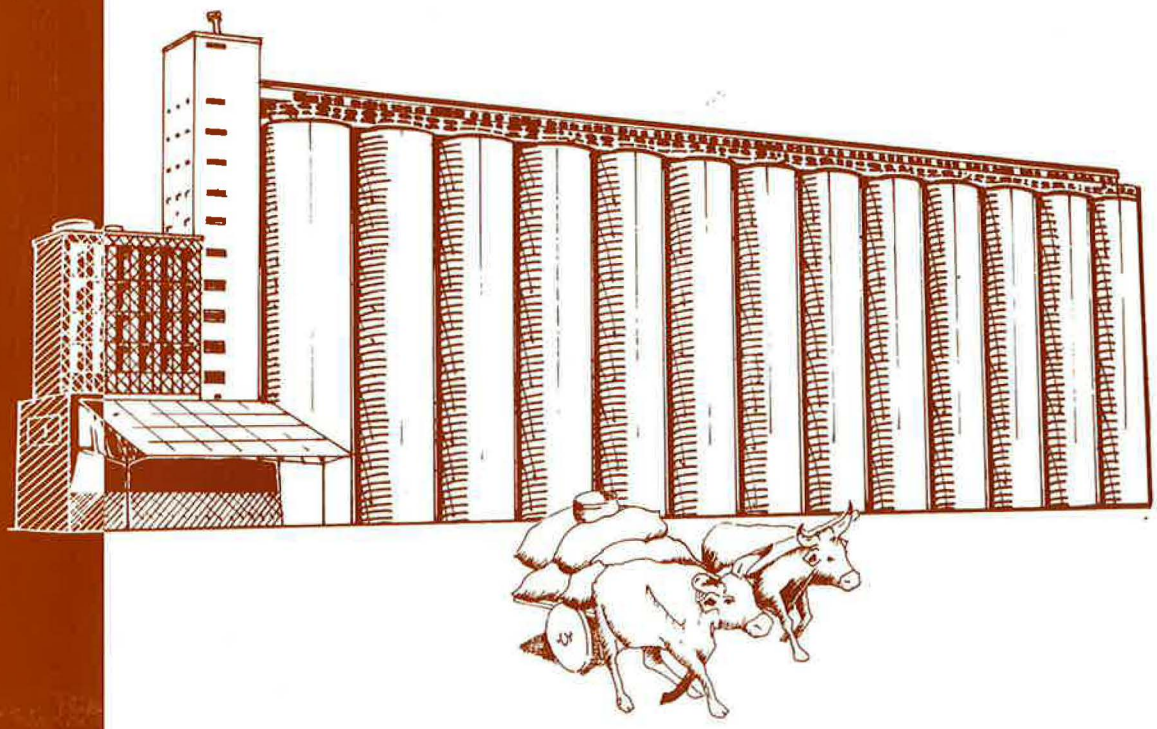
Natural Resources Institute

BAG OR BULK?
A DECISION-MAKING CHECKLIST

Bulletin No. 45



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BAG OR BULK?
A DECISION-MAKING CHECKLIST

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The Natural Resources Institute (NRI) is the scientific arm of Britain's Overseas Development Administration. NRI's principal aim is to increase the productivity of renewable natural resources in developing countries through the application of science and technology. Its areas of expertise are resource assessment and farming systems, integrated pest management, and food science and crop utilization.

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SUMMARY

This bulletin is prepared as a guide for policy makers and administrators considering economic and technical improvements to national food-grain storage and distribution. Bulk storage and handling are widely thought to be effective ways to reduce operating costs, including losses, although there are many other reasons for considering change.

The text first identifies questions leading to a decision on the feasibility of bulk handling under local conditions. The second part of the text looks for the potential economic and technical advantages of bulk handling over other systems, including upgrading of existing systems.

The principal questions are arranged in a 'decision tree' with four possible conclusions:

- bag handling is necessary;
- bag handling is preferable;
- bulk handling should be investigated further; and
- vertical bulk handling should be investigated further.

RESUME

Ce bulletin est destiné à orienter les décideurs et administrateurs qui cherchent à améliorer les aspects économiques et techniques du stockage et de la distribution des céréales de leur pays. Stocker et distribuer en vrac semblent offrir des formules efficaces pour réduire les coûts d'opération, y compris les pertes, sans parler de bien d'autres raisons d'envisager des changements.

Le texte commence par identifier les préalables d'une décision sur la factibilité de la manutention en vrac dans les conditions locales. La deuxième partie du texte envisage les avantages économiques et techniques potentiels de la manutention en vrac par rapport à d'autres systèmes, y compris le perfectionnement de systèmes existants.

Les principales questions sont disposées comme un dispositif de décision menant à quatre conclusions possibles:

- la stockage en sacs est nécessaire;
- la stockage en sacs est préférable;
- la stockage en vrac doit être étudiée d'avantage; et
- la stockage verticale en vrac doit être étudiée d'avantage.

RESUMEN

Este boletín ha sido preparado a manera de guía para administradores y encargados de la política a seguir, que estén estudiando la introducción de mejoras económicas y técnicas en el almacenamiento y distribución nacional de cereales panificables. El manejo y almacenamiento a granel son generalmente considerados como un método eficaz de reducir los costes de explotación, incluyendo pérdidas, si bien existen muchas otras razones para considerar el cambio.

En primer lugar, el texto identifica los factores que llevan a una decisión sobre la viabilidad del manejo a granel bajo condiciones locales. En la segunda parte del texto se examinan las posibles ventajas económicas y técnicas del manejo a granel sobre otros sistemas, incluyendo la mejora de los sistemas en existencia.

Los principales eguntas se encuentran distribuidos a manera de 'árbol de decisión', con cuatro posibles conclusiones:

- el manejo de sacos es necesario;
- el manejo de sacos es preferible;
- el manejo a granel debería investigarse más a fondo; y
- el manejo vertical a granel debería investigarse más a fondo.

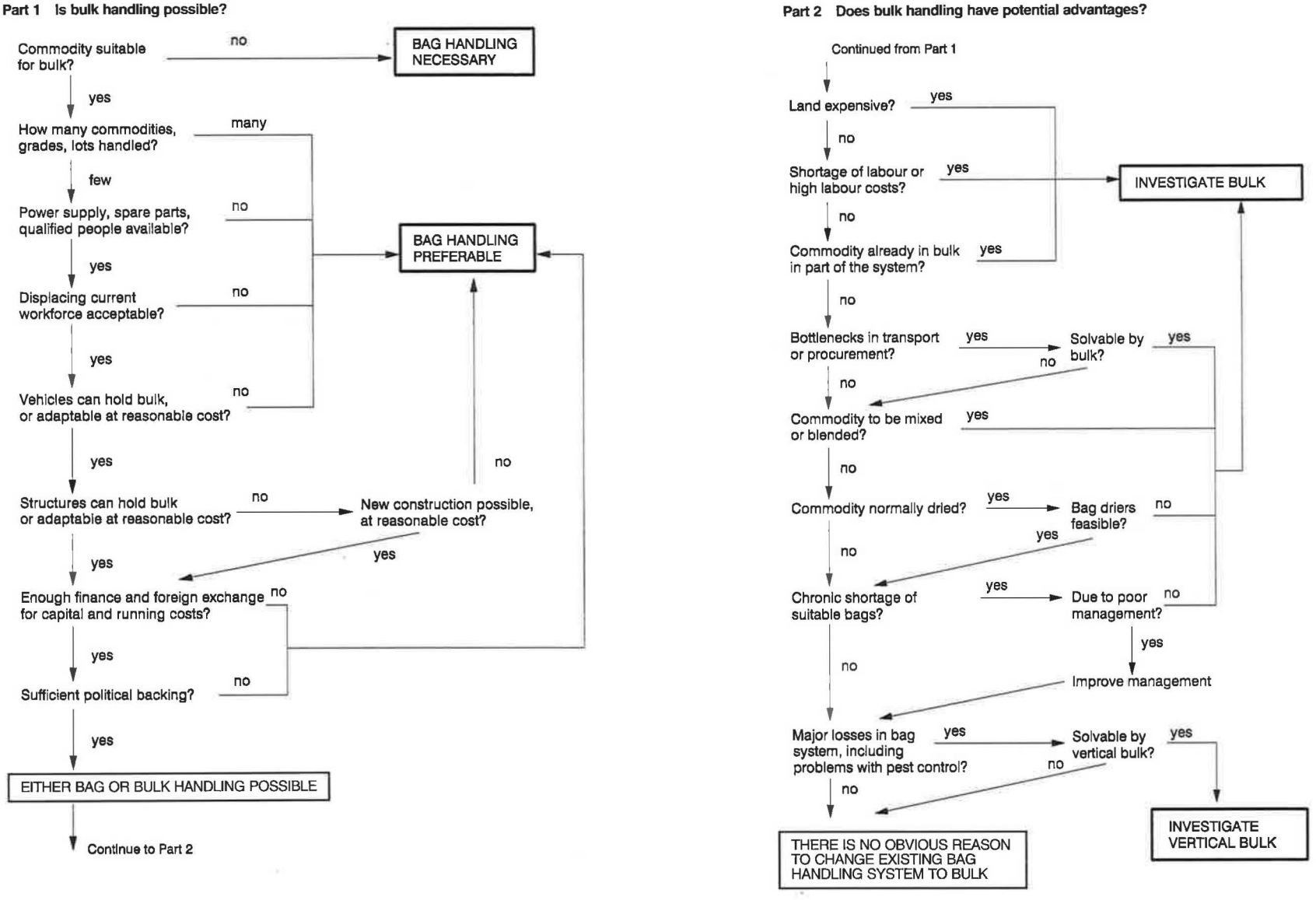

Figure 1 Decision tree for initial study of bag and bulk handling options. The decision tree is simplified from the text.

Bag or bulk?
A decision-making check list

INTRODUCTION

In most developing countries, where average farm sizes are small, food grains are usually moved and stored in bags. Grain distributors, however, frequently express an interest in changing to bulk handling because of internal pressures such as lack of suitable labour at affordable rates, and impressions that losses will be reduced; or for external reasons, such as imports being shipped in bulk. Although the introduction of bulk handling can be beneficial in the right circumstances, a failure to examine all the issues can result in the construction of isolated bulk storage complexes which do not adequately replace, or supplement, the widespread use of bags by producers, primary buyers and transporters.

There are four grain handling options:

- manually operated bag;
- mechanized bag;
- manually operated bulk; and
- mechanized bulk.

A bulk of grain is generally considered to be any amount that cannot be lifted manually. This suggests that 'bulk storage' includes everything from small farm bins to large port-side silo complexes. **Bulk storage is considered here to be an installation in which loose grain is mechanically handled**. Bulk storage structures include silos (an example of 'vertical bulk') and bunkers, sheds and clamps (examples of 'flat bulk').

This bulletin is prepared as a guide for policy makers and administrators conducting a pre-feasibility study to:

- determine the points at which decisions are to be taken;
- identify the information required to make decisions;
- prepare a framework for assessing the advantages and disadvantages of the present bag system, an improved bag system, or partial or full bulk handling;
- decide which system should be investigated further.

The pre-feasibility study should highlight major issues, for example:

- will the proposed change conform with government policy;
- can it be adequately financed;
- are there any obvious technical, logistic, economic or social reasons why change would not be acceptable?

The principal questions are arranged in a decision tree with four possible conclusions (*see* Figure 1):

- bag handling is necessary;
- bag handling is preferable;
- bulk handling should be investigated further; and
- vertical bulk handling should be investigated further.

Under certain circumstances a mixture of bag and bulk is required: for example, small-scale producers delivering bagged grain to an intermediate storage site where it is bulked for transit to silo storage; or in an animal feed store

where bulk storage serves faster moving raw materials and bags are used for products and additives.

Taking a conservative approach, questions are first asked to decide if bulk handling is possible (pp. 4-6). If there is no obvious reason to reject bulk handling, the second set of questions (pp. 6-8), which look for potential advantages, should be answered. No attempt has been made to include a cost framework, as the primary reasons for accepting or rejecting a particular system are those which are of concern. Clearly, once a system has been chosen, a final decision will depend upon financial as well as technical considerations.

PRELIMINARY CONSIDERATIONS

When considering change from apparently inefficient bag handling, one option that must not be overlooked is the improvement of the existing bag system. This may produce considerable savings without resort to massive capital investment. Alternatively, within one country, there may be several storage systems of which one or more may be suitable for conversion to bulk. It is therefore necessary to have a clear understanding of stock movement through the marketing chain.

Grain intake is commonly through a large number of small procurement centres in surplus production areas. Grain may be stored at these centres or transferred to larger intermediate stores which supply the consumption areas. In this situation, bulk stores would usually be inappropriate at the procurement centres, because of the small quantities held and the large range of commodities and grades handled. It may be appropriate to accumulate and hold stocks at district level bulk installations for regular supply and rapid movement to urban silos, where the cost and availability of land would indicate more restricted sites.

Detailed data will be required, obtained from daily receipts, despatches and stock balance at each procurement centre, intermediate store and central store in the system. From this data the storage and transport capacity can be calculated. The study will highlight problems such as shortages or surpluses at any given point, loss in value due to poor or prolonged storage, and inability to deal with variations in stock size.

IS BULK HANDLING POSSIBLE?

Is the commodity suitable for bulk handling?

Milled rice and small grains are difficult to handle in bulk. Oilseeds and cocoa have low maximum pile and filling heights and if these are exceeded the commodity will be damaged. A high level of management is needed to prevent crushing of oilseeds in augers and other bulk conveyors. Paddy rice and wheat varieties such as 'Mexipak' are abrasive, which may exclude the use of some sampling equipment and cause excessive wear to conveyors unless special components such as rubber bucket elevators are used. Milled commodities require specialized handling equipment.

Bulk storage demands grain with a moisture content of 1-2% below that of bag storage. If there are no price incentives for producers to dry grain to these lower moisture levels, it will be necessary to introduce central drying facilities. These have their own complications and may cause a grain movement bottle-neck.

How many commodities, grades and lots are handled?

Segregated storage may be prohibitively expensive in bulk, which lacks the flexibility of bag storage. For this reason seed storage is normally in bags. In Zimbabwe, bulk handling systems became less viable when grain production shifted from small numbers of large-scale producers delivering large quantities directly to silos, to large numbers of smaller producers using intermediaries.

Are power, fuel, spare parts and qualified staff available at all times and in sufficient quantities to operate and maintain bulk handling machinery?

Bulk handling is capital intensive and vulnerable to breakdowns. Appendix 1 lists problems which can occur at different points in the handling system and describes possible consequences for bag and bulk storage. A higher level of staff training is required for bulk handling, particularly in engineering skills. However, the operation of a large bag store can be equally complex in managerial terms. Appendix 2 indicates training needs and skill requirements for the activities carried out in bag and bulk stores. If the installation is powered by electricity, an adequate and reliable mains supply must be available. If the mains supply is inadequate, alternative sources should be installed.

Is displacing the current workforce acceptable?

Bag storage is labour intensive. In some situations it may not be possible to redeploy the workforce easily and the switch to bulk handling may have serious social effects. This applies not only to permanent staff, but also to seasonally employed labour. New jobs requiring higher skill levels will become available in operations, management, logistics and maintenance. Businesses required to make profits, or at least to cover costs, may try to disregard national social objectives, particularly if capital costs of new plant and machinery are not on grant or soft loan terms. Organizations may simply expect to reduce disputes between management and labour by becoming more technology orientated. Employment opportunities must be carefully analysed and the implications of redundancy assessed.

Are existing transport systems able to handle bulk or can they be converted at acceptable cost? Will converted systems be sufficiently flexible?

Transport is a crucial factor to consider. The fleet may be unsuitable for carrying bulk grain and the investment required for conversion may be unacceptable. In situations where the fleet is suitable it will be necessary to calculate operating costs and add these to storage costs. It will be necessary to define long-term availability and efficiency of the transport system, because if this is uncertain it may jeopardize the bulk storage system. Appendix 3 describes transport options and problems for bag and bulk handling.

Can existing structures be used for bulk storage, or can they be converted at acceptable cost?

If existing stores are to be converted, a structural engineer should be consulted to assess the problem. Appendix 4 describes some of the features which should be checked.

If new stores are to be built, can this be done at acceptable cost? Will the new stores be sufficiently flexible?

An important factor to consider is the scope for alternative use of storage at off-peak times or in poor seasons; vertical bulk stores cannot be used for anything but grain. Further questions arise if the decision is taken to build new stores. Is there a choice of location? If the answer is yes, a logistical study may be needed to identify optimum sites. How will unwanted structures be removed?

Will sufficient finance be available for both capital and operating costs?

Vertical bulk storage is capital intensive and may be more attractive if capital is available at low cost. Recurrent costs will include interest, operation and

depreciation. Flat bulk systems are cheaper and more flexible, but do not share the technical advantages of vertical bulk storage. A substantial amount of foreign currency is needed for spare parts and maintenance, although it may be possible to design a system incorporating locally made components. To be economically viable, bulk storage installations should be used for multiple stock turnover rather than for long-term storage. It must be shown that the structures are compatible with the storage system. A mixture of vertical and flat bulk may be appropriate in production areas where throughput is slower and utilization intermittent.

Is there sufficient political backing at all levels to make necessary policy changes?

This is an important point when determining the acceptability of change. Bulk handling may involve modifications to grading standards, reduction in the numbers of buying points and different transport requirements that will affect farmers and other political and vested interests.

DOES BULK HANDLING HAVE POTENTIAL ADVANTAGES?

If the answers to the previous nine questions are positive, then a bulk-handling system is feasible. The following nine questions look for technical and socio-economic advantages for bulk handling over other systems.

Is land expensive?

Where land is very expensive, such as in port areas or the centre of a city, space-saving vertical bulk may have an economic advantage over bag storage. This advantage is not shared by flat bulk.

Is there a shortage of labour for handling bags, or are labour costs very high?

In certain areas there may be serious competition for labour, to the extent that good storage practice becomes impossible and losses increase. Shortage of labour can result in congestion and increased demurrage charges. These costs should be assessed and analysed.

There is a case for questioning the acceptance of 90-100 kg bags commonly used in manual bag handling systems. The International Labour Organization (ILO) has a long standing (but unratified) recommendation that the maximum weight to be handled by one person should not exceed 55 kg and European Community (EC) practice is tending towards even lower weights. Converting a bag system for 'safe' working, either by reduction of the customary bag weight to 50 kg, or by mechanization, would have a very marked effect on the operation and costs of the bag system.

Does the commodity enter the marketing system in bulk? Are there other parts of the system which already handle bulk?

In many countries, the stimulus for introducing bulk handling has come from producers through the introduction of combine harvesters and bulk trailers. In other countries, the stimulus has come from bulk grain imports (*see* Appendix 5). There is clearly a case for investigating bulk handling in these instances. However, the picture is not always simple. In some countries such as Guyana where combine harvesters are used, grain is bagged off since there are few bulk trailers and fields are often inaccessible to commercial lorries. Moreover, farmers weigh the crop in bags before despatch. These factors may make a shift to bulk difficult.

Are there bottle-necks in transport or procurement which could be resolved by switching to bulk handling?

Large and increasing harvests, together with shorter harvest periods achieved with the introduction of harvesting machinery, lead to congestion in transport networks and at procurement centres. Savings in turn-round times might be possible using bulk transport, especially if delays are related to time spent in bagging grain or unloading at the store, rather than to long distances or bad roads. If parts of an existing system already use bulk, 'double handling' and additional costs might be avoided by switching to bulk handling throughout. For example, it is clearly uneconomic to put grain into bags to be transported a short distance to a miller who then empties the bags into bulk stores. The introduction of bulk transport could reduce operating costs in this situation. However, some bottle-necks in the system may be solved by introducing sack elevators or bagging machinery, rather than switching to bulk handling.

Does the commodity have to be mixed or blended before processing or disposal?

Bulk handling may be advantageous for large-scale millers, grain exporters, some feed manufacturers and others who need grain mixed to a certain specification.

Does the commodity normally have to be dried at the procurement centres?

Drying grain in bulk is usually preferred to drying it in bags. At procurement centres, grain is taken out of bags to be dried and then rebagged. Bulk handling can contribute to savings in this case. In Malaysia, an impetus for switching to bulk handling has been the introduction of a second rice crop, harvested in the rainy season, which cannot be dried on the farm.

Are there critical shortages of bags?

The introduction of bulk handling will reduce or eliminate the need for bags. However, grain bags may be very important to the local economy. In many countries, they have a re-sale value and may even end up as clothing for the destitute. It is important to investigate the secondary effects of eliminating bags from the system.

Are there problems with pest control associated with bag storage?

The use of properly constructed vertical silos will eliminate the need for fumigation sheets and may reduce the quantities of insecticide used. However, this will only be true if silos are gas tight, which demands construction to high specifications. For phosphine fumigations to be successful, bin loading must be fast and use automatic dispensers. Dispensers may not be used in slow loading silos and under these conditions gas recirculation equipment, or turning the contents of bins, should be used to control pests. Frequently, the first opportunity to control insect infestations is when the commodity reaches central stores. Larger harvests and shorter harvesting periods may mean that many months elapse before transfer of the crop in bag to central stores, resulting in losses due to insects. A bulk system may accelerate transfer and reduce losses.

Are there major losses in the bag system?

Advantages are claimed for bulk storage with respect to reducing grain losses. However, most of these are only true for vertical bulk and better results could probably be achieved by improving the existing bag system. Bulk storage in silos gives protection against rodent and bird damage, but flat bulk is probably more

susceptible to this type of damage than grain stored in bags. Good management is needed in both bag and flat bulk stores to minimize losses. The cost of periodic rodent control campaigns, and rodent and bird-proofing stores, must be taken into account. Silos are easier to secure from theft and prevent reinfestation of stocks by insects if fumigation has been carried out properly. Pilferage is minimized through accounting systems. In countries where grain is harvested at low moisture contents, the partially sealed silo environment will keep grain dry. The large areas of exposed grain surface associated with bag and flat bulk storage absorb moisture, encouraging insect and mould development. Breakage during grain movement is usually more serious in bulk than bag. It has been claimed in the United States that 'grain loses a grade every time it is (mechanically) handled'.

Grain losses in silos, as well as costs of pest control, are generally lower than those in bag storage. However, a switch to bulk storage should not be seen as a panacea for management problems. The potential for high losses and excessive costs in badly managed bulk storage is extremely serious.

CONCLUSIONS

Bulk handling may be advantageous in certain situations, but is not always feasible or appropriate. A shift to bulk has implications for finance, labour and management which must be considered at an early stage. The storage system must be seen in context: linkages to transport and procurement may be crucial factors in the success or failure of bulk. In certain cases, improvement of the existing bag system may be the best option.

The introduction of bulk handling does not necessarily imply change to a full bulk system. If a switch to bulk is recommended, the technical options for vertical and flat bulk should be examined and potential problems assessed.

If the decision tree indicates that bulk handling has potential advantages, then a multi-disciplinary team should be commissioned to conduct a feasibility study. The disciplinary skills required are engineering, socio-economics, storage management, transportation and nutrition. Objectives of the feasibility study will be to set out a strategy for bulk handling and storage to help planners assess benefits and costs and develop an implementation programme.

Appendices

APPENDIX 1 THE MOST FREQUENTLY OCCURRING PROBLEMS OF BAG AND BULK STORAGE

Pre-intake sampling

BAG – samples taken from accessible bags using sample spears.

Problem: difficulty in obtaining representative samples with this method; making more bags accessible involves restacking at the receiving point and causes delays in unloading.

Solution: there is no solution without converting to bulk.

BULK – samples obtained from the bulk delivery using a suction device or by diverting a proportion of the grain from conveyors.

Problem: none unless mechanical breakdown occurs; if this cannot be remedied, hand sampling, may have to be employed.

Weighing

BAG – vehicle weighbridges, platform scales or spring balances may be used.

Problem: hand-operated equipment can be slow and inaccurate; malpractices are difficult to avoid.

Solution: careful supervision required; frequent calibration of weighing machines.

BULK – rail or road vehicle weighbridges with automatic or manual operation; bulk cargo discharged from vessels can be batch weighed in the silo workhouse and checked against vessel displacement.

Problem: breakdown in electronically operated weighing equipment can delay unloading.

Solution: batch weigher can be used, but may not be accurate; use equipment which can be repaired on site and for which adequate spares are available.

Pre-intake sample analysis

BAG and BULK – samples may be analysed manually, or mechanically if no visual examination is needed to determine imperfections.

Problem: unloading delays if acceptance depends on grading, particularly with manual analysis.

Solution: employ simple acceptance grading and check vehicles ahead of discharge.

Unloading

BAG – all manual.

Problem: possibility of queueing and delays with unloading.

Solution: allow vehicles to enter the store and use sack conveyors; provide adequate discharge points; pack bags on pallets and move with fork-lift trucks.

BULK – use self-emptying vehicles or some form of tipping device discharging directly into the reception hopper; vessels can be discharged using mechanical or pneumatic elevators, or cranes can be used fitted with 'clam shell' grabs.

Problem: breakdowns and blockages cause long delays.

Filling the store

BAG – stack plans show optimum use of available storage space; operations may be manual or partially mechanized using barrows, conveyors, elevators and fork-lift trucks.

Problem: poor logistic planning results in delays and low capacity utilization; use of equipment may involve mechanical failure and damage to floors.

Solution: prior knowledge of deliveries permits optimum loading of the store; additional access points will reduce queueing by delivery vehicles; most equipment is simple and easily repaired or replaced with manual labour.

BULK – various types of elevators and conveyors are available, including front-end loaders for flat bulk; choose a system which is compatible with the commodity and the rate of intake.

Problem: unsuitable equipment results in delay, under-utilization and damage to equipment as well as damage to the commodity.

Solution: careful planning is essential to ensure equipment is appropriate and operators correctly trained; maintenance schedules must be planned in advance to minimize downtime; flat bulk involves simpler equipment and reduces the risk of delays due to mechanical failure.

Drying

BAG – natural drying; mechanical drying in bags; or in bulk using batch or continuous flow dryers – method depends on the weather at harvest.

Problem: sun-drying is labour intensive and commodity may need to be covered at night; batch and continuous flow drying involves double handling; bag drying is difficult to control.

Solution: where natural drying is practised, a satisfactory result is obtained using farmers' local knowledge; large quantities of produce and unfavourable weather conditions require considerable labour and expertise to achieve a satisfactory result. Mechanical drying does not fit in well with a bag handling system and would generally be employed only on high value crops such as seeds.

BULK – mechanical drying is more suited to bulk handling systems; better sampling allows pre-treatment moisture contents to be measured more accurately and monitored; driers can be part of the grain handling system and by-passed when not required; drier specifications must be suitable for local conditions; many driers are more economical when used continuously rather than intermittently because of start-up costs; batch driers may be used, but differential drying can be a problem.

Problem: over or under-drying involves cash losses and must be avoided by careful sampling, analysis and management; high levels of technical skill are required to use mechanical drying effectively.

Cleaning

Commercial grain is not normally cleaned unless the extraneous matter content is in excess of the tolerance limit set by the customer; grain intended for specific purposes such as seed will be cleaned.

BAG – if bagged grain is to be cleaned this may be combined with another operation such as repacking in standard sized bags.

BULK – many bulk installations include a pre-cleaner which can be by-passed if necessary.

Problem: dust removal represents a weight loss, but excess dust can cause explosions in silos; dust can be recovered and returned to the consignment later, but it should be noted that use of pneumatic conveyors for moving grain often involves involuntary loss of the dust fraction.

Damaged bags

BAG – second-hand bags are employed for low-value commodities and internal use. Bags can be cleaned and repaired manually or the operation can be mechanized using a cleaning plant and mechanical stitchers. All second-hand bags should be fumigated to avoid insect carry-over before re-issue.

Problem: imports of bags require foreign exchange and represent a capital investment; over supply ties up capital, and shortages cause problems in grain movement and storage.

Solution: bag shortages may be solved by on-floor bulk storage.

Spillage

BAG

Problem: every time bagged grain is moved there will be spillage, this can be swept up, sieved and rebagged; care must be taken to ensure that spillage does not become contaminated with pesticides; it is much more difficult to recover milled products and normally this spillage would be downgraded for animal feed.

Solution: grains should be rebagged as soon as possible and stock records adjusted to avoid loss.

BULK – partial failure of conveying equipment can cause large-scale spillage, particularly where high-density movement is taking place.

Problem: excessive downtime may be incurred in clearing spillage.

Solution: good planning and operational management is required to avoid spillage; attention to design detail will reduce risk and aid recovery; vacuum plant may be used for recovery.

Inspection during storage

BAG – bag stacks may be inspected visually and by obtaining spear samples.

Problem: only exposed bags available for sampling; interpretation of results to the entire stack will depend upon the skill of the inspector; inspections should take place weekly where storage conditions favour deterioration.

BULK

Problem: ability to monitor grain condition will depend upon instrumentation and ability of the inspector; thermocouples will record temperature in the immediate vicinity, but are liable to be displaced during grain movement; moisture content can also be measured during grain movement.

Solution: a thorough knowledge of grain condition at loading and the effect of silo design and climate on quality are needed to anticipate deterioration and plan management. Flat bulk is more difficult to monitor automatically and requires frequent visual inspections. Probes may be used to obtain samples, but it is difficult to relate the samples to a particular area within the bulk.

Rodent control

BAG

Problem: rodent infestations occur in rural as well as urban areas and severity and persistence are influenced by local conditions; extensive burrowing may seriously damage the fabric of store buildings.

Solution: buildings can be made rodent-proof; bait programmes must cover localities as well as stores to limit re-infestation; rubbish should be removed.

BULK – rodent infestations will occur at any bulk storage installation where there is spilled grain.

Problem: established rodent colonies will infest work areas, conveyor ducts and finished product stores and will be difficult to eradicate; rodents eat and contaminate grain with urine and faeces and can seriously damage electric circuits.

Solution: area baiting programmes must be established and, where appropriate, control by fumigation can be used; high standards of hygiene will reduce populations.

Insect control

BAG – insect damage must be held at levels acceptable to the customer; levels will vary between markets and commodities.

Problem: insect control in bag storage is concerned with eradication and prevention of reinfestation; standards of insect control in many countries are poor, because techniques are misunderstood and essential equipment and suitable pesticides are unavailable.

Solution: the accumulation of infested stocks must be avoided at all points in the food distribution system; damaged stock must be separated from clean stocks; carry-over stocks should be disinfested before new stocks are brought into store; pest control operations must be carried out efficiently and effectively and timed to prevent damage to commodities; where losses are sufficiently serious, consideration should be given to bulk storage in bins.

BULK – bulk storage in bins will give protection against insect infestation; where grain condition favours insect development and grain is infested on intake, insect damage will occur unless remedial action is taken.

Problem: silos have to be sufficiently gas-tight to hold insecticidal concentrations for a sufficient length of time to kill the insect population; many silos, particularly those of metal construction, do not meet this requirement; concrete bins deteriorate and will eventually cease to be gas-tight; fumigation is frequently carried out by automatic phosphine tablet or pellet dispensers which require bins to be filled in a short time. Recirculating infested grain, to allow fumigation, is expensive.

Solution: residual insecticides should be sprayed on to grain when silos are insufficiently gas-tight for fumigation; in gas-tight silos, both methyl bromide and phosphine may be circulated through the bins giving good penetration without turning; floor-stored bulk grain may also be fumigated with phosphine if perforated plastic tubes are sited during loading; mixing infested and uninfested grain should be avoided.

Loading and issue

BAG – sampling, quality analysis and weighing ensure that the customer receives goods which correspond to the manifest.

BULK

Problem: removing grain from gravity discharge silos can be difficult and even damage the structure if bridging occurs.

Solution: grain must be fit for storage and aeration can be used to maintain or even improve condition; augers will assist discharge and air-slide systems can be used to discharge milled products.

APPENDIX 2 LEVELS OF STAFF EDUCATION AND TRAINING NEEDED FOR THE MAIN ACTIVITIES INVOLVED IN BAG AND BULK HANDLING

Activity	Formal education*	Technical training*	Experience*
BAG AND BULK HANDLING:			
Weighing bags on platform scale	1	1	1
Using weigh-bridge	1	1	1
Pre-intake sampling and analysis (manual)	2	1	2
Operating mechanical dryers	1	1	2
Sweeping up spillage	0	0	0
BAG HANDLING ONLY:			
Carrying bags	0	0	1
Tally clerk	1	0	1
Stack building	0	0	2
Operating sack elevator	0	1	1
Operating forklift	0	1	2
Operating screening equipment	0	1	1
Restitching and repacking bags	0	0	1
Store inspection	2	2	3
Pest control manager	2	2	3
Pest control foreman	1	2	2
Pest control operator	0	1	1
Storekeeper	2	1	2
Depot manager	2	2	3
BULK HANDLING ONLY:			
Pre-intake sampling and analysis (automated)	2	2	2
Cleaning machinery	0	1	1
Electronic measurements in silo	1	2	1
Pest control foreman	1	2-3	2
Pest control operator	0	0-1	1
Silo manager	3	3	2-3
EQUIPMENT REPAIR:			
Repair of simple equipment†	0	1	1
Repair of medium equipment†	1	2	1-2
Repair of complex equipment†	2	3	2-3

Notes: *The scale of 0-3 is used to provide a rough guide to *minimum* levels of staff education and training required. To some degree, experience can be replaced by in-service training. Clearly, the levels given are highly arbitrary and impossible to define precisely, but they will be useful to assess the availability of suitable staff when planning a new system

Level	*Formal education*	*Technical training*	*Experience*
0	None	Minimal	None
1	Primary	1-year	Some
2	Secondary	2-years	Quite a lot
3	Tertiary	3-years	A lot

† Equipment can be sub-divided according to complexity:

simple: sackbarrows

medium: platform scale, sack elevators, roller conveyors, forklift trucks, cleaners, bag stitchers, spray equipment (bag); fumigation equipment (bulk)

complex: weighbridge, driers (bag or bulk); grain elevators, reclaim conveyors, sweeps (bulk)

highly complex, requiring supplier's agent: electronic equipment for sampling and measuring in silos (bulk)

APPENDIX 3 TRANSPORT

The cost of transporting the commodity should be calculated on a tonne/kilometre basis and, because requirements and conditions may differ, separate rates should be calculated for different journeys, e.g. between procurement centres and provincial stores and between provincial stores and main depots.

Road

In calculating costs for road haulage the following should be taken into account:

(a) operating costs including vehicle maintenance and depreciation (covering extra wear and tear due to poor road conditions);

(b) average length of the journey – it may be appropriate to create zones from the receiving depot if distances are variable;

(c) availability and opportunity for return loads; and

(d) average waiting times at loading and unloading points.

Rail

Railway authorities have fixed tariffs, but additional cost will be incurred if road transport has to be used from storage sites to railheads.

Availability

Shortage of transport and unreliability will increase operating costs and may be responsible for quality loss to the commodity.

Bag handling

Transport requirements are flexible since the bag is a container and multiples can be made into large or small loads to suit the type of transport available. General-purpose goods vehicles are used and have more opportunity for finding return loads than bulk grain vehicles. General-purpose vehicles can also be diverted to other loads outside the grain handling season. Poor organization of operations may involve vehicles being idle for long periods.

Bulk handling

A rapid transport system minimizing multiple handling and spillage losses should be available. Adequate quantities of commodity must be available for intake and issue to make maximum use of high-cost grain handling equipment, otherwise equipment will not generate sufficient revenue to be cost effective. The availability of suitable transport is crucial to the success of the rapid transport concept of bulk handling.

If rail haulage is to be used, there should be rail links to both the issuing and receiving bulk storage sites. Ideally, block trains of suitable bulk grain wagons should be used, but because of the high capital cost of equipment, the maximum possible number of revenue-earning journeys must be made. Excessive idle time, non- availability of locomotives, and slow speeds because of poor rail conditions may preclude the use of the rail transport system.

Road transport also requires specialist bulk vehicles, for which there may be few alternative cargoes to bulk grain. Frequent, fast trips with a minimum of downtime are needed to keep the capital-intensive bulk storage system fully operational. Increased use of the fleet may be achieved using articulated vehicles so that the tractor can be used to haul semi-trailers and a variety of cargoes. Flat-bed trucks can be fitted with removable containers suitable for bulk grain.

The transport type selected must be compatible with the loading and unloading systems.

APPENDIX 4 STORAGE STRUCTURES

Functions

Existing and proposed structures should be assessed for their suitability for the following functions:

(a) security of stocks;

(b) protecting the commodity against damage from:
- rain
- flood
- damp
- solar heating
- pests, including insects, rodents and birds;

(c) accessibility of stocks for:
- accounting
- assessment of quality
- pest control
- remedial action to reduce other forms of deterioration;

(d) maintenance of the structure; and

(e) satisfactory working conditions.

Bag stores

Bag stores may be purpose built or modified existing structures and there will be wide variation of design and suitability. Few will meet all the above requirements, and savings in construction costs should be balanced against commodity losses during storage. Security and protection against insects, rodents, birds and changes in temperature and moisture content are problem areas in bag storage; vehicles may need access if a store is to be worked in all weathers and this will involve increased costs to strengthen floors; and bag stacks occupy more storage space than the equivalent weight of bulk. If not required for bag storage the stores will have alternative uses.

Vertical bulk (silos)

Silos are purpose built in concrete or steel (and occasionally other materials such as wood) and designed to meet specific storage objectives. For example, a bulk installation in a production area could include a mechanical drier. The storage period may be six months or so until stocks are called forward to a port silo for export. There will be sufficient storage capacity to balance the rate of intake against despatch. For imports, intermittent arrivals of large quantities of grain, which must be off-loaded rapidly from ships to avoid demurrage charges, have to be balanced against regular despatches at a much slower rate.

Silos provide security, protection against insects, birds and rodents and reduce the effects of radical changes in temperature and relative humidity, but it is essential that commodities should be fit for storage.

There are no alternative uses for silos.

Flat bulk

Flat bulk sheds may be purpose built or converted from bag stores. They are less expensive to construct than silos, but provide little protection against rodents and birds, and large surface areas of grain are exposed to insect infestation and to changes in temperature and relative humidity of the surrounding air. Flat bulk grain is difficult to fumigate, although in some countries contact insecticides can be added to the grain to control insects. Suitable mechanical handling equipment must be available. If not required for flat bulk storage these structures may be used for other purposes.

An open bulkhead (also known as 'pad' or 'bunker' storage) is a temporary construction with low metal retaining walls on a suitable flat surface or a pit lined with timber, metal or concrete. The grain is permanently covered with plastic sheets and must be in a suitable condition for this type of storage. Rapid deterioration will take place if the moisture content is too high. Storage of this type gives little protection against rodents, but the cover sheets reduce attack by birds and insects. Control of insects by fumigation is difficult and contact insecticides are generally used. These structures have no alternative uses, but provide relatively inexpensive storage in areas where land values are low.

APPENDIX 5 MANAGEMENT OF IMPORTED COMMODITIES

Procedures for handling bags

Small general cargo vessels can be used to carry bagged grain, but bag handling is not common in major grain exporting countries and attracts additional costs because of slow loading and lower density stowage compared to mechanically handled bulk. Preslung pallets and on-board forklift trucks reduce loading time.

Sampling and analysis – can take place from exposed bags before and during discharge. The objective of the analysis will be to ensure that the shipment meets contract specifications and to detect damage or live insect infestation.

Shipboard fumigation – fumigants penetrate bagged cargo more evenly than bulk, but ventilation after fumigation is a problem unless the vessel is fitted with a forced draught ventilation system.

Cargo discharge – a labour-intensive operation using slings and ship derricks or dockside cranes. Spillage is a major problem. Added costs are incurred because of slow ship turn-round time and long wharf occupancy. Vessels standing off may unload into lighters when no berth is available or the draught of the loaded vessel is greater than the depth of water alongside the quay.

Port storage – general transit sheds in the port area and outdoor stacks are used for temporary storage. This operation will require local transport and an adequate supply of experienced labour. Facilities must be available for direct loading to road and rail vehicles for transport up-country or to storage facilities outside the port area.

Fumigation in the port area – fumigation, especially with phosphine, may be a problem because of interference with general store working. Properly prepared outdoor stacks can be fumigated.

Primary and secondary storage – bagged commodities can be moved directly to wholesalers or retail outlets. Mills can receive stocks from stores or directly from the port.

Options for receiving bulk at a bag-handling port

(a) Bag off on board ship.

(b) Discharge by cranes fitted with clam shell grabs, by pneumatic conveyors or elevators directly onto wharf. Bags are then filled manually or by using a bagging plant incorporating a weigh machine to give standardized bags.

(c) Specialized plant is available mounted on barges for bulk discharge.

Operations of this type are highly labour intensive (an advantage in areas where employment opportunities are limited); produce excessive quantities of spillage, dust loss and pollution; and result in port congestion.

Procedures for handling bulk

Regular high volume imports or exports justify provision of high-speed handling equipment. Purpose-built bulk carriers are used which are compatible with loading machinery at the port of origin. However, the draught of such vessels when loaded may present difficulties at the port of discharge.

It is essential that all components of the system are compatible. For example, poor forward planning causes delays and payment of demurrage on vessels; unreliable electricity supplies will disrupt grain movement; complete stoppage of the system may be prolonged if repair and maintenance facilities are inadequate.

Sampling and analysis – samples can be taken from the exposed surface of the grain. Where this has been loaded as one grade it will be more homogeneously mixed than with a bagged cargo. However, over-stowage of an inferior quality of grain will not be detected.

Shipboard fumigation – bulk vessels can be fitted with equipment for fumigating the entire cargo with phosphine. The absence of this equipment means that insects infesting the upper levels of the cargo only will be controlled because of slow dispersal of fumigant.

Port grain terminal – silos should be constructed on the quayside to avoid long distance conveying which is expensive to maintain and operate. Unloading rates can be up to 1000 tonnes/hour allowing vessels a quick turn-round. Commodities can be loaded directly to block trains and bulk road transport. Any excess of discharge over despatch can be held in the silos. Moisture and mould problems occur when low-temperature grain is off-loaded at hot, humid ports. Driers may be needed at port terminals to reduce grain moisture content to a safe level.

Fumigation – port silos can be fitted with a fumigation system so that insect-infested cargoes can be dealt with on shore rather than on board ship.

Portside mills – must have sufficient silo capacity to accommodate different grades of grain which will be blended to give an optimum quality product.

Low volume bulk

Where bag handling facilities are inadequate a modified bulk system may be employed to handle smaller or intermittent imports of bulk grain. This may be a scaled down version of a full bulk system with a slower rate of grain handling and longer periods of storage in silos. Occasional arrivals of bulk grain may be handled with improvised equipment such as port side cranes fitted with clam shell grabs and bag stores converted for on-floor bulk. However, this system is time consuming and may involve considerable spillage.

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