

4.6 COMPETITIVENESS OF SMALL AND MEDIUM ENTERPRISES (SMES)

With increasing globalization where competitions with foreign competitors are occurring even on home grounds or local traditional markets, the packaging challenges for SMEs are likewise enhanced. This problem can be viewed instead as an opportunity in terms of an untapped potential for the packaging sector to cater to. The key is to know what the market requirements are and which packaging solutions will meet them best.

Of the marketing mix strategies of SMEs, competing on product and on price (including cost control) are the usual basic concerns as they form part of the considerations of the place and promotion strategies. Thus, the example cited below showcase how packaging innovations enhance enterprise competitiveness.

A major packaging cost concern for SMEs is package containers for transport. The options are to go for cheaper single use containers, usually boxes, or invest in multiple-use containers. Many organizations today are turning to reusable containers (totes, boxes and bins), reusable pallets, and pallet pooling systems (pallet rental) for multiple transport trips in closed-loop and managed open-loop shipping systems (Stop Waste Partnership & Reusable Packaging Association, 2008).

Reusable transport packaging has a higher initial cost than one-time use or limited use transport packaging, because it is designed and manufactured with more durable, longer lasting materials. Other costs may include new material handling equipment and storage systems, reverse logistics (the return transportation

of empty reusable packaging components), maintenance and repair, and asset tracking and depreciation. However, these costs are off-set by the saving opportunities and frequency of reuse over the extended useful life of the packaging (Box 2).

4.7 PRE-PACKING AND CONTRACT PACKING

An interesting aspect of the increasing need to supply pre-packed products to export markets is the possible application of contract packing. At present many importers in industrialized countries have to undertake pre-packing operations themselves at labour rates which may be 20 to 50 times more than those in developing countries. The principles and advantages of contract packing are however almost unknown to producers and exporters in developing countries (ITC UNCTAD/WTO, Export Packaging Note No.30), wherein this opportunity if not appropriately assessed and tapped on may just remain a wasted one. This scenario is already changing as developing countries are recognizing that potentials abound for the packaging sector, not only in terms of volume, but also in form. A case in point for the Philippines is the Packaging Research and Development Center of the Department of Science and Technology (DOST)-Industrial Technology and Development Institute (ITDI), which assists SMEs in accessing packaging technologies through technology transfer and purchase facilitation, among others.

For certain products it may well be feasible to set up local contract packing facilities at exporting harbours or bonded warehouses as in Box 3. The goods would be received unpacked and the packing operations would be performed centrally on behalf of a number of exporters. Such contract packing stations could for instance obtain packaging materials and packages on a joint purchasing basis, being allowed duty free imports of any necessary high quality packaging which could not be produced locally (ITC UNCTAD/WTO, Export Packaging Note No.30). In some cases, smallholder producers/packers purchase packaging materials collectively, either through informal groups or cooperatives to benefit from bulk purchase discounts and to save on transport costs. Packaging research institutions, in service to the SMEs they are assisting, sometimes do the bulk purchasing and retail them to the SMEs who otherwise cannot afford to buy in bulk given the smallness of their operations.

4.8 RECYCLING OF PACKAGING MATERIAL

A particular issue of concern is the implication of environmental friendly moves in relation to recycling: how applicable are they to food packages, particularly when they directly come in contact with food. So far, there are few applications that allow recycled packaging materials to be in direct contact with food.

In societies where there is starvation and a lack of materials, modified criteria could be employed as the decision relates to availability. An abundant supply of packaging materials can tolerate more regulations and constraints than a tight supply. Regulations for packaging materials that allow slightly higher levels of contamination could be allowed to increase the availability of materials. Risk-benefit analysis needs to incorporate both the safety level of the materials and the detrimental effects of a restricted supply (Marsh, 2001). There are applications in which recycled materials may be safely used with direct food contact. Dried food, for example, can be safely packaged in recycled paperboard containers because there is no medium for transfer of potential contamination to the product. Such materials could be used to increase the supply of packaging materials and reduce food losses.

4.9 PACKAGING MACHINERY

While technological advancements, in general, are welcome aspects of development, their applicability and appropriateness to the level of need and capacities of would-be adopters have to be taken into account. This is true for the adoption of packaging and packaging technologies, particularly in a developing country scenario. In the case of packaging machinery, availability and purchase may not be a problem, but after sales services and maintenance could be a limiting factor later on. It is not uncommon to see a situation in developing economies where highly promising modern machinery was purchased only to be minimally used at the start and then remaining idle for most of their productive life due to lack of repair and maintenance facilities.

Box 3. Packing and packaging facility for fish

A Fish Port with Packing & Packaging Facility Boosted Tuna Industry

The 32-hectare General Santos Port Complex facility of the Philippine Fisheries Development Authority is considered of great importance to the East-Asian Growth Area (EAGA). It has six -35 °C cold stores with a 300 MT capacity each; 4 tons/day brine freezer; a 60 tonner ice plant and a 758 meter area for landing/ preparation. With its postharvest facility crucial in prolonging shelf-life of tuna and other species, the port plays a vital role.

The captured tuna and tuna-like fishes have been monitored and to be delivered to 3 major destinations. These include the canneries, the processors/ exporters, and the local market catering to the local consumers. Fishing is a PHP 50 billion industry in The Philippines, with an annual production volume of 2.4 million metric tons of fish, directly providing livelihood and employment to over one million Filipinos. Tuna is among its 200 kinds of fish with high commercial value. The tuna industry contributes 4% to GDP and 19% to gross value-added in the agricultural sector. The Philippines rank 7th among the top tuna producing countries in the world, both fresh/frozen and canned.

Packaging Materials

Fresh Tuna

Many traders in General Santos, the tuna capital of The Philippines, prefer to export sashimi grade tuna in a chilled instead of frozen state. For small producers who prefer chilling it is usually done using large containers filled with ethanol and dry ice to freeze their products. When dry ice melts with ethanol, it reaches a temperature of -40 °C, enough to freeze tuna. This method is widely used by the traders since it is cheaper, takes only minutes to finish, and doesn't dehydrate the tuna. Packaging materials are locally made insulated boxes in plastic and cartons. For big processors, blast and brine freezing technology are used to process the tuna. This is an expensive technology that usually takes 3 to 4 hours to finish.

Canned tuna

Raw tuna as main raw material is available locally. However, if local supply is not sufficient, the country imports frozen tuna (canning grade) for the production of canned tuna. Other imported inputs include soya oil, and tin cans for packaging. Packaging materials account for 60-70% of the total production cost.

1. Fish labelling

2. Wrapping with plastic

3. Double wrapping

4. Put in insulated boxes

Information source: Website of general Santos City, The Philippines, and actual site visit.

Unless modern machinery comes in complete packages, such as establishments for in-country after sale service units and spare parts stores, these modern, but inappropriate technologies cannot flourish in the developing world. However, such a scenario is far-fetched unless the volume of business is enough to sustain suppliers' interest and the environment is enabled whereby country regulations are attractive enough to would be food product enterprises as users and to would be packaging machinery suppliers.

Unfortunately, there are many reasons for pessimism in considering this problem and a range of issues has been identified and extensively discussed by ITC as follows:

- Many leading machinery manufacturers are today pre-occupied with the objective of producing faster, more automated and less labour-intensive machines. These are generally unsuited for the volumes handled by producers in developing countries. These companies are also ones that have worldwide sales and service networks at their disposal. An unfortunate result of this is that in some cases developing countries have been "oversold" with machinery that is too fast and too complicated. Such investments may turn out to be expensive "status symbols" which cannot be operated to capacity and often give mechanical problems. Electronic monitoring devices and delicate mechanical components are particularly prone to malfunctions in tropical climates.
- There are undoubtedly many small and reliable manufacturers who have developed slow- or medium-speed machines, which would perfectly suit the needs of developing countries. These companies, however, often operate only nationally, and have no experience in exporting their machinery, or of providing after-sales service over great distances. Language problems and export pricing and documentation may also be important obstacles.
- Regarding the need to adapt machinery to meet the particular requirements of customers in developing countries, the worst problem seems to be difficulty in understanding the prevailing labour conditions. For example, it was difficult to convince a manufacturer of slow-speed vertical carton fillers to strip his machine of its automatic blank feeding device and substitute manual feeding.
- Most manufacturers of packaging machinery and materials usually consider overseas countries as marginal markets - necessary when business is bad, but uninteresting when the demand is sufficient in their traditional markets. This inconsistency in marketing policy may be economically justified, but is very difficult for customers in overseas countries to understand and accept. (ITC UNCTAD/ WTO, Export Packaging Note No.30).

Given the aforementioned scenarios, the option of utilizing reconditioned, second-hand machinery should be seriously investigated. While most new machinery available on the world market today is too fast and often too sophisticated for use in many developing countries, a vast amount of older, slower machines that are well maintained and in good working condition, are in storage throughout Europe and the United States because they no longer meet present productivity standards. For this opportunity to be pursued, however, their acceptability in recipient developing countries needs first to be addressed. Industrialists and governments in developing countries are often suspicious -and with reason- of second hand machinery in general.

Much worthless machinery found its way to developing countries in the past through the hands of irresponsible salesmen. As a result many developing countries have even introduced legislation, explicitly prohibiting imports of any kind of second-hand machinery. To re-establish the image of used machinery and to study all investment alternatives including second-hand equipment with the correct economic perspective, some form of centralized action is needed. Ideally, there should be an impartial evaluation and certification body or other quality control and checking arrangements for second-hand machinery. One possibility is that the original machine manufacturer assumes responsibility for the quality of used models as well. Another is that the seller installs the machines and accepts responsibility for operation over a certain period of time.

In conclusion, it is felt that a world-wide inventory of appropriate types of packaging machines and reliable suppliers should be prepared to serve as a guide for purchasers in developing countries. As the situation is today, many such investment discussions are made on inadequate grounds, sometimes resulting from the visit of a passing machine salesman, or at the whim of a company president visiting a machinery show abroad. In addition, guidelines for purchasing and specifying machinery should be widely distributed to industries in developing countries. They should be accompanied with specific advice on how to include provisions for operator training, installation and running-in, maintenance and spare parts supply.

4.10 CREATIVITY, INNOVATIONS AND INITIATIVES

Though confronted with structural limitations and industry barriers, creativity, innovations and sustainability consciousness are taking off in developing countries. Plastic bags developed from fruit waste in Malaysia and edible food packaging in Turkey are most recent examples of developing country's packaging innovations (Box 4-5)

Other examples of creativity include the use of indigenous packaging to sustain market presence, the use of branding (aided by appropriate packaging) to reposition products and packing innovations to aid entry into new markets (Boxes 6-7).

Box 4. Case of packaging innovations from developing countries

Bags developed from fruit waste in Malaysia

Scientists in Malaysia, on one hand, have introduced fruit waste-based plastic bags that could solve the degradable issue. The researchers at Universiti Sains Malaysia (USM) say they have developed FruitPlast by converting tropical fruit waste into flour, which is then fabricated into biodegradable plastic film. The plastic manufactured from these fruits stands up in both tensile strength and 'elongation at break' level, compared with normal plastic wraps, according to the scientists. The bags, which naturally degrade in three to six months and last one to two years on the shelf, cost 10% less than the current non-biodegradable plastic bags commercially used. Featured in Packaging Gateway, May 2010 is-sue.

Box 5. Case of packaging innovations from developing countries

Edible food packaging in Turkey

The edible packaging material is a product of the Turkish Scientists research using more flexible film compared to competing products on the market. The flexible film is made using egg white and corn protein and natural substances and can kill microbes in food. The new packaging is 500% more flexible than those currently on the market, as claimed and will soon be produced three to four years hence. Featured in Packaging Gateway, May 2010 issue.

Box 6. Indigenous packaging of olive oil in Egypt

Indigenous Packaging Made Waves & Facilitated Sustained Presence in Export Market

The situation:

Industry level
Competition in the global olive oil consumer market is very fierce and is monopolized by traditional producing countries like Italy and Spain, and there is very little room for newcomers, unless in bulk, where the oil would be bottled under known brands of traditional producers.

Country level
Egypt emerged as an olive oil exporting country only in the mid-nineties and the tiny export quantities were mostly in bulk. As such, the country lacked image and branding which negatively affected producers who wanted to export added value olive oil in consumer packages.

The packaging strategy:
Objective:
to add uniqueness to the product through packaging which would attract consumers, and Egyptian olive oil producer innovated a premium package with well executed details for export markets.
The package: consisted of a wooden box made out of recycled light wooden boards covered with papyrus which is a thick paper-like material produced from the pith of the papyrus plant, Cyperus papyrus. The papyrus is hand-painted with scenes of Egyptian old civilization.

The outcome:
Thanks to this innovative packaging style, consumers in export markets were attracted to buy from a new non-traditional producer with little track record in the market. Note that the painting on the packaging bears no relation to olive oil what so ever. The package, which is entirely hand-made, also helped sustain the livelihood of craftsmen and women and young artists.

Information source:
Mohamed el-Kholy
Farmer and Olive Oil Producer
Egypt

Box 7. Positioning native potatoes in Peru

Repositioning Native Potatoes as Gourmet and Health Food Through Branding Made Possible by Appropriate Packaging

Potatoes are an important source of nutrients and calories, as well as income for small highland producers in Peru. It is a source of the nation's traditional heritage and promotes biodiversity with about 3,500 varieties of native potatoes cultivated in the Andes Highlands of Peru. They command low price when sold in local fairs and other traditional markets.

The richness and nutritive value of potatoes, as well as their role in biodiversity conservation, are not known to urban consumers who usually use only 2 or 3 varieties.

Production and marketing challenges confronting native potato growers

- Adverse climatic factors in the highlands
- Inadequate technology
- Grown mostly by poor farmers in remote areas on small fields
- Limited marketing development

Trends and potential

- Emerging high value niche markets
- Enhanced promotion with value-added for quality fresh and processed products
- Increased awareness of nutritional qualities of native potatoes as a natural product
- Culinary importance of native potatoes in the gastronomic wave in Peru, promoting cultural and national identity.

The products

The first commercial brand of native potatoes T'ikapapa was sold under strict quality standards. Using potatoes of a single variety and uniform size ensures even cooking. A one kg bag package guarantees clean handling while purchasing as well as at home. Coloured potato chips with high processing quality standards promote healthy consumption.

Information source:
André Devaux, Papa Andina Initiative
Miguel Ordinola, Papa Andina Initiative
Graham Tiele, International Potato Centre (CIP)

The packaging solutions

Packaging and labelling

- Packaging highlights delicious taste, interesting forms/ bright colours and natural production conditions.
- Label generates better knowledge of benefits and attributes of native potatoes. Previously native potatoes were not available in supermarkets. It promotes value chain practices with the CAPAC logo, which is a value chain platform.

Branding

- T'ikapapa (potato flower) – redefined as 'fresh, selected, classified, clean and bagged native potato', with a registered brand. Each bag contains a single variety and over 15 varieties are sold regularly.
- Lays Andina – processed coloured potato chips. Recreating the image of native potatoes into a gourmet, natural healthier product with links to Peru's cultural heritage.

In developing countries, most initiatives are coming from the private sectors' side (Box 8-9).

Box 8. Case of industry initiatives in developing countries

TIPMSE in Thailand

In Thailand processed and nicely packed food products are enticing locals and tourists alike. A great initiative came from the Federation of Thai Industry in 2005 where the Thailand Institute of Packaging Management for Sustainable Envi-ronment (TIPMSE) was officially established by four industry clubs under the Federation of Thai Industries namely the Plastic Industry Club, the Pulp and Pa-per Industry Club, the Glass Industry Club, and the Aluminum Industry Club. The Thai Metal Packaging Association, as well as other related consumer product manufacturers also participated. TIPMSE aims to reduce packaging wastes via safety and sustainable methodology. Basically TIPMSE, a non-profit organiza-tion, is financially supported by the above mentioned industry clubs and related consumer product producers. One of the key projects of TIPMSE is to reduce packaging waste by 12% in five years (Thailand Country Report, 2008).

Box 9. Case of industry initiatives in developing countries

PET in The Philippines

In the Philippines, the biggest food conglomerate, San Miguel Corporation (SMC) set up a 150 million $ recycling project to produce environment-friendly packaging materials for the local food and beverage industries using polyethylene terephthalate (PET). PET is the preferred packaging because of its light weight, clarity, and shatter resistance. It also ranks as the most recyclable packaging material in the world today (SMC website). The main processing plant is in San Fernando, Pampanga in Luzon, with conversion operations in the three major islands of Luzon, Visayas and Mindanao. PET is already being recycled abroad into second-generation products, such as T-shirts, windbreakers, sleeping bags, carpets and athletic shoes, among other things. The collection of PET bottles is an ongoing nationwide campaign with the support of existing bottle collectors and SMC's subsidiary, Coca-Cola Bottlers Philippines, Inc., on the crest of its successful 'Mission P.E.T.' project launched in 2000. The first of its kind in Asia, SMC's PET recycling plant opened doors of opportunity in the community through direct employment and contracting services.

5. Concluding statements

On the importance of packaging and the packaging industry sector

1. As packaging technology development is one of the keys to food loss reduction, and as addressing food loss is relevant to both the poor smallholder food producer and the poor food insecure consumer, the issue of food losses and the development of packaging solutions to address them are major global concerns.
2. The packaging industry is the world's third largest industry sector, next only to food and petrochemical industries. It is also among the top five industries in almost all countries, with its annual growth rate of 3-5%, which is a range even higher than the GDP's growth rate in almost all countries.
3. Present day innovations and responses to changing consumer preferences and demands have extended functions of packaging from mere protection to include promotion, information, convenience, initiation and handling.
4. Packaging becomes an added P to the 4 Ps of marketing (product, price, place, promotion), particularly in terms of facilitating branding, product differentiation and identity which is best communicated at the point of purchase

On packaging and food loss in the value chains

5. Packaging spans the entire value chain and is a shared responsibility for all trading partners. Losses are highest at pre- and post harvest stages in developing countries underscoring the need to focus on packaging solutions and concomitant farm to market support infrastructures required at these stages of the value chain. This is in great contrast to the industrialized countries where losses are at their peak at the retail and consumption stages.
6. Products generally represent greater resources and have a much higher inherent value than the packaging used to protect them. Thus, product losses due to underperforming packaging could cause greater adverse effects on the environment than the gains made through packaging reduction.
7. Knowing what the losses are as well as when, where and how they occur can help pinpoint solutions, packaging included, to minimise them. In the same manner, knowing which packaging solutions are available, currently and in the future, is a crucial first step in addressing food loss.

On packaging trends and potentials for development

8. A lot of changes are occurring in the global food system from the way the foods are produced, distributed, stored, processed and retailed. This increasing dynamism in the food system, on the one hand is placing a lot of challenges on the packaging industries, but on the other hand is opening up opportunities and potentials for the packaging industry to develop and appropriately respond to.
9. The trend towards processing traditional export commodities at the country source and the introduction of new consumer-packed products from developing countries to the world market will necessitate a thorough understanding of customer requirements in industrialized countries on the part of developing country exporters. This brings with it accompanying challenges in terms of marketing directly to consumers in target markets, using their own brand names, and maintaining competitive packaging designs and of high quality levels, challenges that likewise spill-over to the packaging industry in developing countries, as well as their exporters.
10. Given the general tendency of packaging manufacturing firms to move nearer to their customers, investment potentials for developing countries abound in this sector. The ethnic appeal of products

(fruits and vegetables particularly) from the developing Southern economies to their Northern and Western markets will have to be extended to their packaging. While generally the relative lack of sufficient strength and durability of indigenous materials limit their potentials as raw materials for packaging, their innovative use in combination with other materials aided by research and technological advancement is an area in which it is worth investing.

11. Container standardization is starting to be a cost reduction strategy, and this has given rise to a wider range of package sizes to accommodate the diverse needs of wholesalers, consumers, food service buyers, and processing operations.
12. Of the three packaging sub sectors, potential exists more in package manufacturing than in packaging machinery or packaging services for developing countries. This is in the light of the fact that the packaging machinery sub sector is highly dominated by developed countries. There is value in looking at the potentials of the second-hand machinery market in the short- to medium-term. However, in the long term, it will work best for the developed countries to look into the potentials of simple in-country fabricated packaging machinery that is appropriate for their specific needs and requirements.
13. Developing the packing service provision sub sector, specifically in relation to pre-packing and out sourcing, will provide the much needed boost to food packaging in developing countries. They will not only lend affordability to packages and packing but will likewise enhance handling and distribution efficiencies to exporters, especially to SMEs.
14. As packaging materials are in short supply in developing countries, relaxing packaging regulations a bit without compromising food safety, will surely help the industry. An example is allowing the use of recycled packaging materials when they pose no problem of contamination (i.e. dried foods). Such relaxation of packaging standards will help increase the supply of packaging materials, while at the same time addressing food loss concerns.

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