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A PROGRAMMED APPROACH TO FOOD STORAGE IMPROVEMENTS

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(Based upon a paper presented by P S Hindmarsh at the International Warehousing Conference, New Delhi, 1982 and reproduced here with the agreement of the conference organisers.)

Abstract

This paper discusses the problem of putting technical developments and improvements into effective practice, with particular reference to the operational management of durable crop storage systems.

Examples are given of technological improvements that require careful analysis and appropriate adaptation to permit integration into existing systems. The current approach adopted by the TDRI (TPI) in dealing with these problems overseas is described and illustrated with reference to the examples given and to a relatively simple but instructive case history.

It is concluded that experienced storage scientists have an essential role in this area.

Résumé

Cette communication étudie le problème de la mise en pratique performante des développements et des améliorations techniques, en particulier sur le plan de la gestion opérationnelle de systèmes d'emmagasinage des récoltes de longue durée.

Il est fourni des exemples d'améliorations techniques nécessitant une analyse attentive et une adaptation appropriée afin de permettre leur intégration dans les systèmes existants. Le profil actuel adopté par le TDRI (TPI) pour prendre en charge ces problèmes à l'étranger fait l'objet d'une description et d'illustrations relativement aux exemples indiqués et à une étude individuelle relativement simple mais pleine d'enseignements.

On conclut que les spécialistes scientifiques expérimentés dans le domaine de l'emmagasinage ont un rôle prépondérant à jouer à ce sujet.

Resumen

En este artículo se analiza el problema de poner en práctica efectiva mejoras y desarrollos técnicos, haciéndose especial hincapié en la dirección operacional de sistemas duraderos de almacenaje de cosechas.

Se incluyen ejemplos de los perfeccionamientos técnicos que requieren un detenido estudio y una adaptación apropiada para permitir su integración con los sistemas existentes. El enfoque actual adoptado por el TDRI (TPI) al tratar de solucionar estos problemas en ultramar se describe e ilustra, haciéndose referencia a los ejemplos facilitados y a un caso típico relativamente simple pero instructivo.

Se llega a la conclusión de que en este sector representan un papel esencial los científicos experimentados en almacenaje.

Introduction

The adoption of a technical recommendation into the post–harvest system will result in the system changing in some way. Reaction to the change will depend not only upon the technical relevance of the recommendation, but also on its indirect effect on other parts of the system. Some obstacles to implementation are commonly recognised, such

as lack of equipment and materials, shortage of technically trained staff, or lack of transport. Other constraints are more difficult to identify and may not become apparent until much time and money have been spent.

These hidden constraints are the subject of this paper. They contribute, in some cases dramatically, to the technology transfer barrier. We describe here the methods we are using to penetrate that barrier and bridge the gap between technologists and management.

The development of technological capability

A common approach by national and international organisations to the development of improved storage practices and to the problems of maintaining quality in harvested crops has been to guide those most closely involved in the day-to-day operations of handling and storage. On long-term assignments TDRI staff have achieved this by working with Pest Control Officers, Produce Inspectors, Agricultural Extension Officers and Storekeepers, feeding back some of the technical problems for home-based staff to solve. In many cases local counterparts have been allocated and perhaps expected to pick up the knowledge and experience of the adviser in two, three or, at most, five years. To accelerate the process counterpart staff and others, broadly grouped as Storage Technologists, have been given additional training to provide a thorough grounding on storage principles. They then return to their countries, to work under guidance for as long as this remains available. This approach has inevitable limitations. It is technically sound as far as it goes but the crucial step of long-term implementation is often left to relatively inexperienced technologists. Such people may sometimes need to "stand on their own feet" for a time but there may also be need for further support at a later stage. It is useful here to consider some examples of technological improvements that require careful and expert analysis with regard to implementation.

Store fumigation The concept of total store fumigation, in which an entire storage structure and its contents are disinfested by one fumigation, has been advocated and can offer many advantages if the storage structure is sufficiently gas-tight or can be effectively sealed. Otherwise, this system is generally less effective and therefore less economic than fumigation of individually sheeted bag stacks. Furthermore, repeated fumigations in conditions which do not give complete kill of the insect population may be leading to the development by insects of acquired resistance to insecticides, including fumigants like phosphine (Tyler, *et al,* 1983) which are technically very difficult to replace by new or alternative chemicals. Management decisions on the question of which fumigation system to choose are complicated by these issues and wrong decisions can be made, in either direction, in the absence of fully competent expert advice or full consultations on the many factors that must be considered.

Protection of bag stacks by physical barriers. Lightweight polyethylene sheets, left in place after fumigation, have been used to provide very effective protection against re-infestation in several countries. In a recent account (McFarlane, 1980) the technical and economic feasibility of using various forms of permanent sheeting, for this purpose, has been discussed with particular attention to the management aspects. For impermeable sheets to be used as permanent covers on stacks of bagged grain it is essential that adequate safeguards should be provided against the risks of moisture translocation and condensation which may arise from several causes. Nevertheless, with a properly planned management programme and adequate monitoring of physical conditions in the sheeted enclosures, this system can provide economically effective protection of the stored grain with minimum use of chemical pesticides. Here again, fully competent technical advice on all the factors to be taken into account is essential and this must be coupled with comprehending and purposeful management.

The use of insecticidal sprays on bagged commodities. It has been shown by various workers that layer-by-layer spray treatment of bagged commodities, as they are stacked, can give safe and reasonably effective control of insect infestation, after fumigation, if a suitable insecticide is used at the correct application rate. This method is unlikely to give complete protection against re-infestation, even when reinforced by further 'capping' sprays on the exposed surfaces of the stacks. However, the system has been applied, with satisfactory results, in some situations. A decision on whether or not the system is likely to prove both safe and sufficiently effective can only be made when several technical factors have been taken into account. These include the nature of the commodity, in particular its susceptibility to chemical contamination, the kind of infestation that is to be controlled and the level of local infestation pressure. In addition, several management issues must be considered. These include the level of infestation that will be economically acceptable in the commodity, the level of possible insecticide residue that will be acceptable in the commodity and, equally important, the level of pest-control 'interference' with routine bag-stacking operations that can be tolerated in the system. There are, undoubtedly, some situations in which all these issues can be satisfactorily resolved. However, there are many instances of storage programmes in which surface spraying treatments have been used, with very limited and possibly negligible effectiveness, because the technical and

managerial problems have not been adequately solved. Furthermore, there are many instances of the total withdrawal of such programmes, not because they are of no potential value at all but because they were recognised as being a waste of time and money in a particular set of circumstances where they could not be applied in full or where re-infestation pressures, perhaps unavoidably, were excessively high.

These examples describe improvements to large scale storage, but improvements on the small scale, at the farmer level, require equally careful attention to implementation. Hindmarsh, Tyler and Webley (1978) have discussed this problem.

A programmed approach for effective implementation

Experience and confidence are highly important qualities needed to deal with the sheer size and complexity of post-harvest systems. These qualities are acquired with time and are essential in management. There is a need to bring this maturity together with the specialised technical knowledge in such a way that both obvious and hidden constraints to implementation are identified and solved.

There is, of course, no easy answer to problems in which financial, social and political factors, in addition to technical considerations, need to be taken into account. It is possible, however, to identify a procedure which gives an opportunity for all staff concerned to voice their opinions, give support and allocate responsibilities. Constraints are then identified not by trial and error but through a programmed approach applied to each situation.

Table 1 outlines this approach. It begins with the technologist making a recommendation based upon his own specialist knowledge and his observation of the problem and its effect on the system. Representatives of all the staff concerned with local implementation have then to be identified and given the opportunity to discuss any difficulties at an early stage. This serves two purposes, it encourages a team approach to the problem and it sets out the responsibilities of each member of the team. Furthermore, an understanding among staff of the background and the new developments creates an interest which would otherwise be lacking if co-operation depended solely on following an instruction to complete one isolated part of the job. A practical recommendation can emerge from these preliminary discussions. The next step is to obtain agreement and support from all the various levels of authority responsible for this part of the system. Management support is crucial, but cannot be expected unless time has been given to discussing the changes with all those concerned, at all levels of management.

Preliminary appraisals of this type will indicate the time scale that must be placed on each step, since the major constraints will have been identified at an early stage. These contraints might be technical, financial, political, or due to lack of experience or information at one or more staff levels.

Reasons for failure of technical recommendations can be identified in a logical manner. For example, the implementation of pest control improvements is commonly attempted by the provision of more equipment and further training for Pest Control Operators. Although lack of equipment and insufficient training may be constraints that will need attention, a closer look may reveal the more basic problem of lack of commitment to the programme because of extra work load, unpleasant working conditions, or various other matters of genuine concern, some of which may greatly affect the overall economic viability of the proposed change in the system.

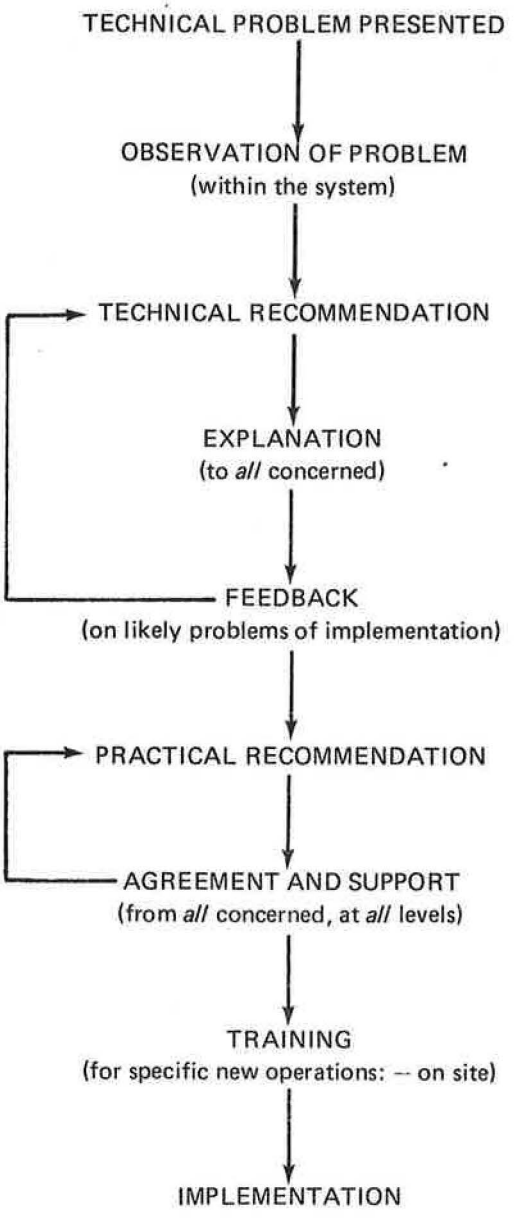
The use of the programmed approach can be illustrated by reference to a problem encountered recently. This was a relatively simple and straightforward case, but it demonstrates quite well the 'hidden constraint'.

Four new warehouses had been constructed in a major sorghum production area to hold grain over the six month rainy season. Each store was 100 metres long, 20 metres wide and 6 metres to the eaves, with a nominal capacity of 4500 tonnes. This works out at approximately 50 per cent utilisation of the store volume and would be a conservative figure when dealing with a single crop in a large store. The possibility that lack of experience in the construction of high bag-stacks might lead to serious problems was not initially recognised. Two years after the construction of the stores, management problems were still arising and additional training for storekeepers was sought. Preliminary observations showed that technical recommendations were needed on stacking methods, stack organisation, inspection and insect control.

Recommendations were prepared and presented to representatives of all concerned with local implementation: in this case, the Depot Manager, Senior Storekeeper, Pest Control Officer and Labour Contractor. It was suggested that 6 stacks should be built in each store, each stack 30 metres long, 8 metres wide and 5 metres high, giving a storage capacity of just over 5000 tonnes in each store. Discussion brought up the following points:

Table 1

A Programmed Approach to the Implementation of Storage Management Improvements



i. Labourers were not able to construct bonded stacks.

ii. Daily wages paid on the basis of each bag carried to the stack would fall as stack height increased beyond the traditional 12 layers.

iii. The pest control squad required assistance with placing fumigation sheets on higher stacks.

These constraints, if not anticipated, would be sufficient to cause the failure of the technical recommendations.

The Depot Manager needed approval from higher authority to change stacking procedures and to increase labour rates. He was able to obtain this approval, with the help of technical advice, by pointing out the increased storage capacity that would be made available, together with the reduced losses and improved working conditions. A team approach to the problem also resulted in better co-operation with the pest control squad and assistance with placing fumigation sheets. An appropriate training programme could then be developed on the foundation of full local understanding and co-operation and with the clear support of managers who had approved the change to the system, thus removing the barrier to implementation.

Further examples of the use of the programmed approach are given in Tables 2 and 3.

Table 2 Using the programmed approach in practice: Example 1 (Hindmarsh and Macdonald, 1977).

PROBLEM	Protection of high-yielding maize varieties from insect attack during farm storage.
OBSERVATION	Economically significant weight loss due to infestation by *Sitotroga cerealella* and *Sitophilus* sp. during storage.
TECHNICAL RECOMMENDATION	Application of dilute malathion powder at 10ppm on shelled maize.
EXPLANATION	As required
FEEDBACK ON LIKELY PROBLEMS OF IMPLEMENTATION	i. Insecticide not available in rural areas. ii. Some farmers wives are reluctant to admix chemicals with food grain. iii. Cost-benefit ratio not clear to farmers. iv. Maize for domestic use normally stored on the cob.
PRACTICAL RECOMMENDATION	i. Identify effective channels for distribution and sale of insecticide on pilot scale. ii. Encourage senior villagers to try the recommended method. iii. Ensure that agricultural extension staff are fully briefed to explain the advantages and benefits and to demonstrate these. iv. Construct and demonstrate appropriate alternative stores for shelled grain; ensure the availability of suitable containers at acceptable cost.
AGREEMENT AND SUPPORT	From Extension Services, insecticide supplier, village councils, etc.
TRAINING	As required
IMPLEMENTATION	i. Pilot-scale project to prove the system. ii. Expansion of project, *where appropriate,* based on pilot scale results; *with sufficient development and maintenance of all necessary inputs and services, and further supervision where necessary.*

Table 3 Using the programmed approach in practice: Example 2

PROBLEM	Protection of fumigated grain, in bagstacks, against reinfestation by insects.
OBSERVATIONS	i. Reinfestation almost immediate despite reasonably good store hygiene. ii. Surface-spraying treatments ineffective at economic application rates.
TECHNICAL RECOMMENDATION	Use of polyethylene stack-covers, on dry grain, as fumigation sheets and for subsequent protection.
EXPLANATION	As required
FEEDBACK ON LIKELY PROBLEMS OF IMPLEMENTATION	i. Control of grain moisture content at intake may be inadequate. ii. Fumigation treatments may not always be fully effective. iii. Stock inspection procedures and sampling programmes will be impeded. iv. Store workers may be exposed to greater risk due to non-airing of fumigated stacks. v. Rodent problems may be increased.
PRACTICAL RECOMMENDATION	Undertake an initial management trial on a limited but realistic scale, with all necessary inputs and programmes: e.g. i. Effective control of moisture content at intake and/or provision for ducted aeration of sheeted stacks. ii. Effective supervision of fumigation procedures and modification of these if necessary. iii. Appropriate modification of inspection and sampling procedures, together with the use of transparent sheets. iv. Provision for adequate safety checks. v. Provision of effective rodent control programmes.
AGREEMENT AND SUPPORT	From store managers, storekeepers and other workers concerned; from other supervisory agencies where necessary.
TRAINING	As required, specific to any modified management procedures to be adopted.
IMPLEMENTATION	Extended management trials, based on the results of the initial trial. General introduction *where appropriate.*

A catalyst for change

The programmed approach is used to identify the difficulties that occur in the implementation of storage improvements and to draw attention to the essential point of liaison between the technician and the manager. Each must have an understanding of the aims and objectives of the other and be prepared to adjust established procedures and technical recommendations to reach an acceptable but effective compromise.

In following up requests for assistance with in-country development programmes we recognize that conventional training of technologists in the theory and practice of storage management is not enough. An experienced assessment of the underlying problems and the background to the request, informed discussion of requirements at all relevant levels, careful identification of the target groups, preparation of an authoritative action programme, which may or may not include conventional training, and agreement to the proposals by senior officials are also needed.

This approach is generally well-accepted and there is genuine interest when Managers are included in the technical discussions. In our most recent overseas programmes we are paying particular attention to the decision-makers in management. We are discussing improvements to storage systems in one country with a group of newly recruited Depot Managers who have little or no background in storage and need first to develop their own knowledge and self confidence before moving on to discussions with other staff. In another country, we are involved in discussions with all levels of depot staff to encourage a team approach to a newly introduced bagged grain storage system. In both cases, storage principles are covered but the emphasis is on implementation and relevance to the Managers' problems. In both cases 'training courses for storekeepers' had been requested, but were clearly inappropriate or insufficient.

There is a very real need to consider technical recommendations in relation to all aspects of the post-harvest system and the experienced storage scientist has a responsibility as a catalyst in this action programme.

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