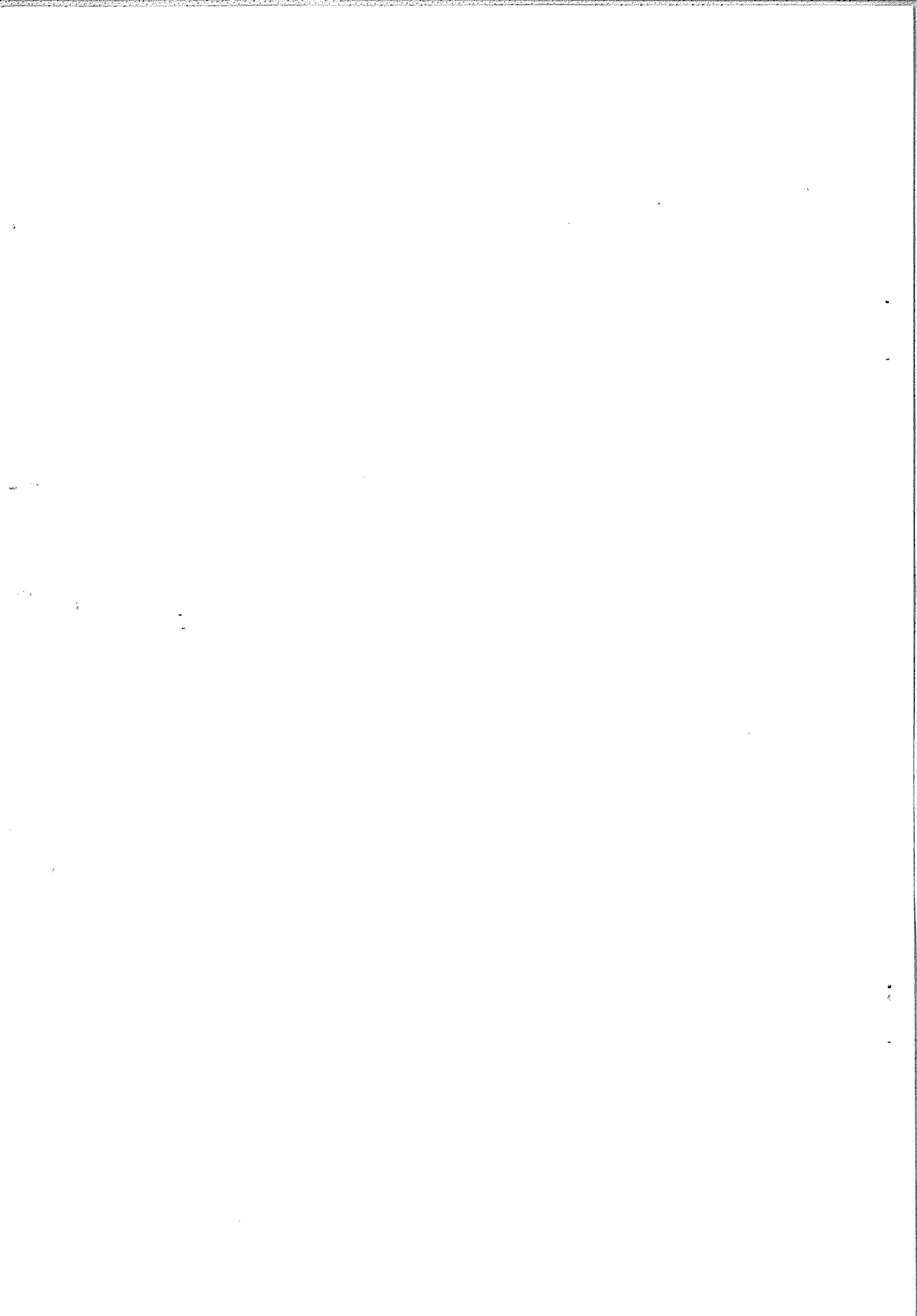


A MARKET ORIENTATED APPROACH TO POST-HARVEST MANAGEMENT

AGSM OCCASIONAL PAPER NO. 5

**Marketing and Credit Service
Agricultural Services Division
Food and Agriculture Organization
Rome**

September 1991



A Market-Orientated Approach to Post-Harvest Management

by

Andrew W. Shepherd¹

Introduction

An orientation towards the market can be considered to have several elements. It implies that all activities undertaken throughout the marketing system are aimed at meeting the needs of the consumer. Only by satisfying those needs can marketing be profitable and for marketing to be carried out effectively all actors in the system must make a profit. This, in turn, implies that changes to marketing or post-harvest techniques will only be viable when they provide the necessary profit incentive to participants in the marketing system. Finally, a marketing system is an integrated whole. Changes to one part, e.g. by introducing a new type of packaging or a new store, cannot be planned in isolation from the total functioning of the system.

Many past interventions in the post-harvest sector have failed because, whilst being technically correct, they have been planned without reference to the market's needs and its ability or willingness to pay for the supposed improvement. The aim of this paper is to emphasise the need to place post-harvest activities, particularly, but not exclusively, loss-prevention activities, within a market context, so providing pointers for planners and technologists active in the post-harvest sector. Relation of production to market demand, so minimising losses due to oversupply, is stressed as is the need to ensure that post-harvest interventions are economically viable. The interrelationship of the various components of the post-harvest and marketing system is discussed and examples of where changes in one area require an awareness of their possible impact on other aspects of the system are given. Improved post-harvest management can often be brought about by relatively small actions at several stages in the production/marketing chain; a willingness to examine the food system is thus a precondition for successful post-harvest work. The role of government intervention in marketing and its impact on post-harvest management is examined, together with the positive steps that governments can take to promote improved marketing. Emphasis, throughout, is placed on identifying ways to ensure that post-harvest interventions are both profitable and sustainable.

Relatively few people in developing countries can now be considered beyond the influence of the market. Even so-called 'subsistence' farmers have some limited cash requirements which normally require them to market a part of their output. Furthermore, farmers in the more affluent developing countries and those living close to urban areas in all countries are increasingly realising the potential for diversification away from the traditional subsistence and cash crops towards production of food crops and particularly fruits and vegetables. Such crops bring with them totally new post-harvest problems, which cannot be solved without reference to the needs of the market.

¹ Marketing and Credit Service, Agricultural Services Division, FAO, Rome. Valuable comments on drafts of this paper were received from Messrs J. C. Abbott, R. H. Booth, S. Carter, G. Dixie, J. Novoa-Barrero, E. Reusse, G. Schulten, E. S. Seidler and V. J. Tickner.

Emphasis by donors and technical-assistance agencies on the post-harvest sector expanded as a response to the increases in production which resulted from the "Green Revolution" experienced by India and other Asian countries from the 1960s.¹ Production increases led to even greater increases in the marketed surplus, causing the supply of food to the marketing system often to exceed the capacity of the system to handle it. Problems with losses were initially perceived to be problems with marketed grain, not with the processing and storage of grain held for own-consumption. During the late 1960s and early 1970s post-harvest specialists tended to concentrate on the quantification of losses and, as Bourne² points out, there was often a temptation to cite "worst case" figures to dramatise the problem. Extrapolations from limited samples to produce country-wide figures were used and may have exaggerated the true picture. This reinforced concern and, no doubt, the willingness of donors to support further activities. However, it seems that researchers rarely attempted to quantify the extent to which the losses could be economically avoided.

With hindsight, there may have been an over-investment in loss-assessment methodologies.³ However, the approach did gradually change to one in which greater attention was paid to studying the post-harvest system and to identifying its problems and bottlenecks. Even then, however, improvements were often seen in terms of what was technically possible rather than what was economically justified. Losses could be reduced by building stores--so stores were built. Consideration of alternative approaches to the problem, which involved examining a range of possible solutions, was often not done. Some processing facilities were introduced with only limited examination of the market potential for the processed products, or even of the availability of sufficient supply for the economic operation of the processing facility. New packaging was promoted, with only a vague notion of the impact that this would have on total marketing costs.

A market approach implies identifying consumer needs and then seeking profitably to satisfy them. Such an approach is essential if the food system, stretching from the farmer through to the consumer, is to function effectively. As governments gradually liberalise their economies and permit increasing involvement in food marketing by the private sector, the need for post-harvest improvements to be conducted within a market framework grows. Thus there is now an increased requirement for market-orientated post-harvest support by technical specialists. The challenge will be to provide it.

¹ see Greeley, M. "Pinpointing post-harvest food losses" in CERES Vol. 15 No.1 Jan-Feb 1982, FAO, Rome.

² Bourne, M.C. "Post-Harvest Food Losses--The Neglected Dimension in Increasing the World Food Supply" Cornell University, April 1977

³ see Booth, R. H., Toet, A. and L. Bevan, "Investing in Sustainable Post-Harvest Programmes," FAO(AGS/PFL), December, 1987

1. Producing for the Market

Food losses stem both from poor post-harvest handling and from overproduction. In order to avoid wasteful overproduction, post-harvest loss reduction activities should begin even before the crop is planted. If there is limited consumer demand for a product (whether sold at the market price or at an official government price) then production should only be undertaken if the market has been clearly identified. This, of course, refers primarily to horticultural crops, although there have been cases of governments promoting excessive production of grains, beyond the ability of the marketing system to store and market them. On the occasions when total harvest and marketing costs are likely to exceed the market returns the best thing to do is plough the crop back into the ground or, where possible, use it for animal feed. This is a fact of life which has been faced by farmers for generations (other than those benefitting from generous subsidies!) but is, nevertheless, difficult for both farmers and governments to accept. In these, fortunately infrequent, circumstances a food loss may be preferable to a financial loss.

Emphasis on food-loss prevention in recent years has, perhaps, increased the pressure on governments to "do something". This has led, for example, to gluts of produce being stored, with no market prospects. In the Near East, tomato paste factories, built to utilize gluts of tomatoes, are now operating way below capacity. There are many similar examples and FAO continues to receive requests for advice on establishing stores and processing facilities based on the availability of raw material, rather than on the demand for the stored or processed product.

Some crops lend themselves to long-term storage, which offers the potential to increase the value of the product. For some fruit and vegetable crops, however, sales must be carried out almost as soon as the produce is harvested. If demand is limited, or if the farmer has poor access to the demand, then losses are inevitable. Such losses can only be avoided by more effective production planning.

Production decisions which have an impact on post-harvest management and food losses relate to:

- which crops to grow?
- which varieties to grow?
- how much to grow?
- when to grow?
- when to harvest?
- where to grow?

All of these decisions must be related to the capacity of the market to provide an acceptable return for the growers' efforts.

-which crops to grow?

Few farmers, particularly in developing countries, are likely to take the risk of growing an entirely new crop in the hope that it will meet consumer acceptance. When this is done it is usually on a trial scale and the farmer can afford to take the loss if the

product proves unacceptable. Thus most farmers are limited in their choice of which crops to grow to the same crops as other farmers in their area. Unfortunately, farmers tend to be very predictable in their choices. High prices in one year encourage overproduction in the next; the resulting gluts lead to low production and high prices in the following season which, in turn, lead to yet more gluts. Perhaps the logical response for a farmer is to take the opposite course to that of his neighbours, but few are prepared to take this perceived risk. Improved marketing information and knowledge of marketing by extension workers, as well as improved post-harvest technologies, can help to overcome the problem of alternate gluts and surpluses.

-which varieties to grow?

The effects of seasonal gluts can be reduced by the production of a range of varieties. Use of early and late types extends the season and should increase returns. However, profits will only be achieved if the varieties used produce reasonable yields and if they find acceptance with consumers.¹ Some varieties also have more acceptable post-harvest characteristics than others (i.e. they store for longer) which can also be used to lengthen the period the crop is available to the consumer. However, while consumers in some societies may be prepared to pay the price for year-round availability of crops those in poorer countries may lack the necessary purchasing power.

-how much to grow?

Government policies designed to promote production can often lead to high food losses. One Southern Africa country, for example, promoted maize production over several years through a policy of subsidized farm inputs, subsidized credit and subsidized transport. Inevitably, production grew rapidly, to be far in excess of demand, thus necessitating construction of additional stores of both a permanent and temporary nature. Inevitably, also, losses were high as maize was being stored for longer and the additional storage management was beyond the capacity of the marketing agencies. Although governments wish to guarantee food security and guard against the implications of bad harvests, this may not always be best achieved by the promotion of production significantly in excess of demand. Even where physical losses can be controlled, quality losses are inevitable. Eventually, the country found that the cost of subsidies and of financing the stocks became unsustainable and support to farmers was reduced. This led to significantly lower production and potential food security problems, which could perhaps have been avoided if less of a subsidy-based policy had been pursued from the outset. Similar problems have been experienced in several Sahelian countries.²

If farmers producing grains for sale to government agencies do not suffer the immediate consequences of overproduction, farmers producing horticultural produce for

¹see, e.g. Harris, S.R. "Improvement of Fresh Fruits and Vegetables Handling" FAO, Bangkok, 1986 and "Prevention of post-harvest food losses: fruits, vegetables and root crops" FAO Training Series No. 17/2 Rome 1989 which both provide detailed discussions of the technical aspects raised here and elsewhere in the paper.

²see Creupelandt, H. and A. Shepherd, "Developing Foodgrain Production for the Market" in Structural Adjustment and Agricultural Marketing, Marketing and Credit Service, FAO, 1990

the commercial market certainly do. Risks are high for all crops but are highest for extremely perishable produce such as high value fruits, e.g. strawberries and grapes. In developing countries with limited consumer purchasing power, demand for such crops is necessarily small. Production planning in relation to market demand, and in relation to what is known about the planting intentions of others, is therefore essential.

Extreme cases of overproduction of horticultural produce are not uncommon. Examples include a rich Near East state which encouraged overproduction as a means of supporting its farmers; up to 90 per cent of all crops were eventually destroyed while the use of subsidised irrigation to produce them was having damaging environmental effects. In Colombia, a transnational banana corporation encouraged production of, and paid for, bananas which were subsequently destroyed for lack of markets.¹

It is unfortunate that development projects can often lead to produce gluts and significant post-harvest losses. Such projects may have increased production as a direct aim or may rely on expanded output to provide the economic rationale for infrastructure provision, such as new roads or irrigation schemes. Too often, the investigation of market demand is rudimentary. Forecasts may be based on urban market prices, with insufficient attention being paid to quality aspects, transport availability and market costs. A market opportunity may encourage several development activities in one country or region when demand could be met by just one such programme. Where schemes are large, the potential impact of project area output on total market supply may not be considered until it is too late. One development agency which undertook fruit-tree development projects in several Near East countries only began to be concerned about possible market saturation more than half-way through the planting programme. A frequent criticism of integrated rural development programmes in Latin America is that production was often promoted with no reference to market demand.

-when to grow?

One approach to avoiding production gluts for all perishable commodities is, where possible, to stagger planting dates. Without the benefit of plastic tunnels or greenhouses out-of season production can result in lower yields. However, successful out-of-season production can result in significantly higher returns than would otherwise be the case and may well be more economical than long-term storage. Farmers in developing countries are increasingly waking up to these opportunities.

-when to harvest?

Farmers have some scope to delay harvest, although this may reduce post-harvest life. However, for most crops the opposite is not the case. Produce which does not ripen after harvest cannot be harvested early to take advantage of demand; it has to be commercially mature. In more sophisticated environments growth-regulating chemicals, which permit staggered harvesting, are available.

¹ "The World Banana Economy-1970-84," FAO Economic and Social Development Paper, No. 57, Rome, 1986. The company was promoting production in excess of demand in order to gain market share.

-where to grow?

The decision on where to plant is probably as important as what and when to plant. Studies of post-harvest losses have often given "insufficient transport" as a reason for such losses. While effective transport services can be suddenly disrupted, it is far more likely that the losses stemmed from the organization of production in areas with inadequate transport in the first place. "Poor marketing facilities" are also often given as a reason; again, marketing facilities can rarely be expected to be good in remote areas far removed from urban markets. Left to themselves, few farmers would venture to produce perishable crops in such areas. However governments and well-meaning donors often see horticultural production, in particular, as a way of increasing incomes of the poorest farmers, while failing to address questions of marketing costs and availability of suitable marketing channels and infrastructure.

Consideration of locational aspects can have an important impact on extending produce availability and reducing gluts. A country the size of Australia or one with diverse climates such as Colombia, has sufficient variation to ensure potato harvest throughout the year. Smaller countries can be as successful. Thailand, for example, can grow onions in three different areas within an altitude range of 800 metres. This provides three different harvest times which, when combined with simple types of post-harvest storage, permits onion availability for nine months of the year.¹

¹ Wills, R. H. "Fruit and Vegetable Marketing," unpublished study prepared for FAO.

2. Economically Viable Loss Reduction

The application of known technology and infrastructure could, theoretically, reduce losses in the post-harvest system to practically nothing. Unfortunately, it does not follow that such technology should be applied or that such infrastructure should be built. In certain cases there may be social benefits (e.g. food security) which can be used to justify uneconomic post-harvest interventions. However, the guiding principle of all loss-reduction activities should really be that the assumed benefits through reduced losses, higher quality or higher prices must exceed the costs of the proposed improvements by a factor sufficient to justify the risk. As actors in the post-harvest system, whether farmers or traders, are usually economically rational, any attempt to maximise loss reduction without reference to economic criteria will be doomed to failure.

Estimation of costs of improved handling, storage, etc. is, perhaps, compared with estimation of benefits, easier to carry out. Care must be taken, however, to ensure that estimates of likely usage of improved facilities are reasonable. For example, with horticultural produce, will it be possible to fill a new cold store or will it only be used at 25 percent of capacity? Will new plastic containers be used once a week, or once a month? It is also essential to consider the impact on other marketing costs of changed post-harvest practices. A store may reduce losses but its location may increase transport costs unacceptably. A new form of packaging may improve produce quality but the packaging may be more difficult to handle, so increasing handling costs. Again, with plastic containers, what will be the cost of returning the containers to the farm? Such calculations require a detailed knowledge of the operations of the marketing system.

Estimation of benefits is somewhat more difficult. The calculation of losses, and hence loss reduction potential, is fraught with difficulties. Many figures for losses are estimates rather than actual measurements and are often based on extrapolations from small samples. With grains, a survey of on-farm or trader stores immediately before the next harvest may well show high levels of infestation. However, as infestation builds up over a season, the average levels are much lower.¹ Grain drying improvements, if not accompanied by improved on-farm storage, may result in more grain reaching the market soon after harvest, so depressing prices.² Higher returns which may result from longer grain storage durations must be set against the cost both of the store and of the capital tied up in stocks, as well as the cost of possible quality losses. Even if calculations show a positive return, certain other aspects need to be taken into account. A farmer, for example, may have immediate cash needs such as school fees and government taxes, and may not be able to consider long-term storage. A trader may be unable to raise sufficient finance to tie up part of his operating capital in stocks. To address some of these problems, several Asian countries have recently introduced variations of a "Paddy Pledging Scheme" which permit farmers and traders alike access to credit, with security provided by crops deposited in bonded warehouses.

With horticultural produce, the benefits of improved quality are difficult to quantify. Moreover, low-income consumers may not repay emphasis on improved quality as they

¹ Bourne *op cit*

² Cardino, A. "Market needs for grain drying in the Philippines," in Young, R. H. and MacCormac, C.W. Market Research Needs for Food Products and Processes in Developing Countries, IDRC, Ottawa, 1982

may simply be unwilling to pay more for a nicer appearance; produce appearance is relatively unimportant if the fruit or vegetable is going to be cooked. For a poor consumer, a tomato which is to be used in a soup is almost as valuable squashed as a perfect salad tomato. For this reason handling improvement activities for horticultural produce must generally be targeted initially at the top end of the market where there is a greater awareness of and willingness to pay for quality. It seems sensible to work with traders supplying supermarkets rather than with those selling in ordinary urban markets.

An analysis of seasonal price patterns should be used to identify the advantages of medium to long-term storage in terms of higher prices.¹ However, the impact on seasonal price variations if a large number of farmers or traders start storing for longer periods should be considered.

In theory, a post-harvest improvement can be introduced, regardless of cost, as long as that cost can be recovered from the market and no other, more cost-effective, solution is available. In practice, the most complex system is not necessarily the most cost-effective one. Where possible, improvements should be relatively simple and low cost, ensuring that farmers, rather than technology suppliers, receive a significant proportion of the consumers' expenditure. For small grain stores, for example, simple improvements to make existing structures proof against rats and vermin and to facilitate the application of insecticides may be more appropriate than the construction of new, more sophisticated stores.² It is unfortunate that this approach is not always adopted in developing countries, where officials seem to gain status from managing shiny new facilities, even if they are underutilized, and where equipment suppliers and donors are often happy to provide and governments pleased to accept unnecessarily complex structures.

A particular problem facing those trying to improve post-harvest handling by small farmers is that those farmers often see no correlation between improved handling and market returns. An individual, small farmer practising improved techniques will receive no benefit if his produce is going to be bulked up into a larger consignment with the crops of others, particularly if the trader is not applying any form of quality control. In some countries an approach has been adopted which involves promoting downstream marketing ventures by small farmers.³ If, for example, a farmer retains his interest in a crop during processing (e.g. rice milling), both the relationship between handling and quality and the potential financial benefits become clearer.

Benefits of improved post-harvest management must be capable of being demonstrated to those who are actually doing the marketing. For horticultural produce, the quality benefits of improved post-harvest handling techniques often only show up at the retail stage, or when the consumer gets the produce home. If consumers suddenly find they can keep fruits for 3-4 days instead of the previous 1-2 days they may, over time, be prepared to pay more for those fruits. However, this price response will not be

¹For a good example of this in the case of potatoes, see Booth, R. H. and Shaw, R. L. "Principles of Potato Storage," International Potato Centre, Lima, Peru, 1981.

²see "Handling and Storage of Food Grains," Agricultural Services Division, FAO 1970 for a full description of various types of stores.

³ see Booth, Toet and Bevan, *op cit*

immediate and, meanwhile, it is unlikely that the marketing system will reward farmers and traders for improved handling. Again, improvements which are introduced at the top end of a consumer market are more likely to achieve success in the short term and, thus, demonstrable benefits to the marketing system.

Many modern post-harvest techniques for horticultural produce are expensive, requiring a high initial investment, often in imported equipment. They also require highly trained staff and managers and immediate access to spare parts and skilled technicians. Thus, while there is a clear need to develop improved technologies such technologies should not, as a general rule, be significantly more advanced than the general level of technology in a society. As an example, cool chains require specialised refrigerated stores close to the production areas to remove the crops' field heat, as well as refrigerated vehicles. Produce, once stored in refrigerated containers, should then be refrigerated all the way to, and in, the retail shop. The cost can usually only be justified when an integrated chain is established, when there is a highly developed infrastructure (good roads, reliable electricity), when there is a skilled workforce and, most importantly, when there are consumers prepared to pay a high price.¹

It was noted in the beginning of this Section that there may be occasions when the social benefits from post-harvest improvements may outweigh purely economic calculations. At the subsistence level, for example, standard cost/benefit analyses may not always be applicable. A family's response to high food losses may be to eat less; on the same basis reduced losses may lead to increased consumption, with positive nutritional benefits, rather than increased sales to the market which produce economic returns. At the national level improved food storage may offset precarious food supplies by reducing losses. However, the foreign exchange cost of building the storage facilities can often exceed the foreign exchange savings on food supplies which no longer have to be imported.² Such calculations take no account of the lead time required to import food but they do illustrate the need to consider carefully the relative options before decisions to invest in expensive post-harvest infrastructure are taken.

¹ This point and others in this paper are highlighted in "Horticultural Marketing--a Resource and Training Manual for Extension Officers," AGS Bulletin No. 76, FAO, 1989. Chapter 6, "Eight Common Mistakes in Horticultural Marketing," identifies areas in which frequently proposed solutions to problems are often misguided.

²an argument made by Reusse, E. in "Marketing Aspects to the Development of a Food Loss Reduction Policy," a paper presented to an Expert Consultation held in Monrovia, Liberia, Oct. 1976

3. Post-Harvest Improvements and the Marketing System

(a) Produce Standards

Except for grain drying, efficient post-harvest handling cannot usually compensate for poor initial produce quality. The control of produce quality before it enters the marketing system is therefore vital. One way to encourage farmers to improve the quality of their production is through the enforcement of buying standards. Legally enforceable purchase standards can normally only be imposed by state buying agencies. Most such agencies operate standards but experience great difficulty in enforcing them at the buying-depot level. Lack of trained staff and a shortage of grading equipment often combine with an emphasis on maximising quantity purchased and a lack of any incentive for depot managers to be too fussy over the qualities they accept, to defeat the best-drafted standards.

With the gradual reduction in the role of grain marketing boards and the increased role for private traders, it becomes increasingly unfeasible for official controls to be implemented at the point of first sale. However, in countries where grain trading has been in the hands of the private sector for many years, traders have often developed extremely sophisticated unofficial standards which govern the prices they are prepared to pay to farmers. Post-harvest improvement activities should therefore aim to create an awareness amongst traders of the consequences of buying poor initial quality produce and of the need to impose more rigorous buying standards.

Attempts have been made to introduce horticultural produce standards in developing countries, but these have often failed as a result of a lack of recognition of the nature of the market and the marketing system. Where the bulk of consumers is relatively poor, use of elaborate standards of quality, size and maturity can be counterproductive. It may lead to higher consumer prices and an increase in food loss as the result of the inability to sell produce which fails to meet necessary standards. It needs to be recognised that quality requirements of the market are affected by demand and supply. At times of shortage consumers will accept qualities which would not be acceptable in times of surplus; at all times, consumers with little money to spend are unlikely to be overly concerned with the size of the produce or whether it has physical blemishes.

In Africa, in particular, the marketing of horticultural produce is conducted by a large number of traders handling relatively small quantities. Under such circumstances useful, legal standards may be difficult to introduce or, more importantly, to police. Where standards are felt to be necessary they must be framed to allow marketing at all quality levels to satisfy all consumer groups. Standards are most effective where they are simply a codification of existing informal market practices, or where they are aimed solely at the top end of the market. Standards for horticultural produce to be sold through supermarkets may benefit both the consumer and the farmer; standards applied to local retail or street markets may benefit neither.

A related issue is the question of grading. Grading never improves quality, it merely separates qualities and only on the basis of size. As noted elsewhere, it is a common and recurring belief that technology will, in itself, solve problems. Greater improvements can

be perhaps achieved through improved management and more attention to initial produce quality. For example, FAO was recently approached by a Near East country seeking to establish sophisticated lines to grade and pack for retail sale, in the belief that this would lead to higher quality for the consumer. However, the horticultural marketing board was implementing no quality control when purchasing from the farmer, and any improvements in post-harvest quality would have to commence at that initial stage of the marketing chain.

(b) Storage

The tendency to see technological solutions to post-harvest problems, while failing to consider economic, social and management aspects, is all-too-apparent in the case of storage. There are many examples of stores constructed with the best of intentions that now lie idle or are used for other purposes. For example, in the 1960s in Peru the Government constructed large forced-air stores in an attempt to regulate supply and price of potatoes. A combination of high storage costs, potato collection difficulties and bureaucratic problems combined to defeat this aim. The stores have never served their intended purpose and some are now used to store rice and milk powder.¹

A common view is that, in times of oversupply, produce can be held in storage and marketed when price rises occur. However, much horticultural produce is only suitable for short-term storage, i.e. a few days or so. This is rarely long enough for prices to rise; when produce is brought out of store it may have lost freshness and quality and has to compete with fresh produce. Prices received may be reduced and storage costs are incurred. Although produce is often stored to avoid it being sold at a loss, it sometimes ends up being sold at an even greater loss.

Many cold stores constructed at wholesale markets to store local produce end up being used solely to store imported fruits awaiting distribution.² Storage of many domestically produced perishable crops is usually inconsistent with marketing practices which involve the daily selling of fresh produce on consignment. Traders are rarely prepared to tie up funds in stored produce unless there is a clear opportunity to increase their income. Relatively few crops are suitable for long-term storage. These include potatoes, carrots, onions, citrus and pome fruit. Only that part of the harvest required to satisfy future demand should be stored. If too much of the harvest is stored and subsequently released on the market, prices received may not cover the high cost of storage. Cold stores can be expensive, not only because of the high initial investment costs, and high maintenance and fuel costs, but also because their seasonal use means that average capacity utilisation is often low.

Storage of all crops needs to be considered in the light of possible alternatives. For example, an FAO consultant who visited the former South Yemen to advise on long-term onion storage concluded that storage was not the problem. The problem stemmed from the government's practice of offering farmers the same price for onions throughout the year, thus providing no incentive for off-season production. The pricing policy was

¹ see Rhoades, R. et al "Traditional Potato Storage in Peru--Farmers' Knowledge and Practices," International Potato Centre, Lima, Peru, 1988.

²see Abbott, J.C. "Marketing Improvement in the Developing World," Marketing and Credit Service, FAO, Rome 1986

reviewed and farmers started to produce onions year round, significantly reducing the need for storage.

Successful use of stores of any type requires an ability to integrate them into a working system that maximises market return but minimises costs. Use of sophisticated grain silos, for example, works best when the silos are part of a total bulk handling system. Delivery of grain to and collection from silos in bags may cause greater losses than the savings which result from storage in silos. Location is a vital aspect; poorly located stores can result in higher transport costs, or increased damage to produce during transit, offsetting the benefits of storage. The storage of grain for marketing to towns can, for example, be carried out in rural areas. However, care must be taken to ensure that stores are located close to all-weather roads so that stocks can be transported during the rainy seasons. Storage is an area which particularly repays attention to management aspects. Efficient use of existing stores through effective logistics planning can often reduce the need for new store construction.

With increasing liberalisation in the marketing of basic foodgrains, particularly in Africa, many of the larger stores constructed by or for government marketing parastatals are now inappropriate. While some of these will be used to house food security reserves, others may, at least temporarily, go unused. Most traders are presently relatively small-scale and are unable to utilise efficiently large stores or silos built for marketing board operations. Few traders have the capital to undertake long-term storage or to contemplate the necessary investment in good-quality storage facilities. The implications of grain marketing liberalisation for food loss prevention are therefore that there may need to be an increased emphasis on farm-level storage, to enable farmers to take advantage of seasonal price changes, together with increased attention to the needs of traders for small-scale stores.

(c) Processing

When prices are low because of overproduction a common political response is to suggest that a processing plant should be established. Excess supply is the worst of all possible reasons for processing food at factory level. Governments of Colombia and several Central American countries, for example, responded to export-quality banana surpluses by setting up processing plants to convert bananas to alcohol. The economic feasibility of such plants was never examined.

Profitable processing industries cannot be based on the occasional supply of raw material when the fresh market is glutted. Horticultural processing requires expensive investment in machinery; idle time at a factory must be minimised and this cannot be achieved if produce supply is seasonal. Moreover, to be successful a factory must have a guaranteed supply of raw material at a price which will enable it to compete on the market. This may be difficult to achieve; farmers who demand processing facilities when prices are low will be the first to sell to the fresh market if prices rise, even if they have a contract with the factory.

No factory should be established unless the demand for the processed product is clearly identified and that product can be sold profitably. Market assessment is usually, and unfortunately, the least thoroughly elaborated element of a feasibility study. Complicated calculations to ascertain the likely "Internal Rate of Return" are often carried out with demand assumptions which are based more on wishful thinking than on any

realistic analysis of sales potential. Considerable benefits can be achieved, however, when a clearly identified market for a processed product coincides with the availability of the raw material. An example is the use of surplus cassava in Colombia to produce shrimp food.

Attention has been paid in recent years to the development of village-based processing. Improved processing of root crops, (e.g. gari in West Africa) and more efficient, and labour-saving, methods of milling grains have been promoted. Similarly, attempts have been made to develop rural processing of fruits and vegetables in the form of jams, chutneys, fruit leathers, tomato puree, etc. Where such processing is designed solely to preserve crops which would otherwise be discarded, so that they can be consumed after the fresh season is over, few problems can be envisaged. Indeed, this is an area which would appear to justify much additional support. However, if village-based processing is seen as a way of developing cash incomes for rural areas then market surveys are needed every bit as much as they are needed by factory-size operations.

(d) Packaging

New packaging should not be introduced without considerable research into the role of packaging within the marketing system. It should not automatically be assumed that packaging improvements can reduce losses economically. In Thailand, for example, cabbages are transported in bulk from the north of the country to the southern border with Malaysia. Significant weight losses are experienced before the vegetables reach the consumer because each time the cabbages are handled some outer leaves are stripped off. In this way the cabbages provide their own inexpensive packaging material. This permits bulk transport and transport costs to be held to manageable levels. In all societies, leafy vegetables have their outer leaves stripped off in preparation for retail sale, as this is often preferred by consumers. Theoretically this represents a food loss but, in reality, the removal of outer leaves often increases the value of the product and only serves to bring forward by one stage the practice of consumers in their own homes.

It is often assumed that the quality of packaging is the cause of post-harvest problems, but this may not be the case. More important may be how the packaging is handled in the marketing chain. Existing containers may be overfilled, poorly stored or otherwise misused. Truckers and market authorities, for example, often charge on a per piece basis rather than on a weight basis, so encouraging overfilling of perfectly adequate packaging. Jute sacks used for grain marketing are, if sound, very suitable for the job. However, losses still occur when they are thrown from trucks, dropped from the tops of stacks, lifted with hooks or otherwise mishandled. Thus a thorough investigation of the marketing system may identify improvement measures which reduce losses and are easier and cheaper to implement than packaging changes. Improved management at all stages of the marketing chain can be promoted through various training activities; as noted elsewhere this implies the development of marketing extension services and the identification of traders' groups as vehicles for training activities.

Many factors need to be taken into account in developing appropriate packaging. These relate to the type of produce to be marketed and the effect of packaging on it, to any post-harvest treatments to be applied (e.g. cold storage), to the distance from market, the type of transport and the weather conditions en route, to the type of consumer aimed at and to the wholesaling and retailing methods. New packaging proposals must take note of the current type of packaging used and of market preferences, of the size of container

required and of whether containers will be disposed of or used again¹. Packaging must complement the handling system and methods of transport and storage used. In Nepal, for example, much horticultural produce is carried on peoples' backs. As the packaging is designed to fit backs it would not be sensible to introduce boxes. It is pointless to design a technically acceptable package which is not acceptable to market operators. It makes even less sense to design a package which will cost more to use than the benefits in terms of losses prevented and improved quality.

Containers produced from locally-available materials will normally be more appropriate than those which depend on imported supplies. Cardboard cartons may be required by an export industry but they may not be suitable for most domestic markets at present. Most cartons can only be used once; they require considerable investment in manufacturing facilities and the continued importation of raw materials. Plastic containers are generally considered ideal for fruit and vegetable marketing but they are only likely to be economically feasible if the marketing system can be organised to return them for multiple re-use. In Yemen, farmers are increasingly using plastic crates to take produce to the wholesale markets, with considerable benefits in improved quality. However, many of these benefits are lost when the fruits and vegetables are transferred at the market to containers provided by the retailers. It has yet to prove possible to integrate the plastic crate into the entire marketing chain. Plastic containers may need to be used at least twenty times for them to be financially viable but achieving this may be difficult. They are prone to theft, as the Malaysian Federal Agricultural Marketing Authority discovered; two years after it introduced plastic containers 40 percent could not be found.² Any container, even a simple jute sack, may have a resale value and this needs to be acknowledged when setting deposit charges, etc. Whatever the type of material used for packages, the supply both of the raw material and package must be assured. Breakdown in supply of packaging is a frequent cause of losses. However, ensuring supply may require storage which, of course, puts up costs.

It is rarely desirable to try to introduce new packaging throughout the entire marketing system in one go. An approach which is more likely to be rewarded with success is to first work with leading farmers and traders. A pilot operation with the more-dynamic members of the trading community will, if seen to offer immediate benefits, be picked up by those traders and, in time, copied by others in the marketing system. In many countries market traders form informal associations. It is often a good idea to work with these as they can provide the focus for training in packaging, handling, etc.³

Gaining acceptance of an innovation, whether in packaging or any other post-harvest area, is probably the most difficult task facing projects which seek to reduce food losses. Too often, expensive and time-consuming research is wasted because those conducting the research fail to involve the farming and trading community from the outset. Frequently, people with the skills to design technology do not have the skills or personality necessary to enable them to work closely with farmers or the trading community. This factor needs to be recognised at project design stage if post-harvest projects are to be successful.

¹ Wills, R.H. *op cit.*

² *Ibid.*

³ Booth, Toet and Bevan, *op cit.*

(e) Demand Conditions

Improvements in post-harvest management may be justified when prices are high but not when the market is glutted. Thus it is feasible that different types of post-harvest handling will be applied for a particular type of vegetable, depending on the season. Similarly, the appropriate handling system for a particular crop will inevitably vary from country to country, depending both on the marketing system and on demand factors. Where a product has high status considerably more care will be justified than when it is seen as a day-to-day product.

In tropical Latin America, for example, plantains are used by the café and restaurant sector. Processed, they are used as snack foods in restaurants as a substitute, for example, for potato chips (crisps). Good-quality handling for such utilization is therefore justified. In Africa, on the other hand, plantains have not achieved this level of sophistication, being more or less a daily staple. Improved handling, even if it were possible to introduce, may not be rewarded by increased prices.¹

A similar situation applies to the use of flours other than wheatflour in bread baking. Where there is an economic incentive to introduce such flours (e.g. where wheatflour is expensive or where government legislation requires it) attempts to improve the quality of flours processed from, e.g. cassava, will be justified. This appears to be the case in parts of Latin America where various mixes for tortilla-like foods are widely available. In Africa, on the other hand, with the recent exception of Nigeria, the policy and/or economic environment has not justified significant investigations of processing techniques because the cost at which such flours can be supplied to bakers exceeds the cost of imported wheatflour.

(f) Securing the Supply of Inputs.

The need to ensure that the supply of packaging is uninterrupted has already been stressed. There are, however, many other inputs required for efficient post-harvest management. These include pesticides for grain storage and various chemicals which are applied to fruits and vegetables to delay the development of rot, etc. Encouragement to farmers and traders to adopt such chemicals is pointless unless there is a marketing system in place which can ensure timely delivery to rural areas. Developers should beware of successful results which are based on a project supplying the necessary inputs; if no provision is made for efficient input marketing after the project is completed the results will not be sustainable. Often, the cost to the farmer of making frequent visits to the nearest town to purchase pesticides can offset the benefits of using improved storage techniques.² Indeed, if the introduced technology is totally dependent for success on the availability of chemicals, post-harvest losses could actually increase if the chemicals cease to be available. In those many developing countries where foreign exchange availability is a constraint, the supply of post-harvest inputs may well be jeopardized.

¹ see Creupelandt, H. "Basic food crop marketing and prevention of post-harvest food losses," in Report of the Regional Workshop on National Programming and Inter-Country Cooperation in Prevention of Food Losses, Dakar, Senegal, 1985

² see "Prevention of Post-Harvest Food Losses--A Training Manual" *op cit*

'Inputs' also include simple building materials such as cement, galvanised sheeting and wire netting. Development projects which have been successful in demonstrating reduced losses also need to ensure the development of adequate marketing arrangements for such products. From an early stage it is desirable to establish contact with input traders. The same applies to manufacturers of equipment such as portable threshers. A concern of any post-harvest improvement activity is to ensure there is a sustainable capacity to produce and market such equipment and that the benefits to farmers of using it are such that they are able to pay a commercially viable price.

4. Government Involvement in the Post-Harvest System

As is noted below, governments do have many opportunities to undertake positive steps to improve post-harvest and marketing systems. These include improving rural and urban marketing infrastructure, maintaining roads, strengthening the marketing and post-harvest skills of the extension services, carrying out training and, where appropriate, providing basic market information. Unfortunately, government interventions are often not so positive.

There has been a tendency in the past to see improved marketing in terms of government taking physical control of the produce. While food security concerns may necessitate some government intervention, the widespread establishment of marketing boards in past decades is now being seen as misguided. Government involvement in marketing may well have retarded the cause of food-loss prevention; there is much evidence that farmers either sell their post-harvest problems to the state (e.g. in the form of wet grain) or pay insufficient attention to post-harvest handling because government agencies do not reward improved quality.

FAO has been consulted on many occasions by government agencies experiencing post-harvest problems. Frequently, the cause has been traced back to overproduction or to the quality delivered at the initial point of purchase. As is often observed about computers; if you put rubbish in you get rubbish out. The same applies to food marketing and no amount of expensive post-harvest handling treatment will rescue produce which is basically unsound at the start. If private traders are not rigorous in rejecting poor-quality produce, they stand to lose financially if quantity or quality losses show up while produce is in their hands. This does not normally apply to depot managers of cooperatives or parastatals. In fact, such managers may be rewarded for increasing purchases, with no regard to the quality of the additional purchases.

Pricing and other legislation can also disrupt marketing systems. Announced prices for foodgrains often have little significance if the parastatal lacks the funds to purchase more than a small proportion of the crop. Traders who are unable to compete with the announced prices may withdraw from the market, leaving considerable quantities unsold and in danger of being lost.

On-farm storage can play an important role in national food security but government policies often discourage this. The application of pan-seasonal prices for grains, i.e. the same prices throughout the season, runs counter to market principles and encourages farmers to sell all their crop at harvest rather than invest in improved storage and drying techniques and wait for later price rises. There is also no incentive for traders to store. Having to buy a high proportion of the crop within a short period places great pressure on marketing boards and may be seen as a factor contributing to high losses. Pan-territorial prices, i.e. the same price throughout a country, introduced for egalitarian reasons, encourage production in remote areas. This can increase marketing costs and lead to losses because of the difficulty of evacuating large quantities from such areas.

Many governments operate legislation against inter-provincial movement of foods, particularly grains. This makes it difficult for traders to exploit price differentials in different parts of the country and may mean that stored produce is losing quality in one area while there is a shortage in another. Of course, government regulations tend to be widely ignored; evasion, however, has costs in terms of increased transport costs, bribes, etc.

which all add to marketing costs and the final price to the consumer. Other restrictive legislation can include control of transport rates. Where official rates are seen as unprofitable by hauliers the rates are either ignored or result in high food losses due to the hauliers' failure to lift produce from rural areas.

Despite recent changes brought on by the arrival of Structural Adjustment Programmes (SAPs), there remains considerable residual hostility to the private sector both within governments and their bureaucracies. Its role in providing spatial and temporal food availability frequently goes unacknowledged, as does the fact that the provision of such a service can involve a high element of risk. Difficulties are often placed in the way of private traders. Many countries still view people who build up large stocks as hoarders. Because of this uncertainty regarding government policy, traders are often reluctant to invest in large stocks or in necessary storage or driers.

5. Improving Marketing Systems

(a) Better market information

Production in excess of demand, resulting in high losses, may be reduced if farmers have access to reliable information concerning market demand and price trends. If farmers are aware of seasonal price patterns they can perhaps better plan their production to schedule harvest both before prices are expected to drop and after prices start to rise again. This requires information and analysis of previous years' price trends to be made available by some Government agency. Larger farmers will probably have direct access to the agency, or will be sufficiently alert as to monitor market prices and compile their own records. Smaller farmers will, however, require assistance from the extension services with the interpretation of price data.

Daily or weekly market price information can help the farmer to decide when to harvest and, in larger countries, to decide to which markets he should send his produce. Similarly, price information permits traders to move produce from one part of the country to another to take advantage of price differences between markets. This benefits both consumers and producers and may also lead to reduced losses when surpluses in one area can be transported to another and sold at a profit.

Establishing an effective market information system (MARIS) in a developing country can run into several problems. There is always a tendency to want to introduce a system which is far too complex for the local environment. The cost of a complex system covering numerous markets is often not justified by the benefits. It is preferable to develop a MARIS which covers a limited number of markets and concentrates on obtaining price information. Later, if the system proves useful and viable it can be expanded to include new markets and to monitor quantities being sold.

Difficulties with introducing effective information systems have been well documented.¹ Considerable training of staff is required and market price enumerators may not always be conscientious, even after training. However, the main problem that such systems have to overcome is that governments and their officials rarely appreciate the value of the immediate transmission of data to farmers and traders. At one level this might lead to state-owned radio stations refusing to broadcast market prices without payment (when the information agency has no funds to pay!); at another it might mean that data gathering is seen to be for purely bureaucratic purposes, e.g. for the preparation of statistical analyses.

(b) Marketing Extension

Subsistence farmers, selling only small surpluses to the market, have limited requirements in terms of understanding how that market works. However, as farmers increasingly concentrate on the production of foods, particularly fruits and vegetables, to supply urban markets they need to be much more aware of market forces and of post-harvest practices.

¹see, for example, "Marketing Information Systems," AGS Bulletin No. 57, FAO 1986

Unfortunately, extension services, whilst usually well trained to provide advice on production aspects, normally lack knowledge of marketing or post-harvest aspects. Many agricultural colleges do not even offer courses in agricultural marketing. This is a situation which needs to be rectified if farmers are to be provided with the sort of commercially orientated advice which is necessary when producing for the market.¹

Ideally, extension workers should have some basic ability either to advise farmers on marketing aspects or on where to get the necessary information. Areas which they should cover include which crops to grow and when to grow them, how to interpret market price information and basic post-harvest handling. Extension workers should also be able to facilitate contacts between farmers and traders, if necessary encouraging farmers to work together in groups to provide sufficient quantities in one place to interest the traders. Ensuring input supply is another area where extension workers have a role to play.²

(c) Better Markets

Congested, unhygienic markets which offer poor protection from sun and rain can have a considerable impact on post-harvest losses, particularly for the more perishable produce. Additionally, congestion slows down the speed at which transactions take place and so puts up marketing costs. In a large proportion of developing countries markets are not treated as functional institutions which play an important role in the economy of the country. Rather, they are seen as revenue earners, whether for central government, municipal authorities or village councils.

It is often possible to make significant improvements to markets with relatively minor investments. However, because those with responsibility for operating markets wish to maximise their incomes in the short run, there is normally a reluctance to make investments in infrastructure or to provide efficient services such as water supply and garbage removal. While the long-term benefit of providing more functional marketing facilities may be seen in increased revenues, few urban councils have access to the necessary investment funds which are usually only provided by donors through central government. Increased attention of funding agencies to market infrastructure requirements is desirable. One encouraging trend, particularly in South America, is the construction of privately-owned wholesale/retail markets in urban areas.

Where funds do exist for public market infrastructure improvement, there is often a tendency for these to be 'overdesigned.' Care must be taken to plan the market to meet realistic throughput requirements.³

¹ FAO recently published "Horticultural Marketing-a Resource and Training Manual for Extension Officers," *op cit*, as a contribution to providing basic training materials in agricultural marketing. A companion Video is under preparation.

² for a more detailed discussion of this subject see "Marketing Extension Services for Small Farmers," AGSM Occasional Paper No. 1, FAO, Rome 1987

³this topic is covered in depth in "Planning and Design of Wholesale Markets," AGS Bulletin, FAO, under preparation.

(d) Improved Roads and Transport

The quality of roads in most developing countries represents the major constraint to improved marketing and a significant cause of post-harvest food losses. While most countries have main arterial roads of reasonable standard, feeder roads are often extremely poor and frequently impassable in rainy seasons. This can result in food grains being stored in inadequate rural depots throughout a rainy season, with inevitable consequences for food quality and losses. Where roads are passable they are often in such a bad condition that traders, or hauliers working for parastatals, are either reluctant to use them or impose high charges which can make commercial production uneconomic. Ungraded, pot-holed roads lead to produce damage in transit and cause vehicle breakdowns which, when perishable crops are being transported, can lead to the loss of an entire consignment. A truck-load of tomatoes, for example, will not last long sitting at the side of the road in 30°C temperatures.

Approaches to the improvement of road networks are beyond the scope of this paper. Procedures adopted in many countries have, however, been shown to be both inadequate and costly. While efficient road systems are often central to overall development, it is unfortunately the case that, employing existing methods, costs often far outweigh the economic benefits. More consideration needs to be given to encouraging rural communities to maintain their own roads¹ or, where possible, to transferring road-maintenance responsibility to private entrepreneurs who would work on a contract basis. Certainly, the whole question of rural road improvement merits considerable investigation.

Most developing countries suffer from a lack of transport vehicles and/or a shortage of spare parts. Where transport services continue to be provided by state organizations, or where food marketing agencies operate their own fleets, these shortages are often exacerbated by poor vehicle utilization. Increased attention to logistics planning, e.g. through the use of now widely available computer programmes, can help overcome these problems.

¹see, e.g. Mittendorf, H.J., "Improving Agricultural Physical Marketing Infrastructure through More Self-Help," AGSM Occasional Paper No. 3, FAO, Rome 1987

6. Conclusions

Planning for improved post-harvest management and loss reduction necessitates a full awareness of and willingness to research the food system. Factors such as demand, the role of marketing agents, and their profit orientation are important elements to be considered in any food system analysis.

Post-harvest improvements commence at the pre-production stage. Available market information can be used to plan which crops and varieties to grow, when to grow, when to harvest and in what quantities. Farmer support in the form of information and marketing extension services is therefore vital. Various techniques to expand seasons and hence reduce seasonal 'gluts' can be employed. Micro-climates can be used effectively to provide almost year-round availability of some crops, although care must be taken to ensure that production in remote areas is supported by appropriate marketing services.

Farmers and others operating in the marketing/post-harvest system are unlikely to accept new post-harvest techniques unless the benefits can be shown to exceed the costs by a factor sufficient to justify the risk involved. Post-harvest specialists need to be aware of methods for assessing potential benefits and costs. Optimistic assessments of potential returns need to be avoided if sustainable development is to be achieved. An awareness of the impact of post-harvest changes at one stage of the marketing chain on the efficient operations of other stages is important. Consumer requirements and the ability of the market to pay for improved quality must be borne in mind at all times. Simple improvements to the post-harvest chain are often more cost-effective than sophisticated technologies.

Although control of quality as it enters the marketing system is vital, standards for grains are often poorly implemented, particularly by government marketing agencies. Official controls of private-sector buying standards may not be desirable but governments should seek to educate traders in the benefits of quality control. Use of elaborate retail standards for horticultural produce needs to be considered in the context of the purchasing power of consumers. Sophisticated equipment to grade produce is only relevant when the initial quality is high and when consumers can afford to pay for high quality. Construction of stores is often seen as a way of overcoming produce surpluses; such construction should be carried out only after a full examination of the potential market benefits and the operation of the marketing system. Good models for such research are available. Storage is often less viable than may be thought at first; alternative approaches could be more rewarding and should be investigated. Similarly, processing of fruits and vegetables should never be seen as a solution to surpluses unless a regular, assured supply of produce and a profitable and reliable market for the processed product is clearly identified.

Packaging problems often stem less from the quality of the packaging than from the way in which it is used. This needs to be taken into account when proposals to design new packages are made. Packaging must be appropriate to the marketing system and the supply of materials for any new packaging must be assured. Similarly, the supply of other post-harvest inputs such as threshing machines and pesticides needs to be ensured both during and after the life of a development project.

Direct government involvement in marketing involving the physical handling of produce by government agencies has, particularly for fruits and vegetables, often been disastrous. Activities to promote improved post-harvest management cannot be divorced

from the context of government policy. Pricing and other policies have often discouraged post-harvest improvements. The provision of various government support services can, however, have an important positive impact on post-harvest management and loss reduction. The potential for the private sector to provide some of these services (e.g. markets, extension support to farmers through input suppliers) could be promoted. Areas requiring government support include marketing information services and the development of marketing extension skills among extension workers, as well as the provision of improved market infrastructure and rural roads.

Continued efforts to improve the post-harvest system are very much required. Such efforts need to focus both on the improvement of technology and better application of existing technology as well as on the general planning and management of the food chain. An integrated approach which recognises the interrelationship of technology and management within the context of the requirements of the market would appear to provide the best opportunity for effective post-harvest interventions in the future.

