



# Economic and marketing aspects of post-harvest handling of grains

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# 1. Introduction

## Contents

Why is it that engineers have been very successful technically with innovations in drying and storage but that in most countries of the world these innovations remain largely unadapted small and medium farmers? Could it be because farmers see no advantage in using the technology? If the traders who buy grain from small farmers pay the same price for different moisture contents there is no incentive to improve drying. If the farmer needs to sell his grain immediately after harvest to raise money, there is no reason for him to improve his storage. When there appears to be a good reason for the farmer to introduce new methods, the costs may outweigh the benefits. Even if the benefits are greater than the costs the investment required from the farmer may present him with a risk he is not prepared to take. The technologist seeks to reduce losses: the farmer wants to reduce costs.

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## 2. Grain marketing systems

### Understanding the Relationship of the Farmer with the Market

To assess the benefit of post-harvest improvements for small and medium farmers we need to know the interrelationship between these farmers and the marketing system. Farmers may sell their crop immediately after harvest, they may keep it for a couple of months or they may store it for much longer. Sometimes farmers may want to sell it later when prices are higher but feel constrained by, among other things, poor drying and storage facilities. Farmers may sell to small traders, to cooperatives, to marketing boards or direct to mills or animal feed processors. The buyers may have minimum moisture standards for what they buy; they may offer premiums for well-dried produce or they may buy all the grain at the same price regardless of moisture content and dry it themselves.

### After the Farmer

After purchase from the farmer nearly all grain is either stored or milled or

both before reaching the final consumer. There are some marketing systems where grain is purchased by traders and immediately transported to urban markets where it is sold, unmilled, to consumers. But this is rare in Latin America. Storage can be carried out by private traders, by cooperatives, by marketing boards, by millers, or by governments as food security reserves. The willingness of commercial participants in the marketing system to store will, in most cases, depend on whether it is financially attractive for them to do so. This, in turn, depends on whether there is a sufficient price spread between time of purchase and time of sale to cover the storage costs involved. Where governments actively intervene in the market this price spread may not exist. Indeed, as in some countries of the Region, government marketing boards may buy at a fixed price throughout the year. There may also be an inadequate price spread in years when harvests are exceptionally good. As government policy with regard to grain marketing changes, the patterns of storage within the marketing system will also change. Liberalisation of the market can be expected to lead to more storage by traders and by farmers.

## **Major Grain Channels in Selected Countries**

<b>CHILE</b>	
Wheat:	Farmer direct to mill Farmer to intermediary to mill Farmer to state marketing agency to mill
Maize:	<b>Farmer direct to feed processing plant</b> <b>Farmer to collection centre to plant</b> <b>Farmer to intermediary to plant</b>
Rice:	<b>Farmer to mill</b> <b>Farmer to intermediary to mill</b>
<b>COSTA RICA</b>	
Maize:	<b>Farmer to marketing board</b> <b>Farmer to wholesaler to feed industry</b>
Rice:	<b>Farmer to mill</b>
<b>ECUADOR</b>	
	<b>Farmer to mill</b>

<b>Rice:</b>	<b>Farmer to rural collection centre</b> <b>Farmer to State Marketing Agency</b>
<b>COLOMBIA</b>	
<b>Rice:</b>	<b>Farmer to mill</b> <b>Farmer to marketing board direct or through trader</b>
<b>Maize:</b>	<b>Farmer to trader</b> <b>Farmer to processor direct or through trader</b>
<b>MEXICO</b>	
<b>Maize:</b>	<b>Farmer to marketing board (90%)</b>
<b>Wheat:</b>	<b>Farmer to mill</b>

**Millers also look for a price spread to justify storage, but they have other considerations as well, such as the need to keep their mills working.**

**Storage of grains can be in bulk or in bag. The choice between the two, often**



**mistakenly made in favour of bulk, will depend on whether the capital investment can be recouped through increased efficiency of other capital-intensive equipment, such as ships, ports, railways and trucks. It will also depend on whether the rest of the marketing system operates in bag or in bulk.**

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### **3. Grain drying and the marketing system**

#### **The Incentive to Dry**

**Grain cannot usually be stored or milled unless it has been dried to acceptable levels. Thus there can be no dispute about the importance of drying. With a high moisture content grain is susceptible to mould, heating, discoloration and a variety of chemical changes. Ideally, most grains should be dried to acceptable levels within 2-3 days of harvest.**

**Farmers who store grain, either for their own use or for sale later in the season, will clearly have to dry this grain to required levels or they will suffer**

**unacceptable losses. Farmers who sell their grain immediately after harvest may, however, have little incentive to carry out proper or, indeed, any drying. The cost of drying and the resultant weight loss must be covered by the higher prices which result from doing it. Where the marketing system does not make any deductions, or only inadequate deductions,<sup>2</sup> for excessive moisture levels, there is a strong incentive to leave the grain as wet as possible as this increases the weight.**

*In many countries of the Latin American region, both small and medium farmers sell their crops to mills, feed mills or intermediaries without first carrying out drying. In Chile, for example, crops are sun dried in the Central Zone but sold moist in the South. In Ecuador, maize grown in the tropical areas is sun dried but other grains are dried by the mills. In Colombia, small farmers sun dry maize and beans but other crops, such as rice, sorghum and soya are dried by the mills or processing factories. There is little evidence in the region of any systematic implementation of moisture standards which would provide an incentive for on-farm drying.*

**While many Government marketing boards have official buying standards for**

**the grains they handle it is not uncommon for such standards to go unenforced, in part because employees receive no incentive to enforce the rules. Further, necessary equipment, such as moisture meters, is often missing. In most countries private traders do not operate formal standards and are very unlikely to use moisture meters. Where premiums or discounts occur these are normally on the basis of visual inspection, which is often very subjective.**

**Where the above conditions prevail it will prove impossible to introduce technical improvements to drying. While on-farm drying may well lead to higher milling yields or reduced mycotoxin levels this means nothing to farmers unless they receive a higher return from carrying out improved drying. This simple economic reality has to be recognised by post-harvest technologists or they will waste considerable time and energy developing driers which will never be used.**

### **The Desirability of New Technology**

**In nearly all tropical countries the most common form of drying is sun drying.**

**It is important to recognise that the sun is often all that is required. It provides an inexhaustible source of heat to evaporate moisture from the grain and in many locations the velocity of the wind to remove the evaporated moisture is at least the equivalent of the air flow produced in a mechanical drier. Thus, while there may be many circumstances where mechanical driers are desirable, e.g. when the harvest takes place in the rainy season, care should be taken not to promote expensive driers when the sun will do just as well. Post-harvest technologists need to ask whether the frequency of rain warrants investment in new techniques. It may be that all farmers require is assistance with an improved drying floor.**

**Consideration needs to be given to the possible labour displacement effect of new technology. In many countries rice mills have purpose-built concrete drying floors where drying is completed prior to storage for milling. This sun drying requires considerable labour as the paddy must be turned if it is not to dry irregularly and as care must be taken to ensure the paddy is not exposed to rain. If sun drying is replaced by mechanical drying there could be significant loss of employment among the poorer sections of the community.**

## **Who Should Operate Driers?**

**In assessing the economic viability of a new drier attention needs to be paid not only to comparing the benefits with the costs but also to where the drier should be located and who should own and operate it. Driers must be part of a logical marketing sequence. If farmers presently sell poorly dried paddy to traders who then sell it to mills who do their own drying, the introduction of a village-based drier will not be welcomed by the traders or by the mills. This, for example, would be the case in Costa Rica where rice farmers sell direct to mills. Even state marketing agencies may prefer to dry all the grain they buy and not be bothered with operating a two-tier system of pricing for dried and undried grain. The end result could be that farmers using the village drier receive the same price per kilogram for well-dried paddy as do farmers who do not do drying. Under the above circumstances it would make sense to work closely with the mills to improve drying procedures rather than introduce driers in the villages.**

## **Grain Drying and the Marketing System**

***Do farmers produce only for their own consumption or for the market?***

***If the latter, do they sell immediately after harvest or do they store first?***

***Do the grain buyers pay incentives for well dried grain or make deductions for excessive moisture levels? What is the theory and what is the practice?***

***What facilities are already available to traders, cooperatives, millers and marketing boards?***

***If new facilities are required are they best operated by the farmer, the village, a cooperative, traders, millers or the marketing board?***

**Despite significant evidence that low-cost solutions to on-farm post-harvest problems such as drying are preferable, governments, donors and post-harvest technologists continue to promote high-cost approaches in many parts of the world. Moreover, instead of seeking more cost-efficient approaches for individual small farmers the same governments, donors and technologists sometimes try to organise farmers into cooperatives or groups**

**as a means of justifying economically the use of the new technology. While pilot-scale group activities can, when supported by projects and external assistance, often be shown to be effective, it is frequently difficult to replicate the success when groups are required to function without external support. There is a great tendency to organise artificial "groups" solely for the purposes of delivering new technology; groups created in such a way are unlikely to work. On the other hand, existing cooperatives which have a proven track record can be supported to provide cooperative drying facilities and storage, as long as farmers are fully supportive of such cooperative activities and as long as a realistic assessment of economic viability is carried out.**

### **Costs versus Benefits**

**In carrying out an economic evaluation of a new drying method at village level it is essential not to overestimate the likely throughput. On the assumption that a fee which allows for full cost recovery will be charged to farmers for use of village drying facilities (this is essential for sustainability) it will probably cost them more to use a mechanical drier than to carry out sun**

**drying. Thus, if there is plenty of sun they may continue to use the traditional technique and the throughput of the drier will be reduced. This is particularly likely if the higher quality of dried grain which can result from mechanical drying does not attract a premium from the marketing system.**

**Most traditional designs of drier have been shown to be unprofitable at farm level for both small and often medium-sized farmers. Clearly, much of the grain produced in the Latin American region is grown by fairly large farmers, to whom some of the above considerations do not apply. Nevertheless, even larger farmers will only carry out drying if the marketing system is prepared to pay a premium for dried grain.**

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## **4. Storage in the marketing system**

### **Why Store?**

**Grain storage is clearly necessary. Most places have one, at best two, harvests a year while consumer demand is more or less constant throughout the year.**



**Even if they could afford to do so, it would be ridiculous to expect consumers to buy all their maize, wheat or rice at harvest time and store it in their houses for up to a year.**

**Thus the main function of storage is to even out fluctuations in supply during the crop year. However, each participant in the marketing system has his own motives for storing. Farmers may store in expectation of higher prices later in the season and traders may store for similar reasons. Millers store as much of their raw material as possible to keep their mills working throughout the year. Importers store because they may import by the shipload, and such quantities take time to sell. Governments store for food security reasons' to provide intra-seasonal storage where there are significant fluctuations in annual harvests and, sometimes, in order to intervene in the market.**

### **Understanding the Marketing System**

**Any steps to improve storage must understand why storage is carried out and, just as importantly, why it is sometimes not carried out. Numerous attempts to improve storage by farmers, marketing boards or governments**

**have not succeeded because of a failure to place proposed improvements within the context of the marketing system. To take an extreme case:**

***Country X has a very efficient marketing board which buys the entire maize crop. The buying price is set annually by the Government and does not change throughout the year. Thus farmers try to sell their crop to the marketing board as soon as possible after harvest. Nevertheless, proposals are made to improve on-farm storage, with the justification that on farm losses of the marketed crop can be reduced.***

**There have been many attempts similar to the above by post-harvest technologists, governments and donors to improve storage. There is clearly no scope for on-farm storage of grain destined for the market if sales are to a marketing board which buys at a fixed price. Brazil may be an example of this.**

**It is important not to regard the marketing system as something which is static. Particularly in recent years there have been many changes in governments' policy which require a complete rethink of storage requirements. Consider the following:**

***The Government of Country X is discussing whether to implement a programme of Structural Adjustment. One component of most such programmes is the liberalisation of agricultural markets and the closure of marketing boards. While these discussions are under way, however, a donor approaches the marketing board and offers to build new warehouses in the country's capital. The warehouses are built, the Government changes its policy and the warehouses are never used.***

### **On farm storage and the marketing system**

**Apart from storing for their own consumption requirements, farmers may also store grain for seed for the following season. For grain produced for the market they may store because they have no immediate opportunity to sell their harvest or, more likely, because they wish to hold on to their produce in expectation of higher market prices later in the season. In Colombia, for example, maize and wheat farmers store part of their production on the farm to be able to sell it when they require money. Where marketing is not controlled by the government or by a marketing board it is usual for prices to fall to very low levels immediately after harvest, and rise gradually as the**

## **season progresses.**

**However, even if there is scope for farmers to store in expectation of higher prices later in the season many, particularly the poorest, will not wish to do so. This may be because they lack suitable storage but is more likely to be because they do not have the financial resources to hold grain for several months. Governments often levy taxes or require school fees to be paid immediately after harvest and farmers are forced to sell all or part of their crop to pay these. Credit for production also needs to be repaid. Indeed, with informal credit arrangements, repayment is often made "in-kind." Farmers may need money for other activities which they consider likely to be more profitable than holding stocks of grain. Finally, farmers want to avoid risk. As the English saying goes, "a bird in the hand is worth two in the bush," which in this context can be rewritten as "money in the pocket is worth more than grain in store when the grain may be attacked by insects or the market price for grain may collapse. "**

**Thus, the relationship between the farmer and the marketing system needs to be considered in some detail when planning storage improvements. A**

**suggested Check List is given below:**

**On-farm Storage and the Marketing System**

- ***Do farmers sell within 2-3 months of harvest or do they store the crop for longer?***
- ***If the latter, is this the practice of all farmers or only some? If only some, what are their characteristics?***
- ***Are existing on-farm stores adequate for short-term storage while awaiting buyers for the grain?***
- ***What credit arrangements do farmers have? How and when do they repay their credit? What other financial needs do they have at the time of harvest?***
- ***Is the price paid to farmers fixed by the Government or does it vary according to supply and demand? Does the usual price rise over the***

***season cover the cost of the capital which would be tied up in stocks as well as all storage costs?***

- ***Is the marketing system in transition? If yes, will farmers have to retain stocks on-farm for longer than before?***
- **If the conditions appear to be right for on-farm storage, do farmers want to store?**

**If grain is only stored on the farm for a short period before being sold then only very basic storage is required. Such a situation would be unlikely to justify improved storage structures. This may be the case in much of Latin America. If, on the other hand, the functioning of the marketing system implies that there is scope for on-farm storage then the next step is to see whether such storage would be justified from a socio-economic standpoint.**

**Where countries are carrying out policy changes which promote private-sector grain traders and reduce the role of marketing boards the existing arrangement between the farmer and the marketing system will change. This**

**could have important implications for on-farm storage:**

***Country X abolishes its grain marketing board, announcing that from now on all marketing will be the responsibility of the private sector. While welcoming its new role the private trade is faced with a number of problems. Chief among these is the fact that it has no stores for long-term storage. The traders are too small to rent the mammoth warehouses formerly operated by the marketing board and, anyway, cannot persuade the banks to lend them money for stockholding. This presents farmers with a problem as, instead of having their crop bought immediately after harvest by the marketing board, they now have to wait until traders can raise enough money to buy part of their crop. Instead of selling their crop immediately, they may have to wait for nine months until all is sold.***

**Of course, the situation illustrated above is never so black and white. Marketing boards were rarely so efficient. Usually they ran out of money within a few weeks of harvest, leaving the private trade to buy the bulk of the grain. Nevertheless, in countries which are undergoing structural adjustment there may well be a forced movement towards increased village-**

**level storage, whether on the producers' farms, in stores constructed by richer farmers who act as intermediaries between the farmer and the trader, or in cooperative stores.**

### **Economics of On-Farm Storage**

**It has to be recognised that storage improvements which are technically possible will only be used by farmers if they are economically possible. When we talk of food loss prevention we should really be talking about the prevention of economically avoidable loss. But in working with small farmers it is necessary to go a step further. Small farmers will usually only introduce new technology if the perceived benefits substantially outweigh the likely costs.**

**Storage involves numerous costs. If it is to be profitable people who store grain must receive a price on sale which is significantly greater than the costs of storage added to the price they would have received if they had not stored.**



## **Annual Costs of Storage**

***The cost of the store itself (rent or depreciation/interest)***

***Labour and supervision***

***Pest control***

***Storage and spillage losses***

***Cost of capital invested in the grain***

**Even though losses may be quite a significant component of on-farm storage costs farmers are likely to tolerate quite high storage losses before making complex or expensive changes to their storage systems. Improved storage does not generally rank high among the priorities of small farmers even where the benefits exceed the costs. This is because they are usually unwilling to meet the high initial capital costs (even if credit is available) and, even more, are unwilling to take the risk involved with such an investment. Moreover, they are often unable to bear the financial cost of not selling grain at harvest.**

**Often, the benefits of new storage technologies do not exceed the costs but,**

**unfortunately, they continue to be promoted. In most places the established storage systems are usually well adapted to local conditions and losses are acceptable to farmers. Economic studies to compare different types of traditional on-farm storage have generally concluded that, while these systems result in higher losses than improved methods, their returns to the farmer are usually better than the returns from improved methods. Post-harvest technologists must therefore avoid becoming obsessed by the idea of reducing losses and instead concentrate on reducing losses in a way which is economically acceptable to the farmer. This will usually mean modification of existing structures, possibly combined with the introduction of pesticides, rather than construction of new ones.**

**In carrying out cost-benefit analyses great care must be taken not only to ensure that the estimates of costs and benefits are realistic but also that social and other considerations are taken into account. There is, for example, a great tendency to exaggerate the level of losses in all post-harvest activities, including storage. Loss levels are not easy to assess and are often a matter of guesswork which rapidly becomes the accepted wisdom. Losses must be estimated over the entire season, not just at the end of the season. There**

**may be a ten percent loss in grain stored for twelve months but most on-farm storage will be for shorter durations with, perhaps, negligible losses. Thus it is totally inappropriate to use the figure of ten percent to calculate storage benefits.**

**Costs of materials for construction are often underestimated. Labour for construction may be assumed to be free even though farmers have other, profitable, uses for their time. Further, false assumptions may be made about the availability in villages of products such as pesticides. Finally, the acceptance of new technologies will depend on who will bear the costs and who will enjoy the benefits. For example, if a new storage technique requires maize to be stored off the cob and women are required to do the shelling while their husbands benefit from higher incomes there will clearly be problems!**

### **Storage for traders and millers**

**The role of traders in cereal storage varies significantly between different parts of the world. In Latin America traders function primarily as**

**intermediaries between farmer and mill. In most African countries traders carry out very little interseasonal storage, seeking instead to make a quick profit by buying and selling. With marketing liberalisation, there is scope for traders to take over storage functions from former grain marketing parastatals. However, traders are generally constrained by a lack of capital to finance stocks. One way to overcome this problem could be for traders to deposit stocks in secure warehouses and obtain loans-with those stocks as security. FAO is presently working to develop such an arrangement for African countries. However, traders will only store if the difference between the price they can buy at and the price they sell at more than covers the cost of storage.**

**Millers generally use storage to guarantee themselves availability of raw material rather than to speculate on price rises. Indeed, it is common for them to store when storage, on its own, would be unprofitable. Storage is only part of a business activity which involves milling and distribution of the milled product. Millers must store in order to keep the mills running for as much of the year as possible and to maintain supplies to regular customers. Losses on storage are then offset by profits on milling.**

## **Planning Government Storage**

**Nearly all governments are involved in grain storage to a certain extent. The extreme case is where government parastatals continue to be responsible for the procurement, import and distribution of all grains. Other governments, while leaving grain marketing to the private sector, may wish to operate food security reserves to guard against shortfalls in supply. Yet others may wish to intervene in the market occasionally to even out extreme fluctuations in price, and they require stocks to do this.**

**Planning for new stores at the national level needs to take into account not only the quantities required but also their location. There is, in many countries, a great tendency to overestimate new storage needs, particularly where storage is carried out mainly by parastatals. Often, this tendency is encouraged by donors and government officials who see in new stores the opportunity to provide highly visible evidence that something is being done. As already noted, there is little point in providing new stores to a parastatal if its activities are to be reduced. Under market liberalisation, it may not be desirable to encourage private traders to invest in building new stores if**

**governmentowned stores are standing empty and could be sold or leased to the private sector.**

**It is not uncommon for there to be a surplus of storage capacity at some stages in the marketing chain and a shortage in others. A frequent problem with state marketing agencies is that they have too much capacity in the major consuming areas and too little in producing areas. Storage has been planned with reference to the number of tons that need to be stored but not with reference to the ability of the marketing system to rapidly move the grain from the producing to the consuming areas. In Colombia, for example, there is adequate storage in total but there are shortages in areas which have relatively recently become involved in commercial production.**

***It is probable that the most serious losses of grain have been recorded in government or parastatal storage. A typical example is Country X where for several years the Government pursued a policy of heavy subsidies to maize farmers. This policy led to surplus production every year and this had to be bought and stored by the parastatal. The length of storage and that fact that much of the maize had to be stored outside under tarpaulins led to very***

***high losses. The solution to this problem was not, however, the construction of new stores but are reexamination of the policy which promoted excessive production.***

## **Bulk versus Bag**

**If there are a large number of ordinary warehouses which remain empty around the world there are probably even more bulk silos. Governments have had a tendency to be obsessed with introducing sophisticated bulk technology but too often marketing boards have been unable to make good use of them and they have become rusting monuments to bad planning.**

**In planning silos there is a tendency to use-exaggerated estimates of the losses which could be avoided by using them. There is little doubt that for wheat, barley, maize and sorghum silos do offer the potential for reduced losses. However, whether the reduction in losses can justify the higher costs of bulk storage is often less clear. Silos are most justified where labour costs are high and where there are bottlenecks in the marketing chain. The latter usually occur where grain has to be handled in large volumes and at great**

**speed, for example at ports, railway terminals or large mills. Under these circumstances investment in bulk handling equipment can be more than offset by reduction in ship, road or rail demurrage charges.**

**The case for silos is much less convincing for long-term storage of grain, e.g. for food security reserves. Here savings in labour and bags are unlikely to cover the high capital cost of silos. Standard warehouses are generally more efficient for long-term storage. They also offer the advantage that they can be used to store almost anything when there is no grain to store, whereas silos can only be used for grain. It should also be remembered that silos can break down and require frequent and expensive maintenance. Bulk handling also needs to be part of a bulk chain. It makes little sense to operate a system of silo storage where grain is delivered in bags, stored in bulk and then rebagged for onward transport. It does make sense, if farmers are using combine harvesters, to transport in bulk from the farm, store in bulk in a silo and then transport in bulk to the mill.**

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## **5. Conclusions**



**The main themes of this paper, which I have perhaps been guilty of repeating ad nauseam, are that post-harvest interventions cannot be considered in isolation from the economic environment in which the farmer operates. Thus, as post-harvest technologists, your role is to develop improved methods which not only work technically but also work economically and make sense in the context of the marketing system.**

**To lapse, I hope for the only time in the paper, into economic jargon; post-harvest developments must be "demand driven" not "supply induced." Producers of consumer goods may easily persuade people that they want a particular item even though the consumers had never felt any need for the item before it went on sale and the advertising began. They can create a "supply induced" demand. But you cannot similarly persuade farmers that they need to install a drier or build a new store if they see no incentive from the marketing system to do so or if the investment required involves too much of a risk on their part. Your technology must be "demand driven," i.e. it must be in response to the needs of the farmers. An understanding of the economic environment in which small and medium farmers function is thus essential for successful post-harvest planning.**

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