Tropical Stored Products Information (Number 36)

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Editor
Mrs S.P.D. STOKES B.Sc., M.Sc.

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PREFACE

This issue of Tropical Stored Products Information, presents the Proceedings of a Seminar on Post-Harvest Grain Losses, 'Introducing Food Loss Assessment Studies into Loss Reduction Programmes', convened by the Tropical Products Institute in London, 13-17 March 1978. The Seminar was attended by delegates from 31 developing countries and 31 donor and technical agencies.

An abstract is given of each of the technical contributions and country papers presented at the Seminar, followed by the rapporteurs' summaries, donor statements and, finally, the Seminar conclusions. The latter are presented in English, French and Spanish. The paper on 'Coordination of Loss Assessment and Reduction Work, by A A C Huysmang is reproduced in full.

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Monday am

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10.00 **Welcome and Introduction** – Mr J E Tomlinson, MP, Parliamentary Under Secretary, Ministry of Overseas Development

The Seminar Objectives – Dr P C Spensley, Director, TPI

10.30 Coffee

Chairman – M G Vallaeys, IRAT

LOSS ASSESSMENT AND LOSS REDUCTION

11.00 1. THE CONCEPT OF LOSS AND ITS DEFINITION – M J P L Deuse, IRAT
M Y de Luca, ENSAM

11.35 2. SITUATIONS WHERE LOSSES OCCUR – Mr K Harris, AACC/LIFE, USA

12.10 3. MEASUREMENT TECHNIQUES AND THEIR ACCURACY – Mr P S Tyler, TPI
Dr D A V Dendy, TPI

Monday pm Chairman – Dr K Krishnamurthy – Deputy Commissioner (Department of Food), India

14.00 4. SURVEYS IN RELATION TO THE STAGES IN THE POST-HARVEST SYSTEM – Dr G H Freeman, NVRS

14.40 5. THE DESIGN OF LOSS REDUCTION PROJECTS – Mr G G Corbett, FAO

15.20 Tea

15.50 6. CRITERIA AND METHODOLOGY FOR THE APPRAISAL OF LOSS REDUCTION PROJECTS – Prof D T Edwards and Mr Frank A Wilson, Bradford University.

14 MARCH

Tuesday am CASE STUDIES ON ASSESSMENT AND REDUCTION OF LOSSES

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b) Reducing field losses in grain harvesting operations – Mr W E Klinner, NIAE

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b. The Indian Grain Storage Project 1974-78 – Mr T M Greeley, IDS and Mr R A Boxall, MAFF (formerly IDS)

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16.00 — 5. THE POST-HARVEST SYSTEM – Mr D J B Calverley, TPI

15 MARCH

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Wednesday pm — Chairman – Mr M S O Nicholas, Commonwealth Secretariat

14.00 — Country papers

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16 MARCH

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b. research and development – Dr D de Padua, SEARCA

c. material inputs – M J Deuse, IRAT

d. finance – Mr G G Corbett, FAO

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The World Bank	–	Mr T J Goering
United States Agency for International Development	–	Mr W Smith Greig, USAID
Agence de Co-operation Culturelle et Technique, France	–	Mme Beaulieu-Gingras
International and Development Research Centre	–	Dr G Yaciuk
Commission of European Communities	–	Mr R H Bennison
Commonwealth Secretariat	–	Mr A Lynch

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19.00-20.30

17 MARCH
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Chairman – Mr D J B Calverley, TPI

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SEMINAR CLOSURE – Dr P C Spensley, TPI

Friday pm — Visit to Tropical Stored Products Centre, Slough

12.45 — Coach departs from Westminster (allowing time for delegates to stop for a snack lunch en route)

16.30 — Return coach calls at Heathrow Airport, Terminal 2

18.00 — Coach returns to central London.

Tropical Products Institute

SEMINAR ON POST-HARVEST GRAIN LOSSES

LONDON, 13-17 MARCH 1978

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WELCOME AND INTRODUCTION

by

Mr J E Tomlinson, MP

Parliamentary Under-Secretary For Overseas Development

I would like to extend a very warm welcome to all delegates both to London and to this Seminar on the Reduction of Post-Harvest Losses, organised by the Tropical Products Institute. TPI – as it is commonly known – is, as you may know, a part of my Ministry, and has a long and interesting history. Also, on the historical front, it may interest you to know that, as a meeting place this room, the Hoare Memorial Hall, is not without distinction. In the disturbed years of the 1940s when the House of Commons was out of action the Hall was used for the daily business of the British Parliament. In 1949 the inaugral meeting of NATO (the North Atlantic Treaty Organisation) was also held here and many other equally important international conferences have taken place in this room over the years.

At this Seminar we are delighted to have wide international representation. This is, of course, essential to its success. I see from the list of delegates that you represent three broad interest groups: firstly, thirty-one developing countries of the tropics and sub-tropics, secondly, the donor organisations mainly of Europe and North America, and finally, but equally important, the technical institutions who have expertise in the subject of the Seminar. The composition of the meeting therefore bodes well for a lively and stimulating exchange of views, enriched with much practical, first-hand experience of post-harvest problems. It is my belief that whilst a lot can be achieved in the formal sessions, of equal value are the opportunities that you have for exchanging views during the breaks; over coffee, lunch and in the Hotel. The Seminar provides opportunity for study and discussion of post-harvest problems particularly relating to the assessment and the reduction of losses of cereal grains and pulses. International conferences on post-harvest subjects of major interest are organised regularly by the Tropical Products Institute. Usually however the emphasis has been on technical development, better product utilisation or local or international marketing. For instance, fish and fish products, animal feeding stuffs have been topics for such conferences in the recent past. This time the intention is slightly different.

You will be looking particularly into the management aspects of the conservation of staple food grains essentially for local consumption. I suggest you should interpret the term management in the widest sense. I see it embracing the whole range of handling and storage from Central Government storage organisations through to the small scale subsistence farmer. In all sectors there is a clear need to be able to conserve grain and prevent loss although the scale of their operations and their motivation are very different.

The Ministry of Overseas Development recognises a clear need to support programmes which will provide the basic needs of the people. Of these needs, surely food is of the highest priority. Whatever is done by means of rural development schemes or urban development schemes to help improve the living standards of the poorest and notwithstanding the importance of suitable policies for adequate and suitable housing, education and health schemes, there is no more basic need than sufficient, nutritionally balanced food.

In this respect, it is necessary to distinguish between the immediate world food problem and the longer term prospects. The present world food crisis is essentially the result of bad harvests caused by unusual and widespread adverse climatic conditions at a time when world food stocks were unusually low. As a result the price of food has increased rapidly. This coincided with the sharp rise in oil prices and also in key manufactured goods such as fertilisers. The poorest of the food importing countries have found it more and more difficult both to sustain their own agriculture and to pay for the food that they need to import.

Cereal prices have this season fallen below their peak level, but future price levels are bound to be significantly affected by the increase in production costs which have occurred, as well as by increasing world demand. Because of the rapidly growing populations in the poorest countries who find themselves forced to import food, and the great need to raise their nutritional levels, their demand for food will also continue rapidly to increase. It is generally held that most of this increased requirement will have to be met from domestic production within these countries. This means that although in the short term some emphasis for those giving outside assistance must be on food aid, the focus of attention in both the short and longer terms must be on increased agricultural production in these countries and the resources needed for this.

The main aim of British development assistance policy in relation to the food needs of developing countries must be to support them in efforts to greatly increase local food production and provide for its equitable distribution. In addition, by harnessing the natural and human resources of the countryside the farmer will be making a growing contribution to the agricultural export earnings of his nation. Assistance to agriculture and especially food production is an essential part of our bilateral rural development programmes. We are supporting relevant research and exploring methods of helping agricultural investment through the multilateral agencies. Agricultural production has received, and rightly received, considerable support. In the initial stages of programmes to improve crop production dramatic increases are achieved. However, resources for increasing production are not limitless and when the best possible production levels are reached attention must be turned to the alternative ways of making more food available. This is the area where effort to reduce post-harvest losses may have greater impact on the availability of food than will a further increase in production.Increasing grain production without having the necessary expertise and capability for its post-harvest conservation is obvious folly. To be able to conserve grain without loss is vital in countries where large quantities of grain are being put into food security resources as a buffer against crop failures. At the same time we must not forget the role of the small subsistence farmer as a conservator of grain. Indeed in many countries the subsistence farmer holds the major part of the stored grain. This group therefore plays a major role in the food storage strategy of the country. I would therefore encourage you to give particular attention to problems arising in this area.

Finally, I feel confident that the Seminar will provide opportunity for study and discussion of post-harvest problems, particularly relating to the assessment and the reduction of losses of cereal grains and pulses. Arising from the meeting I hope there will be a fuller understanding of what needs to be done and what can be done to reduce losses. I hope that the developing countries in need of help and the donors and technical institutions able to provide that help will have clearly defined the type of collaboration that they can jointly pursue. I think it would be optimistic and premature to expect this Seminar during this week to produce firm proposals for Country Action programmes to reduce losses. I shall be disappointed however if requests for help and the formulation of worthwhile loss reduction projects do not follow in the months after this Seminar. You can be assured that when requests for aid and technical help are received by ODM we will be sympathetic to your demands and will be pleased to contribute in whatever ways we can.

THE SEMINAR OBJECTIVES

An Extract from the Introductory Speech by Dr P C Spensley,
Director of the Tropical Products Institute

I consider it of great importance that much more effort should be given around the world to securing reliable assessments of the food losses that are occurring. The amount of firm information that is available on losses at present is paltry; yet one cannot expect to get appropriate attention to food loss reduction by governments, or by the organisations that they control, or, indeed, by the private sector and at the farm and village level, if information, in which confidence can be placed, is not to hand. Moreover, one cannot judge what expenditure of resources on reduction of losses is justifiable or what success interventions are having, unless loss assessments are carried out. So one of the things that we need to emphasize in this Seminar is the need to give much greater attention to reliable loss assessment itself. Indeed, this meeting could usefully identify ways in which further work of this nature could be carried out.

Having said this, I would not wish to suggest that food loss assessment should be an end in itself. It does not put any more food into any mouths. It should, however, be regarded as an integral part of most efforts made at post-harvest loss reduction; and in many instances some initial loss assessment study may be necessary for a sound decision on the pattern of food loss reduction programmes to be adopted.

We have deliberately kept this meeting smaller than the usual TPI conferences as we wanted to focus on a limited number of situations where action was taking place or seemed possible very soon. We congratulate those who have already taken significant steps to tackle their food loss problems and hope that from the strength of your experience you will be able to assist your neighbours. More immediately we look forward to benefitting from your experience in this Seminar.

The purpose of this Seminar is to provide the opportunity for both the developing countries and the technical cooperation bodies to meet together and to discuss the problem as to how best to establish loss reduction programmes with integral loss assessment components. I hope that the objectives we have set and the way we have structured the programme will enable steps to be taken towards mounting new action projects. These objectives may then be summarised as:-

1. To review present knowledge and experiences for determining post-harvest grain losses.
2. Through the examination of country statements and selected case studies, to draw up a list of aspects of the post-harvest system where investigations into the reduction of loss are most urgently required.
3. To discuss how loss assessment studies can be incorporated into national food loss reduction programmes.
4. To consider how best to carry out these studies, taking into account the resources that are required and the inter-country collaboration and exchange of information and expertise that can be utilised.

THE CONCEPT OF LOSS AND ITS DEFINITION

by

Y de Luca and J P L Deuse*

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The concept of post-harvest loss is defined as the cumulated result of damage caused by abiotic, biotic or anthropic factors during the sequence: maturation, harvesting, handling and processing, transportation and storage. Losses may be grouped by the way they affect the individual or the country. Those affecting the individual may be divided into direct losses, resulting from quantitative and qualitative damage, and indirect losses, eg shattering of grain, spillage during transport or handling. Damage, which may occur before or after storage, has two effects, for which the same agent may be responsible. The two effects are

a. qualitative, eg treatment residues, effects of heating, contamination by infesting organisms;

b. quantitative, eg the combined effects of primary and secondary infestations.

The losses affecting the country may be termed socio-economic losses, eg the cost of research on plant protection, price rises due to a fall in production or a lowering of food value causing malnutrition which in turn will affect labour output. The type and diversity of post-harvest loss may be determined by the storage environment, the stored commodity, the infesting organisms or mans involvement. As there are no precise data on post harvest losses, they must be defined more accurately if the objective of loss reduction is to be achieved. There is a need for more information on the types of post-harvest loss for specific areas or countries, and a standardised definition or method of interpreting losses.

In order to achieve a reduction of post harvest losses it is necessary to design a realistic programme with precise objectives, both short term and long term. Until 1985, the programme should concentrate on determining the extent of post-harvest losses to identify areas where action is needed, directly improving stages in the existing post-harvest system and investigating ways of improving the system in future, eg selecting crop varieties resistant to storage pests. The second stage, until the year 2000, should concentrate on continuing to improve the stages in the post-harvest system and intensifying studies and extension of new cropping systems.

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SITUATIONS WHERE LOSSES OCCUR

by

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Post harvest grain losses occur from field storage losses to birds, insects, and rodents, in storage, transport, and processing situations, on government and commercial holdings and distribution systems, and on into retail sales and to the household itself. The important thing is to take a fresh look at the entire grain flow system to see which loss points are significant as to the volume of grain at that point, the amount of loss, and the feasibility both technologically and culturally of introducing loss-reduction measures.

Village storage is not necessarily wasteful and central storage is not necessarily the solution of choice to prevent manifold small leaks in the grain flow system.

The Post-Harvest Grain Loss Assessment Methods manual sets forth a three-step procedure for making loss assessments and intervention feasibility decisions. This procedure was explained and examples were given. It consists of

1. Obtaining an overview of the post-harvest system
2. Making an on-site rapid appraisal that will focus on potentially significant losses (leaks in the system) and
3. Studies of specific losses and loss reductions.

Where widespread village stores exist in warm and humid areas over extended periods of time, losses may be expected to be serious. Similarly, large central stores without sophisticated technological controls over the temperature and moisture of the grain, over incipient insect and rodent damage, and without sound rotation and inspection/analytical procedures may also be serious. Examples were given.

The factors to be used in any on-site rapid appraisal are

- Moisture
- Time and temperature of holding
- Local quality and quality controls
- Types of bins and other holding vessels
- Sanitation-insanitation
- Trading quality factors and presence or absence of their use
- Use, nonuse, and quality of use of pesticides
- Evidence and non-evidence of grain insect and rodent damage and the kinds and amounts of
  - Insects
  - Frass and webbing
  - Insect exit holes
  - Rotten kernels
  - Rodent-chewed kernels and excrement
- Mechanical losses (which is a subject in itself)

MEASUREMENT TECHNIQUES AND THEIR ACCURACY

by

P S Tyler and D A V Dendy

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This paper attempts to focus on some of the problems that are encountered when it is desired to actually measure losses of cereals and pulses in the post harvest system. The paper discusses loss measurement in terms of its objectives and of the extent and *adequacy* of the available methods for measurement. Limitations encountered when trying to measure losses will be discussed and what are some of the *acceptable* levels of loss will be outlined.

Objectives in loss measurement. A major criticism of many surveys of loss is that objectivity is lacking. For example a record of losses in farmers stores made at one time during the storage season will not give an indication of overall losses throughout the year. Only once the whole post-harvest system has been fully understood can accurately determined estimates of losses of grain be realistically related to the system. The figures obtained can then be used in the determination of priorities for loss reduction work in a positive way. The loss measurements must be undertaken with a positive aim in view – that of loss reduction.

The components of loss are:

1. Broken and damaged grains.
2. Mould damage.
3. Loss of viability.
4. Insect infestation.
5. Loss of weight.
6. Rodent damage.
7. Bird damage.
8. Nutritional quality.

Those components at the top of the list can be measured with far greater ease than those at the bottom. A measurement technique for broken or damaged grains therefore has greater potential value for use in loss assessment than has one for nutritional quality – the latter techniques being highly sensitive and requiring careful interpretation of results.

Losses may be either quantative or qualitive. Quantative loss is a physical loss of substance (as shown by reduction in weight or volume) and is in the form of loss that can be most readily valued and measured. Qualitative loss is more difficult to assess but can be described through comparison with well defined standards. Other losses such as nutritional and germinative losses may be a combination of loss of both quantity and quality.

Limitations in loss measurement. It is simplest to divide the post harvest system into stages to reveal the complexity of the measurement problems that are involved. The system divides into two types of phase – those where time is an important element and those where time is less important but movement of the grain is involved. For example storage involves a period of time only and transport involves movement whereas harvesting involves both types of phase.

The three basic methods for determining weight loss are described.

Estimation of total loss. An important consideration in making estimates is to relate losses to the pattern of grain consumption. If the grain is left untouched throughout the storage period and at the time of removal, the estimated loss is 10% then this represents the total loss over the storage period. However in most cases grain is removed at intervals during the storage period 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. The total loss over the season can be obtained by accurately weighing all the grain in and out of the store and comparing the totals. This does not however,

indicate the relationship between loss and time, ie whether the loss reached a peak or whether it was related to a particular part of the season.

Processing

Included here are all the processing operations carried out on grain in the homestead or mill eg cleaning, parboiling, hulling, debranning, grinding, separating fraction. Secondary processing (cooking baking, fermenting, extruding) is excluded; such losses as occur being unavoidable.

Two fundamental methods are used:

a. Measurement of the total system where the optimum process gives zero loss and by weighing the input of grain and the output of products the difference represents the loss.

b. The second involves making a comparison against an optimum standard. This is useful for unit operations (eg hulling and polishing).

Losses at this stage are very closely affected by the previous history of the crop and our choice of measurement techniques must take this into account.

Acceptable levels of loss

The amounts of loss that we can consider as acceptable are not really quantifiable as precise figures. The acceptable level of loss for the *subsistence farmer* is the minimum which the good average farmer is capable of achieving. In the commercial, post harvest sector, acceptable (minimal) levels of loss are those which can be achieved by good management at optimal cost while safeguarding the condition of the commodity.

SURVEYS IN RELATION TO THE STAGES IN THE POST-HARVEST SYSTEM

by

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In any survey, especially in tropical conditions, there are obvious difficulties in achieving in practice what statistical theory may suggest as desirable. Some of the practical considerations are listed here, the first point being the importance of the systematic approach to data collection. Too often, only vague impressions are given of the loss at any particular stage. Having decided the purpose for which the information is needed, a *survey* is usually undertaken to quantify the loss, and some form of *sampling* is needed.

A *survey* is the actual procedure by which information is collected: a *sample* is that part of the population on which the information is actually obtained. Surveys must be conducted at various stages after harvest, or else it will be impossible to determine when losses actually occur; entirely wrong policies on loss reduction could be adopted. Surveys will almost always need some form of sampling, and to obtain representative samples as much randomness as possible must be included. Randomisation may be easy to suggest in the office but difficult to implement in the field. However, provided the purpose of the survey is clearly explained, there should be little difficulty in obtaining the co-operation of those whose crops or stores are the ones selected at random.

A *preliminary* survey may often help to clarify problems, to train new staff and to ensure that a uniform standard is adopted, even though it may take more time. The *detailed* survey will then seek to obtain all the information required as accurately as possible. Surveys will need different techniques according to the stages at which they

are conducted. Discrepancies between results from different places, if they are genuine, may themselves give very valuable information.

Having conducted a survey, it should be possible to pinpoint those places where most losses occur. It is almost certainly better to use resources to obtain at least some information on a wide range of conditions rather than to go into detail in only a few areas. There is no point in suggesting as a consequence of a survey a loss reduction programme which will greatly reduce what is only a small cause of loss: it is much better, if less dramatic, to recommend smaller reductions in a more important area.

THE DESIGN OF LOSS REDUCTION PROJECTS

by

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The purpose of this paper is to outline how to design or put together the series of actions, collectively known as a project, for reducing losses.

Basis of design. Loss reduction projects (LRP) are designed for

1. The country concerned - which may both finance and implement the project
2. The donor country (if a donor is involved)
3. A technical executing agency (if such an agency is involved in implementing the project)

Four essential elements are necessary for a good foundation to any project. These are:-

1. That a loss survey has been carried out and that measurements have shown that losses of a certain magnitude do occur in the system.
2. That measures are known which can reduce these losses, measures which have been proved technically successful either in the area concerned or in areas similar enough to enable one to predict with a reasonable degree of certainty that they will be successful.
3. That the benefits of the loss reduction measures will be sufficiently attractive to the potential user, in relation to their cost and the magnitude of losses, that after an initial demonstration period, they will be adopted and maintained voluntarily by the users.
4. The Government of the country concerned (ie both the decision makers and top officials in the Ministry or organisation concerned) should be enthusiastic about the project and committed to its success.

The components of an LRP project which must be considered are: Personnel; Supplies (consumable); equipment, including transport equipment; travel costs (vehicle and other); contract services, eg for construction of laboratory services; training, both within and outside the country; and lastly the agency's overhead cost for implementing the project. For each element we need to know how much is required and for personnel, how long they are required, ie what is the duration of the project and of each activity in it.

Three examples of different types of projects are given. These are:

1. **On-Farm Project** – to reduce losses in operation occuring on the farm.

   The project actions are listed below:

   a. *Inform* – personal contact, talking; radio; press; leaflets; films; posters.

   b. *Demonstrate* – eg earlier harvesting, better threshing, drying, storage structures, pest control.

   c. *Organize the supply* of necessary inputs in a suitable form in the right place at the right time, eg insecticide in packs, equipment or bins, made to the required standard and delivered to a point where the farmer can obtain them, with credit arranged if necessary.

   The project *elements* are:

   a. Personnel
      - to prepare information for selected media
      - to organise and initiate the training of the extension staff who will contact farmers and set up demonstrations
      - to organise input supplies
      - to organise credit if necessary

   b. Supplies – for information materials/visual aids

   c. Equipment
      - for demonstrations, structures, machines, chemicals, material
      - for transport of staff and supplies

   d. Training – In-country training
      (i) short 'awareness' course for senior staff.
      (ii) 'Training of trainers' at one centre - selected extension workers who must know why as well as how.
      (iii) Locally organised training of extension workers in essentials of what is to be passed on.

   e. Duration – A minimum of three years, with a review in the third year to amend/redraft as necessary for expansion into other areas, using the same staff for 2-3 more years.

2. **Loss Reduction Projects at interface with marketing system**

   These projects are aimed at –
   - first procurement or assembly point
   - cooperative or village store

   Project *actions* are
   a. construct and equip
   b. Train staff
   c. Support and supervise

   The project *elements* are:

   a. Personnel
      - to design store - simple, multi-purpose, office, collecting area
      - to specify equipment
      - to train staff
      - to support and supervise staff for initial period

   b. Supplies Equipment – cleaner and scales, moisture meter, possibly a drier, fumigation sheets and insecticide/'Fuffle', depending on how long the grain is kept

   c. Training – of staff, eg to operate drier and cleaner

   d. Contract Services – for construction of store

3. **Other LRP Projects, to reduce losses in central/marketing organisations**

   — simpler to design and execute because fewer people are involved

   — eg to build warehouses, organise pest control teams, or warehouse management, install driers or mills

   The project elements are also easier to define. Training would include external, higher level training — as well as internal.

CRITERIA AND METHODOLOGY FOR THE APPRAISAL OF LOSS REDUCTION PROJECTS

by

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This paper reviews the approach to appraising and examining the feasibility of loss reduction projects in a way which will be helpful to the applied scientists, the technologists, and the administrators who are particularly involved in promoting such projects. Economic appraisal and how it is applied to both public and private initiatives is discussed. Economic appraisal of on-farm storage, a large commercial grain producing farm, a commercially oriented milling and compound company, a quasi-government cereal marketing organisation and a public sector centrally planned scheme are outlined, but economic appraisal is only one of several aspects from which projects have to be appraised. Three additional aspects of appraisal are commercial appraisal, financial appraisal and the appraisal of management and implementation procedures. Technical appraisal is not discussed as it is outside the scope of the paper.

Commercial appraisal relates to prime functional areas; to determining not only *what* should be done but *how* it can be best carried out. It is concerned with establishing that commercial arrangements are adequately built into the project plan. It is also necessary to establish that the planners of schemes have built in adequate incentives for producers, transporters, traders or other intermediaries operating independently or on some kind of cooperating basis, to adopt new methods, procedures or systems. It may be especially important to identify real incentives to individual operators within a distributive chain.

Financial appraisal involves the flow of funds to from and within project entities. Projects may be technically acceptable, economically justified from the point of view of the economy and comercially acceptable at the level of the individual enterprise, but not necessarily financially possible. This may arise in two ways. Firstly, a project may have a long gestation period in that it involves waiting over a period of years before cash benefits are returned. Finance of a short term nature may be available but not medium or long term finance which fits the project's cash flow. Therefore special provision has to be made or the project will not be workable. Secondly, many projects do not generate cashable benefits, eg the provision of a centralised storage scheme, improved transportation infra-structure or an infestation control advisory service. Such projects are typically the responsibility of the government. The role of financial appraisal in this case is to establish that the financial provision and procedure of the govern-ment is adequate to cope with the requirements of the project. Cash flows within projects are also discussed.

The appraisal of management and implementation procedures is one of the more neglected areas of project planning. It is part of management and, therefore, a responsibility of those planning for management, to ensure that as far as possible effective projects produce benefits which continue after their identifiable lives have ended.

It is important to stress the inter-relationships between these types of project appraisal and it is not productive to even attempt to put up a case for any one part of appraisal procedure being more important than any other.

Project planning as a discipline is only of real use to us if it helps to better define and analyse technical and management alternatives.

PROBLEMS IN ASSESSING HARVESTING LOSSES

by

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When assessing harvesting losses of food grains, the operation must be studied as a whole from the time the grain reaches maturity until it is safely in some form of storage. All operations involved in harvesting the crop are inter-dependent, and as the optimum period for many operations is so short, it is usually impossible to perform every one at the optimum time, so some compromise must be reached. To minimize overall losses, a systems approach can be used but this implies knowledge of where losses occur, and how they vary with time or season. This paper identifies the principal sources of loss and outlines the problems in measuring those losses.

In general it is impossible to measure the potential yield of a crop accurately enough for estimating losses during harvest, so all losses have to be estimated by finding the 'lost' grains in sample areas and measuring the loss directly. This is a slow and tedious process, and examples are given where these losses are obscured by soil conditions or harvesting methods.

With the systems approach the losses due to harvesting immature grain; fungal, insect, rodent or bird damage during field storage or drying after the crop has reached maturity (whether reaped or not); together with their effect on the final quality of the product should be considered as well as the more conventional shedding and shattering losses in the field during harvest.

Some examples of the effect of harvest date on harvesting losses are given. These show in general two-stage harvesting allows the harvest to be spread over a longer period compared with direct combining. Different varieties have very different characteristics at harvest time, and this is a point that should be studied very carefully by breeders in an effort to prolong the time available for harvest.

Most of the work done in the developed countries suggests that farmers tend to delay starting harvest until the optimum stage is reached – or even past, and this invariably means that by the end of harvest the losses due to over-maturity are very high. Very little grain is harvested too early.

Unfortunately, much of the data for the effect of time on harvesting losses in the tropics is based on single observation and is therefore statistically suspect. However, all the evidence suggests that the problem is just as serious in the tropics as in the temperate areas and that the farmers tend to delay the start of their harvesting to the point where the losses at the end of the harvest period are unacceptably high. Where farmers hire labour or machines for harvesting, or use a system of exchange labour, there is a very good case for discounts for early harvesting to compensate for the slight reduction in yield or complications with drying due to immaturity, as this will be much less than the losses expected by the farmers at the end of the queue with over-mature crops.

REDUCING FIELD LOSSES IN GRAIN HARVESTING OPERATIONS

by

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Pre-cut losses

For the full potential seed yield to be obtained, cereal crops must have reached at least morphological ripeness before harvesting commences. In temperate climates so-called binder ripeness follows within a few days and combine ripeness traditionally within a further week or so. However, where a grain drier is available, combining can start much earlier, and in hotter climates the interval between morphological and harvest ripeness can be very short.

On reaching maturity the crop immediately becomes subject to dry matter losses by leaching and oxidation and to shatter losses due to wind, birds and wildlife. The losses increase with time because the effects of exposure are cumulative, and the ease with which seeds and whole heads become detached from the straw is progressive.

In European conditions typical pre-cut losses for wheat and barley can amount to 3.5% of the grain yield 3 weeks after combine ripeness, and to about 7 and 9% respectively after 5 weeks. Whilst in wheat the losses are usually in the form of free grains, barley tends to shed whole heads.

Harvest losses

Some losses are inevitable, whether harvesting is by any of the multi-stage systems based on the sickle, reaper, binder or swather, or by once-over combine-harvesting. Irrespective of the system, the longer harvesting is delayed beyond the earliest suitable date, the more easily and heavily losses are incurred.

Mechanically induced shatter

Any disturbance of mature crop can dislodge individual grains or whole heads. Disturbance is caused by the movement through the crop of a sickle blade or scythe, and by the action of reciprocating knives and reels of reapers, binders, swathers and combine-harvesters. Further jolting occurs as the crop falls to the ground and is handled during bunching, tying and stooking.

Controllable factors affecting harvest shatter include operator skill, the design and sharpness of cutting components, forward speed, and reel design, speed and fore-and-aft position. As far as combine-harvesters are concerned, most operators tend to set the reel too low and too far forward, and drive it unnecessarily fast.

Cutting losses

Only seed heads above the level of the knife are capable of being harvested mechanically. Data relating to the change with time of the height above ground of cereal heads indicate that the taller the crop initially, the faster the rate at which height is lost. Similar information for widely grown crops elsewhere in the world would provide valuable guidance for optimising the height setting of cutting mechanisms.

Apart from crop and cutterbar height, factors which affect the cutting losses by combine-harvesters include the direction of 'lean' of the crop, forward speed of the machine and table width. Crop lifters are capable of reducing header losses significantly.

The soyabean crop is particularly prone to shatter and cutting losses; improved headers are designed to reduce them.

Threshing and separation losses

Correct setting of threshers and combine-harvesters is important if all the grain is to be detached and separated from the straw. The lower the percentage of straw to grain which is fed into the machines, the higher is usually the throughput at a given loss level. Where the straw is not important, raising the header can therefore be an advantage. High straw moisture content can be less of an obstacle to successful combining than is widely assumed. Brittleness of the straw, and hence combine performance, vary widely between seasons.

Transport losses

Untied bundles of crop and sheaves are subject to shatter losses during loading for transport and during the journey from the field. The magnitude of the losses depends on the skill of the workers, the state of maintenance of tools and equipment, including transport vehicles, and the state of the crop and ground.

Body losses can occur during the harvesting operation through cracks and badly sealed joints on combine-harvesters and from grain trailers during the journey to the store. Such crops as linseed and oilseed rape call for particular attention to machines and containers. Spillage of loose grain and from sacks during transloading from the harvester is a common occurrence, yet is so easily avoided with reasonable care.

Loss assessment

Simple procedures are available for assessing the pre-cut and harvest losses. Accurate measurements require larger samples to be analysed with special apparatus and equipment.

Conclusions

It is economically sound to commence harvesting as soon as possible after crop maturity is reached. Adequate harvesting capacity and good resource management are vital to minimise losses. A timely harvest favourably affects subsequent operations and crops. Loss measurement is a good discipline and valuable aid to the optimisation of machine settings.

DRYING AND CONSERVING MAIZE IN THE HUMID TROPICS

by

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Drying is a major problem in the forest and parts of the high savanna zone of West Africa where high humidity persists after ripening of the crop. Maize is the most important food grain crop in this area. To the casual observer the drying or preservation of this crop in high humidity conditions would seem impossible, without having to resort to artificial drying methods. However a study of the equilibrium moisture content of grain crops in relation to humidity will show that even under the most adverse humid conditions of over 80%, the equilibrium moisture content of maize is somewhere in the order of 16%. This is extremely significant, as provided the crop can be kept in an environment which will inhibit fungal growth it will attempt to move from its moisture content of over 30% at ripening to the equilibrium level at 16%.

A ready supply of oxygen is the main inhibitor of fungal growth and a freely ventilated environment seems to fulfill these conditions. Traditional storage techniques take advantage of this by the suspension of cobs in trees, under roofs and stooking the crop.

An in-depth study provided quantitative data for optimal design and use of maize cribs which would permit high moisture content maize cobs to be safely stored immediately after the ripening of the crop. It was found that the cribs should have a width no greater than 60 cm to allow for safe-drying of dehusked cobs in the most adverse conditions such as the high rainfall zones. In the upper forest zone, 100 cm would be the optimal dimension and in areas further north, this would be as high as 150 cm. A rectangular structure is preferable to a round structure as its capacity can be expanded by increasing its length. The side walls of the crib could be constructed of any material that offered no more resistance than the cobs themselves to the passage of air.

Wire netting, stripped bamboo or similar slats of local material were all found to be acceptable. By drying the cobs in these cribs rather than in the field, field losses are minimized and the same land can be used for another crop in the second rains. Field losses through the hazards of wind, rain, birds, rodents and insects are in the order of 5-10% in the Northern areas and as much as 40% in the more humid Southern forest zones.

The currently most promising technique for the control of insects in such cribs involves the use of certain liquid insecticides which are applied periodically to the outside of the cribs using a simple domestic type applicator. After three years trials the most promising insecticides using an outside-spraying technique appear to be permethrin and pirimiphos methyl.

The use of cribs of optimal design are becoming popular notably on institutional farms and in areas where maize is being introduced as a new crop. Plans have been drawn up for a number of national projects in which loss assessment studies would be made simultaneously with the evaluation of loss prevention methods and farmer response to it.

PROCESSING LOSSES

by

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Two studies are described to demonstrate the general principles of assessing processing losses; these may be measured by comparing the results of a given unit of operation with those in an ideal situation, (eg the best possible commercial process or a laboratory process).

1. Drying losses at Mills

A TPI study of post-harvest lossess in rice carried out in Malaysia in 1975 included studies of the effect of drying methods on mill returns, which were used as an indication of quality loss. Paddy was sampled before and after drying by three methods used in the mills (continuous, batch and sundrying). Samples were also dried on a laboratory drier as the method that would give the minimum if not zero damage at that stage of processing. All samples were milled in the laboratory.

Sundrying results did not show a consistent pattern. The average loss of yield was 1.2% in terms of whole grains plus large brokens and results indicated a relatively efficient operation by the millers.

Samples from the top and bottom of batch drier bins indicated that paddy at the bottom was often overdried. Milling tests showed a decrease in the yield of whole grains of about 4% for a moisture removal of 10%, with an increase in brokens equal to this.

Most continuous driers recycled paddy continuously without an intermittent rest period for conditioning. The percentage moisture reduction was correlated with loss of yield.

From data derived from a study of batch drying it was possible to compute the value of losses in milling caused by poor drying. Continuous driers were operated more or less as batch driers and it is assumed that the calculation can also be applied to continuous driers. The value of losses increase with an increase of moisture content at intake at the mill. In an average year the value of the loss could be expected to be M $6.6 million.

2. Losses in Shelling of Maize

Losses occur where mechanical shelling is not followed by hand stripping of grains left on the cob. Additional losses occur because of damage to the grain. All these losses may be relatively easily measured, with hand stripping as the ideal method for comparison since this will give 100% yield of grain.

A comparison of maize shellers has been carried out, measuring the losses on the cob and the grain damage. Samples of cobs were shelled, the grains collected, weighed and samples taken for damage assessment. Grains remaining on the cobs were hand stripped weighed and sampled. The % ratio of hand stripped maize to the total is the shelling loss.

The shelled sample of grain was subsampled after separation of broken grains and dust and examined for cracks and scratches. The excess of damaged grains over those in an entirely hand stripped sample represents the sheller damage.

Trials conducted at TPI and in Swaziland determined the capacity and efficiency of maize shellers, durability of equipment, user preference and loss and damage to maize and indicated where modifications or new designs might be desirable. A wooden hand held maize sheller has been developed at TPI.

Choice of sheller in a rural community is dictated by scale, cost and availability of equipment. Effectiveness is not always considered important if loss is low.

Five methods of shelling have been studied:- beating with a stick, hand stripping, ring shellers, 'washboard' type shellers, small rotary units and mechanical shellers.

THE ZAMBIA STORAGE LOSSES PROJECT

by

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The terms of reference for this project were:

1. To develop a satisfactory methodology to evaluate the extent of losses,
2. To establish reasonably reliable cost-benefit relationships for a simple improved farm storage technique, and
3. To recommend whether a longer term project should be undertaken over a wider area to evaluate cost-benefit relationships of improved storage techniques for the purpose of planning development programs.

Following these criteria a detailed study was made of various methods of assessing losses. These methods were then applied to maize stored by small farmers in selected areas of Zambia and an evaluation made of the costs and benefits to these farmers of adopting an improved storage technique.

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Two areas were selected for study – Chivuna where the maize was stored on cobs with the husk attached and Chalimbana where shelled maize storage was typical. A questionnaire survey was conducted among a number of farmers within the two areas chosen. Information collected included background economic and social data relating to individual farmers and information on their stores and storage practices. Other sections of the questionnaire covered losses and farmers usage of their stored maize. At the end of the storage period a second questionnaire was conducted among the selected farmers to obtain data required for the economic evaluation of losses.

Simulation of the farmer storage was carried out at the project's base at Mount Makulu using stores similar in construction to those of the farmers whose stores were sampled. Weight losses in the insecticide treated shelled grain simulation stores were 1% or less (except where termite damage occurred), 3% in the untreated shelled grain stores and 13% in the stores containing unselected cobs with husks. Cobs without husks suffered a 9% loss, an additional loss of over 5% had already taken place between harvest and placing in store.

Losses of maize in farmers' cob stores increased as the season progressed and at the end of the storage season were 8-10%. When the reduction in stocks throughout the season is taken into account losses averaged 2-5% over the storage period as a whole. The low magnitude of these losses demonstrates the benefit of cob selection which was practised by the selected farmers.

Due to a poor harvest only one of the selected farmers in Chalimbana was able to store shelled grain throughout the storage season. He stored a hybrid variety and suffered a loss of approximately 6%.

The costs and benefits for the small farmer of storing his maize in the way recommended by the Ministry of Rural Development were assessed. The recommendations were:

a. Storage should be in grain form

b. Stores should be muddied both inside and out

c. Insecticide (malathion) should be added when storage takes place.

The conclusion reached from comparing costs with benefit was that, except when the most unfavourable assumptions were made, benefits were the greater. The most likely ratio was 1:1.6 for a farmer currently storing cobs with husks and 1:2.4 for a farmer currently storing grain. This analysis is based on the losses sustained in the simulation stores.

To enable African countries to plan development programmes in the field of improved storage, it is recommended that our benefit analysis be applied to data obtained from the area where the improved technique is proposed, since the results derived in one situation are unlikely to be transferable to another.

Recommendations are also given on the carrying out of research projects designed to obtain the necessary background technical and local economic data required.

THE INDIAN GRAIN STORAGE PROJECT 1974-78

by

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The object of the project was to establish the social rate of return from farm level storage improvements programmes. The research results are based on two years' field work in eighteen villages of Andhra Pradesh, South India. Socio-economic and storage data were collected over the two year period of field work from approximately 350 households obtained from a three stage stratified random sample. Sample households provided access to one or more of their paddy stores and estimates of food loss were prepared, centred upon an analysis of samples at the laboratories of the Indian Grain Storage Institute field station, Bapatla. The best estimate of weight loss of paddy stored at farm level in Andhra Pradesh was 4.26% (with a confidence interval, at the 95% level, of plus or minus 1.33) for an average period of storage of seven months. In the second year of the project certain improvements to traditional stores, the use of new, metal structures and alternative pesticide treatments were evaluated. These were variously successful in reducing losses to around 1%. Using shadow prices, social cost-benefit ratios were calculated for improvements to traditional stores and for substitution of traditional stores by metal bins. In both cases a positive rate of return was found. Based upon these results the major recommendations were for the expansion of the existing specialist storage extension services with increased emphasis upon improvements to traditional structures and for the improvement of the retail outlets for fumigants and rodenticides in rural areas.

THE POST HARVEST SYSTEM

by

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The post harvest system embraces a number of phases usually sequential: Harvesting, threshing, drying, storage, processing, transport, marketing -- wholesale and retail. Programmes for the improvement of a post harvest system with the object of reducing losses must be based on a wide and detailed knowledge of the existing system. Very few comprehensive studies of losses within the total system have been carried out. One attempt has been made by TPI to survey a post harvest system in peninsular Malaysia. The study was seen as an opportunity to develop a model for post harvest system studies that could be adapted to a number of country situations.

Post Harvest study in the Muda Scheme. The study was carried out in an irrigated area known as the Muda (Muda Agricultural Development Authority) Scheme. The objectives of the study were to identify the losses and bottlenecks in the movement of second crop 'off season' or dry season padi (harvested during the onset of the monsoons) at all stages from harvesting through to post milling storage, to evaluate the economic size of the losses and make recommendations on how they should be eliminated and reduced.

The Muda region is a fairly homogenous area of paddy land with small farm holdings, low income and cheap labour. Landless tenants of the area provide much labour for planting and harvesting. Fragmentation of farms is a severe problem to the development of mechanization.

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A survey procedure was defined and implemented to cover three broad study areas and a survey team was allocated to each of the studies.

i. **The Kampung Study.** This included a detailed examination of farmers harvesting operations, carrying out harvesting loss trials throughout the region and a survey of farmers harvesting within the vicinity of each harvesting loss trial, at the time of trials.

ii. **The Padi Marketing Study.** This study was intended to evaluate quantitatively the marketing methods used and routes which padi followed from the farms to the mills; in particular to quantify bottlenecks and losses caused by the marketing system and to identify areas where current practises might be improved. A survey procedure was designed and implemented to evaluate the practises of the 5 main operators in the marketing chain; the farmer, the agent, small millers, large private millers and the public sector millers.

iii. **The Drying and Milling Study.** 83 large mills and a random selection of 40 small mills were visited. An inventory on drying and milling facilities was made and the efficiency of use of equipment and the cost of the various operations assessed and problems identified.

Results of the study

i. **Labour.** There is an acute shortage of labour caused by a reduction in migrant labour and young people receiving an excellent education, no longer wishing to work on the land. The paradox of the labour situation is that many people in kampungs are under-employed but they are unwilling to move to different kampungs in search of employment. The development of mechanized planting and harvesting cannot be regarded as a satisfactory solution because of the limitations imposed by the existing farm structure.

ii. **Harvesting.** Most of the harvesting takes place in standing water. The act of putting the cut crop onto the stubble caused an increase in moisture content of almost 6% by the time the crop was threshed. The moisture content of the crop when it was bagged after threshing was 24.3%. This uptake of moisture is a major problem which requires considerable and immediate attention. It is critical to the whole harvesting and marketing operation since, if the moisture content of the marketed crop can be held at less than 20% the majority of drying problems for farmers and millers would cease to exist. Improvements to the drainage system now being planned will considerably alleviate the problem but only in the longer term.

The total harvesting loss to the farmer was 10.7% of the potential whole grain yield. The most important component of this was unthreshed padi left on straw at 9.2% for whole grain. The responsibility for this rests almost entirely with the threshing gangs. They make relatively large bundles of padi to reduce walking time in the field. These bundles are difficult to thresh satisfactorily and the threshers do not put sufficient effort into the job. Mechanised harvesting appears to be the only solution but the total losses using a combine harvester can be quite high. Furthermore the rapid expansion of mechanised harvesting will deprive the landless tenants of an important supplement to their incomes, inducing them to move to urban areas and so reduce the labour available for planting. Mechanised harvesting and planting are complementary and need to be developed simultaneously together with improved access to fields from roads and paths.

Field Transport of Padi

The major problems were:

a. The absence of footpaths making access to the fields impossible except through adjacent fields.

b. The poor surface of the tracks that do exist along the access bunds making it impossible to use bicycles or even to walk in wet weather.

c. An inadequate number of passing places on existing roads; the relative absence of foot bridges for small vehicles over canals and drains. Apart from accidents few opportunities for loss during transport were noted and no measurements were attempted.

Farmer Drying. The general standard of farm sun-drying was high. In many cases the farmers did not benefit as a result of their sun-drying, the quality of the padi was reduced through delayed drying, and the deductions at sale were greater than they might have been had the padi been sold immediately from the threshing tub. Padi was dried on any convenient surface – plastic sheeting, matting, concrete bridges, metalled road surfaces and any other

clear spaces on the farmers land. A proportion of paddy dried on roads was lost in the cracks and on the grass verge. Cars and lorries often had to drive over the drying padi and presumably increased the number of broken grains. The extent of these losses was not measured. In a year with average rainfall (the study year was exceptionally dry) it is highly probable that extensive losses would occur (particularly through germination.) because of farmers uncertain knowledge about deterioration.

Farmer Storage. A serious rodent infestation was identified particularly in padi in temporary storage. There was also some evidence of insect infestation.

Marketing of Paddy. The general impression was that the marketing system was efficient. The major defect was the parochial nature of transactions. The procurement period of paddy was that of the local harvesting period with consequent problems of a concentrated intake at mills and a greatly intensified drying problem.

Sampling by agents and at all mills is unsatisfactory. The examination of padi is cursory and often the agent and miller offer a price that is to their disadvantage because the examination is not rigorous.

Drying at mills. The aggregate capacity of large private and public sector mills could satisfactorily dry only 73% of their total purchases in an average season and only 55% of purchases in a wet year. Drying facilities could be improved substantially by better management and operation. Any improvements would not be easily achieved at the present time as the millers have a very inadequate knowledge of drying and milling technology and how to operate and install dryers. There is a substantial training requirement for upper management and middle management and technicians in public sector and private mills.

Milling and Mill Storage. Few mills had properly integrated production lines with machines of compatible capacity installed in the same line. The standard of milling was below that which could be achieved and most mill managers had only a limited technical knowledge. Some incentive for improvement in milling could be achieved by reviewing the present rice grading standards in order that poor drying, milling and storage are penalised.

COUNTRY PAPERS

IRAN

by

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Iran, situated in the Middle East covers an area of 628,000 square miles. Much of the country is a plateau rising 3,300 ft above sea-level, Most parts of the plateau are dry with rainfall not exceeding 21 inches p.a. Temperatures in the summer are high (110^0 F) and low in winter with frequent snow and rain. Along the Carpian Littoral, humidity is high with a rainfall of 79 inches p.a. and rich sub-tropical plant growth. Traditionally Iran has had an agrarian economy and in 1972, 47% of the labour force were engaged in agricultural production. The major crops grown for home consumption are wheat, barley, rice, potatoes, onions, sugar beet, cotton, fresh fruits, sugar cane and pulses. During 1976 the main export crops were cotton and pistachio nuts. The specific quantitative target of the agricultural sector programme is to achieve an annual growth rate of 5-6%.

Wheat losses in Iran are estimated to be not more than 15%. Generally storage in rural areas results in few losses but in urban areas storage losses have been estimated to be as high as 10%. The high losses are due to a shortage of silo capacity and consequent storage in unsuitable stores; and storage in privately-owned urban stores which are often substandard and infested by rodents. Significant losses in imported wheat result from poor loading facilities at the ports, lack of bagging facilities, lack of handling facilities and poor unloading facilities at the silos. Losses occur during transportation due to spillage, poor bagging and handling facilities and the unsuitability of the trucks for carrying wheat. Losses during processing are thought to be negligible. Barley losses and their causes are estimated to be the same as for wheat, but since barley is used largely for animal food less care is taken in handling and storage.

Rice losses are estimated at 10%. Production is confined to one area of the country where the systems for handling and storage are better controlled than for wheat and barley and so losses through spillage and during transport are lower. Losses during milling are high. Pulse losses are estimated to be 5%. Storage of pulses is undertaken by commission agents or middlemen who purchase from the farmers and sell to the wholesalers.

The Ministry of Agriculture and Rural Development have studied the question of losses in detail. A number of projects have been identified and four major projects are being undertaken:

1. **Project on prevention of agricultural losses through plant protection measures.** This project will be carried out by the Plant Protection Organisation with the objective of reducing losses occurring both in the field and after harvest. The existing plant protection units of the Ministry of Agriculture and Rural Development will be strengthened by providing more pesticides, transport, spraying aircraft and the training of manpower. Storage in silos and warehouses of the Grains Organisation will be incorporated in this project. Starting in 1977 the project will run for 7 years at a cost of 225 million US dollars.
2. **Project to enlarge the Plant Protection Research Institutes.** Existing research laboratories in the country will be expanded and extra staff and equipment provided to carry out research into weeds, pests and diseases of farms and orchards and to determine the best methods of control to achieve a reduction of losses. The project starts in 1978 and will last 5 years at a cost of 49 million US dollars.
3. **Project on prevention of post-harvest losses in farm corporation and production cooperatives.** This project will be carried out by the Plant Protection Research Institute. It will include establishing specially equipped warehouses and cold stores for fruit and vegetables, small silos and processing units. It also includes the purchase of trucks for transport, fire fighting units and contact units for remote areas. The project will run for five years starting in 1978 at a cost of 73 million US dollars.
4. **Project on the use of cooperative societies and rural cooperative unions for prevention of agricultural losses.** The Central Cooperative Organisation will undertake this project. The means of grading and packing will be improved and factories will be established. The project will take 5 years starting in 1978 and will cost 23 million US dollars.

PAKISTAN

by

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Pakistan has a total land area of 196.7 million acres. The area cropped each year is about 41 million acres, out of the total cultivated area of 49 million acres. The population of the country is nearly 76 million, about 75% of which live in rural areas and are engaged in agriculture or related pursuits. Small-sized farms dominate the scene. The average farm size in Pakistan is 13 acres. Crops can be grown throughout the year where water is available. Rice, cotton, maize, sorghum and millets are grown in the summer (March-September). Wheat is the major crop in winter (October-February). Sugarcane is grown throughout the year.

Storage losses are high and were further increased during 1976 with a marked increase in wheat production which the existing storage facilities could not cope with. Much wheat was stored in inadequate facilities and was badly damaged by weather, insects, rodents and pilferage. Official estimates quote 13,000 tons of grain as being damaged beyond use in 1976. Even in less extraordinary circumstances, physical losses of foodgrains and oilseeds in store probably exceed 5%.

The following actions have been initiated in an attempt to reduce these losses:

1. Current stocks are being protected from insect and moisture damage — especially those in temporary stores.
2. A survey of projected production, consumption, imports and exports for wheat and rice is being carried out.
3. Storage capacity in the private sector is likely to be mobilised to relieve the pressure on public storage. An immediate assessment of the potential of a procurement price policy which offers incentives to farmers and others to store and deliver wheat later in the season is under consideration.

Medium-term actions which have been initiated or are likely to be initiated are:

1. Selection of additional storage capacity should be undertaken on the basis of technical and economic considerations. Where data and time do not permit such an exercise preference is to be given to:
   a. Bag storage with the exception of storage at flour and rice mills. Here bulk stores would minimize handling problems.
   b. Wherever possible new stores should be located on railway lines.
   c. Construction of large-scale terminal facilities up-country may need the help of donor agencies. Small-scale bag stores near the production source in surplus areas can in the meantime be initiated.
2. Expert assistance will be required in evaluating alternative methods of constructing and operating low cost storage facilities.
3. Research institutes should evaluate low cost storage facilities for use at the village and cooperative level.
4. Cottonseed storage facilities are inadequate — plans for improving these will be developed. Priority should be given to storage of seed, cottonseed.
5. Coordinated management of wheat, rice and oilseed storage facilities may encourage multiple use of these storage units.
6. Government procurement prices are being modified to reflect transportation costs of major consumption areas.

7. It is planned to introduce a commodity grading system which would offer farmers an incentive to deliver superior quality produce.

8. A study should be made of the sources and magnitude of on-farm storage losses. This study would provide guidelines for improving farm storage facilities.

9. Training of grain storage entomologists, storage engineers, agricultural economists and microbiologists needs to be undertaken.

Long term recommendations are as follows:

A major planning exercise is recommended to determine the development of future grain storage and marketing facilities. It is likely that outside help from donor organisations will be required.

SUDAN

by

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The magnitude of losses in harvested grain in the Sudan has not yet been fully ascertained.

Losses of harvested grain occur at all stages between harvesting by the farmer and delivery to the consumer. The greater proportion of losses are caused by insect pests during storage. Losses are high in the more humid parts of the country, that is in the Southern region (where losses are estimated at 20% pa) and along the Red Sea Coast (where the the value of annual losses has been estimated at about LS 25 million).

In the Sudan, the main crops are sorghum, wheat, groundnuts and sesame. The first three crops are all mechanically harvested and threshed. Losses due to spillage and breakage of sorghum seeds are estimated to be about 4%. In wheat in the Gezira, losses are in the range of 4-6%. In the case of groundnuts up to 15% of the nuts are broken during the process of decortication. Sesame is harvested manually and it is estimated that up to 15% of the crop is lost through shattering.

A study made by Howe International in 1972 for the Sudan government showed that there was an urgent need for creating additional storage facilities to accommodate 1,265,000 tons of grains. Since then agricultural production has considerably increased but no additional storage facilities have been constructed to match the increasing production.

The lack of adequate storage facilities, the non-existance of sound storage management, unawareness by all sectors of the means for effectively controlling storage pests and the lack of specialised system for transporting grain in bulk, all contribute to losses in harvested grain in the Sudan.

As poor storage management is responsible for most of the losses in the existing system, there is an urgent need for training of grain industry personnel, eg agricultural extension staff, storekeepers, mill operators, storage managers and pest control operators.

THE REPUBLIC OF THE PHILIPPINES

by

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A considerable amount of work has been carried out by the International Rice Research Institute (IRRI) on losses in post-harvest rice production. Reports by IRRI show that losses range from 1–3% for harvesting, 2–7% for handling, 2–6% for threshing, 1–5% for drying, 2–6% for storage and 2–10% for milling. The kinds of losses include weight loss, loss of food value, loss of economic value, loss of quality or acceptability and actual loss of the seeds themselves.

From the trials undertaken at IRRI, the moisture content of the paddy is a good criterion in determining the optimum time of harvest, irrespective of varieties and days of heading. A close correlation has been found between harvest time and milling recovery. Both early and late harvests resulted in higher percentages of broken grains. Higher moisture content resulting from an early harvest generally means lower grain losses. The same relationship is applicable in the handling part of the system. In many cases to reduce losses the present post-harvest system will have to be modified. To achieve maximum field yields, minimize handling and threshing losses and produce a high head rice recovery rate it would be necessary to thresh at moisture contents exceeding 20%. There would also need to be partial or total modification of the handling system and the introduction of some type of mechanical drying. Handling and threshing losses can be reduced by performing threshing in the field at the time paddy is harvested. High moisture paddy resulting from this operation can then be transferred to a mechanical drier to reduce the moisture to a safe storage level. Measuring the reduction of losses will allow circulation of the resulting benefits from use of the improved system.

The major objectives of the field trials have been met, although there is a need for further replication of the trials to verify the reliability of the methodology and to investigate factors other than technology which affect the efficiency of this operation. Considerably more work is required at the mill level to assess comparative milling performances and to quantify the usefulness of milling services by location, size and type of service provided.

Priorities and Plans for Future Loss Assessment Studies and Loss Reduction Programmes 1978-1987.

The primary aim is to improve the country's internal capability to produce its basic food grains and raw materials requirements and maintain a stable food supply. Reserves for food security purposes will be boosted.

To improve grain marketing and post-harvest operations, greater efficiency in all components of the post-harvest marketing phase of the industry will have to be achieved. The marketing facilities of agricultural cooperatives will be expanded and modernised in order to increase their market share.

Grain storage facilities will be improved and expanded to carry out price stabilisation and buffer stock management more effectively. An increased storage capacity of 1.5 million cavans (50 kg = 1 cavan) annually will be built by the warehousing construction programme. Terminal silos will be built at the ports, eg Manila, Cebu, General Santos City, Cagayan de Oro, Davao, Albay, Iloilo and Tacloban. Post-harvest losses will be reduced from 10-37% to about 10-20% with the improvement of in-farm processing, milling, storage and handling activities.

Buffer stock Maintenance Programme. The buffer stocks are designed to maintain sufficient stocks of foodgrains against unexpected calamities and lean seasons. The programme is being carried out through expansion of the government storage capacity of 1.5 million bags annually (50 kg).

Self-sufficiency is targeted for both rice and corn production.

Post-Harvest Technology Development. An integrated programme of research, extension, manpower and skill development is envisaged in order to reduce losses from 10-37% to about 10-20%. Credit regulation and incentives have been designed to upgrade and modernise existing facilities and to promote efficient on-farm and commercial processing and marketing techniques.

INDONESIA

by

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Rice is the staple food crop of Indonesia although a considerable amount has to be imported to meet market demands. Attempts are being made to make Indonesia self-sufficient in rice production. Two programmes have been developed to encourage self-sufficiency; these are BIMAS and IMAS. BIMAS is a supervised credit programme for the intensification of rice and secondary food crops. The credit extended consists of high yielding seed, fertilizer and pesticides at subsidized prices and a certain proportion of the operating costs. IMAS is a similar programme where subsidised fertilizer and pesticides are provided on a cash basis.

A price stabilization programme was started in April 1969. The price of rice is allowed to fluctuate between the 'floor' and 'ceiling' price. BULOG (the National Logistic Body) implements this policy.

BULOG was estimated rice losses (based on some case studies) as 25% from harvest to market. In more detail this breaks down into:

	Source of loss	*% loss*
1.	Losses during harvest due to shattering	8
2.	Losses during movement in the field	2
3.	Drying losses	2
4.	Transport losses from drying-godown	1.5%
5.	Losses in the farmer's godown	4
6.	Losses in subsequent store or warehouse	1
7.	Milling losses	4.5
8.	Losses due to hooks being used on bags of rice during transport	1
9.	Transport losses from warehouse — market	1
	Total:	25%

A USAID team in 1971 estimated that savings of rice losses of up to 10.5% could be made if efforts are implemented in all sectors of the post-harvest process. During the last 8 years important developments have occurred. With the change to new high-yielding varieties, the traditional harvesting implement has been replaced by the sickle as the former caused too much shattering of the grain. The first Five Year Development Plan (1969-1974) encouraged investment in the rice milling business; within 5 years more than 12,000 small rice mills (SRM's) were established in the villages using small rice mill machinery made in Japan. After 1974 the problem changed, too many SRM's had been built and milling fees became lower and lower. Investment in new SRM's is now limited by government intervention to prevent unfair competition.

Before 1968 rice mills stored their paddy in the open on drying floors. Heated by the sun and wetted by rain, part of the paddy was spoiled. Losses were estimated at 2-5%. Today with the change to new high-yielding varieties, paddy is stacked in gunny bags and stored in covered buildings. Storage is carried out by farmers, private rice traders and private rice millers. The village cooperatives also have their own godowns. More than 2,000 of these have been built, each with a capacity of 200 tons. BULOG has to manage 2,000,000 tons of rice annually either for domestic procurement or import. In the last 4 years, BULOG has built 300 warehouses with a total storage capacity of 1,000,000 tons.

Sun drying is still the most popular form of drying, although the government is promoting the use of a flat batch type dryer (developed by IRRI) with a 1-1½ ton capacity. The dryer is only needed when the main harvest comes during the rainy season. This is often the case with some of the new rice varieties. With the new rice varieties, threshing is done manually in the fields. New roads have been built and old ones improved so helping to reduce transport losses.

International Cooperation and Future Activities

International cooperation on post-harvest technology began in the 1960's.

1. In 1968 a mission from the Tropical Products Institute (TPI) visited Indonesia to study the rice milling situation.
2. In 1970 a Japanese mission from the Overseas Technical Corporation Agency (OTCA) studied the rice mill situation.
3. In 1970-71 a USAID mission studied the problems of rice handling, storage and marketing.
4. Several other missions visited Indonesia, especially from FAO.
5. Many Indonesian junior staff have been trained abroad with OTCA, TPI, USAID and FAO sponsorships.

Existing Cooperation

1. Since October 1976 BULOG assisted by TPI has carried out two storage trials. One is on pest and quality control within the BULOG procurement, storage and distribution system and the other on a full-scale trial of on-floor storage and drying for bulk paddy grain. Three TPI experts are now working at the BULOG Rice Research Centre in Tambun, West Java.
2. Since October 1975 BULOG and IDRC have been cooperating on a joint post-harvest technology project with experiments being carried out on drying, threshing and other post-harvest problems.
3. The Australian government in cooperation with five ASEAN countries (Indonesia, Malaysia, Singapore, Thailand and the Philippines) is conducting a Food Handling Project which includes grain handling and storage.

Future Activities

The Indonesian Government welcomes all international cooperation in post-harvest technology. In the coming years commodities other than rice will need more attention.

THAILAND

by

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Thailand has a predominantly agricultural economy with approximately 80% of the population engaged in agriculture and 33.4% of the total land area being devoted to farming. The major crops are rice, maize, sorghum, mungbean, soybean, peanut, tapioca, sugar cane, kenaf, rubber, coconut and cotton. Many of these crops (with the exclusion of the last two) are for export. Rice is the most important cereal grain.

All but 4% of Thailand's rice crop is harvested in the dry season. The sickle is used to cut the panicles everywhere except in the Southern Region (where the rainfall is higher) where harvesting is done with a small knife. In the south, harvested panicles are transported directly to the farmstead where they are threshed or stored unthreshed.

In the rest of the country the panicles are tied in bundles and left to sun-dry in the field for 2-3 days, before being dried on the level ground of the threshing area. The causes of high post-harvest losses are:

1. Paddy variety ie resistance to shattering, maturity, plant height, stalk length.
2. Field conditions, ie yielding level, lodging, weed infestation, field moisture, pest damage.
3. Harvesting conditions, water level, optimum harvest time, labour constraints.

In many cases a second crop of rice is now grown and harvested in the early rainy season which has raised the problem of alternative methods of drying and has increased the drying losses. All threshing is done by the farmers. Paddy being transported from the field to the threshing floor is subject to some losses as it is carried by a variety of means including shoulder poles, bamboo baskets, buffaloes, wagons, tractor-drawn cars, trucks. Transport from the farm to the mills is mostly done by boat and truck in bulk.

Two types of rice mill are to be found one with imported machinery and the other with locally made machinery. Losses due to breakage in the former type are lower and the quality of the finished product is better, but the cost of the machines is higher than the locally produced ones.

Rice is stored by the farmers, millers and exporters. Farmers storage is in small granaries, the wooden floor raised a few metres above ground level and the wall is made of soil-plastered bamboo. The roof is made of corrugated iron, wood or tile. Damage and losses are due to rodents, birds and insects. Most of the rice mills have godowns. Paddy is stored in bulk or in sack, while rice is stored in the sack only. Most of the mill storehouses are wooden structures. Losses have been estimated at 5-15% during a storage period of 6 months to 1 year and are attributable to insects, birds and rodents. Rice exporters own riverside warehouses. Fumigation and inspection are conducted at these warehouses prior to ship loading.

Two crops of maize are grown per year in Thailand, the first crop is harvested at the height of the rainy season giving rise to drying shelling and storage problems. Losses are caused by insects, micro-organisms, rodents, birds and weathering. In Bangkok there are 4 large modern silos equipped with driers, graders, cleaners and grain conveyors. Wastage and spoilage is very much reduced in these silos. Losses occur during mungbean, soybean and peanut post-harvest operations.

Little work has been done on estimating post-harvest operations. Losses in paddy have been estimated as 8% during harvest, 4.6% during threshing and 4.6% during transportation. The Department of Agriculture has recently developed a small grain drier which will dry 2 tons of rice in 5 hours using rice hull as a fuel. Currently the Department of Agriculture is developing a design for a small rice miller, a small peanut thresher and they are studying the efficiency of small silos for farmer storage.

Priorities and plans for future loss assessment studies and loss reduction programmes

1. Encouraging the research institutes to study post-harvest technology.
2. Survey and assess grain losses during harvesting, drying, transportation, threshing, shelling, processing and storage of cereals and pulses.
3. The development of harvest and post-harvest equipment, ie threshers, reapers, dryers.
4. The improvement of crop varieties leading to a reduction in losses.
5. Development of more efficient paddy huskers and millers.
6. Training of extension workers and farmers in post-harvest techniques.
7. Encouraging closer cooperation of government organisations concerned with post-harvest technology.
8. Exchange of information and expertise on post-harvest technology with other National and International institutes.

INDIA

by

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Grain passes through various stages between harvesting and the consumer. These include threshing, transport to market, sales to wholesale traders and procuring agencies, transport to storage places, transport to the retail traders and storage at various levels including the consumers.

TABLE 1

Estimates of losses to foodgrains during post-harvest handling, processing and storage.

The table gives an estimate of losses at the various stages during post-harvest handling, processing and storage. These figures were obtained by the Expert Committee of the Government of India on post-harvest losses in the mid-1960s.

The annual average production for the years 1962-63, 1963-64 and 1964-65 was 78,317,666 thousand tonnes. Estimates of losses during post-harvest handling, processing and storage are as follows:

Stage where the loss is caused	Estimated loss in thousand tonnes	Estimated loss expressed as %
Threshing yard	1,317,708	1.68
Transport	117,478	0.15
Processing	748,913	0.92
Storage:		
i) Rodents	1,957,940	2.50
ii) Birds	668,105	0.85
iii) Insects	1,992,166	2.55
iv) Moisture	534,114	0.68
Estimated Total Loss:	7,386,424	9.33

For these estimates loss is worked out on the basis of food value only. Drying which causes loss in weight but not loss in food value, spillage, loss in weight on account of theft, loss on account of conversion where some quantity may be lost for human consumption but is available for animal consumption, are not considered as loss.

In 1965-66 the Department of Food of the Central Government launched the Save Grain Campaign as a pilot project to demonstrate to farmers methods of reducing losses during storage. In 1969-70, the Save Grain Campaign was implemented as a country-wide programme. The main objectives of the campaign are to educate, motivate and persuade farmers and others to store foodgrains without loss. This is done by:

1. Training of:
   a. farmers, traders and extension workers;
   b. trainers in the teaching institutes;
   c. medium and senior level officers in the food storage administration.
2. The organisation of demonstration programmes.
3. The arrangement of wide publicity programmes.
4. The supply of improved storage bins to the farmers.
5. The creation of state Government, Save Grain Campaign teams to implement the new storage proposals.
6. Assisting the Farmers' Training Centres on the dissemination of scientific storage techniques to the farm women.
7. Colloborative research and development work on storage of foodgrains in rural areas.
8. Supplying inputs to the State Governments to enable implementation of large-scale programmes in the country.
9. Assisting State Governments in enforcing the provisions made to ensure proper storage by millers and foodgrain dealers.

   (For a fuller account of this project see Tropical Stored Products Information 35 p 31).

NEPAL

by

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From a total population of 12 million, more than 90% are engaged in agriculture which accounts for 67% of the GDP and 80% of national export earnings. Out of the total land area only 14% is cultivated, the rest consists of snow-clad peaks, uplands and forests. The Terai (low flat land) produces 70% of Nepal's food grains. The major cereals are paddy, maize and wheat with barley, millet, buckwheat, pulses and potatoes grown on a small scale.

Food Grain Storage System

At the farm level, threshed paddy is stored in bulk, in variations of the woven bamboo bin or 'Bhakari'. In the Terai these baskets are larger and sturdy and are constructed on a wooden platform with a thatched roof either free-standing or on the flat roof of a house. These are normally mud-lined inside and out. In the hilly areas, Bhakaris are much smaller, being mere cylinders of bamboo placed on the earth floor or the loft of a dwelling house. In the Western hills small mud bins or boxes are used for cereal storage and occasionally underground pits. Maize is

commonly stored outdoors with sheath intact on racks or cribs. An improved concrete silo has been introduced into the Terai but with the rise in cost of the essential imported components of this silo it has not been accepted. The Gurkha Resettlement Scheme has introduced a metal sheet alternative to the Bhakari but the stored grain is still exposed to rodent and insect attack.

Storage facilities at the primary purchase level in the Terai are lacking in the West and are inadequate elsewhere. Emphasis is now being placed on the use of cooperative societies acting as agents for the Rice Exporting Companies. These societies are often operating at buying points without storage or mechanical drying facilities and large amounts of high moisture paddy are held for long periods. Fifty-six new multi-purpose godowns in the 150-500 tonne range have recently been completed in the East.

The Rice Exporting Companies have started to construct new godowns, although until recently they relied on poor quality rented godowns. Processing and storage facilities operated by the commercial rice traders/millers have lagged behind the government and quasi-governmental sector. Losses have been high but a pilot project in the Far West which will allow the Rice Exporting Co to run its own modern mill and storage godowns is nearing completion. At the National level the Nepal Food Corporation (NFC) runs an expanding system of purpose-built godowns on a three tier basis. Multiples of 1,000 tonne units are situated at the food grain collection centres in the Terai. Grains are moved into the hills in the dry season where they are stored in 250-500 tonne units. Before the monsoons they are moved from there to the more remote hilly areas where smaller godowns are located.

Levels of Post-Harvest Losses

The extent of losses during the various post-harvest processes has not yet been fully studied. It is estimated that total post-harvest losses are about 18-25% due to insects, birds and rodents. It is estimated that 3-5% is lost in the farm-field before farm storage. Loss in farm storage is about 15% because of poor drying and sub-standard storage practices. Losses in central stores are about 3-5%. Transport losses are thought to be high because of the difficult terrain and the varied forms of transport.

Current Loss Reduction Programmes

A TPI/NFC grain storage project is underway. This involves the construction of godowns and improvements in storage techniques. Godown building has also been undertaken under HMG/UNDP programmes as well. Fifty-six new godowns in the 105-550 tonne range are being constructed with the financial support of ADB for the Sajha Development.

Future Loss Assessment Studies and Reduction Programmes

1. **At the Farm level.** The Gurkha Resettlement scheme is planning to introduce mobile seed dressing facilities and village seed stores as well as pesticides and materials for fumigation.
2. **At Cooperative level.** When completed the Sajha godown construction programme will provide 50,000 mt storage capacity.
3. **At Rice Exports Companies level.** Three rice export companies plan to construct godowns for grain storage and one 2 metric tonnes/per hour rice mill is being constructed in the West.
4. **At Nepal Food Corporation Level.** NFC is carrying out a loss assessment exercise with TPI collaboration and is to introduce improved procurement and conservation techniques. At present NFC has 40,000 metric tonne capacity godowns but by the end of 1978 they will have 61,000 mt capacity.

Necessary Inputs

Training and personnel requirements have been submitted under the existing NFC/TPI collaboration. The installation of drying facilities at strategic buying points is essential. Modernisation of traditional rice milling facilities will also be necessary to improve quality and reduce milling losses.

SRI-LANKA

by

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The main crop is paddy but maize and sorghum are also grown. Pulses such as cowpea, black gram and green gram are grown in the dry zone areas. In general the major food crops are not exported as the country is not yet self-sufficient in these crops. Marketing is undertaken by such organisations as the Paddy Marketing Board (PMB) and the Food Commissioners (FC) Department. The PMB handles paddy, maize, sorghum and black gram.

The rice crop is usually left to dry in the field but this is known to cause a certain amount of loss due to shattering, rain damage, lodging and insect and rodent attack. As a result of this the practice of early harvesting was introduced; the paddy being harvested at 22% mc. The grain is sun-dried before storage at the village level. Paddy sold to the government is usually too wet for safe storage. The farmer sells his paddy to the cooperatives who store the grain for short periods with other commodities. This results in insect and rodent attack and good dry grain is often mixed with wet grain. The co-ops sell to the government and losses occur in their large godowns. Losses may be due to moisture migration from the ground, rodent attack, insect and mould damage or heat damage. In 1975 the Paddy Marketing Board estimated that losses in government godowns amounted to 6.42%. To try to lower the losses several programmes were started. These were:

1. Moisture testing equipment was introduced at all Paddy Marketing Board warehouses.
2. This was followed by the introduction of moisture testing devices for the cooperatives in certain districts. It is intended that all the cooperatives who purchase grain will eventually have moisture testing devices.
3. Warehouses were renovated.
4. Stacking, issuing and paddy conservation was begun on a systematic basis.
5. Training for Marketing Board officials. A small training centre was established with funds from the Ford Foundation. UN/FAO provided more funds for some expansion. Twelve regional laboratories were established under the direction of Training Officers. These officers are in charge of all pest control measures such as spraying of insecticides, fogging and fumigation. They also monitor the grain quality periodically.
6. The Engineering Division of the Marketing Board was expanded and trained engineers investigated the procurement, storage and processing of grain. Recommendations were made for integrated storage and milling complexes three of which are functioning at present.
7. The UN/FAO Training Research Centre is working on several projects including an investigation of a typical traditional village storage structure; storage studies on paddy treated in different ways; estimation of losses in a warehouse; brown rice storage; studies on sun drying; construction and testing of a simple mechanical drier and a village level parboiling plant.

Future loss assessment studies and loss reduction programmes

United States Agency for International Development (USAID) will be implementing a warehouse improvement programme in the government and private sector. This will be centred on the procurement, drying, storage and milling aspects. To support this the Government have the following plans:

Phase I. a. The provision of additional storage for 1978-1982.

b. The provision of cleaning and drying equipment at all government warehouses.

c. The supply of 10 rice mills for the government sector and 25 for the private sector.

Phase II. A sum of 12 million US $ has been allocated and plans are being currently drawn up.

At the farmer and cooperative level, moisture meters will be introduced to monitor the moisture in the grain, and cleaners (to clean the grain brought in) are envisaged. The latter have been built locally and the entire scheme has already been tried in a selected district. The grain purchased was also dried (if necessary) at government warehouses.

The Rice Processing Development Centre of the Paddy Marketing Board has been conducting several experiments in village level storage. Simple driers and rice parboiling equipment needing little investment are being tested at the Centre.

At the Marketing Board level, additional storage needed is 50,000 tons. Temporary forms of outdoor stacking under cover are being used to alleviate the problem. Bulk storage is planned wherever a government processing complex is located. Additional stores each of 1,000 ton capacity are to be added to the present bag stores.

Inputs for future loss reduction programmes

The most essential input would appear to be training in store management, pest control, grain inspection and the drying of grain. It is hoped that the Tropical Products Institute may help with this. Trained personnel could form a nucleus of extension workers and a Research and Development team which would improve the quality and reduce the losses of grain in Sri Lanka.

GHANA

by

T B Biney

Ministry of Agriculture,
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Approximately 60% of the total land area is cultivated and of this, 40% is devoted to food crops. Maize is the most important crop (12% of cultivated land, 44% of cereal production land). Rice is the second most important crop, but millet, sorghum and legumes are becoming increasingly important. Production of maize increased in 1972 but since then there has been a decline mainly due to poor weather conditions. Rice production has similarly been affected. Against this background there is an obvious need to increase production and save what is produced. Great importance is placed upon the assessment and reduction of losses. A small team of officers is engaged in this work but progress is hindered by a number of constraints. There is an immediate need for i. vehicles, to increase the mobility of the team; ii. training of staff, perhaps overseas training of graduate team members and local training of technicians, iii. laboratory equipment for loss assessment studies, and iv. expatriate assistance with the design of improved traditional stores.

The northern part of the country suffers periodic food shortages due to insect infestation developing in grain which has to be stored for long periods. There is an urgent need to study the problems in the area as past studies have been confined chiefly to the south. It is suggested that two expatriate specialists backed by a local team of graduates and technicians are needed to undertake this study.

Assistance is also required in the fields of rice production and processing. Rice has become an important crop in the north and many people in the area are settling down to rice production, whereas in the past the tendency was to migrate south in search of work. On the production side, assistance with weed control is necessary, to identify suitable herbicides and to train local extension workers in control techniques. Problems in rice milling arise since the rice is harvested in the dry season resulting in a high proportion of broken or pulverised grains. The aim of increased rice production was to increase the food supply but at present much of the rice has to be diverted as animal feed or for brewing. Because of the difficulty with rice production in drought-prone areas of the north, efforts have been made to produce rice on irrigated land in the south, but here a problem of bird damage has arisen.

NIGERIA

by

O A Phillips

Federal Department of Agricultural Research,
Lagos, Nigeria

Nigeria was a predominantly agricultural country 15 years ago but production declined with the advent of an oil economy. However, in recent years the costs of both imported and home produced food products have been rising rapidly. About 5 years ago food production projects were introduced to boost domestic production of the six basic foods, maize, rice, sorghum, millet, wheat and cassava. The projects were initiated in 8 states but have now been expanded to cover the entire country. Results have been encouraging, farmers have shown great interest in the scheme and over 2000 agricultural personnel have been trained, many at International Institutes. To supplement this programme, a second project — Operation Feed the Nation — was started two years ago to highlight constraints to food production, for example supply of fertilisers, provision of subsidies for fertiliser purchase, etc. A coordinated seed service has been established to carry out multiplication and distribution of improved seeds. Agro-service centres are now being set up to improve the supply of agricultural inputs, including seeds, fertiliser and pesticides.

There are a number of institutions in Nigeria working on the problems of post-harvest loss and loss reduction. In the north, storage problems particularly of sorghum and millet are being investigated at the National Stored Products Research Institute at Kano and at Ahmadu Bello University, Samaru. In the south, at Ibadan are situated the International Institute for Tropical Agriculture, the Institute of Agricultural Research and Training and the National Stored Products Research Institute.

Work in the south primarily relates to storage problems of maize, rice and tuber crops.

Because of the anticipated huge increase in food production, help will be required in several areas:

1. Design of improved traditional storage structures so that produce can be stored safely at the farm level.

2. Expansion of the Agro-Service Centres, providing large scale storage facilities at the points where farmers will sell their grain.

3. Modernisation of the rice processing systems to cope with the increased production resulting from double cropping.

4. Training of extension workers in food production and food storage techniques.

5. National coordination of work on storage carried out at the various Institutes in the country.

SIERRA LEONE

by

S Said

Ministry of Agriculture and Natural Resources,
Freetown, Sierra Leone

The government of Sierra Leone has given a high priority to agriculture in its search for new areas of economic expansion away from minerals. A wide range of crops has been introduced, and rice is now the most important, produced on 62% of the cultivated land. However, only about 20% of the total production is marketed, the bulk being retained for consumption. The Rice Corporation buys paddy at a guaranteed price fixed at the beginning of the season, mills it and stores the rice. The Corporation holds the monopoly for the import of rice. Less than 5% of the marketable surplus reaches the Corporation, most is taken by private organisations.

The marketing system is organised along traditional lines, farmers sell in small lots to traders who in turn sell to dealers and so on to merchants. At the farm level, rice is stored in traditional structures, but the Rice Corporation has permanent stores where rice is stored in bags.

A survey of storage problems in Sierra Leone has revealed that insects, rodents, and birds are responsible for significant losses. No special loss assessment exercise has been carried out but a survey questionnaire indicates post-harvest loss of paddy is likely to be around 15%. (This is equivalent to 90,000 tonnes of paddy or 72,000 tonnes of rice.) The small farmer community, comprising some 75% of the population, is hardest hit by this loss.

The Produce Marketing Board supplies pesticides free of charge to farmers and pest control is carried out by the Pest Control Unit of the Ministry of Agriculture.

An improved storage bin has been developed for paddy/rice storage but legumes and pulses are still stored in small traditional containers, gourds, bottles and drums. Dried ground chillie powder may be mixed with the legumes and pulses to prevent insect damage.

The need for action to reduce losses is recognised and a farm management study to collect data on losses at planting, harvesting and post-harvest stages has been drawn up but implementation has been delayed by lack of funds and support services. Assistance with training, particularly of extension staff to be engaged in the project is urgently needed. An initial survey indicates that losses of rice occur at the following stages: field drying, threshing, winnowing, parboiling, milling, storage and marketing but more information is required.

Of the pulses, cowpeas and black eye beans are most susceptible to insect attack and perhaps more attention should be paid to new resistant varieties.

BENIN

by

P Gbegbelegbe

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Watitingou, Benin

It has been estimated that losses in farm stored grain in Benin often amount to 20%. Benin is trying to reduce these losses by improving traditional farm storage which requires little financial outlay. Losses are highest after the first

maize harvest as the crop is harvested during the rainy season when the moisture content is high. The second maize crop is harvested and stored during the dry season.

In 1967 the Department of Agriculture in collaboration with Volunteers of the American Peace Corps, introduced a cement stave silo and a drier at the village level. The grain was dried to 12% moisture content by the drier before being stored. The silo and drier have proved successful and are now being used throughout the country. The silo's capacity varies from 2-10 tonnes and the total cost of construction and storage including pest control measures works out at 8,000F (CFA) per tonne). Two tonne silos are commonly used by the farmers whilst the 10 tonnes silos are used at the commune level, financed by the National Grain Commission and managed by the Agricultural Products Marketing Board. Any surplus grain the farmer has is sold to the Marketing Board and stored in the 10 tonne silos at the commune level. This is sold back later in the year to the farmers, so keeping the price stable.

Loans from the National Agricultural Credit are available to farmers who wish to purchase the new silos. Very often the farmers have difficulty in paying back the loans so the government is now giving financial assistance to the cooperatives and a credit policy has been introduced which facilitates payment of the loan. The government also subsidises the cost of the materials used in silo construction where the price of any of these materials starts to rise.

Technical personnel from the provisional rural development centres teach the farmers how to apply pesticides to their crops during the harvest period. The National Plant Protection Laboratory carries out experiments on the effectiveness of insecticides used and also train the staff of the rural development centres.

IVORY COAST

by

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Ivory Coast

The population of the Ivory Coast exceeds seven million of which two-thirds are rural. The major subsistence crops are yams, cassava, sweet potatoes, bananas, rice, maize and sorghum. Export crops are coffee, cocoa, rubber, pineapple, palm oil, sugar cane and soybeans.

The storage capacity for rice at the end of 1975 was 39,850 tons in sacks and 6,000 tons in bulk although the latter was not always useable because the bulk units are not equipped with a ventilation system. The installations presently being constructed should bring the storage capacity in bulk up to 16,000 tons and eventually to 77,000 tons. Sack storage remains unchanged, therefore the total storage capacity would be 116,850 tons.

The causes of post-harvest loss. There has not been a thorough study of post-harvest lossess. The Director of Statistics of the Ministry of Agriculture acknowledges the following losses: paddy 15%; maize 15% and groundnuts 10%. For millet and sorghum the losses are estimated to be about the same as rice and maize. Losses in rice during mechanized harvesting are caused by: late harvests causing shattering of grain; harvesting carried out under unfavourable atmospheric conditions or before grain maturity – this provokes losses by deterioration in the quality of seed, mould and overheating. Paddy is often dried on uncovered or poorly arranged surfaces which are subject to unexpected rain. Moist paddy is stored in sacks and often the sacks are left in the open with insufficient protection for a long time. Damage by insects, especially *Sitotroga cerealella* and *Sitophilus oryzae* is common especially during seed storage.

Problems of the same nature exist for the other cereal crops especially maize and soybean.

SENEGAL

by

G Diop

State Government Marketing Board,
Dakar, Senegal

Approximately 80% of the population of Senegal is directly dependent upon agriculture. The government has established a rural development policy based upon agriculture (crops and livestock farming) and fisheries, with the ultimate aim of making the country self-sufficient in food. A number of development agencies, boards and corporations have been established, some with assistance from international aid agencies. The National Cooperation and Development Assistance Board plays a major role in implementing agricultural policy.

There has been no detailed evaluation of post-harvest losses but an in-depth study of the problem is planned for the near future. ONCAD (the Government Marketing Board) will carry out long term and short term studies of post-harvest losses. A medium term policy to reduce losses has been drawn up. The first objective is farmer training in improved drying, threshing and storage techniques. ONCAD will build a number of small silos to store farmers' grain before it is marketed, improve the supply of inputs including fertilisers and pesticides and develop extension services for the farmer.

MALI

by

Z Sountera

Operation Traitement des Semences,
Bamako, Mali

Mali, one of the Sahelian countries, has been very severely affected by drought in recent years and so a policy of careful management of harvested produce and improving production has been adopted. Staple food crops include millet, sorghum and rice.

The weaver bird, *Quelea quelea*, is responsible for heavy losses of grain crops in the two to three week period immediately before and just after harvesting.

Traditional methods of harvesting and transporting grain to store are inadequate and result in substantial losses. It is usually necessary to store produce temporarily in the field after harvest and at this stage grain may be consumed by rodents and/or domestic animals.

At present there are two projects concerned with reduction of losses under way in Mali, a seed treatment and crop conservation project financed by the European Development Fund and a Government Project in which two British expatriates are investigating losses in central stores. The European Development Fund project is concerned with the protection of seeds and growing crops by the use of pesticides and investigating ways of improving traditional farm grain stores. Some tests have been carried out on improved storage bins with a view to reducing rodent damage but no results are available yet. The fund has also provided help for the extension services.

Support for loss reduction work in Mali is required in the form of training of personnel, especially training of staff to replace the expatriates to ensure the continuation of the project when their contract expires.

Training at two levels is required, firstly training of trainers for extension workers, and secondly, training of researchers to assist with the design of improvement programmes particularly in relation to farm level storage.

Rodents are a severe problem both in the pre- and post-harvest stages of production. A design for a cheap, rodent proof storage bin is urgently required. An in-depth study of local storage practices and losses is required. At present the traditional methods of controlling insects in farm grain stores are being monitored. A number of plant materials and ashes of plant materials appear to afford some protection when mixed with the stored grain.

TANZANIA

by

A M Mushi

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Ilonga, Kilosa, Tanzania

Tanzania has a population of 15 million, 95% of the population are rural and earn their living from agriculture. Production of crops is carried out on farms which are communally, individually or rarely government owned. Most of the harvested crops are stored on the farm, either in individual farmers' stores or in communal/cooperative stores. The surplus crops are sold to the National Milling Corporation (NMC) which is responsible for purchasing all agricultural food crops. The produce may be stored temporarily in the open, awaiting transport to NMC district godowns. From the district godowns it is transported to regional godowns. Some of the produce may be kept at the regional godowns for more than a year (food reserves).

Causes of post-harvest losses. Harvesting and threshing losses are usually highest when machines are used, especially when these are not adjusted properly. In most of Tanzania field-drying is most common. In the coastal plain, the Lake Victoria basin and the highland areas above 1,500m (eg Mporoto mountains in Mbeya and Njombe) field drying is not possible because of the high rainfall. In these areas moulds destroy a large portion of the harvested crop.

During storage the major causes of loss are insects and rats. The most important cereal pests are *Sitophilus* spp. and *Sitotroga cerealella.* Attack starts in the field and the insects are brought into the store with the harvested grain. Serious outbreaks of rats have been reported in several areas and rat infestations appear to be on the increase. Termites are a problem in Southern Tanzania. The main cause of loss during NMC storage is the weather. Loss occurs when the grain has been bought from the villages and is awaiting transport to the godowns. Often the produce is stored in the open for a considerable time and if it rains, losses are heavy.

The NMC has trained personnel who ensure that the crop is at a safe moisture content and that the produce is fumigated to control storage pests.

Current work to reduce/estimate losses. The National Crop Storage Research Programme is based at the Agricultural Research Institute, Ilonga, Kilosa. Several projects are in progress. These include:

A. A research extension project to improve on-farm and village crop storage in Tanzania. The objectives of the project are

   a. To train agriculture extension staff in improved crop storage methods.

   b. To train farmers in the use of insecticide application to stored grain.

   c. To assess the magnitude of crop loss under village conditions.

   d. To develop a model on how to reduce crop losses at farm and village level in Tanzania. One district has already been covered.

B. The improvement of local storage structures for long term storage (2 years). This project is developing and improving an airtight basket of about 2 tons capacity for long term storage in villages.

C. Insecticide dusts are being tested for controlling bruchids in beans and weevils in cereals.

D. Maize and sorghum are being tested for their resistance to various stored products insects.

E. Training and Extension. A 3-month course for 30 extension staff was organised last year (1977). Similar courses are planned in the future. Tanzania Food and Nutrition Centre is conducting seminars and workshops on improved crop storage and food preservation in different regions of the country.

F. NMC and other crop authorities are building godowns in different districts to store the produce they buy from the farmers.

Priority Plans for future Loss Reduction Programmes

At the Farm Village and Cooperative Store Level. The Ministry of Agriculture has established a Farm and Village Crop Storage Improvement Team which will be expanded in future. The duties will include training agricultural extension staff; carrying out applied research in crop storage; undertaking crop loss assessment studies.

At the Marketing Board and Central Storage Level. Special training of pest control personnel in these stores is required. Special training should be sought overseas.

More trainers are required to teach crop storage in the various agricultural institutes.

KENYA

by

C M Warui

National Agricultural Laboratories,
Ministry of Agriculture,
Nairobi, Kenya

Kenya has a population of 13.5 million people with 90% of the population living in rural areas and deriving their livelihood from small holdings. The remaining 10% derive their livelihood from large-scale farming in the private and public sector. Crops grown include coffee, tea, pyrethrum, bananas, and traditional food crops such as maize, sorghum and millets with cotton and groundnuts as cash crops.

Throughout the food grain storage system, ie harvesting, threshing, storage, marketing, the major causes of loss would be spillage, moisture, insect pests, rodents, fungi, birds and wild animals. The post-harvest processes are completely unmechanized for most food crops. Loss assessment is difficult but losses are considered to be high.

Crop storage situation in Kenya. Government legislation has allowed several Statutory Boards to develop, covering most of the cash and subsistence crops. These Boards have responsibility for safe storage, transportation, distribution and marketing for both internal and external trade. There are also cooperative societies involved with storage and marketing of certain commodities. Processing of grains is carried out by private traders and millers.

Work on loss reduction in Kenya. There is a considerable history of stored products research and extension in Kenya. This includes:

1. Pioneering work on insecticide treatments

2. Warehouse ecological studies
3. A UK/FFHC (Farm Storage Improvement Campaign 1969-1971) investigated some extension parameters affecting rural storage practise.
4. A UK/ODM (Ministry of Overseas Development) Crop Storage Team. This carried out fundamental studies on maize storage and investigations in relation to problems arising from the anticipated change to bulk handling.
5. The incidence and degree of insecticide resistance to storage pests (lindane and malathion).
6. Protection of grain by insecticidal dust formulation in both cob and shelled maize grain.
7. Ecological studies on maize stored in traditional stores and the insect pest complex in various parts of Kenya. It is hoped that this will give accurate weight loss assessment figures in Kenya.

Statement on future plans. The Ministry of Agriculture in collaboration with the International/Foreign Agencies should assist in combatting the problem of food conservation. Continued support by the Ministry of Agriculture should be given for the establishment/strengthening of a permanent stored product institute to cater for the following:

1. The improvement and assessment of all existing methods of subsistence farmer storage.
2. Practical recommendations and implementation of appropriate methods of pest control and storage practice to all storage facilities. This responsibility is now fragmented between many organisations.
3. Training of all personnel concerned with storage of durable produce including extension workers.
4. Advice and the extension of appropriate and relevant information and technology to all named agencies as well as to large and small scale farmers.

ZAMBIA

by

N E MUMBA

Ministry of Lands and Agriculture,
Lusaka, Zambia

The major crops are maize, groundnuts, sunflower, cotton, tobacco, soyabeans, sugarcane, rice, wheat, sorghum and beans. The marketing of all crops except tobacco is done by the National Agricultural Marketing Board. In some areas marketing co-operatives purchase commodities on behalf of the marketing organisation. The main crops for export are groundnuts and tobacco. The overall aim for the future is self sufficiency and the development of some export crops eg tobacco, coffee and tea.

Causes of loss include termite damage, weevil and rat damage, poor drying facilities, losses due to diseased produce, bags bursting in transit and theft of bags. In the processing and marketing stages a loss of 5-10% occurs. This is caused by poor marketing and arrangements that do not provide immediate safe storage after purchase and before resale for milling and consumption. Losses occur due to deterioration in store when commodities are stored at too high a moisture content.

Estimates of Loss. In Southern Province of Zambia losses in maize (used for consumption at the village level) were between 20-30% by weight. This was mainly due to insects and rats. In 1973 a survey showed that losses during marketing amounted to 8% and were caused by moisture migration in stacks, rains soaking uncovered stacks and weevil damage due to improper fumigation.

Plans for the future. Loss assessment has a low priority, the intention is to concentrate on loss reduction.

At the farm level a new improved storage structure called the ferrumbu bin has been developed. Maize has to be stored in the shelled form in this.

At the central stores storage arrangements are adequate but when there has been a good harvest there is insufficient storage space and produce is temporarily stored outdoors. This will be overcome by constructing simple stores in the marketing areas.

In processing and marketing attention is being focused on getting the grain to the processors as soon as possible so reducing handling losses. Bulk handling of most crops will be introduced starting with maize.

Marketing Board level. Losses are highest at this level as commodities are bought and then stored in the open until they are transported to central stores. Losses in these temporary grain stores are high. The aim is now to construct simple but safe stores at these depots which will relieve the pressure on central stores and on the transport system.

Drying studies should be undertaken to find out whether early harvesting and subsequent drying contributes to reduction of losses due to disease.

There is a need for a produce inspectorate to look after the export side of various commodities. At present only the Eastern Co-operative Union has an inspector dealing with the export of groundnuts. A central organisation is required with perhaps 6-8 inspectors seconded to specific enterprises. More staff are required in the Department of Agriculture particularly a stored products chemist, a stored products entomologist, a food storage officer, a storage engineer, an extension/liaison officer.

SWAZILAND

by

V Pungwayo

Ministry of Agriculture,
Mbabane, Swaziland

Agriculture displays an unusually sharp duality between an intensive, largely foreign-owned and managed, modern farming sector and the traditional subsistence sector. Most subsistence farmers live in the 57% of the country known as the Swazi National Land, here traditional authority and land tenure systems prevail. The main cereals and pulses are maize, groundnuts, sorghum, jugo-beans, field beans and rice.

Causes of post-harvest losses. During the drying of the maize cobs and subsequent storage of shelled grain it is known that substantial losses occur. Insects cause the bulk of the damage, especially *Sitophilus zeamais,* and *Sitotroga cerealella* which are the most important pests of stored maize in Swaziland. Rodents and moulds also damage the grain.

Estimates of losses. The Ministry of Agriculture has conducted three surveys of stored maize. It appears that whilst the level of damage can exceed 30% the actual weight loss is about 8%.

Current work to estimate/reduce losses

The Grain Storage Section of the Ministry of Agriculture is presently carrying out a preliminary loss assessment survey in conjunction with the Agricultural Economics Department of the University College of Swaziland. The programme aims to give — a clearer understanding of the magnitude of losses, the position in the system where they occur and some indication of the economic and financial aspects that are involved.

The present policy to reduce losses is to improve on-farm storage. The Grain Storage Section, operative since 1972, is working to improve farm storage, particularly at the subsistence level. Trained field personnel cover all four districts of the country. Their activities include: promoting the use of insecticides and fumigants where such measures are necessary; encouraging farmers to construct improved maize cob drying cribs, and in general reducing the depredations of loss-causing organisms.

Future loss assessment and loss reduction programmes should be primarily concerned with storage at the farm and cooperative levels. There is a requirement for a Research Officer to initiate and conduct research into storage topics of particular relevance to Swaziland. These are: to determine the extent of resistance to insecticides; to conduct a detailed loss assessment survey of the maize storage system; to investigate the relationship between moisture and temperature in small metal grain tanks with a view to improving the management of these stores; to evaluate the significance of field infestation prior to harvest; to monitor and compare the drying rates of maize cobs in different drying structures.

Training will be needed for managers of large depots and for any inspectors required in the future. There will be a substantial need for driers, silo installations and ancillary equipment as the large scale storage capacity is increased.

ZAIRE*

The Republic of Zaire is a predominantly agricultural country with 80% of the population earning their living from agriculture. The growth of cereals for the commercial market is being encouraged by the National Executive Council through their National Cereals Office (ONACER). The National Cereals Office is working through two special bodies for the cereal programme. These are the National Maize Programme (DNM) and the Chinese Agricultural Mission (MAC).

Zaire has a total area of 2,500,000 square kilometers and a population of 25 millions. The climate ranges from humid equatorial to tropical. The main cereals grown are maize and rice. Sorghum and millet are cultivated in small quantities. The most important legumes are haricots and groundnuts.

Losses are from a variety of causes and are found at all levels of production.

Losses in cereals

a. **Maize.** Losses occur both in the field and store. Field losses are caused by mildew whereas losses in store are attributed to insects.

b. **Rice** is attacked in the field by birds and also suffers from mould damage. Losses in store result from insect attack.

c. **Legumes.** In the fields groundnuts and haricots suffer rot and bird damage whereas in the store they are attacked by insects.

To control these losses it is necessary to create a Plant Protection Service. To create this two or three experts will be needed to train staff and work can then be undertaken on research into the control of plant pests, storage and the types of storage or packaging necessary for the crops. For example storage of grain could be studied from the point of view of insect control, the types of losses occurring in store; physical factors during storage and the treatment of stocks with insecticides, fumigants and rodenticides. The help of TPI will be needed.

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* Abstract of country paper received from ONACER. It was unfortunately not possible for a delegate to attend the Seminar.

PAPUA NEW GUINEA

by

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Papua, New Guinea

The independent state of Papua New Guinea is located on the eastern half of the island of New Guinea and includes the offshore islands to its North and East. It has a population of some three million. The importance of agriculture to the economy is considerable with the income earned by the sales of coffee during 1976-77 exceeding that earned by copper which has previously been the major single source of foreign exchange. The main crops grown for home consumption are sweet potato, taro, yams, bananas, sago and coconuts. Marketing arrangements are mainly private but the State owned Food Marketing Corporation was recently established to overcome some of the logistical problems involved in the supply of fresh foods to urban countries. Local rice production amounted to 6,000 tonnes milled in 1977 with imported rice totalling 67,000 tonnes. The Government has placed a high priority on increased local rice production. Maize and sorghum production is being expanded in the lowlands to meet the demands of the internal stock feed requirements, and to restrict imports to concentrates only. Irish potato cultivation is being encouraged in the highlands. The principal export crops are coffee, cocoa and copra, with chillies, palm oil, rubber and tea.

Estimation of losses

1. No quantitative work to identify the causes of post-harvest losses has been carried out. Observations indicate that poor handling (particularly with fork lift trucks) and transport, poor warehousing facilities and absence of pest control, inadequate storage facilities and ignorance are the main factors involved.
2. There are no estimates for post-harvest losses.
3. An investigation of losses in central paddy stores planned for 1977 has had to be delayed until the 1978 harvest is brought in.
4. Current work to reduce losses is mainly concerned with producing an increased awareness of good storage practice and introducing the use of insecticidal protectants.
5. The planners do not place any emphasis at the moment on the introduction and implementation of any programme of post-harvest loss assessment in foods or any other commodity produced in Papua New Guinea.

All rice grown at the present is sold to the Department of Primary Industry which stores and mills it and then markets the rice. This situation is not expected to change until production increases well beyond present levels.

With maize and sorghum all production is harvested from large scale expatriate owned farms where storage facilities range from primitive bulk (flat) storage to large metal silos. One group of farmers has a contract to supply 200 tonnes of maize to a feed mill for whom an inexpensive cooperatively owned bag store is being designed and built with assistance from the Department of Primary Industry.

Any food loss assessment programmes would appear to have to be biased towards a cooperative or central storage level. All imported rice is stored in 'rice terminals' owned by the firm of importers and here loss assessments could be made along the line of supply.

There would appear to be a requirement for one or two expatriates experienced in loss assessment studies, supported by a staff of nationals who would require training. Training requirements would also be needed for management, extension workers, store keepers, inspectors, etc.

The problems of storage peculiar to Papua New Guinea are similar in nature to other South Pacific states and it is suggested that there exists a necessity for a forum to discuss these problems and to exchange information to our mutual benefit.

AFGHANISTAN

by

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Approximately 90% of the population is engaged directly or indirectly in agriculture. The main objective is to increase agriculture yields and achieve self-sufficiency, particularly in wheat. The principal cereal crops are wheat, maize, rice and barley. Cotton is becoming increasingly important and is the major export crop. Agriculture is largely subsistence. Plant protection measures are rarely applied, reflecting the fact that insecticides and fungicides have only recently become available in the country. Wheat is the staple food crop and is grown both under rainfed and irrigated conditions.

Causes of post-harvest losses

Government grain storage facilities have a capacity of 280,000 metric tonnes and are adequate for present needs, although they would be deficient if a wheat stabilization programme were introduced. Storage losses are serious, estimated at about 20% in godowns but only 2% in hangars. In addition to the government facilities, large producers and merchants have storage facilities but these are largely unsatisfactory structures in which losses are about 10% annually. The total capacity of these stores is 200,000-300,000 tonnes.

There are five modern silos in Afghanistan. One is located in Kabul and has a capacity of 50,000 metric tonnes, with a milling and processing plant. Silos of 20,000 tonnes are located in Kandahar, Herat and Puli-Khumri each with a milling plant. A silo is under construction in the city of Mazar-i-shariff with a capacity of 20,000 tonnes.

There are two main types of godowns, constructed from either stone or brick. Loss of grain in the godowns is due to high moisture content of the grain and poor ventilation. Hangars are open-sided stores and losses as high as 20% have been estimated when produce has been kept for long periods.

KOREA

by

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Korea is a mountainous land with arable land amounting to only 23% of the total territory. The nation's climate is temperate, the hottest months being July and August and the coldest December and January. 50% of the rains fall between June and August. The year has been divided by the government into three periods for grain storage: from October to March, safe period; from April to June, warning period; and from July to September, dangerous period. The major farm products are rice, barley, soyabeans, vegetables and fruit. Agricultural policies are concentrating on sustaining the state of food self-sufficiency through the introduction of new high-yielding varieties, improved irrigation and use of fertilisers and mechanisation of farming.

Rice is the major staple food grain. Rice is managed either by government or private sector. The marketing system controlled by the government is well established but the private sector varies from province to province. Paddy is sun-dried to about 18-16% moisture content before threshing. The threshed paddy is again sun-dried to 15% mc before being milled, the maximum permissible moisture content at which the government will purchase. On the

farm paddy is stored as such in straw bags but brown and milled rice may also be stored. Bulk storage is practised on a small scale.

Losses. Losses during harvesting are caused by combine, binder and sickle. Some rice varieties show a higher loss probably due to their high shattering characteristics. With traditional harvesting systems losses vary from 1.20-4.83%; with the binder they range from 2-11% and with the combine from 3-6%. Weight loss of paddy during storage at government stores in a 12 month period range from 2 to 7%. Losses during storage at farmers' houses average about 4.9%, the longer the storage period, the greater the loss. Losses whilst the produce is in store waiting to be sold by the retailers are high, eg storage of only 18 days can result in a loss of 2.9%.

Current Loss Reduction Programmes in Korea

1. **Ministry of Agriculture and Fisheries.** A nation-wide survey for the estimation of losses of rice and barley from harvesting to distribution was initiated in 1977 with the cooperation of the National Agricultural Cooperative Federation.
2. **Seoul National University.** A project is being undertaken called 'Post-Harvest Technology in Korea' supported by the International Development Research Centre, Canada. The first report concerning the losses of rice from harvesting to milling was released in July 1977.
3. **Korea Institute of Science and Technology**
   a. Investigations into the use of vertical-type silos with flat floors for the bulk storage of rice.
   b. Storage at farm level – the introduction of small scale bulk storage facilities.

Future Loss Assessment and Reduction Studies

The ultimate goal is to modernise the post-harvest system for rice. The major proposals are:

1. The operation of a rice processing complex to rationalize the rice marketing systems.
2. Extensive studies to modernise distribution and grain management. This includes:
   a. Survey on post-harvest management from harvesting to distribution.
   b. Improvement of existing stores and mills.
   c. Improvement of rice marketing systems.

The project will take about 5 years. Research funds and experts familiar with agricultural marketing systems and loss assessment studies are required. Feasibility studies on bulk storage of rice have been initiated by the Korean Institute of Science and Technology.

BOLIVIA

by

M Perez

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Bolivia has a land area of one million one hundred thousand square kilometres with a population of approximately 5 million. There is a wide range in altitude and climatic conditions. Agriculture contributed, in 1975, 15% of the GNP. In the Andean areas agricultural practices are traditional and it is estimated that approximately 70% of the population are engaged in subsistence farming. Consequently any improvements in agriculture in this area will have

to be developed at the family, community or cooperative level In the tropical/subtropical flat lands where agricultural practices are recent more progress could be made with production programmes.

The main food crops include wheat, barley, rice, maize and soyabeans. Market prices are mostly regulated by seasonal changes with the exception of some products such as sugar cane and rice which are government controlled. Bolivia imports 207,000 tons of wheat annually.

Post-harvest losses are primarily due to excessive handling, adverse climatic conditions, especially at the field operations stage, inadequate storage and insect and rodent infestations in store. Losses due to excessive handling arise because of the many traditional operations eg harvesting with the sickle, threshing with animals and winnowing by hand. Rain at harvest time is responsible for causing serious losses. Grain stores may be used for storage of other materials and they provide little protection against rodents or moisture.

New machinery eg combine harvesters etc cannot easily be introduced as such a change is opposed by the small producers on the grounds that large machines could not be operated economically on the small plots of land. Perhaps an alternative would be to introduce animal drawn harvesters and static threshers and winnowers designed to improve the operations yet maintaining employment opportunities for the community. New storage structures designed to suit a particular region need to be introduced and tested.

No data are available on post-harvest losses but an estimate of between 5% and 10% may be given, assuming that conditions in Bolivia are comparable to those in neighbouring countries.

Post-harvest loss reduction programmes will be encouraged at the peasant community level and will consist of demonstrations and training courses carried out by the extension services.

As a first step it is suggested that systematic pilot projects to introduce and test new methods be established in selected areas.

A loss reduction programme will require outside assistance in the form of a. technical advisers, to study harvesting, threshing, cleaning and storage operations, b. training; perhaps scholarships for post-graduate staff, c. experimental silos and equipment for post-harvest operations to develop improved methods of handling and grading, d. technical assistance in establishing 3 pilot projects one in each of the 3 major regions of the country. Bolivia can provide the experimental station sites on which new equipment and methods can be tested and extension staff to operate in the pilot project areas.

PERU

by

F Chocano

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Peru has a land area of approximately 1 million 285 thousand sq km and a population of 19 million. The country may be divided into three distinct zones, the coastal region, the highlands and the mountains. Approximately 1.2% of the land area is cultivated. Staple foods include rice, maize, sorghum, wheat, pulses and soyabean. The most important crop however is the potato. Peru is deficient in a number of food grains and wheat, maize sorghum and soya have to be imported. Improved cultivation techniques have helped to reduce the maize deficit by about 10%. Post harvest losses occur at all stages from harvesting to storage and are due to excessive handling in field operations and transport, inadequate storage and transport facilities, adverse climatic conditions, mould damage and insect and rodent infestation in store. Some producers store directly and others send their produce to the silos from where it is distributed to industrial centres.

Losses in transport occur because of the long distances between production and industrial centres, geographic obstacles and adverse climatic conditions.

The government is to promote loss reduction by encouraging an exchange of technical information between national and international organisations, promoting credit facilities, developing an improved storage infrastructure and increasing storage capacity.

Peru will require technical and financial assistance in developing its loss reduction programmes, the technical assistance to be devoted specifically to a study of methods of improving crop production, grain harvesting and handling and storage.

COSTA RICA

by

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Costa Rica is an agricultural country with a tropical/sub-tropical climate. Between 1965 and 1975 agricultural production expanded rapidly. Grain accounts for approximately 8% of total production, but despite this seemingly low figure Costa Rica is practically self-sufficient in staple food grains. Maize, sorghum, rice and beans are the important grain and legume crops.

The National Council for Production (CNP) promotes agricultural production, stabilises grain prices, markets a high proportion of staple grains and is responsible for the central storage facilities.

Grain is stored in traditional stores at the farm level and it is in this sector that loss reduction programmes need to concentrate. Approximately 40% of all grain produced remains on the farm. There is no information about the real causes and extent of storage losses although insects and rodents are generally accepted to be the major pests at harvest and during storage.

High moisture content grain, resulting from inefficient or inadequate drying is susceptible to mould damage. Mould damage may begin on the crop in the field but becomes more serious during storage.

A detailed survey of the causes of loss is necessary and this work could be based on the Centre for Research on Seeds and Grain at the University of Costa Rica (CIGRAS). The Centre is well established but needs some strengthening in order to undertake an investigation of storage problems and assessment of loss by regions.

The National Council for Production is providing a loan specifically for improvement of storage, training of personnel. The loss reduction programme will include estimation of losses.

Assistance is required with the designing of loss reduction programmes, designing of surveys, training at all levels and in strengthening of its own existing agencies which will have responsibility for loss assessment/reduction in the future.

HONDURAS

by

C Andres Zelaya

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Tegucigalpa, Honduras

The important food crops in Honduras are maize, rice, sorghum and beans. Cash crops include banana, coffee and sugar cane.

The production of the basic food grains depends critically on the climate. In recent years fluctuations in the climate have been responsible for a deficit in food grains.

Most produce is marketed, reaching the consumer by way of middlemen, eg road haulage contractors or wholesalers, and the municipal market or through the government controlled system — National Development Bank and retailer. It is estimated that only about 10-15% of the marketed produce enters the latter system. A new Marketing Board is to be established to replace the National Development Bank's function in marketing of produce.

The organisation of the marketing system and the standard of storage facilities are so poor that grain losses are high. The causes of loss in Honduras may be said to include social and environmental factors as well as the more usual agents — moulds, insects and rodents. There is widespread ignorance of the causes of deterioration of stored products.

At the farm level losses may occur during the drying period, through poor handling or due to exposure to periods of heavy rainfall. Floods are not infrequent during the drying of maize and if the grain is not washed away completely, severe moulding often occurs. Annual losses of grain at the farm level have been put at 20-50% for maize and 10-30% for beans. To date there has been no detailed programme of loss evaluation and only isolated efforts have been made.

Although there are no specific projects concerned with loss reduction, some of the many agricultural development projects do have an element relating to storage.

The problem has now received recognition and a post-harvest loss assessment programme has been proposed. The programme could be started as a pilot study in one area during which staff could be trained. Help from a specialist in establishing the project and in the form of laboratory and sampling equipment would be required but the government of Honduras would make ample resources available to help such a programme.

GUYANA

by

Winston Smith

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The Co-operative Republic of Guyana is situated on the mainland of South America, has an area of 53,000 square miles and a population of about 800,000. The country can be divided into four natural regions, the Low Coastal Plain, the Hilly Sand and Clay Area, the Highland Region and the Interior Savannahs. Average annual temperature is about 27^{o}C and annual rainfall ranges between 90 cm and 290 cm.

Guyana is critically dependent upon agriculture, which can be divided broadly into four sub-sectors: a developed sub-sector producing mainly sugar for export and three developing sub-sectors producing a. rice, b. livestock, eg beef, pork, poultry and c. food crops such as bananas, cassava, coconuts, citrus and other fruits, vegetables, etc.

No studies (apart from a pilot project on blackeye peas) to identify causes of post-harvest loss, have yet been undertaken.

Estimates of annual food loss have been prepared by the Ministry of Agriculture in a Pre-feasibility Study of the Food Crop Production/Marketing Project. The figures serve to highlight the size of the problem and the need to reduce food losses in the country.

Interest in undertaking studies and developing programmes aimed at reducing losses in Guyana began in 1977 when an inter-disciplinary/multi-organisational team began to investigate work in this area. Guyana participated in the seminar on reduction of Post-Harvest Losses in the Caribbean and Central America in August 1977 and undertook the testing of a method to identify and quantify food losses that had been developed at the Seminar. A pilot project on black eye peas was undertaken between October 1977 and January 1978 with financial assistance from the Inter-American Institute of Agricultural Sciences (IICA). The study indicates that losses in black eye peas are due to poor storage and drying. The study also suggests that a Second Phase investigation be undertaken to identify the specific nature and appropriate location for storage and drying facilities. Technical assistance with this second phase would be appreciated. A Third Phase, involving implementing loss reduction projects, eg erecting silos, upgrading of transport, etc is envisaged but for this phase the government would need both technical and financial assistance.

Because of the critical importance of reducing food losses, a priority objective of the Guyana Government is to expand investigations and implement programmes in this area. Some of the crops listed for immediate study are rice, copra, food legumes, plantains, cassava and citrus. Assistance to undertake loss reducing projects for the priority crops of rice, copra, plantains and citrus is being sought by the government.

JAMAICA

by

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Jamaica's economy is largely dependent upon agriculture. The principal food crops include peas, rice, maize and beans. There are no formal marketing arrangements although the Government operates an Agricultural Marketing Corporation to buy produce at fixed prices, arrange transport to their stores and arrange distribution to their retail shops. Towns and villages have their own markets.

Production has decreased in recent years, mainly due to changes in weather pattern; since 1973 there has been a protracted drought. In an effort to stimulate production, subsidies and land have been offered by the government.

Post-harvest losses are mainly due to poor storage facilities, improper stacking, poor handling, packing and transport, inefficient drying and milling and infestation by insects and rodents.

A cursory survey of losses carried out in 1975 by the Storage and Infestation Division gave an estimate of 8% loss of stored foodstuffs. Losses were due to insect, rodent and fungal infestations, condemnation due to contamination and storage under insanitary conditions.

The Storage and Infestation Division was established in 1958 following a survey on the extent of losses initiated in 1954. The Division's inspectors carry out regular inspections of stored produce in an effort to reduce losses. The Division's Control Team carries out pest control treatments in Government-owned facilities if required.

Some experimental work aimed at reduction of losses is carried out by the Division's scientific staff.

The Division will soon be expanded and more emphasis will be placed on loss assessment studies and loss reduction programmes, at the farm, cooperative, and marketing levels, in central storage, processing establishments and for exports and imports.

DOMINICAN REPUBLIC

by

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The principal food grains include rice, beans and pigeon peas. Some rice, beans and wheat are imported.

The 1976-1986 agricultural development plan aims to raise the nutritional level of the poorest sections of the community, ie about 75% of the population, mainly rural based, and to increase agricultural production by various means including reduction of post-harvest losses. Reduction of losses is seen as a necessary step in improving nutritional levels and a loss-reduction programme has been included in the 1978-82 National Marketing Plan.

Interest in post-harvest loss reduction has increased since 1975 when the Integrated Marketing Project was established by the Secretariat of State for Agriculture (SEA). The Interamerican Institute of Agricultural Sciences (IICA) provided technical cooperation in a number of fields including studies of post-harvest losses. Early work has concentrated on quantifying losses in vegetable products at all points from farm to final urban consumer. No work has been carried out on grains but a project to quantify rice and red bean losses has been proposed.

A Seminar on Post-Harvest Loss Reduction in the Caribbean and Central American Region, sponsored by SEA and IICA was held in Santo Domingo in August 1977. The purpose was to learn more about activities in this field and at the regional level and to make the experiences of the region known at the international level. Representatives from 12 countries and 9 international institutions participated. Following the seminar it was decided to include a Programme for Post-Harvest Loss Reduction as part of the National Marketing Plan. The programme, oriented towards the identification of methods and techniques to reduce losses and the overall improvement of the marketing system will include several projects.

a. A series of studies to quantify losses in rice, beans, pigeon peas as well as vegetable products is contemplated. Methods and experiences of organisations such as TPI and Kansas State University will be adapted to the Dominican situation. Financial and technical assistance in the study of grain losses will be required.

b. Rural assembly centres will be established, not only to provide improved handling and storage facilities at the rural level but also to provide bases for directing training, information and marketing extension services. Again financial and technical assistance will be required.

c. Development of agro-industries may help to reduce losses which are primarily the result of seasonality of harvest and short period durability of certain crops. Feasibility studies need to be undertaken.

d. The construction of an adequate but simple infrastructure at the rural level is urgently required to reduce losses in products such as potatoes, onions, garlic and beans.

e. New markets will be required to guarantee adequate demand and acceptable prices to be sure that the facilities and techniques introduced in other projects are put into use, to create incentives for producers and help eliminate some losses.

f. In order to be able to implement such a programme considerable training at technical, extension and farm levels will be required.

TURKEY

by

E Erzurumlu

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Despite large scale industrialisation in Turkey, the agricultural sector retains a dominant position in the country's economy. Approximately 58% of the working population is employed in agriculture.

Grains are by far the most important farm products with wheat as the single most important crop.

The Farm Products Office (TMO), an agency of the Ministry of Food, Agriculture and Animal Breeding, has many and varied responsibilities including responsibility for the grain trade.

Latest observations show that losses occur at a number of stages in the post-harvest system.

- At harvesting. Because of early harvesting, before the crop is fully mature, or because of maladjusted harvesters.
- Threshing. On small mountain village farms this is often done by horse-drawn threshers and it is estimated that the loss may be around 4%. On mechanised farms the loss may be reduced to 2% but losses still occur because of maladjusted machinery.
- Transport. Losses occur during transport from field to store.
- Storage. No detailed study of the causes of storage losses has been made but some investigations were carried out in 1970-73 and 1975-77. These were to determine the extent of losses in wheat purchased and stored by the TMO.

There is a need to determine the extent of post-harvest losses in Turkey and training, technical and financial assistance would be welcomed.

RAPPORTEURS SUMMARIES
STAFF REQUIREMENTS: TRAINING AND EXTENSION

by

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There is a lack of well-trained workers in the post-harvest sector and many countries have placed a high priority on the need for training. There is a need for specialist personnel in a number of areas of activity including preparation of extension material and provision of training. It has been suggested that this training should be organised primarily on an in-country basis and might comprise three types of course; short awareness courses for senior staff — senior extension staff etc; longer courses to train trainers, particularly the trainers of extension workers; and local courses for extension workers given by those trainers. These should be short, practical courses very much focussing on the 'how' rather than the 'why'. It has been suggested that loss reduction activities might be linked with crop production projects, in other words that use might be made of extension workers already existing within crop production projects, following the provision of specific training for these people in the technology relevant to post-harvest work.

In summarising the manpower and training requirements the following broad areas emerge:

First of all there are needs for expert assistance, the provision of specialist staff in various areas of storage technology eg storage entomology, storage engineering, microbiology, economics and training in the context of training trainers.

Secondly the provision of specialist training with particular reference to training in developed countries, institutions or universities for national research workers and overseas staff in the fields of biology, pest control, engineering, economics and storage management.

Thirdly, the provision of in-country training for personnel at all levels through the system, ie farmers, agricultural extension staff, personnel to undertake loss assessment studies, storekeepers, mill operators, storage managers, inspection and pest control staff.

One interesting point raised in the context of training farmers is the need for literacy campaigns. If the literacy of farmers could be improved, the effort and input required from the extension staff would be reduced since more use could be made of visual aid material which the farmer could read.

Finally particular emphasis has been placed on the need for training the trainers; eg the staff of agricultural training institutes. Really here, the identified need is to make a positive move to rectify the inadequacy of extension services in the post-harvest area through the inclusion of post-harvest technology in their training curriculum. There are many instances where there is an extension service which is responsible for the farmer activities up to the point of harvest and there the matter ends: there is no one from whom the farmer can get advice on the post-harvest areas of his activities.

In the African countries there are needs in all of these areas, in Asian countries there is perhaps more need for training in research and extension and in Latin America and Central American countries there is a need for short-term assistance in mounting and developing loss assessment and loss reduction projects.

In many cases the first step in developing a loss reduction programme will be to conduct an initial survey to identify the component that is needed, though one might envisage that for any such study a multi-disciplinary team of three or four specialists might be required covering the various areas of expertise already mentioned. Projects involving loss assessment will need to be serviced by personnel having suitable technical expertise in relation to the part of the system under study, probably experience of loss assessment methodology. They will need to be supported by suitably trained survey teams in order to ensure the proper collection of data. The availability of finance is clearly of the utmost importance to the success and implementation of such a programme but it is the availability of adequately trained and experienced manpower which will be one of the major constraints.

The problem is two-fold: the long term objective through training must be to up-grade the capability of local staff involved at all levels of operation from subsistence farmer through to consumer in all sectors of the post-harvest system. However, any agencies planning activities designed to meet this objective are already aware of the global shortage of expertise in tropical post-harvest technology and there is an urgent need for action to increase the availability of such expert manpower. Much thought has already been given by most of the aid agencies to ways in which this problem might be overcome. FAO has for a number of years operated its Associate Expert Scheme whereby qualified technologists who are lacking in field experience may gain that experience through association with experienced personnel in field projects. Other aid agencies also see this as a mechanism whereby specialist staff may acquire the capability to fully participate in projects overseas.

Clearly further thought and consultation between aid agencies and recipient governments is urgently required in order that we may develop the manpower resources needed to assist governments to initiate post-harvest food loss reduction programmes.

There is an urgent need for national training programmes in post-harvest technology to be directed towards extension services, agricultural colleges and farmers' training institutes. There is also a need for the establishment of on-going, in-service training and career development, for workers at all levels of responsibility in the food storage, processing and distribution and marketing system. Career development should be emphasised because all too often problems are posed by the fact that in this area there is not a sufficient career development opportunity to retain staff once they have gained the experience they need. Courses need to be designed to meet the special needs of those responsible for procurement, quality control, pest control, warehouse management, drying, handling and processing of foods. Graduate level training in these technical areas is necessary to the establishment of a cadre of professional staff. It is equally important that managers of both government and privately operated marketing and processing agencies should be given sufficient technical knowledge to increase their awareness of the problems involved in decisions made by them and by their technical staff. However the training need which requires the greatest input, both in terms of national commitment and expert assistance, is the establishment of in-country training aimed at the lower cadres of staff in government and quasi-government marketing agencies, produce inspection and pest control services, extension services, etc. Many aid agencies provide training both through courses for graduate and senior level staff in technical institutions and universities in their own countries and by assisting national training organisations through overseas courses. A greater emphasis needs to be given to the development of local training programmes from this type of overseas course, in which training the trainers will be the most significant contribution that needs to be made.

It is impossible to quantify this training need — how many people at how many levels of operation require training — even when given all the information currently available. Perhaps support should be given to the proposal which was made at the 1975 meeting of the FAO Committee on Agriculture that a survey should be carried out of available technical expertise for agricultural development both in developed and developing countries, and to establish and up-date from time to time this inventory. As a second part of such a study it was proposed that an evaluation should be made, both at national and international level of long-term demand for skilled manpower. Training capacities of both developed and developing countries need to be adapted so as to be capable of meeting these demands. Reference needs to be made to what in the United Nations circles is now being referred to as technical cooperation between developing countries (TCDC). Positive emphasis should be given to the availability of manpower within developing countries and the possible ways in which developing countries within regions may be able to assist each other.

RESEARCH AND DEVELOPMENT

by

D de Padua

SEARCA, Philippines

Almost all of the papers presented indicated that the best estimates of post-harvest losses were very rough and that there is a great need to quantify and obtain more accurate figures. Survey studies belong under the category of research. Countries listed a lot of problems and it is apparent that many of the problems of different countries within the same climatic regions may be similar.

In looking at these problems it appears that some indicate needs for basic studies. Others indicate that there needs to be an improvement in the technology transfer both from the developed countries as well as from co-developing countries. Some of the developing countries are way ahead of the others in attempting to arrive at solutions to specific problems and countries indicated that they would be interested in obtaining information from the co-developing countries so this technology transfer could be expanded. Certain problems indicated the need for development of new processes or development of new facilities to respond to the unique problems that exist in developing countries. The individual problems should be studied in the context of the entire system: but this does not necessarily suggest a research and development in-system study.

There are six basic areas of research and development; first is loss assessment. The methodology developed should enable countries that are interested in pursuing this as a research area, to quantify losses. There is a need for more accurate figures in losses in different situations in order to guide policymakers in the proper allocation of resources. For technical staff, loss assessment projects would lead to better understanding of the nature and causes of loss and would enable them to design appropriate loss reduction projects.

The second area of research and development is the loss reduction programme. In most of the countries of Asia and Africa there are drying problems. The problems are not so much technology problems but more problems in the drying system. The problems are not in the drier itself but rather in how drying facilities may be utilised in the context of small farm areas, in the context of the levels of education of the farmers or traders and millers that use the driers, the types of driers, fuel economies etc. So the research and development area here should be attempting to solve the problem of how to introduce drying systems that the farmers or traders and millers can and will adopt.

The third area, harvesting, threshing and farm transport was clearly indicated as one in which large losses seem to be prevailing, particularly under adverse climatic conditions. In Asia the threshing problem is of such a magnitude that machines have not really been able to cope with extremely wet grains.

The fourth area of research and development definitely needed, particularly in the African and South American regions, is the storage problem at the farm level, the cooperative level and in government stores. The problems seem to to be of pest control, resistance of pests to insecticides, and store design. In Asia metal silos have been used with great difficulty because of moisture migration. The theory of moisture migration is known but the problem still has not been solved satisfactorily, consequently most of the silos in Asia are not being used at this time.

The fifth area is milling. There are two aspects to the milling problem;

1. improvement of the quality of the product that reaches the mill; even the best and most efficient rice mill cannot improve on the quality of the grain if it has previously been damaged.
2. improvement of village mills; only Thailand appears to have an alternative to the horizontal cylindrical mill, which might be acceptable to village mills. This technology could perhaps be transferred from Thailand to the Philippines, to Indonesia or to wherever it may be of interest.

The last area of research and development is that of rodent control in the entire post harvest system and perhaps including the pre-harvest period also.

MATERIAL INPUTS

by

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It is extremely difficult to summarise all the physical, material and financial requirements expressed by the different countries, but the requirements can perhaps be classified under four heads.

1. **Training.** There are requirements in terms of audio-visual equipment, information material and general extension techniques and materials.
2. **Research.** This is a vast and important sector, There is a requirement in the area of material, means and facilities for actually carrying out surveys and appraisal missions for loss evaluation, and a need to strengthen Research Institutions which already exist in the developing countries.
3. **Infrastructure.** An important sector underlined by a large number of delegates. One important aspect of this is the improvement of the road network in general, provision of small vehicles at village level, or for the marketing boards larger trucks, lorries and perhaps rail transport.
4. **Facilities for improving post-harvest systems and the quality of the products of such systems.** There are requirements at various levels; the first relates to the farmer. There are very considerable requirements to improve traditional structures which represent in total by far the biggest storage capacity in the world. There is also a requirement for increased supplies of pesticides and equipment for their application. At the collection points there should be proper facilities for collection and a reduction in handling, as far as possible, in order to avoid loss. At the centralised store level; either the improvement of the existing structures or establishment of new structures. Marketing services, boards, or agencies may be improved, either by establishing special food grain boards or by extending or strengthening existing boards, according to the demands of the individual country eg new premises, or improved management techniques may be required.

The final sector which relates to commodity quality, is the processing or milling area. The requirements may call for an improvement of the milling facilities which are already in existence or the construction of new mills especially in those countries where no mills are yet available.

FINANCE

by

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It is impossible to describe the scale of the finance needed for the various resources. However an indication of the level and the source of the finance required for the resources, ie manpower and training, research and development and material inputs, can be attempted. The source of finance may be internal – where the action is to take place – or external – outside the country from an aid source.

1. **Manpower and training.** Most of the in-country training will require internal resources and finance, in the way of facilities, travel expenses for the many people who are going to be trained and subsistence expenses while they

are being trained. This will require some addition to, or perhaps rearrangement of, internal budgets by re-allocating people who are already doing one job to make them available for a new kind of job in the post-harvest programme. In certain cases, some agencies do help with the internal costs of training courses but in general internal costs of the kind mentioned above would be met within the country itself. There are in addition the specialist inputs for training that might be externally financed, eg entomologists, microbiologists, engineers, post-harvest technologists and those generally who are required to initiate training courses. Similarly the fellowships required for local graduates to obtain external training would be externally financed. Different continents seem to have rather different requirements as between in-country training, external training and fellowships for post-graduate training.

As regards the finance for manpower for surveys, some indication of the costs involved can be gained from the costs quoted for the two loss survey projects, one in Zambia and one in India, but the costs must be related to the length of time that was spent on each of the surveys and the number of man years of specialist manpower that was employed.

An inventory of worldwide specialist manpower was suggested as an important requirement. In this area the specialist UN agency — the International Labour Organisation (ILO) may be interested in providing finance for manpower studies or inventory studies. Finance may also be available from the UN programme for technical cooperation between developing countries (TCDC).

2. **Research and Development.** The first need is for loss surveys and then the improvement of loss assessment methodology, again dividing internal and external finance. There would be a great deal of internal requirement for loss surveys, because a great many pairs of feet and pairs of hands are needed to conduct such a survey. At least initially external finance will be needed because the present experience in developing the methodology and the kind of people who are needed to set up the loss surveys are rather rare. Similarly the need for continuing to improve the loss assessment methodology will require the same kind of contractual assistance from aid agencies as has been available for developing the methodology.

The need for technology transfer centres or information exchange centres has been mentioned. There will need to be external finance to establish such centres and to bear the costs of collecting, printing and disseminating information. This may also need manpower, not just printing processes because often, usually in fact, it is necessary to supplement such a Centre by a small permanent team of technologists who go and explain the technology rather than just sending a leaflet on it.

For research and development in drying, in storage and in milling there will be a need for internal finance for the local support and local materials needed because, as drying systems are developed and evaluated, and storage for farm or intermediate level is developed, it is to be hoped that these will take account of, and draw upon, the local materials in the countries concerned.

This work cannot be done externally in research centres in developed countries or in temperate climates. As much of the work will be done in developing countries there will be some internal financial needs for the local support; at the same time external finance will be needed for the necessary equipment, eg measurement equipment and items that cannot be supplied or made locally, and for the particular kind of expertise whether it is drying engineers or systems engineers, general agricultural economists to study a system, pesticide specialists or post-harvest technologists. For donor agencies there is undoubtedly, and will continue to be a need to finance such expertise and manpower to work with local institutions, to support local institutions and to carry out the research in the developing countries.

3. **Material Inputs.** These seem to fall fairly evenly between those which we should aim to obtain locally, that is internally, materials for on-farm local structure improvements, for the buildings, for primary collection points and central stores, for the simple mills that can hopefully be locally produced. All these are inputs which could be drawn from the countries themselves, but in addition there are the more complex pieces of equipment; the audio-visual equipment for training, the more complex research equipment, the vehicles, the insecticides, pesticides, etc., which will need external finance.

DONOR STATEMENTS

THE WORLD BANK

by

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Bank operations pertaining to the post-harvest system include three different kinds of activity. These can be classified into lending for storage and nutrition projects and for general support of related research activities.

1. **Storage projects:** These are perhaps the most easily identified area of Bank operations which relate to post-harvest loss reduction. The first major storage project supported by the Bank was in Turkey. In 1950 the Bank loaned about $4,000,000 to construct grain silos in a project costing $12,000,000. Since that time the Bank has assisted in the financing of 12 projects in 11 countries which had grain storage as the major component. Lending for storage remains a fairly small but growing part of the Bank's lending for agriculture and world development; however a large increase in storage lending has occurred in the current year. Up until February of the current fiscal year the Bank committed nearly twice the amount loaned for grain storage during the pervious 20 years. At least one additional grain storage loan to Bangladesh in the current fiscal year is likely.

The two large grain storage loans made so far this year indicate the diversity of activities supported. The storage loan to India will assist the Indian government in its programme for constructing storage facilities required for public sector food grain procurement and distribution system. The programme will finance the construction of about 3,500,000 tonnes of additional storage capacity at important grain procurement and distribution centres. Most of the storage would comprise units of 5,000 to 50,000 tonnes capacity. The project would also finance 6 local grain procurement centres with unit capacities of 3,000 to 5,000 tonnes and some portable grain-handling equipment at about 50 primary grain markets.

The second major loan for grain storage this year was to the Government of Argentina. This loan is designed primarily primarily to increase the efficiency of the grain marketing system, largely for exports. The major benefits from this project are expected to include improved export prices, reduced grain losses and savings on grain distribution and handling costs. It is estimated that about 3/5th of the benefit at full development will result in improved export pricing while only 1/5th from reduced losses and perhaps 1/5th from reduced internal handling costs. The largest project component here will be the construction of 20 silos with an average capacity of about 100,000 tonnes. The project also provides funds to strengthen management, inspection services and training activities for the Government grain board and provides some funds for some 2,000 rail cars for more efficient grain transport.

Many of the projects supported by the Bank in the past have tended to focus on the improvement of grain storage and handling facilities at regional or terminal market centres. In value terms, much less has been done to improve storage at the farm and village level. This problem reflects our relative inexperience with alternative farm-level storage technology as well as the fact that economic returns to such technologies generally remain to be demonstrated. However the Bank's growing emphasis on multi-component rural development projects will provide useful experience in this regard and should permit an expansion of lending for farm and village-level storage.

Several of the grain storage projects also provide funds to examine post-harvest losses in a country context. One example is the Phillippines 2nd grain processing project approved two years ago. This project will provide improved facilities to transport, dry, store and mill the basic grains as well as funds to undertake studies of post-harvest losses to identify their extent and to suggest remedial action. An agricultural research project which is being prepared for Bangladesh is expected to provide research funds which could be used for a variety of high priority activities including if necessary the study of the post-harvest system in that country.

2. **Nutrition projects:** The Bank's nutrition projects are rather broadly oriented activities and relate fairly directly to the post-harvest system. These projects aim to increase the incomes of small-scale, low income producers and the nutrient intake of malnourished families. They include measures to cut post-harvest food losses and thereby improve both the quantity and the quality of local food supplies for poor communities.

The first nutrition project was made in 1976 and the Bank has approved two others since that time. Assistance to Brazil examines the feasibility of nutrition intervention through the rural extension service and explores the potential of small-scale industries in the local collection, storage, processing and marketing of staple grains and root crops in poor communities in the North-Eastern states of that country.

In Columbia, a series of studies will be undertaken to identify and forecast practical low cost methods for reduction of post-harvest losses of grains, plantains and potatoes at the farm and village level. Another feature of the Colombia nutrition project is the demonstration and diffusion of local technology for processing materials close to harvest sites. The most recent loan for nutrition was made to Indonesia and this demonstrates most clearly the broadly oriented character of these projects. This project includes studies of food storage losses under farm and village conditions and the design of prototype storage units by the Indonesian Food Technology Development Centre. The research studies focus on the termination of losses by weight, volume and nutrient content incurred during storage. They examine marketing practices and the reaction of farmers to food losses. Research will also be undertaken to improve the relative costs and benefits of local traditional storage methods and new technologies. The one-year research phase is to be followed by a test programme in selected villages within seven districts. Small-scale storage units varying in size from 1 to 10 tonnes, managed by farmers or village cooperation are to be established and it is hoped that extension workers will be trained to promote those types of storage which prove successful. Results of the test programme might be expected to be used in formulating a national policy and programme for storage at farm and village levels.

Two additional nutrition projects are under preparation for India and Senegal, reflecting the Bank's concern with the need to improve nutrition of low income consumers at the farm and village level. A basic part of this effort is to increase year-round food availability through intervention in cereal processing, storage and marketing. Seasonal under-nutrition is a serious problem in much of the developing world and this fact alone warrants increased priority to improve post-harvest technology at farm and village level.

3. **Research:** This aspect receives modest support but there can be no doubt that economic and technical research is an essential complementary activity to investment efforts in improved post-harvest systems. One role of the Bank's support is its involvement in the agricultural work carried on in international research centres. There are a growing number of Bank-supported projects to strengthen national research programmes most of which are production oriented, although some significant work to reduce food losses is included. Examples include the work on cassava processing and storage in CIAT, the research on farm-level rice growing at IRRI, potato storage and solar drying at the International Potato Centre and work at CIMMYT to select cereal varieties with greater insect resistance.

Economic and agriculture sector work in the Bank also relates to the post-harvest system and food availability. One study in West Africa undertaken as part of a larger study by the Bank of global food prospects concluded that improved storage and transport facilities in that area were likely to be as important in meeting future food needs of the poor as increasing production.

Other studies seek to determine the gains and losses of various socio-economic groups of alternative policies for national and international buffer stocks of food. The objective of one of these studies is to assess quantitatively the benefits and costs of buffer stocks from several viewpoints including general welfare, the government budget, farmers and consumers. A new study on food distribution and nutrition is to examine among other things the distributional and nutritional implications of improved processing, marketing and storage programmes in the developing countries. The Bank is also expanding its support of post-harvest research work through the funding of external research groups; although modest in scope these country-level studies are expected to provide useful guidance in the design of effective loss reduction programmes. In recent months the Bank has supported a study of the post-harvest system for maize in Mexico in connection with a rural development project there and support of similar work in other areas is under consideration.

This support of research activity reflects the Bank's view that the post-harvest loss problem is an important and a serious one in many countries in that meaningful intervention must be based on a fuller understanding of this problem in the particular country situation, but whilst it suggests that research on these problems should combine loss assessment with a thorough examination of possible intervention strategies, the optimum balance between resources spent on loss assessment and loss reduction is an important question. The past emphasis on developing a loss assessment methodology is well placed but as concensus on the methodology is reached it is necessary to pursue with vigour the no-less difficult task of identifying intervention that is economically sound, culturally

acceptable and administratively feasible, and the World Bank is prepared to cooperate fully in this regard. The sharing of country experiences on these matters is very useful.

UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT

by

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The Agency for International Development (AID) has had a programme in post-harvest development for a very long period of time. The Agency has five bureaux; four of them are regional bureaux, the Asian, Latin American, Near East and African bureaux and these are semi-autonomous bodies. The fifth bureau is the development support bureau which gives technical advice and technical assistance to the regional bureaux and host countries through the regional bureaux.

The current programmes include the following:

In Chad a project on production of seed and grain, and a CARE rural grain storage project; in Botswana a crop production/marketing project, in Ruanda food storage and marketing, in Zaire a project is being developed on grain marketing, and in Tanzania a market development project. There are some other projects on grain storage in the Sahel region.

In Asia, Bangladesh, there is a food grain protection project and in Indonesia a programme of low-cost technology; in Pakistan there is a village food processing project; in the Philippines an integrated agricultural marketing and production project and in Sri Lanka, one on paddy storage and processing. These projects deal primarily with post-harvest food losses. A loan has been made to the Egyptian Government for terminal grain stores.

In the Latin American region, most of the projects are in terms of loans rather than in direct assistance. Proposed projects that should begin in 1978 include one in Guyana on rice storage, one in Peru on sub-tropical land development, and an agricultural sector loan in the Dominican republic.

The development support bureau, the central agency that provides technical support to the bureaux, has projects or programmes that deal in more than one commodity or more than one region: typically these projects hopefully are of global interest, eg the Kansas State University grain storage and marketing project gives technical assistance in grain storage, handling, marketing and agrobusiness. The KSU provides training courses within host countries and at the University. AID also has a programme in association with the National Academy of Sciences which is to identify and try to quantify global post-harvest losses and recommend methods of intervention.

At the University of Missouri there is a breeding project aimed at reducing fungal toxins in maize which has only been underway for three or four months; however this will become a fairly major project.

Finally AID provides support of 25% of the budget for the consultative Group for International Agricultural Research, this includes IRRI, the CIT, the Potato Institute and large number of research institutes around the world.

The Agency would be very pleased to cooperate or collaborate with any of the other donors and with any host countries.

AGENCE DE COOPERATION CULTURELLE ET TECHNIQUE, FRANCE

by

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The Technical and Cultural Cooperation Agency is really a cooperative agency rather than an aid-giving agency, which fosters cooperation between North and South and between developed countries and developing countries.

The Agency, an international organisation founded in 1970, now has more than 30 member countries whose common characteristic is the French language. The Annual budget of about $10,000,000 is entirely funded by contributions from member countries, the main donor countries being, in succession, France, Canada and Belgium. The majority of member countries are African but Lebanon in the Middle East, Haiti in the Caribbean, Laos, Vietnam in Asia, Monaco, Luxembourg in Europe and a Commonwealth country, the Seychelles, are members. The headquarters of the Agency is situated in Paris and it has 100 staff members from member countries on its secretariat.

In spite of the very limited resources the agency has already promoted projects in various fields especially scientific and technical cooperation programmes. In this area the main objective is to facilitate exchanges between scientists in members countries by setting up project networks which are geared to specific problems. The agency has a modest budget related to post-harvest problems and in relation to this it is planned to train trainers by organising training seminars in member countries. Documents will be published in French to meet these training needs.

The Agency would be very happy to consider cooperating with other donor agencies in publishing post-harvest documents in French. A fundamental French dictionary is being prepared which will include a basic vocabulary relating to agriculture and life in the rural environment and could be used in literacy campaigns. A directory of French-speaking research experts in various fields in French-speaking countries is being compiled in the form of a year book and the first edition of this when published will certainly include researchers and research institutions which are interested in some aspects of the post-harvest operations system in French-speaking countries.

INTERNATIONAL DEVELOPMENT RESEARCH CENTRE

by

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The IDRC is a public corporation created by an Act of Parliament of Canada in 1970. Its objectives are to initially encourage, report and conduct research into the problems of developing nations of the world. To carry out this programme the International Research Development Centre is divided into five divisions. The largest is Agriculture Food and Nutrition Sciences, followed probably in size by Social Sciences and Human Resources, Health Sciences, Information Sciences and Publications. The work is regional as well as discipliniarian. The head office is in Ottawa and there are regional offices in Bogota (Latin America), Cairo (North Africa and the Middle East), Dakar (West Africa), Nairobi (East Africa) and Singapore (East Asia).

Agriculture, Food and Nutrition Sciences is sub-divided for our own purposes into five groups; these are: production systems, post-production systems, fisheries, forestry and animal science. The systems are divided into a

series of networks eg the post-harvest technology of rice network which is primarily in Asia. There is a network of post-harvest technology of millet and sorghum in Africa and a post-harvest technology legume programme which is somewhat world-wide; a small farm machinery network worldwide and perhaps most important, a consumer acceptance network which tries to attach itself to all the other AFNS-sponsored divisions. This is quite important, in that if the people will not eat what they are given then everything else is a waste of time and effort. A small farm machinery project in Ghana is developing the IRRI thresher in Ghanaian conditions.

All IDRC projects try to incorporate some form of training, the use of expatriate staff is not advocated. Projects with expatriate staff are, however, financed if the national institution asks for such help. At the same time if an expatriate is provided for the project, the national institution carrying out the research is expected to provide at least one person to be trained either within the institution or out of the country to eventually take over from the expatriate.

Finance is primarily provided for operating capital costs and equipment and for manpower, although manpower itself may be provided if necessary. No loss assessment studies for the sake of loss assessment studies alone are financed, but studies which are oriented towards a loss reduction programme could be.

In assessing the need for financing of projects, IDRC requires that projects must respond to national needs. The Board of Governers is an international group and guards against a duplication of effort within a country.

Projects must be oriented towards rural populations— industrial-level type projects are not supported, and lastly the projects should be of an applied nature with the end results economically feasible and socially acceptable to the people for which the projects are intended.

COMMISSION OF EUROPEAN COMMUNITIES

by

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Of the 50 countries who are signatories of the Lome convention, 14 are attending the conference. The convention governs a period of about 5 years and there are some 10,000,000,000 units of account for the developing countries during that period. The unit of account is about 10% more than the dollar, 1.1. At the beginning of the fund period each of the countries to benefit from the fund are told of the amount of money that will be made available to them during the fund period, and an agreement is made with that country on an indicative aid programme to indicate how that money will be spent. The management of the fund is the responsibility of the Commission of European Communities.

The contents of any indicative aid programme are entirely the responsibility of the state receiving the funds; they decide how the money is to be spent. In most cases the National Ministry of Finance controls the European Development fund. Funds may be used for training, eg training within the country, for scholarships, training the trainers, it is entirely up to the individual government. Secondly, for rural development, eg. for capital investment projects, and thirdly there are funds to mount studies which will define more precisely what is required.

In addition to the national programmes a certain amount of money is set aside for regional and inter-regional projects. A growing amount of money is set a side each year for countries which are not signatories of the Lome convention.

COMMONWEALTH SECRETARIAT

by

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The Commonwealth Secretariat when it was established 10 years ago was involved in just arranging Commonwealth Heads of Government meetings and liaison between Commonwealth countries. Some years later it set up an aid programme called the Commonwealth Fund for Technical Cooperation which has at its disposal approximately £11,000,000 per year. Within the aid programme it was decided a few years ago to set up a specific division, the Food Production and Rural Development Division, whose job was to advise the Secretariat in relation to its aid programme. Increasingly, more and more of the Commonwealth's aid programme is going to agriculture and this has become more evident in the last three or four years. When the Food Production and Rural Development division was established one of the criteria it was given was the work on post-harvest losses. Consequently, as a result of information transfers with IDRC and TPI it was decided to go ahead and issue some publications; this led to the organisation of a West African conference which involved four Commonwealth countries, Sierra Leone, The Gambia, Nigeria and Ghana and the Francophone countries of the Economic Community of West African states. In September of this year it is proposed to hold a similar conference for east, central and southern Africa and Mozambique.

The Secretariat has provided finance for conferences and is currently looking at the concept of technology transfers in relation to design and production of equipment and has supplied storage consultants to various member countries.

COORDINATION OF LOSS ASSESSMENT AND REDUCTION WORK

by

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The importance of this subject is realised by reference to the results of some meetings that have been held in the field of post-harvest food loss reduction studies. An action-oriented workshop for the prevention of post-harvest food losses in Malaysia in March 1977 was organised by the FAO in cooperation with the Government of Malaysia and the Food for the Hungry Incorporated, a seminar was organised in India by FAO Norway, and a seminar in Ghana was organised by the Commonwealth Secretariat.

The main theme arising from these meetings of people directly involved in the post-harvest loss programme was three-fold. It was realised that the constitution of national bodies responsible for the coordination of all aspects of food loss prevention was important. It was further realised that the establishment of regional arrangements for the dissemination of information, coordination of research, of training and of technical assistance were very important as well; finally a conclusion reached at these seminars was that too little is known about the losses and therefore for the assessment of post-harvest food losses a regionally and globally accepted methodology was essential.

The number of meetings that are being held and are being planned for the future is adequate; what we should be concerned about is making known the results of these meetings and the conclusions reached, to those people who have to work on a day-to-day basis with these problems.

For effective post-harvest food loss prevention programmes to be developed in individual countries there must be a national policy with a firm commitment to reduce post-harvest losses. A national plan of action must be developed with allocation of necessary resources both from an internal as well as an external source to implement a programme for food loss reduction. As the post-harvest system spans a very wide range of disciplines the responsibility for the individual phases of a national system is usually spread out over many organisational and administrative units. It will for instance be the responsibility of the Ministry of Agriculture to deal with the harvesting, field drying and farm storage activities. It will in many cases not then be the responsibility of the Ministry of Agriculture to deal with the processing activities. It may or may not be the responsibility of the Ministry of Agriculture to deal with marketing and distribution systems. There may be Ministries of Commerce, of Industry or other government units involved in the whole post-harvest system; therefore, in order to have a national, logically planned programme, it will be necessary to bring all these different units together within a Committee or Group. The Committee would ensure the coordination of all the disciplines within the one national plan and the utilisation of the resources that the country has, to the best advantage.

Such a coordination or cooperation will not only ensure that the country's own resources are up-dated and deployed in the most efficient manner but also that the pertetual support from outside on a multi-lateral or bi-lateral basis contributes most effectively to the national programme. The IICA Seminar, held in Santo Domingo, Dominican Republic, in August 1977 pointed out that conclusions reached and recommendations made by the participants in workshops and seminars do not always reach decision-makers and planners because of the lack of appropriate channels to communicate the findings of such a seminar. The National Committee would ensure that such conclusions reached the right place. There is a closely demonstrated need for countries that do have a programme or wish to have a programme on post-harvest food loss reduction, to bring about an organisation that puts all these elements together.

There has been much discussion in the past few years on the need for international cooperation and coordination. There is very wide recognition, both within the developing as well as developed countries of the danger of duplication of effort, of inefficient use of resources in the areas of investment, training and research, in relation to reduction of post-harvest food losses.

One international coordinating body in existence is the Group for Assistance on Systems relating to Grain After Harvest (GASGA). This group has recently expanded both its activities and membership. Originally it was established to work on African problems on a limited scale; it has now expanded its terms of reference to cover the developing world. The aims of GASGA are, through consultation of its members, to stimulate improvement and technical

assistance given to developing countries in post-harvest grain technology and to coordinate such activities so that the most effective use is made of members' resources. GASGA seeks to fill gaps in national and international research, development and training and it tries to ensure the appropriate dissemination of information about technical developments and activities in the post-harvest sector to donors, to developing countries and to other interested organisations.

Another regional coordinating activity in the field of post-harvest research and development is operated by the South-East Asian Regional Centre for Graduate Study and Research in Agriculture (SEARCA). This Centre aims at cooperation in and coordination of post-harvest research and development programmes and encourages support for such research and development programmes by multilateral and bi-lateral donors. It also seeks to foster effective use of research facilities and tries to facilitate the collection and transfer of knowledge. At present its activities cover five countries in South-East Asia and are concerned mainly with the staple commodity of the region, rice.

In 1975 the Consultative Group on International Agricultural Research (CGIAR) realised the need for cooperation and coordination of efforts by agencies and donors involved in the food loss reduction programme. It was then realised by many that undesirable duplication or even outright competition might take place and that conflicting advice might be given to developing countries.

After discussion of the necessity to coordinate all activities aimed at reducing post-harvest losses in the developing countries, and the need to approach the problem in an efficient rational and consistent manner the CGIAR considered the establishment of a coordinating body of donors and recipient countries for this purpose. A number of meetings were held in London, Washington and Montpellier during 1976 and a proposal was then developed for consideration. The proposal was that a special coordinating group of post-harvest technology should be established by the interested parties made up of donors, UN agencies and governments active in the field of post-harvest systems. This body should be called the Consultative Group on Post-Harvest Technology and it sould be a sub-group of CGIAR. Unfortunately, since 1976 no further action has been taken on this proposed coordination.

Meanwhile in 1977 FAO submitted a proposal for an action programme for the prevention of food losses to its committee on agriculture. This action programme was formally approved by the FAO conference in November 1977. The basic purpose of this programme is to assist developing countries to plan and implement national food loss reduction programmes. The programme as such will be composed of direct action projects such as improving farm and village storage structures, the design, construction and managing of pilot warehouses, the providing of small-scale grain driers, improving processing facilities, introducing improved rodent control and training programmes, at all levels and in all aspects of the post-harvest loss reduction programme. The mechanisms for the implementation of the action programme will be rapid and flexible and will allow for an expansion. The improvements to be introduced in the countries will not only be simple and practical but will be primarily based on the use of local resources and materials. In its initial stage, the programme will concentrate on reducing post-harvest losses of staple food, food grains, roots and tubers. The programme will not be concerned with perishables and animal products or fish as priority items. Furthermore the priority within the programme will be given to the least developed countries, the most seriously affected countries and food priority countries as designated by the United Nations system.

Within the groups of these countries priorities will go to projects that will benefit the rural people, the small farmers, the villagers and the small processors and craftsmen. The membership of FAO asked also that arrangements be made for collection and publication of information on methods of loss prevention with a special emphasis on traditional methods, or improvements to traditional methods, as it was realised that the introduction of new and relatively sophisticated technology into a large number of countries would not be very practicable. It was also realised by a large number of countries that quite a lot of useful technology is known and could, with small improvements, be made very useful for food loss reduction programmes.

FAO has, at the request of its member governments, accepted the responsibility for procuring funds through pledges from member governments for an action programme for the prevention of food losses. A special account has been established within FAO for this purpose and the funding target of this special account is $20,000,000 for the biennium 1978/1979. For the implementation of such a programme FAO has established a small unit responsible for the coordination of all matters related to FAO's programme of reduction of post-harvest food losses.

This unit is also responsible for cooperation with other international, multi-national and national agencies in the field of post-harvest technology and food loss reduction. The programme in FAO itself is very closely operating with GASGA. FAO is a member of GASGA and accepts GASGA's technical advisory role as its function as a post-harvest information exchange organisation. FAO also cooperates with bilateral aid agencies such as DANIDA, NORAD,

SIDA, USAID and others as well as those within the UN system, e.g.UNDP and WFP. This cooperation takes the form of frequent exchanges of information and of the channelling of funds for project implementation in developing countries, the latter mainly through the FAO cooperative programme.

FAO liaison is maintained with the UNDP resident representatives within the countries and with FAO country representatives in order to coordinate programmes. It is hoped that longer-term institution strengthening and research and development and training programmes on a global, regional and inter-regional basis can be established in cooperation with UNDP and perhaps other funding agencies.

An important area for international cooperation is the area of loss assessment. Loss assessment studies, when these have been carried out have used *ad hoc* methods for each separate study. This makes comparison of results and findings difficult if not impossible. The methodology published by the American Association of Cereal Chemists under a contract with USAID and in cooperation with the League for International Food Education, the Tropical Products Institute and Food and Agriculture Organisation of the United Nations, is now ready for large-scale testing in developing countries. The results and findings of tests should be channelled through GASGA which would then be responsible for coordinating adjustments and alterations to the methodology. The members of GASGA would decide which of the participating agencies or organisations would be responsible within GASGA for the coordination of this work, in direct cooperation with the developing countries that have an interest in the post-harvest grain loss assessment and reduction programming.

An over-riding factor affecting future activities is the global shortage of expertise in tropical post-harvest technology. The need for training at all levels has often been pointed out but it should be emphasised that there is a shortage of people qualified by experience to train these trainers. International action in this field is therefore required to train staff for use in the programme. All countries, developed and developing, with experience in this field will be required to assist and to cooperate with this training. Such aid programmes could be held in the developed countries but they would be more usefully held in developing countries. There are a number of developing countries with quite an advanced level capacity for such activities.

It is important to develop a coordinated programme on post-harvest research and development of training on regional or sub-regional basis for various ecological zones and groups of food crops. The area related to regional effort in South-East Asia with the Regional Rice Research Institute is one example, and perhaps this example will be followed for other crops in other regions. The object of such coordination is to ensure that the most effective use is made of limited financial and manpower resources that are available nationally as well as bilaterally and multi-laterally. In order to develop such a coordinated programme existing institutions should be selected and on-going activities of existing institutions should be strengthened through support and assistance by specialists if needed by strengthening their research and training equipment and by organising training programmes for institutes' staff. FAO are currently looking at possibilities for building a network of such institutions to assess, to modify and transfer appropriate technologies as well as to train manpower requirements for the purpose, to tie together on a regional basis and, if it is found feasible, perhaps on a global basis, all the available resources and manpower to coordinate research training etc. for post-harvest food loss reduction programmes.

Lastly, thought should be given to the coordination of capital aid for investment followup. This is already taking place, but will gain even more momentum once the post-harvest food loss programmes get underway in the country. Most of these programmes will begin on a pre-investment activity, e.g. trying to identify the losses and then trying on a pilot scale to introduce improved schemes. These would then logically be followed by large-scale investment programmes.

There are no ready-made solutions for coordination and cooperation at national and international levels. Actual details of national programmes will have to be worked out in the countries themselves. National and international organisations can, when needed, advise and assist in establishing such a coordinating mechanism in developing countries. As far as international cooperation is concerned, seminars bring together interested organisations and contribute to the cooperation and coordination. FAO is ready to cooperate and has already established cooperation with many national and international bilateral agencies and intends to continue and further expand this cooperation.

CONCLUSIONS

The meeting came to the following, broadly accepted, conclusions:-

1. That despite the shortage of scientifically conducted loss assessment studies, it was clear that in most developing countries post-harvest losses in cereals, legumes and pulses were unacceptably high and that a worthwhile reduction of these would be possible and should be attempted.

2. That the importance of loss assessment in the identification of points for loss reduction activities and for monitoring the effectiveness and economic value of these activities was recognised. It was considered more thought needed to be given to undertaking loss assessment studies by those concerned in new or existing loss reduction programmes in developing countries. The Seminar had presented to it the draft manual on Post-Harvest Grain Loss Assessment Methods produced by American Association of Cereal Chemists/League for International Food Education, on behalf of the United States Agency for International Development and recommended its use in developing countries with a view to refinement and improvement and eventual standardisation of the methodology.

3. That from the thirty-one country statements presented, it was evident that worthwhile loss reduction was possible at many stages of the post-harvest system relating to all the main cereal grains and pulses, and that major effort was called for in relation to harvesting, drying, farmer storage, central storage, transport and handling systems generally. Certain aspects concerning particular commodities, such as the processing of rice, also called for special attention.

4. That the resources that particularly would be required to carry out these programmes could be considered under the form headings as follows:-

   a. **Manpower and Training**

      i. A catalogue of organisations having post-harvest expertise in each developing country should be prepared in order to define clearly national capabilities in relation to policy, and to determine what further trained personnel are required.

      ii. Substantially expanded training programmes are required for trainers (particularly in farmer extension and storage management skills) in both developed and developing countries.

      iii. Specialist training or developing country personnel in particular areas of post-harvest work is also needed.

      iv. Recruitment and training of a larger cadre of expatriate staff to assist with developing country post-harvest projects is going to be vital to programmes envisaged for the foreseeable future.

   b. **Material Inputs**

      There are four main requirements: the provision of training centres and audio visual equipment for the Training Programme; material means to carry out surveys and investigations in Research Programmes; infrastructural requirements to assist marketing, including improvement of transport and the provision of inputs, eg pesticides, for farmers; improvements to storage and processing systems including traditional and central storage.

   c. **Research**

      Most problems could be solved by research; by the transfer of technology between developed and developing countries; between developing countries themselves and by the development of new technologies. Five main problem areas were identified; a greater understanding of the nature and causes of losses; the application of technology to loss reduction programmes including particularly harvesting, threshing and drying systems at small farmer level; storage at all levels with particular attention to appropriate pest control including traditional methods; milling at central mill and village level; rodent control.

   d. **Finance**

      Finance for the inputs required for Loss Reduction Projects cannot be quantified until the projects are identified (following loss assessment studies) and designed. As well as external finance to cover

material inputs expertise and out-of-country training, considerable internal budget support is needed for in-country training, strengthening of institutions and the use of local materials and equipment. Evaluation should form an integral part of any programme.

These resources would have, in substantial part, to be provided by the developing countries themselves; but it was recognised also that donor countries and technical cooperation agencies would have to assist if the programmes were to proceed satisfactorily towards the United Nations target of reducing losses by 50% by 1985.

5. That, in considering the present extent of technical information exchange in the post-harvest food loss area, the importance of the TPI periodical publications, Tropical Storage Abstracts and Tropical Stored Products Information was recognised. The Seminar indicated, however, the need for these and other publications to be more widely available and more appropriately distributed. It was suggested that translation of the TPI periodicals into French and Spainish would be valuable. Needs and possible improvements in information dissemination should be pursued by Group for Assistance on Systems Relating to Grain After-Harvest.

6. That there was a widespread need for increased awareness amongst developing countries of the importance of reducing post-harvest losses. In many cases there was a need also for the coordination of activities amongst the various government and other organisations involved. It was considered useful for countries to have a central, focal point to ensure national coordination. At the same time this could also facilitate orderly and effective cooperation with the inter-national community of donor and technical cooperation agencies.

7. That, in further considering this matter of international cooperation, the Seminar recognised the benefits of regional cooperation within geographical groupings of developing countries and of the consultation and coordination of resources in the donor technical agencies provided by GASGA. Further efforts to increase international cooperation of this nature were called for. The Seminar itself was considered to have been a useful step in this direction and TPI and ODM were thanked for bringing it about. The contribution provided by other donors and the participation by the 31 developing countries present were warmly acknowledged.

CONCLUSIONS

Les conclusions du séminaire, acceptées on général, sont les suivantes:-

1. Malgré le manque d'évaluations scientifiques des pertes, il est clair que dans la plupart des pays en voie de développement ces pertes après-récolte de céréales, de légumes et de légumineuses sont élévees à un niveau inacceptable; il est possible de réduire ces pertes d,un degré appréciable et on devrait s'efforcer à le faire.

2. Il est reconnu que l'évaluation des pertes est importante a l'identification des points menant aux activités qui pourraient produire une réduction de ces pertes et au contrôle de l'efficacité et de la valeur économique de ces activitiés. Ceux qui, dans les pays en voie de développement, sont responsables des programmes pour la réduction des pertes, qu'il s'agisse de nouveaux programmes ou de ceux qui existent déjà, devraient réfléchir davantage à l'entreprise des études d'évaluation des pertes. La version de projet du manuel sur les Méthodes d'Evaluation des Pertes Après-récolte des grains, produit pour la 'United States Agency For International Development' (l'agence américaine pour le développement international) par la 'American Association of Cereal Chemists' (l'association améericaine des chimistes travaillant dans le domaine des céréales) et la 'League for International Food Education' (la sociéeé pour l'éducation internationale sur la nourriture), fut présenté au séminaire qui recommenda son usage dans les pays en voie de développement, et ceci dans le but de raffiner, d'améliorer et en fin de compte, de standardiser les méthodes.

3. Suivant les déclarations des 31 pays, il est évident qu'une réduction appréciable des pertes est possible à plusieurs étapes du système après-récolte en ce qui concerne tous les céréales et les légumineuses importants, qu'il faut faire un gros effort général pour améliorer le système de la récolte, le séchage, les procédures d'emmagasinage qu'emploient les fermiers, l'emmagasinage central, le transport et la manutention. Certains aspects concernant certaines denrées méritent une attention spéciale, par exemple, le traitement du riz.

4. Les resources principales nécessaires à l'exécution de ces programmes peuvent être divisés en groupes, comme suit:-

   a. **Main d'oeuvre et formation**

      i. Il faut préparer un catalogue des organisations possédant les experts en procédures après-récolte. Cet exercice aurait pour objet de définir clairement les capacités nationales en ce qui concerne la politique, et permettrait de déterminer le nombre de personnel formé dont on aurait besoin.

      ii. Il Faut développer largement les programmes de formation à l'intention de ceux responsables de la formation (surtout en ce qui concerne la compétence requise pour l'éducation des fermiers et pour la gestion des procésures d'emmagasinage) dans les pays développés et ceux en voie de développement'

      iii. Il est nécessaire d'organiser la formation spécialisée du personnel des pays en voie de développement, dans des domaines particuliers de travaux après-récolte.

      iv. L'embauche et la formation d'un plus grand réseau de personnel expatrié qui pourrait aider avec des projets après-récolte dans les pays en voie de développement. Cet exercice est essentiel aux programmes envisagés dans l'avenir prévisible.

   b. **La contribution de biens matérials**

      Il existe quatre nécessités principales: la fourniture de centres de formation et d'appareils audio-visuels pour le programme de formation; des moyens matériels permettant d'effectuer des études et des enquêtes pour les programmes de recherche; de l'assistance infrastructurale pour le marketing, y compris l'amélioration des moyens de transport et la fourniture de provisions, tel que des pesticides pour les fermiers; l'amélioration des systèms d'emmagasinage et de traitement, y compris l'emmagasinage traditionnel et central.

   c. **Recherches**

      Des travaux de recherche résoudraient la plupart des problemes — par le transfert de la technologie entre les pays développés et ceux en voie de développement; entre les pays en voie de développement eux-mêmes et en développant de nouvelles technologies. Cinq problèmes

principaux one été identifiés: une meilleure compréhension de la nature et des causes des pertes est nécessaire; l'application de la technologie aux programmes de réduction des pertes, y compris le système de récolte, de battage, et de séchage, utilisé par les petits fermiers. Le système d'emmagasinage à tous les niveaux, en faisant attention au contrôle des fléaux, y compris les méthodes traditionnelles; le moulage au moulin central et à celui du village; le contrôle des rongeurs.

d. **Fonds**

Il n'est pas possible d'évaluer les fonds nécessaires aux projets pour la réduction des pertes jusqu'à ce que ces projets soient identifiés et préparés (suivant les évaluations des pertes). En plus des fonds provenant de l'extérieur pour couvrir les frais d'expertise et de formation qui doit avoir lieu à l'étranger, il est nécessaire d'avoir un budget intérieur important pour supporter les projets de formation effectués dans les pays mêmes, pour renforcer les institutions et pour l'utilisation des matières et des appareils et outils locaux. Il est important d'intégrer les procédures d'évaluation dans n'importe quel programme.

Les pays en voie de développement devront eux-mêmes fournir la majeure partie des resources mais on reconnaît qu'il faudra faire appel aux pays donateurs et aux agences de coopération technique si l'on espère atteindre l'objectif des Nations Unies d'une réduction des pertes de 50% à l'année 1985.

5. Au sujet de l'échange d'informations techniques concernant les pertes après-récolte de nourriture, on reconnaît l'importance des publications périodiques de la TPI telles que les résumés sur l'emmagasinage tropical et les informations sur les produits tropicaux emmagasinés. Le séminaire indiqua cependant, qu'il est nécessaire de distribuer ces publications et d'autres plus efficacement et plus largement. On suggéra qu'il serait avantageux de faire traduire les publications périodiques de la TPI en francais et en espagnol. Le 'Group for Assistance on Systems Relating to Grain After Harvest' – GASGA (le groupe responsable de l'assistance sur les systèmes relatifs au grain après la récolte) devrait examiner les moyens de fournir et d'améliorer la dissémination d'informations.

6. Les pays en voie de développement devraient en général être plus conscients de l'importance d'une réduction en pertes d'après récolte et dans plusieurs cas, il est nécessaire d'obtenir une coordination entre les activités des gouvernements divers et des organisations qui sont engages dans ces programmes. L'on considère qu'il serait utile pour ces pays d'avoir un emplacement focal et central pour assurer une coordination sur le plan national. Ceci faciliterait en même temps, une coopération ordonnée et efficace avec la communauté inter-nationale de donateurs et d'agences de coopération technique.

7. Au sujet de la coopération internationale, le séminaire reconnaît les bénéfices que rapportent la coopération régionale dans les groupes géographiques de pays en voie de développement et les resources de consultations et de coordination que forment les agences techniques donatrices fournies par la GASGA. Il est nécessaire de faire davantage d'effort pour augmenter ce genre de coopération internationale. On considéra que le séminaire lui-même était une démarche utile dans ce but et on remercia la TPI et l'ODM de l'avoir organisé. On remercia chaudement les autres donateurs pour leur contribution et les trente-et-un pays en voie de dévelopement présents pour leur participation.

CONCLUSIONES

La reunión llegó a las siguientes conclusiones que fueron aceptadas en general:-

1. Que, a pesar de la falta de estudios de aprecio de pérdidas conducidas científicamente, quedó claro que en la mayoría de paises en vías de desarrollo las pérdidas de post-cosecha de cereales y legumbres eran inaceptablemente altos y que una reducción digna de consideración de éstos sería posible y debe de ser intentada.

2. Que la importancia de aprecio de pérdidas en los puntos de identificación, para actividades de reducción de pérdida y para controlar la efectividad y el valor económico de estas actividades fué reconocida. Se decidió que se debería de dar más consideración al emprendimiento de estudios de aprecio de pérdidas por aquellos quienes preocupan con nuevos o existentes programas de reducción de pérdidas en paises en vía de desarrollo. Se le presentó al congreso el manual, en borrador de Métodos de Aprecio de Pérdida en Grano Post-Cosecha, producido por la Asociación Americana de Químicos de Cereal/Sciedad de Educación Internacional de Alimento. (AACC/LIFE) por parte de la Agencia de los Estados Unidos para Desarrollo Internacional (USAID) y recomendaron su uso en paises en vías de desarrollo con una vista al refinamiento y mejoramiento y eventualmente la normalización de la metodología.

3. Que, de las declaraciones que los 31 paises presentaron, fué evidente que la reducción de pérdida apreciable era posible en varios puntos del sistema de post-cosecha en relación a todos los granos de cereal y legumbres principales, y que se debería de hacer más esfuerzo en relación a la cosecha, el secado, el almacenamiento por el granjero, el almacenamiento central, los sistemas de transporte y el manejo en general. Ciertos aspectos en relación a ciertas comodidades, tales como el proceso de arroz, tambien requieren atención especial.

4. Que los recursos que se han de requerir particularmente para desarrollar estos programas podrían considerarse bajo los títulos de forma de la siguiente manera:-

   a. **Mano de Obra y Entrenamiento**

      i. Se debe de preparar un catálogo de organizaciones teniendo pericia en post-cosecha en cada país en vía de desarrollo para poder definir claramente las capacidades nacionales en relación a la política, y para poder definir que personal especializado en adición se ha de requerir.

      ii. Se requieren para entrenadores, programas de entrenamiento substancialmente expandidos (especialmente en la extensión del granjero y téchnicas de manejo de almacenaje) igualmente en paises desarrollados como en los en vía de desarrollo.

      iii. También se requiere entrenamiento especialista de personal de paises en vías de desarrollo en zonas especiales de trabajo de post-cosecha.

      iv. Reclutamiento y entrenamiento de un cuadro mayor de personal expatriado para asistir con los proyectos de post-cosecha del país en vías de desarrollo será imprescindible para los programas previstos para el futuro previsible.

   b. **Inversión de Material**

   Hay cuatro requerimientos principales: el suministro de centros de entrenamiento y equipo audio visual para el Programa de Entrenamiento; recursos materiales para poner a obra estudios y compruebas en Programas de Investigación; requerimientos infraestructurales para asistir en la venta, incluyendo el mejoramiento de transporte y el suministro de inversiones, por ejemplo pesticidas, para granjeros; mejoramientos en el almacenaje y sistemas de tratamiento incluyendo almacenaje tradicional y central.

   c. **Investigación**

   Se podrían resolver la mayoría de problemas con investigación: por la transferencia de tecnología entre paises desarrollados y los en vías de desarrollo; entre los paises en vías de desarrollo entre si mismos y por

el desarrollo de nuevas tecnologías. Se identificaron cinco zonas principales de problemas; un mejor entendimiento de la naturaleza y causas de pérdidas; la aplicación de tecnología a programas de reducción de pérdidas incluyendo especialmente sistemas de cosecha, de trilla y de secado a nivel de granja pequeña; almacenaje a todo nivel dando atención en particular al control de plaga apropiado incluyendo métodos tradicionales; fresado en fresadora central y a nivel del pueblo; control de roedores.

d. **Finanzas**

No se pueden cuantificar finanzas para lor requerimientos de inversión para Proyectos de Reducción de Pérdidas hasta que se hayan identificado y diseñado los proyectos (después de estudios de aprecio de pérdidas). Además de finanzas externas para cubrir pericia de inversión de materiales y entrenamiento fuera del país, se requiere considerable apoyo del presupuesto interno para entrenamiento dentro del país, consolidación de instituciones y el uso de materiales y equipo de la zona. La evaluación debe de formar una parte integra de cualquier programa.

Estos recursos tendrían, en parte sustancial, que ser suministrados por los paises en vías de desarrollo en si mismos; pero se reconoció tambien que paises donantes y agencias de cooperación técnica tendrán que ayudar si el programa fuese a proceder satisfactoriamente hacia el objetivo de las Naciones Unidas de la reducción de pérdidas por 50% por 1985.

5. Que, al considerar el alcance presente de intercambio de información técnica en la zona de pérdida de alimentos post-cosecha, se reconoció la importancia de las publicaciones periódicas del Instituto de Productos Tropicales TPI, Extractos de Almacenamiento Tropical e Información de Productos Tropicales Almacenados. El congreso indicó, no obstante, la necesidad de que se dispongan de estas y otras publicaciones más extensamente y que sean distribuidas más apropiadamente. Se sugestionó que sería valioso tener traducciones al español y frances de los periódicos de TPI. El Grupo para Asistencia sobre Sistemas en Relación a Hierba después de Cosecha (GASGA) debe de proseguir con las necesidades y los mejoramientos posibles en la difusión de información.

6. Que, había una amplia necesidad para un conocimiento aumentado entre paises en vías de desarrollo de la importancia de reducir las pérdidas de post-cosecha. En muchos casos había una necesidad tambien para la coordinación de actividades entre las organizaciones gubernamentales y otras comprometidas. Se consideró provechoso que los paises tengan un punto de foco central para asegurar coordinación nacional. Al mismo tiempo ésto también podría facilitar cooperación ordenada y efectiva con la comunidad internacional de donantes y de agencias de cooperación técnica.

7. Que, al dar más consideración a este punto de cooperación internacional, el Congreso reconoció los beneficios de cooperación regional dentro de grupos geográficos de paises en vías de desarrollo y de la consulta y coordinación de recursos en las agencias técnicas donantes suministradas por GASGA. Se pidieron más esfuerzos para aumentar la cooperación internacional de esta naturaleza. Se consideró que el Congreso en si mismo como un paso útil en esta dirección y se les agradeció al Instituto de Productos Tropicales y al Ministerio de Desarrollo en el Ultramar para su convenio. Se reconoció con efusión la contribución suministrada por los otros donantes y la participación por los treinta y un paises en vías de desarrollo presentes.