



Greenwich Academic Literature Archive (GALA)
– the University of Greenwich open access repository
<http://gala.gre.ac.uk>

Citation for published version:

Tyler, P.S. and Boxall, R.A. (1984) Post harvest loss reduction programmes: A decade of activities - what consequences? *Tropical Stored Products Information*, 50. pp. 4-13. ISSN 0564-3325

Publisher's version available at:

<http://gala.gre.ac.uk/10775/>

Please note that where the full text version provided on GALA is not the final published version, the version made available will be the most up-to-date full-text (post-print) version as provided by the author(s). Where possible, or if citing, it is recommended that the publisher's (definitive) version be consulted to ensure any subsequent changes to the text are noted.

Citation for this version held on GALA:

Tyler, P.S. and Boxall, R.A. (1984) Post harvest loss reduction programmes: A decade of activities - what consequences?. London: Greenwich Academic Literature Archive.

Available at: <http://gala.gre.ac.uk/10775/>

Contact: gala@gre.ac.uk

POST HARVEST LOSS REDUCTION PROGRAMMES: A DECADE OF ACTIVITIES: – WHAT CONSEQUENCES?

P S Tyler and R A Boxall

TDRI Storage Department
Slough, England

Abstract

Major activities and projects undertaken in developing countries, during the past decade, in connection with post-harvest grain loss assessment and reduction programmes are considered. Initiatives taken under the main multilateral and bilateral aid programmes are described. Examples of country loss assessment and reduction projects are given and from the results some general conclusions are drawn. The relevance of the described work and the overall level of activity is appraised in relation to current post-harvest problems.

It is concluded that the prescribed methodology has worked adequately for the assessment of on-farm storage and processing losses particularly in relation to weight loss. There is a lack of proven guidelines for the commercial sector (procurement, marketing, storage and distribution). Such guidelines are needed and should embrace a wider approach which is more concerned with reducing insufficiencies in the total system.

Introduction

The degree and extent of post-harvest grain losses is widely held to be a matter of concern as also is the need to reduce loss and make improvements in the handling and storage of durable commodities. Figures commonly quoted to support remedial actions have ranged from a 10 per cent world-wide loss of cereals in storage to, for example, 35 per cent for grain losses in India after harvest and 46 per cent for sorghum losses in Nigeria (Scrimshaw, 1978). It sometimes appears that the higher the figure quoted for the loss and the more dramatic the manner in which it is presented (eg as equivalent cash value or the number of additional people who could otherwise be fed), then the more likely are the figures to be generally accepted. In reality, such figures have rarely prompted well-directed remedial action. Serious losses certainly do arise post-harvest; there is indisputable evidence even of total losses in some instances, but these tend to have been isolated incidents. Losses can be made to occur – by storing grain under experimental conditions which maximise the effects of loss-causing agents such as insects. The results of such studies may be scientifically obtained and accurate but they, like the isolated incidents, have little meaning in reality except as "worst possible" predictions. The early comprehensive review of literature on post-harvest losses by Howe (1965) and the later one by Adams (1977) clearly showed that much of the data on the extent and types of losses was not particularly meaningful, up to those dates, and certainly did little to assist identification of foci for loss reduction programmes. Adams also referred to the paucity of information from the commercial sector of storage and pointed out that few field surveys of losses had been concerned with the evaluation of implemented post-harvest improvements.

In the 1970's, determined efforts were started to stimulate more realistic understanding and appreciation of post-harvest losses. A significant and oft-quoted trigger for the increased activity was the 1975 Resolution of an Inter-departmental Sub-Committee of the VIIth Special Session of the United Nations General Assembly which committed member states to reduce post-harvest food losses by 50 per cent by 1985. The Sub-committee reviewed the available information on losses and concluded that "there can be no agreed single figure for the percentage of post-harvest losses on a global scale or even on a national basis" and that there was a need "for more accurate assessment of these losses, to establish firm justification for the introduction of measures to reduce them". A decade or so later it is timely to consider how the commitment to reduce loss has been faced and what results and benefit can be seen from the effort expended.

Promotional activities

The initiative for stimulation and encouragement of loss assessment and reduction activities has been taken up strongly by the major aid organisations. In addition to significant multilateral support, many donors have mounted bilateral programmes. A non-exhaustive list of activities is given below.

Multi and bilateral aid commitment and support. By far the largest donor agency activity has been the Post Harvest Food Loss (PFL) Trust Fund Programme administered by FAO. The FAO procured from its member governments some twenty million dollars for an action programme for the prevention of food losses giving priority to the reduction of losses of staple food crops. Aimed particularly towards the rural poor the Action Programme included provision for food loss assessment surveys and practical assistance to combat losses.

The World Bank has provided support for three different kinds of activity relating to the post-harvest system but all feature the reduction of losses as one of the objectives. The activities include major loans for the construction of storage and handling facilities and provision of related infrastructure; assistance aimed at improving the nutrient intake of malnourished families or the incomes of small-scale, low income producers and, thirdly, support for economic and technical research, particularly at the international research centres. This has included loss assessment and a thorough examination of possible intervention strategies that might be justifiably introduced on the grounds of economic soundness, cultural acceptability and administrative feasibility.

The United Nations University, through its World Hunger Programme which was initiated in 1975, has focussed attention on the significance of post-harvest food losses in developing countries and, through fellowships, has provided for the training of key persons in this field in developing countries.

The International Foundation for Science has also sponsored research workers in developing countries to undertake studies relating to post-harvest loss reduction within the programme for research on food crops.

The Group for Assistance on Systems relating to Grain After-harvest (GASGA) has taken a major coordinating role in loss assessment and loss reduction work. The member organisations (FAO, IRAT, IDRC, KSU, CSIRO, KIT, GTZ and TDRI) have each undertaken or supported specific activities and many of these are referred to below.

The European Development Fund has supported loss reduction activities in the various countries which are signatories of the Lome convention.

International Conferences and Seminars. Not all can be mentioned here. Reference can be made only to a selection of the meetings held; those included have been specifically orientated towards losses and loss reduction programmes and have had significant participation by representatives from developing countries.

The Commonwealth Secretariat, Food Production and Rural Development Division has sponsored a series of five regional meetings held in Accra, Lusaka, Trinidad, New Delhi and South Pacific between 1978-1983. Each has served to provide a platform for country delegates to identify food loss problems and the possible solutions. The Agence de Cooperation Culturelle et Technique together with GASGA organised a similar meeting in Mali in 1979 attended by delegates from West Africa, particularly the francophone countries.

In 1978, TDRI hosted a major conference in London entitled "Introducing Food Loss Assessment Studies into Loss Reduction Programmes". This was attended by delegates from 31 donor and technical agencies.

FAO organised several regional workshops, for Africa, Asia and Latin America with the object of studying post-harvest losses and their reduction. The Association of the South East Asian Nations (ASEAN formally SEARCA) and the West Africa Rice Development Agency (WARDA) have provided regional workshops which have considered post-harvest losses. Other meetings have been arranged by the Asian Productivity Organisation (APO) in the Philippines and the UK Institute of Development Studies (IDS) in India. The United Nations University, World Hunger Programme, sponsored meetings concerned with post-harvest loss reduction in both India and Japan.

Major publications. In mid 1976, the American Association of Cereal Chemists (AACC), with a grant from the US Agency for International Development to the League for International Food Education (LIFE), began to assemble a methodology for assessing post-harvest grain losses with the emphasis at the farm level. As a result of this initiative a manual (Harris and Lindblad 1978) was published to provide the means whereby post-harvest losses might be

estimated, in a standardised and meaningful way, so that effective grain loss reduction efforts could be undertaken in developing countries. The authors recognised that, because of the enormous variability of local post-harvest systems, no single definitive loss assessment methodology for all situations would be practicable. Nevertheless the manual has served usefully to provide guidelines to meet a wide variety of requirements.

The Board on Science and Technology for International Development of the National Academy of Sciences, Washington, has stimulated expert participation and contributions to discussions on post-harvest food losses in developing countries. This has resulted in the publication of a report intended to pinpoint the most appropriate ways of allocating AID funding (NAS 1978). Similarly GASGA produced "Priorities for Action in Grain Post-Harvest Loss Reduction (Anon. 1978) in which they sought to indicate how donor organisations and developing countries could both plan effectively to increase the availability of cereals and other commodities.

The TDR (TPI) journal Tropical Stored Products Information devoted a special issue (No. 36, 1978) to a TPI Seminar on Post-Harvest Grain Losses. Since 1979 the journal has published 13 other papers relating to post-harvest loss assessment. Several TDR reports have been published detailing the loss assessment methodologies employed in studies undertaken in Zambia (Adams and Harman, 1977), Malawi (Golob, 1981) and Nepal (Boxall and Gillett, 1982).

The report of the Indian Grain Storage Project 1974-78 (Boxall, et al, 1978) described an approach to loss assessment adopted in villages of Andhra Pradesh and, in its recommendations for loss reduction, paid special attention to the social implications.

Loss assessment activities within the FAO PFL programme were critically reviewed by Schulten (1982). He made general recommendations on the approach to be adopted for the assessment of losses during harvesting, transport, stacking, threshing, cleaning, drying and storage.

Training courses. In-depth training in post-harvest loss assessment methodology is provided within formal courses which are given at the TDR Storage Department, Slough, UK and the Food and Feed Grain Institute of Kansas State University, USA. These two appear to be the only established, regular courses available although numerous workshops serving country-specific or regional needs have been held.

Other information sources. Written information on losses, in addition to the major publications mentioned above and the reviews by Howe (1965) and Adams (1977), include bibliographies of literature relating to post-harvest losses (NAS, 1978) and to grain processing losses (Kasasian and Dendy, 1979). All of the various organisations mentioned in this paper and, probably, a number of others are likely to be able to respond to requests for further information. Particular mention may be made of the KSU documentation service which includes a post-harvest index and abstracts.

Loss Assessment and Reduction Projects

Methodologies employed. The methodologies adopted within loss assessment and reduction projects have been based extensively on that suggested in Harris and Lindblad (1978). This manual detailed the techniques available for the measurement and interpretation of losses during threshing, drying, storage and milling for the major cereal grains and those arising from a range of specific causes including insects, moulds and rodents. Surveys, sampling and interpretation of results are also included. A major difficulty experienced in compiling this methodology was that the authors necessarily drew heavily on experiences gained from developed countries and limited specific examples from some developing countries. A detailed knowledge of the wide variety of systems in which assessments would be attempted was not available and consequently the difficulties encountered in applying the methodology could not be foreseen. Furthermore, techniques which, prior to inclusion in the manual, had been thoroughly researched in one developing country with the local crop were often found to have limitations which made them location- and crop-specific. For example, methods applicable to the measurement of maize storage losses in Zambia were not applicable in Malawi, Nepal or Honduras. Further published contributions to the development of loss assessment methodology have been few. Golob (1981) conducted a practical appraisal of on-farm storage losses in Malawi, carefully evaluating alternative techniques for measuring weight loss. Rowley (1984) endeavoured to develop techniques to assess the losses of millet at commercial level storage in Mali. Myntti (1981) examined three PFL projects, in Yemen Arab Republic, Nepal and Pakistan in order to make a critical assessment of the socio-economic implications of the projects on the target populations and of the effects of mechanisation, choice of technology and the problem of incentive. Greig (1980 and 1981) prepared, for FAO, draft practical guides to the specific procedures

to be used to measure losses that occur during the drying, cleaning and handling of grain at farm and village level and for rice processing losses. Toquero (1981) examined the practical application of these guidelines and the methods described by Harris and Lindblad (1978) in three PFL Projects in the Asia region and prepared detailed instructions for the assessment of losses during harvesting, threshing, cleaning and drying of paddy. Several of the authors of reports on FAO PFL projects have described how loss assessment methodology has been developed to serve the needs of country projects. For example, Hernandez and Drummond (1984) adapted population measurement techniques for rodents to enable estimates of losses to be obtained in central storage in Cuba.

A new method to assess weight losses in stored grain is the Thousand Grain Mass method (TGM) described by Proctor and Rowley (1983). It aims to overcome the disadvantages of other methods which measure weight loss attributable to insect damage by comparisons between damaged and undamaged grains. Recently (Boxall 1985) has undertaken a complete review and has updated the methodology for post-harvest loss assessment at farm level. This revision, which was undertaken as part of TDRI's contribution to GASGA, is based on extensive field experience.

Selected examples of results from studies of losses at farm level are given in Table 1. Table 2 summarises the few available results from thorough studies of the post-harvest system at the farm and village level. The criteria for selecting these examples is that an acceptable methodology was adopted, is described fully and that the results represent the best estimate of loss. Table 3 indicates some of the work done in the commercial storage sector.

Table 1. Examples of comprehensive studies to measure post-harvest loss in farm level storage

Country	Crop	Period of storage (months)	Cause of loss	Estimated % loss of weight and range	Reference
Zambia	maize	7	insects	1.7 to 5.6	Adams and Harman 1977
India	paddy	7	insects, rodents, mould	4.26 ± 1.33	Boxall <i>et al</i> 1978
Kenya	maize	up to 9	insects, rodents	3.53 ± 0.25	De Lima 1979
Malawi	maize	up to 9	insects	3.2 ± 3.4	Golob 1981
	sorghum	up to 9	insects	1.8 ± 3.5	
Nepal	maize	6	insects, rodents	5.7 ± 3.2	Boxall and Gillett 1982
	wheat	3	mould	2.4 ± 1.9	
	paddy	8	insects	3.4 ± 2.2	
Turkey	wheat	8	insects, mould	3.7 ± 1.9	Boxall (pers. comm.)
Tanzania	maize	3–6.5	insects	8.7	Hodges, <i>et al</i> 1983
Swaziland	maize	unspecified	insects	3.66	De Lima (1982)
			moulds	0.53	
			rodents	0.16	
Bangladesh	raw and parboiled paddy	3–4	insects rodents	2.4 (rice equivalent) (average for 3 crop seasons)	Huq 1980
Honduras	maize	7	insects	5.5	de Breve <i>et al</i> 1982

Table 2. Examples of comprehensive studies to measure post-harvest loss at the farm and village level

Country	Crop	Stage	Cause of loss	Estimated % loss of weight and range	Reference
Dominican Republic	Paddy/Rice	Harvesting/ threshing	incomplete threshing scattering	18.1 ± 13.0	La Gra <i>et al</i> 1982
Malaysia	Paddy/Rice	Harvesting Threshing	shedding unthreshed grain on straw	1.5 9.2	Calverley <i>et al</i> 1977
Philippines	Paddy/Rice	Harvesting Handling Threshing Drying Storage Milling	undefined " " " " "	1-3 2-7 2-6 1-5 2-6 2-10	De Padua 1974
Bangladesh	Rice	Farm-level: Harvesting Field stooking Transportation Threshing Storage		1.5 0.5 0.5 1.8 2.6	Greeley 1982

Table 3. Examples of comprehensive studies to measure post-harvest losses at the commercial level

Country	Commodity	Stage	Cause of loss	Estimated % loss	Reference
Cuba	Various processed foodstuffs	Storage (3 months)	rodents	1.0	Hernandez and Drummond 1984
Cyprus	Barley and wheat	Storage (3.5 months)	insects	3.54	Tyler 1981
Mali	Millet	Storage (8 months)	insects	1.0	Rowley 1984
Dominican Republic	Paddy/Rice	Drying (Rice mill)	breakage lower grade	8.1% reduction in whole grain	La Gra <i>et al</i> 1982
		Milling	breakage	2.3% reduction in whole grain	
		Public sector storage	spillage	0.35	
Pakistan	Paddy	Market storage Wholesale storage Public sector storage Processing (milling)	various various various various	1.8 3.2 3.0-5.0 4.0-6.0	Chaudhry 1980
	Wheat	Processing	various	2.06	
	Maize	Processing	various	2.5	

Discussion and Conclusions

Promotional activities. The overall level and type of activity directed towards post-harvest loss assessment and reduction has served well to stimulate general awareness and the need to better measure and evaluate losses. Many regional meetings have been held with active participation from developing countries, donors and technical institutions. It would appear that the major initiative for work towards loss reduction has come from FAO and the technical institutions; few developing countries have instigated programmes on their own initiative: notable exceptions are Honduras and Kenya.

The many laboratory and field experimental studies of loss causing agents continue to be published. They suffer limitations in terms of the practical applicability of results and consideration of such work here is outside the scope of this paper. Although several general articles relating to loss assessment and reduction have been published, rather few detailed accounts of field projects are widely available so far. Demand for specialised training in loss assessment techniques has been met, largely through in-project training. Short courses limited specifically to this topic have not been generally available and this, in part, may be a cause of some of the difficulties encountered with the staffing and implementation of loss assessment programmes. Project leaders have necessarily had to learn and gain experience whilst implementing their projects.

Application of methodology for loss assessment. Undoubtedly the prescribed loss assessment methodology for farm level operations has aided the planning and implementation of projects. In terms of applying the measurement techniques, primarily to weight loss, the procedures are basically sound and little further refinement of this methodology is necessary (Boxall, 1985). The techniques are less adequate for the assessment of quality loss, or the socio-economic implications of loss, at farm level.

The results from nine of the ten farm loss studies, given in Table 1, show that losses appear to be fairly well contained about or below the 5% level over the storage season. The one exception (Hodges *et al*, 1983) was for losses in stored maize caused primarily by a newly established pest (*Prostephanus truncatus*) to which the farmers were unaccustomed and for which the locally traditional storage methods provided an ideal environment.

When the methodology for assessing farm level storage losses was being developed it was generally recognised that loss figures were susceptible to exaggeration if the pattern of grain removed from the store was overlooked. Grain is usually removed from store at intervals for consumption and each quantity removed will have suffered a different degree of loss since it will have been exposed to deterioration for a different length of time and allowance has to be made for this when determining the total estimate of loss. As a result of this approach overall losses during storage have been shown to be considerably lower than earlier (extreme) figures suggested and therefore the introduction of improvements to reduce such losses has been difficult to justify. However, there is a danger in accepting overall figures since the importance of high seasonal losses may be overlooked, particularly if they occur towards the end of the storage period and relate only to a small proportion of the total quantity of grain stored. Nevertheless, some farm households, particularly the poorer ones, may have no option in the hungry season but to consume this grain which may be heavily damaged by insects. In this situation it is little comfort to be told not to worry because the total storage loss for the season is low and does not justify a loss reduction programme. This situation arises because of the emphasis placed upon measurement of weight loss – as the simplest factor to measure – and it is now time, perhaps, to give more attention to other criteria for loss, such as grain quality, that are more related to ultimate objectives. A measurement of storage loss in terms of deterioration in quality (from time of storing) would be likely to result in substantially higher figures – possibly approaching the level of those whose validity was called into question ten years ago.

Experience with the loss assessment studies undertaken confirms that a prerequisite of nationwide loss reduction programmes is a firm government commitment together with the necessary infrastructure and finance. Sadly this commitment has sometimes been lacking even though a short-term commitment to support a project (eg under the FAO PFL programme) may have been made. On completion of the project, national priority has tended to shift away from the post-harvest sector, and towards, say, crop production. Under some circumstances the projects offered have been inappropriate, eg concentrating upon farm level whilst the major problems occurred at the commercial level. Again this points to lack of objectivity and the need for preliminary surveys. Ideally a degree of flexibility is required at the planning stage to accommodate later decisions on the loss reduction programme once the intervention points have been well defined.

A particularly disturbing conclusion to be drawn is that where the stated objectives may have been to assess losses, introduce remedial measures and then to evaluate the effectiveness of the programme by re-assessing losses, nowhere has this been fully achieved.

The data presented in Table 2, for studies of the post-harvest system, relate mainly to work carried out on farm and simple village level operations for which the prescribed methodology has been proved suitable. As with farm storage losses, care is required in the interpretation of measurements of processing losses. In particular, changes in moisture levels during drying may be confused with real weight loss. Emphasis has been on applying the methodology to farm and village level operations as was intended. In addition there have been a few examples where attempts have been made to use the methodology to assess losses in commercial level operations (Table 3). These have been primarily concerned with measuring deterioration due to physical, chemical and biological factors in storage. However, it is apparent that there are overriding factors, such as deficiencies of management, which defy easy quantification.

Objectiveness in loss studies. Some major shortcomings of projects have arisen during the planning stages. Objectivity has not always been clear, particularly in relation to how, once obtained, the data on losses will influence decisions on the subsequent remedial actions to be employed. Sometimes loss assessment has been undertaken seemingly only to justify a course of remedial action which has already been decided upon. It may be asked why the loss measurement was therefore required? Also, an elaborate, time-consuming and expensive programme of gathering loss data has sometimes been embarked upon when a decision on the degree of loss reduction justified might have been made on the basis of a short preliminary survey. This may be particularly true where the level of loss deemed to warrant remedial action can be predetermined. For example, if it is decided that where loss is below a certain percentage no remedial action would be justified, then some of the more efficient aspects of the post-harvest system may be excluded immediately from detailed study. The preliminary survey will also provide an insight into the possibilities for loss reduction.

In the early 1970s, when the first farm level loss assessment studies were undertaken, there was a tendency to concentrate upon the derivation of estimates of loss for the unimproved, traditional system, with little or no consideration of loss reduction. It was soon realised that this approach, in most circumstances, took too long and provided insufficient information on which to develop a loss reduction programme. Taking farm level storage as an example, it is usually possible to identify, at an early stage, improvements in store design or storage practices which could be introduced and evaluated as part of the loss assessment survey. A survey which provides information on the level of loss under existing conditions, an indication of the extent to which the loss might be reduced and an evaluation of the acceptability of new measures, is likely to be of greater benefit than one which simply describes the level of loss in the traditional system. It is, perhaps, fair comment that too much was expected of loss assessment studies; rarely have nationwide programmes of loss reduction developed as a result of a loss assessment survey. More usually, the result has been the development of locally specific programmes to promote improvements which may already have been started.

The need for a systems approach. At this point it is relevant to refer back to the methodology of Harris and Lindblad who advocated taking an early overview of the whole post-harvest system. That approach was recommended in order to understand the food grain supply system before beginning an in-depth examination with a view to measuring losses. However, the methodology they produced was designed to be applied to the on-farm sector and was not suited to detailed study of the whole system. Perhaps this limitation is reflected in the few readily comprehensive system studies undertaken. The tendency has been to direct efforts towards one component, which is identified as in need of attention, without necessarily appreciating that this, in turn, may have far reaching consequences on the system as a whole.

For example, work at the farm level has demonstrated that the traditional system is efficient but problems are created with the introduction of new high yielding varieties or multiple cropping techniques. Such innovations disturb the traditional capability to conserve grain, increase the risk of loss and may place an additional strain on procurement and marketing facilities. The farmer has to face new and intractable problems with an increased quantity of produce. The traditional handling, drying and storage systems are found to be inadequate, the characteristics of the crop are changed (often to a softer grain which is more susceptible to mould and insect damage) and the timing of harvest and subsequent operations may be switched from a favourable dry season to an unfavourable wet season. All of these factors have made the on-farm post-harvest system more vulnerable to loss. The recommendation must therefore be made that changes to traditional agricultural practices should never be introduced in isolation, but should be made after due consideration of the full implications of the change.

There is a need to integrate post-harvest loss assessment activities with Farming Systems Research which aims to link research achievements with the needs of the farmer and community by providing a realistic assessment of what changes are feasible and acceptable under existing, or changing, conditions. This would ensure that post-harvest losses are contained within the acceptable limits of the traditional system. Unless this is done, the farmer will be predisposed to sell his produce early in an attempt to minimise his losses, thereby placing an additional seasonal burden on a procurement and storage system already overloaded because it is having to cope with increased total production.

Turning to the commercial sector itself, we find few examples of loss assessment studies and most have been either insufficiently comprehensive or insufficiently complete in the results obtained. Particularly lacking are studies where losses have been evaluated in the commercial sector along with those in the farming sector in order to obtain a complete picture. A major inhibiting factor may be the lack of a prescribed methodology immediately applicable to procurement, handling and storage and distribution operations, but there may be other reasons such as the difficulty of coordinating studies that involve both the producer and commercial sectors.

One requirement is, therefore, to combine a series of measurement techniques which may be derived from experience obtained in the farm sector, together with a description of how better to evaluate the various commercial operations. A suggested approach to solving problems in commercial storage has been outlined by Hindmarsh and McFarlane (1983) who stress the overriding importance of adapting the technical developments and improvements to fit the operational management system. Such an approach can be aimed towards reducing losses to an agreed acceptable level. However, it must be realised that the implications of forcing technical change to reduce loss in one sector may only serve to exacerbate the situation in another. The plea is made, therefore, for a broader approach to loss assessment and reduction which takes account of overall policies for both food production and food distribution.

Finally, it may be appropriate to widen the consideration of loss reduction in the global context. Over the decade 1970–1980 world food output per capita rose by some 0.5%, the increase being 1.1% for industrial market economies and 1.4% for Southeast Asia (Anon. 1978). Whilst the rise may be taken as an indication of the success of policies and technological developments aimed at this production target, a further breakdown of the figures reveals the disturbing fact that production in the African continent actually fell by 1.1% over the period. In many of these countries physical losses of grain quality and quantity were overshadowed by various perturbations. The fall in production is in part attributable to natural disasters, eg the Sahelian drought, but other factors such as political instability and the insecurity caused by guerilla activities have seriously disrupted the production, storage and distribution of grain stocks. Added to this a depressed world economy has hit agricultural production and distribution through shortage of currency and credit, high prices of essential inputs (fertilizers, pesticides, fuel, etc.) and weakened transport infrastructure.

The real priority for government is to face up to the need to apply integrated policies to food production, marketing, storage and distribution. Given the present difficulties, there is a special need to make the most effective use of the resources available to ensure that the maximum amount of produce of the highest quality reaches the consumer by the most efficient means.

References

- ADAMS, J M 1977. A review of the literature concerning losses in stored cereals and pulses published since 1964. *Tropical Science* 9, (1), 1-29.
- ADAMS, J M and HARMAN, G W 1977. The evaluation of losses in maize stored on a selection of small farms in Zambia with particular reference to the development of methodology. Report G.109, Tropical Products Institute, London. 149 pp.
- ANON 1978. Priorities for action in grain post-harvest loss reduction. Group for Assistance on Systems relating to Grain After-harvest. Joint Secretariat.
- ANON 1978. World Development Report 1978. World Bank, OUP. 172 pp.
- BOXALL, R A 1985. Assessment of farm level grain losses after harvest. Report G.191. Tropical Development and Research Institute, London. (in press).
- BOXALL, R A and GILLET, R 1982. Farmer level storage losses in Eastern Nepal. Report G.157. Tropical Products Institute, London. vi + 29 pp.

- BOXALL, R A, GREELEY, M and TYAGI, D S. with LIPTON, M and NEELAKANTA, J 1978. The prevention of farm level food grain storage losses in India: A social cost-benefit analysis. IDS Research Report. ix + 239 pp. Institute of Development Studies, University of Sussex, Brighton, UK ISBN No. 0 903354 65 9.
- CALVERLEY, D J B, STREET, P R, CREE, T J and DENDY, D A V 1977. Post-harvest losses in rice in Malaysia. Paper presented at the Conference of Food and Agriculture, Malaysia. 2000.
- CHAUDHRY, MUHAMMED ASLAM 1980. Food grain losses in Pakistan. 6 Vols. University of Agriculture, Faisalabad.
- DE BREVÉ, M, RABOUD, G, SIEBER, J, PERDOMO, J A and VELÁSQUEZ, J E 1982. Proyecto Post-Cosecha. Informe sobre los primeros resultados. Ministerio de Recursos Naturales: Cooperación Suiza Al Desarrollo. Tegucigalpa, Honduras.
- DE LIMA, C P F 1979. The assessment of losses due to insects and rodents in maize stored for subsistence in Kenya. *Tropical Stored Products Information*, **38**, 21-26.
- DE LIMA, C P F 1982. Strengthening of the Food Conservation and Crop Storage Section (Ministry of Agriculture and Cooperatives). Project SWA/002/PFL Final Report, FAO, Rome.
- DE PADUA, D B 1974. Post harvest rice technology in Indonesia, Malaysia, the Philippines, Thailand: A state of the art survey. International Development Research Centre, Ottawa.
- GOLOB, P 1981. A practical assessment of food losses sustained during storage by smallholder farmers in the Shire Valley Agricultural Development Project area of Malawi. 1978/79. Report G.154, Tropical Products Institute London.
- GREELEY, M 1982. Farm level post-harvest food losses: the myth of the soft third option. *IDS Bulletin*, **13**, (3), 51-60. Institute of Development Studies, Brighton, Sussex.
- GREIG, D J 1980. Draft manual of procedures to measure the losses that occur during the drying, cleaning and handling of grain at farm and village level. FAO, Rome.
- GREIG, D J 1981. Draft manual of procedures to measure rice processing losses. FAO, Rome.
- HARRIS, K L and LINDBLAD, C J (Compilers). 1978. Post-harvest grain loss assessment methods. xii + 193 pp. Published by the American Association of Cereal Chemists, in co-operation with the League for International Food Education, the Tropical Products Institute, the Food and Agriculture Organisation of the United Nations and the Group for Assistance on Systems relating to Grain After-harvest. ISBN No. 9 913250 14 7.
- HERNANDEZ, A and DRUMMOND, D C 1984. A study of rodent damage to food in some Cuban warehouses and the cost of preventing it. *Journal of Stored Products Research*, **20**, (2), 83-86.
- HINDMARSH, P S and MCFARLANE, J A 1983. A programmed approach to food storage improvements. *Tropical Stored Products Information*, **46**, 3-9.
- HODGES, R J, DUNSTAN, W R, MAGAZINI, I and GOLOB, P 1983. An outbreak of *Prostephanus truncatus* (Horn) (Coleoptera, Bostrichidae) in East Africa. *Protection Ecology*, **5**, 183-194.
- HOWE, R W 1965. Losses caused by insects and mites in stored foods and feedingstuffs. *Nutrition Abstracts and Reviews*, **35**, 285-293.
- HUQ, A K F 1980. Some estimates of farm-level storage losses of rice in Bangladesh. *Tropical Stored Products Information*, **39**, 5-12.
- KASASIAN, R and DENDY, D A V 1979. Grain processing losses bibliography. Report G.117. Tropical Development and Research Institute, London.
- LA GRA, J, MARTINEZ, E and MARTINEZ, J F 1982. Identificación, evaluación y reducción de pérdidas de post-cosecha. Arroz en la República Dominicana. Publicación Miscelánea ICCA 358. Instituto Interamericano de Cooperación para la Agricultura, Santo Domingo, República Dominicana.
- MYNNTTI, C L 1981. A critical assessment of the socio-economic implications of FAO Prevention of Food Losses Projects in Yemen Arab Republic, Nepal and Pakistan. Report of the Prevention of Food Losses Programme, FAO, Rome.
- NATIONAL ACADEMY OF SCIENCES 1978. Post-harvest food losses in developing countries. pp 206. National Academy of Sciences, Washington DC USA.

PROCTOR, D L and ROWLEY, J Q 1983. The Thousand Grain Mass (TGM). A basis for better assessment of weight losses in stored grain. *Tropical Stored Products Information*, **45**, 19-23.

ROWLEY, J Q 1984. An assessment of losses during handling and storage of millet in Mali. *Tropical Stored Products Information*, **47**, 21-33.

SCHULTEN, G G M 1982. Prevention of food losses programme. Report on a consultancy mission on loss assessment. FAO Rome.

SCRIMSHAW, N S 1978. Global use of the instruments of scholarship for the conquest of hunger: The World Hunger Programme of the United Nations University. *Food and Nutrition Bulletin*, **1** (1), 6-14.

TOQUERO, Z 1981. Action programme for the prevention of food losses. Review of loss assessment activities of PFL projects in the Asia Region (particularly in Nepal and Pakistan.) FAO, Rome.

TYLER, PS 1981. Report on a survey of grain losses. FAO Action Programme for the prevention of food losses – Cyprus. PFL/CYP/001. Consultant's Report.