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9. ABSTRACT

Describes the objectives, structure, and outcome of the working meeting on postharvest food losses held by the National Academy of Sciences in Washington, D.C., October 31 through November 3, 1977. Participants came from developing countries and from institutions with experience in food loss reduction. The workshop was designed (a) to examine loss problems for major food categories, (b) to discuss certain important aspects of food loss and loss reduction that are not commodity-specific, and (c) to synthesize both sets of issues into a meaningful perspective on food loss problems and the opportunities for intervention. This account gives the reports of working small-group discussions on cereal grains and grain legumes; roots, tubers, fruits and vegetables; fish; economics of postharvest food loss reduction; training and education for postharvest food loss reduction; and interventions. It gives the report of the final plenary session on food storage in the People's Republic of China and on allocation of resources to postharvest food conservation. It includes these contributed papers: "Postharvest Grain Loss Assessment Methodology" (by K. Harris); "Personnel Needs and Training for Postharvest Food Loss Reduction Activities" (by P.F. Preveatt); "Economics of Postharvest Food Loss Reduction" (by M. Greeley); and "Towards a Social Theory of Postharvest Food Loss" (by H. Guggenheim).

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# Postharvest Food Losses in Developing Countries

Staff Summary Report of an  
International Working Group Meeting  
October 31 - November 3, 1977  
Washington, D.C.

Prepared under Contract AID/csd-2584,  
Task Order No. 23

Board on Science and Technology  
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NATIONAL ACADEMY OF SCIENCES  
Washington, D.C.  
1978

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As a key element of its study on postharvest food losses, the National Academy of Sciences (NAS) held working meeting in Washington, D.C., October 31 through November 3, 1977. This account of the meeting describes its objectives, structure, and outcome.

### Background

At the request of the U.S. Agency of International Development (AID), the NAS initiated a study on postharvest food losses in developing countries. Funds for the study were provided by AID's Office of Agriculture, Bureau for Technical Assistance, under contract AID/csd-2584, T.O. No. 23, authorized in February 1977.

The NAS proposal to AID suggested three principal objectives for the study:

1. To examine the nature and dimensions of the postharvest food loss problems in developing countries;
2. To summarize and evaluate available postharvest loss data and make recommendations for studies to determine the extent of losses; and
3. To recommend ways by which present losses might be reduced.

Overall direction and responsibility for the study is provided by a Steering Committee of ten members (see list in appendix) supported by professional staff members of the Academy's Board on Science and Technology for International Development (BOSTID).

The Steering Committee held its first full meeting in Philadelphia, June 8-9, 1977. At that meeting study guidelines were established, an

outline of the final report was discussed, and a schedule of future work was formulated. (Minutes of the meeting were provided to A.I.D.)

The Steering Committee also decided that an international working meeting should be held later in the year, and that prior to that meeting a request would be sent to persons working on food loss problems in developing countries throughout the world for information on the extent of losses in specific food commodities, on research or other interventions being carried out to reduce food losses, and on the problems that must be addressed to achieve increased conservation of food.

While additional information was being sought and preparations were being made for the working meeting, a bibliography of literature on post-harvest food losses was in preparation. A full-time employee was added to the NAS staff for approximately four months to organize the bibliography which, for the first time, attempts to bring together a reasonably comprehensive listing of the major literature relating to postharvest food losses.

#### Objectives of the Working Meeting

The working meeting was designed to provide major input into the deliberations and conclusions of the study Steering Committee. To accomplish this, participation was sought from a wide range of developing countries and from institutions with substantial activities and individuals with experience related to food loss reduction. As shown by the appended list, participants came from developing countries throughout Africa, Asia, and Latin America, and from institutions with active food loss reduction programs such as the Tropical Products Institute, the Food and Agriculture Organization of the UN, and Kansas State University.

Since the purpose of the meeting was to address those issues specifically related to the NAS study, a number of background papers were prepared on topics requested by the Steering Committee. Discussion groups also were organized to address major aspects of the study. The broad objectives of the meeting were:

1. To agree, to the extent possible, on the magnitude of losses in the major food categories;
2. To identify important gaps of knowledge or information relating to postharvest losses and their reduction; and
3. To explore the important steps that must be taken--the critical interventions--to reduce postharvest losses.

Before arriving at the meeting, participants received background material that included suggestions on eight major issues slated for discussion. These issues are listed in the appendices.

The discussion and conclusions of the working meeting will be reflected in a revised draft of the study report, which will also indicate areas for which additional collection of information or consultation with experts will be helpful.

#### Structure of the Meeting

The four-day working meeting, held at the Joseph Henry Building of the NAS in Washington, was designed (a) to examine loss problems for major food categories, (b) to discuss certain important aspects of food loss and loss reduction that are not commodity-specific, and (c) to synthesize both sets of issues into a meaningful perspective on food loss problems and the opportunities for intervention.

A detailed agenda of the meeting is shown in the appendices. The first day was devoted to presentations on several broad issues that seemed particularly important to the Steering Committee, and to a report on the organization of the bibliography. The presentations were as follows:

- Report on the bibliography, Robert Morris
- Preparation of a manual on methodology for estimating postharvest losses in grains, Kenton L. Harris
- Education and training for reduction of postharvest losses, P. F. Preveatt
- Economic implications of postharvest losses, Martin Greeley
- Sociocultural aspects of postharvest losses, Hans Guggenheim.

Each presentation was made in plenary session and each was followed by a brief period of general discussion.

The presentations on grain loss estimation methodology, training, and economics are included as appendices to this report.

Representatives from developing countries made brief presentations on the major problems from their personal and national perspectives; among the needs identified were the following:

- resources allocated to postharvest food loss reduction; training; more improved storage
- economic batch-driers for rice; loss studies; training in milling; increased emphasis on fruits, vegetables, and fish and transportation losses
- improvement in handling large-scale grain storage; improved marketing; R & D on low-cost refrigeration technology for the tropics
- improved information system (e.g., the bulletin published and circulated by the Inter-American Institute of Agricultural Sciences (IICA)

- new chemicals, insecticides, rodenticides, and fungicides
- improved extension and education arrangements

The second and third days of the working meeting were devoted to small group discussions. On the second day, participants divided into three groups to consider the three major food categories:

1. cereal grains and grain legumes
2. roots, tubers, fruits, and vegetables
3. fish

On the third day the group discussions covered:

1. economics, including presentation of a report from the IBRD, by D. Pickering
2. education and training
3. interventions to reduce food losses, including technical and research needs and problems of organization or policy.

On the final day of the meeting, participants convened in plenary session to hear brief reports from the rapporteurs of each of the six small group sessions. Following the reports, the discussion turned to a broad overview of the activities necessary to reduce postharvest food losses and how these tasks might be accomplished.

In addition to the four days of discussion, participants were asked to make written comments on specific study materials, including bibliographic entries and rough draft sections of the final report. Participants also were requested to provide names of experts in various aspects of food loss and loss reduction who might be listed as key contacts for readers of

the final report seeking information or advice on particular topics.

\* \* \*

Outcome of the Meeting

Since this is a report of a working meeting at which the conclusions and observations do not necessarily represent the final view of the study Steering Committee, no attempt has been made to assign priority to the various recommendations that emerged. Rather, this section presents summaries prepared by rapporteurs for the six small group discussion sessions and for the final plenary session.

Discussion Group 1, November 1

Cereal Grains and Grain Legumes

Chairman: A. Huysmans

Rapporteur: J. Pedersen

I. Review of Circulated Paper Titled

Draft Chapter II Loss Estimation

A. The following modifications of Chapter II are suggested:

1. In present form, the chapter contains only information and methodology applicable to cereal grains. Other commodity groups, i.e. perishables and fish, should be included.
2. There is a need to more clearly define weight loss and economic loss.
3. Factors of contamination should be mentioned along with damage in the introduction even though, by our definition, they are not a postharvest loss.
4. Specific technical data on loss estimation methodology should be removed from the chapter and an "executive" summary of the AACC/LIFE methodology manual included. Reference should be made to the AACC/LIFE manual as a source of technical detail.
5. Rather than including global estimates of losses, case histories should be used to illustrate proper methodology and improper methodology in loss estimation. Costs to conduct proper studies should be included.
6. There is need to conceptualize losses and where they occur within the postharvest system. It was generally agreed that the concept should be described visually, but that the diagrams on P. 13 (Chapter II) and P.II-12 (AACC/LIFE) in the methods manual were not easily understood. Perhaps the Bourne cartoon-type diagram would be acceptable.
7. The section on "Causes of Food Loss" (p.5-10) should be removed, expanded, and included in Chapter III, Cereals/Legumes.

II. Review of Circulated Paper Titled Draft Chapter III

Postharvest Loss of Cereal Grains and Grain Legumes

A. It is suggested that Chapter III be rewritten in two major parts with content as outlined below:

Part I. The Postharvest System

a. General description of the flow of cereal commodities in the postharvest system.

b. Causes of Food losses (from Chapter II, p. 5-10) with main emphasis on the technical aspects common to cereal grains/legumes in general (according to the following sequence):

1. Preharvest factors affecting postharvest losses
2. Harvesting factors
3. Threshing and shelling factors
4. Drying
5. Storage

Physical factors (handling, etc.)

Biological factors (insects, rodents, birds, microorganisms, etc.)

6. Processing (to be added)

7. Transportation (to be added)

c. Farm non-market versus market sector

1. Definition of non-market and market sectors
2. Emphasis of this report on non-market sector

Part II. Commodities

In this section each commodity or commodity group should be considered with emphasis on the loss factor peculiar to the specific commodity.

a. Rice

1. Harvesting - Timeliness of harvest and effect on quality.
2. Threshing - Wet season threshing, varietal differences, alternatives to immediate threshing, kernel breakage, transport from field loss, etc.
3. Drying - Problems in natural drying methods, hazards of over-drying, new technology needs for wet climate harvest, opportunities for technology transfer, etc.
4. Storage - Advantages of paddy (rough rice) storage, need to retain moisture in some situations for processing, research needs on storage methods and time versus quality, etc.

5. Processing

Parboiling - effect on nutrition, milling quality, and storability of milled and dried paddy; modern technology at moderate and large-scale levels; effect on susceptibility to Aspergillus Flavus and aflatoxins; etc.

Milling - Effect of under-milling and overmilling on loss potential, effect of storage on quality, washing losses, etc.

b. Maize

1. Harvesting - Field storage after maize is ready for harvest, field infestation before harvest, varietal differences, etc.
2. Threshing - no problems
3. Drying & Storage - Crib storage applicable for certain areas of world.
4. Processing - no problems

c. Millet and Sorghum

- (1) Harvesting
- (2) Threshing
- (3) Drying
- (4) Storage
- (5) Processing

d. Wheat and Barley

- (1) Harvesting
- (2) Threshing
- (3) Drying - Barley drying for malting purposes
- (4) Storage
- (5) Processing - potential for reduced yield of flour and lower quality from infested wheats.

e. Grain legumes/oilseeds/pulses

- (1) Harvesting - control of field pests to reduce storage pest field infestation
- (2) Threshing - Breakage and increased susceptibility to insect attack of legumes.
- (3) Drying - Excess drying hardens beans (non-reversible)
- (4) Storage - Reduced loss when stored in pod, length of storage in relation to hardness, use of peanut oil in legume preservation, etc.
- (5) Processing - recovery of broken grains as meal, fuel requirements for cooking, salt soaking techniques, etc.

NB: A conference in India (November 1977) should provide papers to assist in preparation of the grain legume/pulse section.

B. There is a general reluctance on the part of the group to include average loss values for commodities at each step in the post-harvest system (i.e., harvesting, threshing, drying, etc.) or to set a value which, at present, appears to be an irreducible minimum for each of the steps in the system. Rather, it is suggested that the key or critical points where losses can occur be identified and specific loss estimates be included as examples where such estimates have been reliably determined.

C. A summary list of institutions doing work on cereal grain/legume losses and interventions (with an indication of present work as known) should be included.

Discussion Group II, November 1

Roots, Tubers, Fruits, Vegetables

Chairman: E. S. Ayensu

Rapporteur: M. C. Bourne

The discussion was organized according to the suggested questions posed by the organizers:

Item #1 What is the best or most reasonable estimate of the extent of losses among the major food commodities?

"Horticultural products" in the section is meant to include roots, tubers, fruits and vegetables. It is noted that the non-grain staples (cassava, yam, sweet potato, white potato, taro and banana) are the major carbohydrate food supply for about one third of the population of the developing world and therefore should be given a high priority in loss reduction programs in those areas where these staples are widely used.

There are few accurate figures available for losses measured by a described methodology. Even those loss figures that have been obtained by onsite measurements are of limited use because they cover the loss for one specific commodity in one location for one specific set of conditions and it is well known that the extent of loss in a horticultural product can vary over a wide range within a short period of time.

The attachment (from FAO and other sources) lists figures for losses in horticultural products and the wide range of loss cited, and in a few cases, the narrow range of loss given in this table shows the inadequate data base that presently exists for losses in horticultural products. Nevertheless, the opinion of a group of professionals with long experience with some of the commodities in developing countries provide the following figures as being typical and normal

ranges of losses as customarily experienced under usual marketing conditions:

White potatoes in Chile, Peru and Venezuela	25% to 30%
Cassava in Venezuela, Colombia, Ecuador, Dominican Republic and Central America	15% to 25%
Bananas in Ecuador	30% to 35%
Tomatoes for fresh market in most developing countries	50%
Yam in Nigeria and Ghana	10% to 20%

Although specific examples of loss can be found that lie above or below the ranges cited above, it is the opinion of the experienced professionals that these loss figures are a good overall assessment of losses in the commodities named. It is considered that these loss estimates are sufficiently close to the mark to be used as a basis for future planning at the present time. It is also considered that it is worth more effort to obtain better figures in order to identify specific areas where loss reduction activities would be most appropriate. There is a unanimous opinion that these levels of loss are sufficient to warrant economic intervention.

Item #2 What is being done about losses?

Colombia, Bolivia and Brazil have already developed wax coating technology for cassava that extends its shelf life from about 3 days to about 30 days. The Faculty of Chemistry of the University of Mexico and CONAFRUT have developed technologies to increase the storage life of certain fruits and vegetables using natural waxes and plant regulators as coating material. Much of this work is sponsored by OAS.

Ghana and Sierra Leone are working on waxing as a means of extending the storage life of plantains.

TPI has had a research effort for about 10 years in the area of loss reduction of non-grain staples (cassava, yams, plantains and breadfruit) in collaboration with CIAT, MARDI, and the University of Ghana. There have also been major efforts with bananas with the Windward Island Banana Growers

Association and the Banana Breeding Scheme of Jamaica and with a wide range of other fruits and vegetables with various collaborators. Publications resulting from the work are listed in the bibliography, and additional publications are in press. TPI has also been involved in operational loss reduction programs in most of these crops, and has recently initiated some loss assessment projects.

The University of Ibadan, Department of Food Technology, Stored Products Research Institute, I.I.T.A., NIHOT, all in Ibadan, and other institutions in Nigeria, in collaboration with overseas institutions, are making encouraging progress in the following research areas to reduce postharvest losses:

- a. Modified atmosphere storage of yams, sweet potatoes, plantain and banana.
- b. Comparison of the clamp and barn storage of yam.
- c. Irradiation of yams to inhibit sprouting and enable them to be stored in good condition for 6 to 9 months.
- d. Adding sawdust wetted with a saturated solution of potassium permanganate (Condys crystals) to plantains held in sealed plastic bags enables them to be held up to 20 days at ambient temperature.
- e. Survey on storage losses in fruits and vegetables.

Publications resulting from the work are listed in the bibliography and additional publications are in press.

CIP in Peru is starting up a postharvest storage project on potatoes. The University of Idaho is working with several institutions in LDCs to use forced or natural cool air circulation up through bins of potatoes to keep them cool, thus retarding the rate of physiological deterioration and the spread of disease.

The Federal University of Vicosa and the Federal University of Bello Horizonte in Brazil annually conduct a course in postharvest handling of grains and tubers.

I.I.C.A. has supported the Ministry of Agriculture in the Dominican Republic over the last two years in two programs:

- a. improving market information service for horticultural products;
- b. developing a methodological approach to quantity losses and identify alternative projects to reduce such losses.

A number of meetings on postharvest loss reduction have been held, and more are planned for the future.

The Colombian National Coffee Federation's marketing department is doing research on agroindustry of tropical horticultural products and cassava. CORABASTOS, IDEMA and I.I.T. in Colombia have ongoing projects on marketing, processing and postharvest factors in cassava, some fruits and white potatoes.

ICAITI in Guatemala is working on the handling and processing of tropical fruits.

CITA in Costa Rica has started processing studies on tropical fruits.

CONAFRUT in Mexico is developing as a center for postharvest problems in fruits and vegetables with programs in training, teaching, research, and technical assistance.

IICA is in the process of preparing a "Who's Who" of professionals in Latin America who are active in the postharvest field. IICA is also preparing a publication on the methodological approach and techniques to assist in postharvest loss reduction and is implementing diagnostic studies in Mexico, Central America and the Caribbean to identify and quantify losses.

Two courses are offered by IICA. One in postharvest handling, storage, packaging, and transportation of perishables (physiological and engineering principles). Another one covers the same principles for grain quality control and conservation. A third course is in the process of preparation and it is aimed at scientists and technicians who would like to study in detail the basic chemical, biochemical and physical principles of fresh food conservation.

The Institute of Refrigeration has a periodically updated publication on the storage of tropical horticultural products.

Item #3 What is the state of the literature concerning food loss?

Dr. Morris's bibliography is an excellent compilation of the present state of knowledge on postharvest losses. It indicates that there are so many gaps in our knowledge that the state of literature can only be described as very inadequate and very unsatisfactory, particularly with respect to case studies of small farmer operations.

Item #4 No conclusions were drawn in this section with regard to economic factors.

Item #5

- a. Does the magnitude of the food loss problem warrant additional efforts to reduce losses? Unanimous Yes.
- b. Are present efforts to reduce food losses reasonable and adequate? Unanimous No.
- c. Are extraordinary additional efforts needed to have a significant impact on loss reduction? Unanimous Yes.
- d. Are regional or worldwide efforts needed as complements to national activities? Unanimous Yes.

Item #6 How can the analysis of food loss problems be improved? What is the state of the art of the methodology for estimating food losses?

Insofar as horticultural products are concerned, the following publication published by IICA in 1977 is the most recent summary of the state of the art. "Postharvest Problems: Actual Situation and Methodological Focus to Realize Diagnostic Studies and Prepare Programs and Projects to Reduce Postharvest Losses," by R. Amezcua, J. La Gra, G. Mendoza, J. Mansfield and C. Foncks. This publication is in Spanish, but an English translation is expected to be available in the near future.

Item #7 This item, on interventions to reduce food loss, was not discussed.

Item #8 A) In the light of what is known about the extent of food loss, the analysis of food loss problems, and the possibilities for intervention, what conclusions can be drawn?

- a. There is a need to convince Ministries of Agriculture and other government agencies of the importance of the problem.
- b. There is a need for greater funding to support more work in this area - not enough is known about postharvest losses of horticultural products in the tropics.
- c. There is a need for better management and marketing of horticultural products.
- d. There is a need for more national and international conferences on the subject.
- e. There is a need for cooperative cool storage facilities in some areas.

B) Are new policies and mechanisms for food conservation needed at national and international levels? Yes

C) What are the research priorities in relation to reduction of food loss?

The technological and economic aspects of the following are considered high priority research problems:

- a. environmental conditions during storage that can minimize losses;
- b. growth regulation and sprout in yam by chemicals and/or irradiation;
- c. basic biochemistry of deterioration of cassava (especially vascular streaking);
- d. packaging, handling and transportation to minimize losses, including use of waxing and mold inhibitors;
- e. detailed surveys on postharvest losses, loss assessment methodology and economic factors;
- f. case studies of marketing of individual commodities using the systems approach;
- g. injury caused by harvesting and handling;
- h. breeding programs including storage life as a criterion of selection;
- i. processing and utilizing of horticultural products and by-products to reduce losses.

NON-GRAIN STAPLES--Losses Reported by Region and Country

(From FAO, 1977 Unless Otherwise Indicated)

Region/Country	Roots/Tubers %Loss	Fruits/Veg. %Loss	Remarks
AFRICA			
Ghana	10 - 20	30 - 35	
Nigeria	15 - 60 10 - 50	10 - 50	Yams, Olorunda (1977)
Rwanda	5 - 40	5 - 40	
Sudan		50	Lack of transport to market
ASIA/FAR EAST			
Sri Lanka		20 - 40	
Thailand		23 - 28	
Indonesia	10 (cassava)	25; 15 - 25	
Philippines		10 - 50	
Malaysia		20	
India		20 - 30	
Jordan		2 - 3; 5 - 10	Lack of cold storage
Iran (Steppe, 1976)	5 - 100 (potatoes)	14 - 28	Frost; Sub-tropical fruits
LATIN AMERICA			
Dominican Republic	24 - 26	25	(Except plantain--10;
" (Tejada 1977)	17 (cassava)		tomatoes--13; green beans--12)
Chile	30 (potatoes)	30	
Brazil	5 - 30	8 - 10	Cassava--10; potatoes--5 - 30; pineapple--8; banana, tomatoes, orange--10
Bolivia	24 (potatoes)	17 - 30	Banana--24; citrus--27; tomatoes--30; pineapple--17
Peru	20 - 50		Potatoes, Werge (1977)

NON-GRAIN STAPLES--Postharvest Food Losses by Commodity

Commodity	Estimated %Loss	Remarks
ROOTS/TUBERS		
Carrot	44	Thompson, in Coursey (1971)
Potatoes	5 - 40	(8% in cold store; 20 - 40% on farm; FAO, 1977)
Sweet Potatoes	35 - 95	Thompson, in Coursey, 1971; Hall, 1970
Yams	10 - 60	FAO, 1977; Olorunda, 1977
Cassava	10	Indonesia, Brazil, FAO, 1977
VEGETABLES		
Onion	16 - 35	Thompson; Steppe, 1976
Tomatoes	20 - 50 5 - 16	Thompson; Steppe; Olorunda In transport only, Rawnsley, 1969
Plantain	35 - 100	Olorunda
Cabbage	37	Thompson
Cauliflower	49	Thompson
Lettuce	62	Thompson
FRUITS		
Banana	20 - 80	Olorunda
Papaya	40 - 100	Olorunda
Mango	16	Singh, 1960
Avocado	43	Thompson
Peaches, apricots, nectarines	28	Steppe, 1976
Citrus	23 - 33 20 - 95	Steppe (Iran) 1976 Olorunda (Nigeria) 1977
Grapes	27	Steppe
Raisins	20 - 95	Steppe
Apples	14	Steppe

Discussion Group III, November 1

Fish

Chairman: E. R. Pariser

Rapporteur: D. James

At the start of the meeting it was agreed that discussion should concentrate on small-scale fisheries: marine, estuarine and freshwater. It is recognized that the subsistence fishermen are the most vulnerable group involved in this sector of the industry -- in fact, together with landless laborers, they are the most vulnerable group in the population. As a result, they are most in need of direct assistance.

Postharvest losses in aquaculture are low, but should be kept under review because of the potential for aquaculture development.

While recognizing the importance of the following industrial sectors in the overall structure, it was decided to leave them out of consideration for the time being:

1. Developed commercial fisheries carried out by large vessels on the high seas.
2. The fish meal and oil industries.
3. Fish discarded at sea because it is presently uneconomic to land them for direct human consumption.
4. Those underutilized species, which may exist in considerable volume, but which at present are unexploited either because of lack of technology, economic viability, or consumer preference.

In addition, fish caught but not consumed because of ethnic preferences or taboos should not be considered. All these omitted items could be profitably studied in the future.

Either preceding or immediately following a delineation of the considerations of the postharvest loss program for fish, there should be a brief review of the importance of fish in the diet (i.e., 20 percent of animal protein is consumed as fi

#### Assessment of Losses

It was agreed it would be difficult, if not impossible (except under specific, isolated conditions) to obtain an accurate overall assessment of losses. Because of the nature of subsistence fisheries, being composed of many very small wide-spread, often isolated, units, both physical and economic losses take place over a wide geographical area. In addition, the products change ownership and form (e.g., from fresh to dried) so many times during the distribution marketing chain that loss assessment is not thought to be as useful as intervention to prevent postharvest losses at those stages where their occurrence is most common and serious. It is possible to characterize and isolate for treatment some of the main stages of the road to the consumer in which losses take place.

For ease of consideration the group decided to divide the small-scale fish processing and distribution industry into two parts:

1. Fresh fish (unchilled, chilled and possibly frozen)
2. Traditionally processed (smoke dried, salted, dried, fermented, etc.)

Postharvest losses in the small-scale fisheries are not high in the fresh fish sector.\* Although there is a level of spoilage, which results in loss, the actual losses are camouflaged because stale or spoiling raw material is turned over to the processing industry for drying. This results in an economic loss, as the price for poor quality dried products is often the same per unit weight as the fresh fish, although the relationship of fresh to dried, in field terms, is 5:1.

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\* We know next to nothing about the losses in the large Southeast Asian fermented fish industry.

Major losses occur with the traditionally processed products, particularly with smoke dried, dried, or salted and dried fish. Although these are very different products, which are often specific to a region, it is possibly sufficient for the report to refer to them as dried products. Generically, they suffer from losses due to the following causes:

1. Insect infestation with Chrysomia (blowflies) followed by Dermeestes (beetles). These losses are measurable with difficulty, but vary so much from one area to another or from season to season that accurate measurement is probably not required. They are also, however, preventable by better drying racks and protection to raise the fish off the ground--and subsequently by the introduction of better storage and disinfestation practices, although this can only be implemented if a sufficiently attractive incentive for the fisherman can be introduced at the same time. (This area of activity should be considered for project formulation.)

2. There is a level of spoilage resulting from storage of improperly processed products, which results in direct losses. Improved quality control procedures will alleviate these.

3. Following losses to insects, the most important physical and economic losses result from crumbling of the product during storage and distribution. Dried fish is a fragile product, which, if roughly handled or vibrated on overloaded trucks on poor roads, will crumble to a powder. Previous insect attack weakens the structure and can result in a mixture of pieces and a powder of fish and insect frass. With poor packaging there can be direct physical losses and there are always economic losses. Inadequate protection is recognized as an

important area for study and improvement to prevent physical losses and reinfestation by insects.

To summarize the discussions on the need for loss assessment studies, the group felt that for fish in particular it may be more expensive to diagnose the disease than to treat certain stages and its cause. Losses are difficult, perhaps impossible in some cases, to measure, and measurements in one country have, more often than not no bearing in another. The recognition that losses are high and giving (quantifiable) loss figures where possible should be the recommendation NAS gives to AID, with supplementary ideas of how these losses can be substantially reduced.

#### Remedies

In suggesting remedies, the group felt that postharvest losses was only one area of activity, albeit important, as the fishery resources available to the subsistence fisherman are very limited because of preferences and in many areas they are exploited at or above their maximum potential. It is therefore essential to make better use of what is landed and to preserve the economic value.

The group took note of the fact that the subsistence fisherman and fish merchant are generally second class citizens, often living in crushing poverty, with no hope for the future. This fact and the role of women in the society conditions what, how and by whom technology should be offered, how it should be delivered, and what incentives are necessary to convince the people to adopt the remedies.

The fisherman is vulnerable to pressures exerted by middlemen who often exploit the situation. However, experience has shown that it is dangerous for external aid to be directed to supplanting the middleman, particularly in the most depressed communities. It is therefore suggested that external aid should rather be directed to gradual improvement of social and economic conditions of the whole community, in order that the fisherman have a better and more prosperous market for his products.

Thus, regarding postharvest loss prevention as the means to the necessary and demonstrable ends of community development, the group recommends that projects in the following broad areas be considered for financing by AID:

1. Technology (development and transfer)
2. Extension (training and strengthening of extension links)
3. Infrastructure (public works, capital investment)

Some possible project ideas are given below, but project preparation will take some time, even after requests for assistance have been received from governments.

#### 1. Technology

The contribution of technology to alleviation of postharvest loss and to social change should not be underestimated. However, the choice of the particular technology should be carefully considered, against the background of the financial and intellectual ability of the recipients. The point of application is recommended to be through government technological research and development institutes rather than through universities. The tendency of U.S. university staff to focus too finely on a small aspect of a broad and pressing problem should be combatted. Without becoming too general,

technological assistance should be directed on a broad front to development of local technology, to adaptation of technology from elsewhere and to its application to local situations. This demands strong extension links. The prospects should be considered of linking into or strengthening the FAO program of regional collaboration in fish technology research. That would probably be more valuable than attempting to start an international fish technology institute at this stage.

These programs which have been started in Asia, Africa and Latin America attempt to link institutes within the region to work on common problems and to seek assistance from institutes outside the region (in developed countries); NMFS and U.S. university departments could well be included in these developments. Exchange visits between institutes and supplementation of equipment are the main financial requirements.

There are a number of other technology projects which could be considered as ideas. They are outlined below:

(a) Community Storage

The principal loss of value to the fisherman for his fresh fish results from the inability to hold fish in the expectation of better markets. Containerized chill stores, supplied with ice from central locations, can be established reasonably cheaply. These can be used to test the economic feasibility and acceptance by the fishermen before ferrocement storages are built. Community storage can also be organized for dried fish--making adequate disinfestation and protection possible.

(b) New methods of drying--on racks, or by improved smoke drying ovens, or by the design and introduction of better solar driers--can contribute to loss prevention.

(Solar-powered chill stores and wind-driven ice plants have been designed, but the U.S. would be ideally placed to encourage their testing and introduction.)

(c) The very severe processing methods used can cause considerable nutritional damage to the protein. Projects should assess this and establish the necessary conditions for prevention.

(d) A quality assurance service backed by the U.S. as the major importer could contribute to avoiding economic losses resulting from import rejection, presently estimated at more than \$10 million.

## 2. Extension

Extension links are weak throughout the third world, although extension services exist on paper in many countries. It is vital to demonstrate that technical extension can be a rewarding career. Many of the solutions to postharvest loss can come from extension work, particularly that resulting from socially oriented research projects with women. Particularly in Africa, women are the economic power in the fish business and extension work is unlikely to succeed unless this is recognized and women extension officers trained (e.g., in Mali).

Where extension services exist, they should be strengthened by direct action. Where they are absent, the governments should be persuaded of their value and every attempt made to train and establish a technical extension service separate from any regulatory or inspection body.

This is a long-term project which could not be completed within 10 years, but is vital if real advances are to be made.

## 3. Infrastructure Development

Technological research and the transfer of technology by extension links will be bound to fail unless there is provision for infrastructure improvement. The economically feasible projects carried out under technology and distributed

by extension efforts need to be multiplied by substantial investments. In addition, these investments are required to improve the quality of life in rural villages. They include provision of port and landing facilities, fish marketing and storage, and proper water supply with improved sanitation and sewage disposal. The provision of road links by road building and supply of trucks or the upgrading of water transport can substantially reduce postharvest losses.

There is a link between the three areas: technology, extensions and infrastructure development. This is the provision of adequate maintenance facilities, chronically absent in the third world. It is felt that this comes out as a major recommendation where the U.S. can make a valuable contribution. As more sophisticated hardware is introduced, adequate maintenance becomes vital.

Discussion Group I, November 2

Economics of Postharvest Loss Reduction

Chairman: D. Brothers      Rapporteur: W. Rathje

The discussion group on the economics of postharvest food loss reduction programs used Martin Greeley's commissioned paper (presented to a plenary session during the first day) as a basis for its deliberations.

Greeley's paper (copy appended), which constitutes an application of cost/benefit analytical techniques, develops a case for focusing postharvest food loss reduction activities on "the rural non-market sub-sector" (on "subsistence producers"). The reasons given are: (a) in many countries subsistence farmers account for the largest share of food production, and therefore comprise the most significant potential opportunity for postharvest loss reduction; (b) the subsistence sector generally encompasses resources for which there are no alternative applications or "opportunity costs" (labor is abundant and often unemployed, local materials are easily available and cheap, etc.); and (c) activities resulting in postharvest food loss reductions result directly in positive social benefits such as improved nutrition and generation of employment and purchasing power for that segment of the population for which such benefits are most crucial. In other words, Greeley argues (admittedly on the basis of certain a priori assumptions) that there is a generally valid economic case on social cost/benefit analysis grounds for directing postharvest food loss interventions to the subsistence sector.

Several participants in the discussion group felt that Greeley's case rested more on his own subjective values than on objective economic analysis. This point of view was characterized by the comment that while an exclusive

focus of loss reduction activities at the subsistence level might serve to reduce extreme poverty, and/or malnutrition, such a focus would likely be inefficient when viewed in terms of intervention costs and loss reductions actually achieved. Others pointed out that in many regions or countries there is no identifiable subsistence or rural non-market sector. While small farmers may consume much of their production, they generally also market (or exchange) some portion for other requirements. Even in instances where farmers produce one crop entirely for their own use, they usually also produce some other crop for the market.

The importance of economies of scale in storage of grains and other foods was raised. In most countries, experience has shown that the most cost-effective size for grain storage units implies village-level consolidation. It was also argued that centralization of storage permits more effective use of "appropriate" technology. It was recognized, however, that this may not always be consistent with social and cultural attitudes and organization. In some parts of the world, for example, a farmer's grain is his only liquid asset and he may be reluctant to sacrifice immediate access to it or to entrust its care to others.

Greeley responded by defending the validity of the social benefit/cost conceptual approach on welfare grounds, but he agreed that the "subsistence" or "non-market" terminology might be misleading in many cases. Both Greeley and his critics concluded that "traditional" is probably a more useful description of the sector to which the recommendations in the paper are directed. Furthermore, Greeley conceded that for countries where the majority of farmers are involved in market-oriented activities, his insistence on a subsistence or traditional sector focus for postharvest food loss intervention would probably not be entirely appropriate. He did, however, defend his underlying contention that social cost/benefit analysis is the appropriate analytical methodology for evaluating in economic terms postharvest food

loss reduction activities--whether or not those activities are directed toward the traditional sector--and argued convincingly that in any case, the results of such activities must be appraised in the context not only of the reduction in food losses achieved, but also with reference to the beneficiaries of these savings and the secondary and lasting impacts on the overall development process.

A related point made was that experience seems to show technology can be introduced most effectively to small farmers when it builds on existing techniques and methods; technology that is introduced from "outside" usually fails to be accepted. It was also observed that numerous projects for food loss reduction have failed in developing countries because involvement by the donor or assisting agency has been too limited in duration. Too often projects with good potential have failed when external assistance was withdrawn after two or three years.

In summary, there appeared to be general agreement with the group that Greeley's approach is a provocative and useful conceptualization and that possibilities for reducing postharvest food losses in the traditional (or subsistence or non-market) sector deserve greater attention than they have received to date. It was observed, however, that in many places in the developing world there is an increasing trend toward market-oriented agricultural production, and interventions directed toward commercial agriculture are generally quite different from those required at the subsistence level. This point, coupled with evidence that the implicit value judgments underlying Greeley's analysis and policy prescriptions were not shared by all the discussants, gave rise to the main reservations expressed regarding the Greeley paper. Finally, it was agreed that the kinds of intervention appropriate for the traditional sector require especially careful planning,

intensive and sustained utilization of skilled and committed technical assistance personnel, and primary reliance on technologies that relate to proven indigenous practices.

Discussion Group II, November 2

Training and Education for Postharvest Food Loss Reduction

Chairman: M. Bourne

Rapporteur: Daisy M. Tagliacozzo

This summary report presents issues on training and education needed to help reduce postharvest food losses; it is also based upon the results of information provided by contributors prior to the panel meeting from a large number of developing countries.

I. Information from Contributors

The request for contributions covered a wide range of topics dealing with postharvest food loss reduction. A recurring theme in almost all of the responses was the critical need for training and education to improve extension activities, demonstration projects, and techniques for reaching food producers. At the same time, critical comments were given both by respondents and by participants at the workshop concerning deficiencies in the kind and adequacy of training and education efforts. As one example, universities in their education, research, and extension services often seem to emphasize topics of academic concern rather than applied, practical questions and problems.

Although extension services constitute one of the basic mechanisms for education and training at the producer and consumer level, extension as currently practiced has a number of weaknesses. Usually, extension service workers are not trained to deal with the broad range of post-harvest food loss problems as they manifest themselves. There are also

mismatches in communication from trainers to people being trained. In some countries this was particularly noted with regard to women who are often the producers and marketers of basic foods as well as the family member responsible for the preparation of foods. Equally important, in the ministries and government there is often no practical awareness of the fact that food losses exist and that simple interventions could significantly reduce such losses.

## II. Conclusions Reached by the Group

1. A national commitment to reduce food losses must exist before programs of a local nature can make consistently significant reductions in postharvest food losses. The commitment must be expressed through a flexible program of interventions and incentives in the production-consumption chain.

2. An institutional mechanism must exist in each country to direct efficiently and effectively the appropriate interventions. It is necessary, therefore, to survey existing institutions and programs in any given country to determine what exists before starting new activities.

3. Education and training to recognize and deal with postharvest food losses should be an integral part of national agricultural development and agricultural education programs.

4. AID should assign staff persons having experience in food loss problems to regional and country missions in order to recognize, plan and deal more effectively in the reduction of postharvest food loss.

5. There is a need for an international clearinghouse for information on research and training focused upon food-loss prevention. Among the functions of such a clearinghouse should be:

- a. To compile information on existing training programs, curricula, institutional organization and certification status;
- b. To gather available literature in the field of food-loss prevention and regularly distribute bibliographic references to interested groups; and
- c. To serve actively in the pooling of information and in the sharing of knowledge and experience.

Perhaps the new United Nations University (Tokyo) which has already begun a series of research projects dealing with postharvest losses would be a logical place to establish a clearinghouse.

6. Education and training on ways to minimize postharvest food loss is needed at every level from public officials who make policy, to administrators and technicians, extension generalists, extension specialists, and to the producer at the farm or fish-catch level. Education and training programs must be locally designed and conducted and, most importantly, be specifically adapted to meet local needs.

### III. Comments and Recommendations Regarding Education and Training

#### 1. Importance of the extension services and of extension specialists.

In most countries the key person to give farm-level training should be the extension agent. Rarely does that extension agent now have training in techniques for food-loss prevention. This situation must be remedied so the extension agent may become the person who helps the food producer recognize the economic consequences of postharvest losses, motivate him to reduce the losses, and train him in practical techniques. At the same time, the general extension agent must be supplemented by specialists who have more extensive and particular knowledge and experience in reducing losses in grains, fruits, vegetables, meats and fish.

2. The initial selection of extension agents is highly important because these people must fit into the culture of the people for whom they serve.

3. There are several techniques and a variety of media to reach food producers through training and education programs. Non-formal education techniques are especially effective. Radio, TV, and visual materials produced for the local area are of particular importance. Use of natural leaders within the community who practice good food-loss prevention techniques can serve as a logical means to extend training and education that the extension agents seek to bring to a community or region.

4. Looking at the longer term, an understanding of postharvest food losses is important at the primary and secondary education levels. It is here that techniques of sanitation, hygiene and prevention of insect infestation can be stressed and taught at an early age as a part of the basic curriculum. It is also noted that literacy is an important prerequisite for many other activities.

5. Elements of the Tropical Products Institute system for postharvest training and advisory units within ministries of agriculture were recognized to offer many advantages. Most countries that do not have such units would profit by adapting this model which stresses national commitment, multidisciplinary approaches to problems, continuing training and education at all levels and integration of intervention strategies.

a. The development within a national framework of postharvest research/training/advisory units and the vesting of authority for such units at a level of government which can be effective (ministry).

b. The multidimensional emphasis of such units, i.e., development and maintenance of effective extension services, along with research (some participants stressed the need for both basic and adaptive research)

and training and assistance at various levels of government and industry.

c. The stress on both the training of lower level staff and the development of career lines for such lower level technicians and extension workers.

d. The goal of graduate level training in technical areas to increase the supply of professional staff and teachers.

#### IV. Further Recommendations of the Group

1. Special support to governments which request programs and information for public officials.

2. More food-loss prevention emphasis in training foreign students in the USA through short courses, seminars, etc.

3. More efforts to support exchange of trained personnel and, generally, more cooperative use between countries of scarce skilled human resources through regional organizations.

4. The development of programs which combine theoretical and applied training more effectively (also efforts to make field work for graduate students more rewarding).

5. Major concern with the training of trainers and teachers at agricultural institutes and opportunities for newly trained village people to become trainers themselves.

#### V. Supplementary Note by the Rapporteur

The focus of discussions was overwhelmingly on training, i.e., modes of assuring the delivery of knowledge. But the problem is not just one of information-giving. It involves the massive problem of education and this includes the receiver. What are effective learning models for village people (often not literate) in developing countries? What kinds of teaching aids are needed (visual??) Who will prepare teaching materials for various levels of learning?

Available studies of extension work have quite clearly shown that merely intensifying extension training and work can be a wasted effort unless a number of other developments take place simultaneously. These include: giving farmers incentives to adopt new approaches; removal of various local constraints which may add to the problem of adopting new methods; giving extension workers enough incentives to do their work properly, including manageable and decent working environments; getting the support of the local community for various demonstration activities. The discussions did not touch on this issue or the organizations necessary to assure that such facilitating conditions prevail.

## Discussion Group III, November 2

### Interventions

Chairman: A.A.C. Huysmans

Rapporteur: M.G.C. McDonald Dow

The Group agreed to look at intervention needs firstly from the viewpoint of national needs. Several country case studies were described to set the context. From the discussion of various detailed needs (e.g., improved marketing arrangements; credit arrangements to purchase inputs, such as driers; and coordination between agencies, such as marketing boards to pool seasonally used transport) the importance of national policy bodies was stressed as a means of

- a. increasing awareness of postharvest problems;
- b. coordination and monitoring; and
- c. providing a national focal point to identify needs for decision-makers in research, training, and transport, marketing, etc.

Policy bodies should also help to counter the traditional bias in many countries in favor of export crops. It is important for the private sector to be represented, as the bulk of food production in most countries is in private hands. Resource allocation considerations must be adequately represented in their membership and they should coordinate the technical assistance activities.

The following areas of priority emphasis (excluding training) were identified, particularly from the standpoint of donor assistance:

1. Surveys, to identify key areas of loss and strategies for reduction (donor priorities often assist governments to assign national priorities where external funding is available).

2. The traditional sector, which has not received adequate attention. This neglected area should be emphasized as one of several areas where food savings can be made, recognizing:

- that the value of food conserved on the farm is greater than in the urban sector
- that the problem of the urban poor is not food losses, but the inability to purchase food
- that the rural areas have a particular problem due to the strain of increasing production and strain on traditional conservation technology; concentration on this sector may offer new possibilities for opening up a route to the market sector.

3. Particular attention should be given to non-grain staple foods. In view of the importance of these staples, appropriate attention should be focused on their postharvest needs. Establishment is recommended of a coordination mechanism between donor agencies analogous to the Group for Assistance on Systems relating to Grain After-harvest (GASGA); this should not be at the expense of resources allocated to cereal grain and grain legume postharvest loss reduction.

4. Economics of food loss reduction:

- particularly at the farm level (traditional sector)
- including effects on secondary target groups
- including post-intervention evaluation
- employing a systems approach including particularly assessment of the cost-effectiveness of alternatives.

5. Research needs. Assistance is recommended with research and development on postharvest food technology, but without duplication and well coordinated, in the following areas:

- a. an inventory of past research
- b. perishables -- physiology, pathology, physics (mechanical properties) and packaging
  - methodology of loss assessment
  - simple processing technology to convert perishable produce to durable
- c. breeding research including enhanced suitability for reducing postharvest losses as a desirable characteristic
- d. rice--improved processing threshing technology should be reviewed both to assess needs for basic research and adaptive research sufficiently broad (multidisciplinary) to include project implementation and effect on secondary target groups.
- e. alternative energy sources for drying--rice husks and biogas for drying; in this context it is noted that solar energy does not appear to offer realistic possibilities, since the greatest need for drying occurs when sunshine is not available.
- f. alternative approaches in the long term to present insecticides, rodenticides and fungicides with their environmental and resistance problems; these are, particularly non-chemical controlled atmosphere and related methods, and new safe, biodegradable chemicals.
- g. social research, paralleling technical approaches, such as on centralized storage; pilot central storage systems should be introduced and evaluated as an alternative, particularly where traditional production is increased through extension efforts and the traditional storage technology overloaded.

- h. assessment of traditional systems--folk wisdom regarding traditional postharvest practices should be examined in order to identify indicators of potential improvement through new technology.
- i. marketing, credit, transport assistance required for improvement; one such mechanism could be a pilot scheme for capital financial assistance (seed money) to the national extension agency to improve delivery of technology at farm level, demonstrate effectiveness of technology, and generate self-sufficiency, perhaps through a revolving fund mechanism.

## Final Session, November 3

The plenary meeting was presented with brief summary reports by the rapporteurs of the six small group sessions indicated above.

### Food Storage in the People's Republic of China

These reports were followed by a presentation by Dr. Edward Ayensu, illustrated with slides, of a recent visit to the People's Republic of China during which he visited food storage facilities and observed the means by which food is conserved.

The main points to emerge from his observations are:

1. The emphasis on food storage hygiene, both in construction of storage facilities and in their continual inspection and monitoring;
2. The professional training and organization of storage supervision and management;
3. The centralization of the bulk of food produced at brigade, commune or provincial level, combined with regional decentralization of responsibility for production, marketing and storage;
4. The emphasis throughout the system on practical means of storage and preservation, usually simple, but with sophistication (such as controlled atmosphere storage of fresh fruit and vegetables at reduced temperatures and oxygen pressure under polythene sheeting) where appropriate.

The system is apparently effective, and losses are evidently low, although little published scientific information is available.

Discussion following the presentation emphasized the evident importance of social and political organization in achieving the degree of control over storage problems observed. While recognizing the importance of this achievement in providing increased food supply and food security for China's enormous population, it was generally felt that the social cost would not be willingly borne in other countries, and the economic cost/benefit is not known.

#### Allocation of Resources to Postharvest Food Conservation

The final discussion period was intended to focus on the priorities for allocation of resources among the various sectors of the postharvest food conservation system to assist governments and technical assistance agencies to decide on the relative importance of research, training, organizational aspects, etc.

From the discussion it became clear that this was an extremely difficult process, since quantitative assessment of the loss situation and economic returns is extremely tentative, since the situation varies so much, both between countries and within different regions of countries, and since the assistance provided by external donors is largely provided on political, not technical, grounds.

It was, therefore, agreed that definitive ranking of priorities was impossible, but that important areas should be reemphasized. From the discussion, the following areas of emphasis were identified:

1. Establishment, or strengthening, of national postharvest food loss policy coordinating bodies, which would
  - a. emphasize importance of the problem, stimulate awareness
  - b. coordinate donor assistance, provide continuity

c. organize appropriate national efforts in research, training and policy areas, including such aspects as:

- i. surveys to identify key problem areas
- ii. identification of national expertise and establishment of technical advisory mechanisms
- iii. strengthening indigenous capabilities
- iv. strengthening marketing, pricing aspects of loss reduction.

2. Training at all levels, but particularly for effective extension efforts at the village level; special attention needs to be given to the general education needs in relation to integrated village development and to the needs of women.

3. Research, particularly aimed at improving knowledge about non-grain staples, and particularly including cost/benefit of loss reduction.

Special attention should be given to practical, applied research, including evaluation of traditional and improved technologies, and basic research into such things as low-cost refrigeration, new chemicals and non-chemical systems to conserve food.

4. Consideration should be given to establishing international and regional institutions ("storology" institutes perhaps patterned on the Tropical Products Institute) for integrated physical, biological and sociological R&D on food losses in different systems and environments

Participants submitted individual priority topics for consideration by the Steering Committee, reflected in the categories listed above.

The Steering Committee met briefly following the adjournment of the meeting to review outstanding business.

### Bibliography

The bibliography was agreed to be a unique collection of important food loss references which could, and should, serve as the basis of an international dynamic system to serve the needs of researchers worldwide.

The Committee requested Mr. Huysmans to consult with FAO regarding the possibility of including this material in the FAO Documentation Service. This was agreed to be the most appropriate location for a postharvest bibliographic system through which papers could be purchased by scientists in local currency, and in which it would be continually updated.

In view of this possibility, the Committee agreed that there was little need to expend further NAS resources on it, other than to include the suggestions received from the meeting participants. The amended version should be made available in photo offset form to a limited number of active research institutions; perhaps 200 copies would be sufficient.

With respect to the selection of major papers for the suggested reading with each chapter of the report, an authority in each field should be asked to supply a brief literature review and reading list.

### Future Schedule

1. The final scheduled Committee meeting will be February 14 and 15, 1973;
2. A final draft report will be circulated in early January;
3. The reviewed and approved version will be transmitted to AID in mid - late April 1978.

## Agenda

- October 30 - Steering Committee Informal Meeting - Howard Johnson's  
2500 Virginia Ave., 7 p.m.
- October 31 Plenary Session Room 200 A  
Chairman E. R. Pariser
- 09:00 A.M. - Summary of status of study (E. R. Pariser, M.G.C. McDonald Dow)
- 09:15 - Plan of study bibliography (Robert Morris)
- 09:45 - Methodology for estimating food losses (Kenton Harris)
- 10:45 - Coffee Break
- 11:00 - Personnel needs, education and training for food loss analysis  
and reduction (P. F. Preveatt)
- 12:00 - Luncheon 2nd Floor Dining Room
- 01:30 P.M. - Economic implications of food loss and food loss reduction  
(Martin Greeley)
- 02:45 - Coffee Break
- 03:00 - Sociocultural implications of food loss and loss reduction  
activities (H. Guggenheim)
- November 1 Small Groups
- 9:30 a.m. - 12:00 noon; 1:30 p.m. - 5 p.m.

(Coffee will be available mid-morning and mid-afternoon. No special arrangements are being made for luncheon - a limited number of buffet lunches are available in the 2nd floor dining room; there is a snack bar on the 3rd floor, and a good restaurant "Adam's Rib" on the ground floor, as well as many good restaurants in the immediate neighbourhood of the Joseph Henry Building).

Three discussion groups on major categories of food commodities:

1. Grains/legumes Room 200A  
Chairman: A. Huysmans; Rapporteur: J. Pedersen
2. Roots/tubers/fruits/vegetables Room 500B  
Chairman : A. Ayensu; Rapporteur: M. Bourne
3. Fish Room 500C  
Chairman : E. R. Pariser; Rapporteur : D. James

Discussions of these commodity groups should include the following issues:

- Agreement on current understanding of minimum levels of loss supported by good evidence and observation on a regional or worldwide basis.
- Are improvements needed in loss estimation procedures for this category of food commodities?
- What significant reduction programs have been or are now in operation and what lessons can be learned from this experience?
- What is the state of technology for storage and loss reduction?
- Do significant technological gaps exist? Do interesting new technologies deserve to be highlighted in the report?

November 2                      Small groups

9:30 - 12 noon; 1:30 - 5:00 p.m.

(Coffee will be available mid-morning and mid-afternoon. No special arrangements are being made for luncheon - a limited number of buffet lunches are available in the 2nd floor dining room; there is a snack bar on the 3rd floor, and a good restaurant "Adam's Rib" on the ground floor, as well as many good restaurants in the immediate neighbourhood of the Joseph Henry Building).

Three discussion groups will meet and address the following issues:

- Group I    Room 200A    Chairman: D. Brothers; Rapporteur: to be selected.

Discuss and make recommendations on economic issues and policies related to food loss and the reduction of food loss. The paper by Martin Greeley will serve as a basis for discussion. A paper will also be presented by representatives of the IBRD.

- Group II    Room 500B    Chairman: M. Bourne; Rapporteur: D. Tagliacozzo

Discuss education and training needs related to analysis of food loss and food loss reduction activities. Particular attention should be given to the role of women; education needs for farmers; kinds of technicians needed to carry out analysis of food losses for loss reduction programs, new types of education and training programs needed for personnel in food loss activities. Peter Prevett's paper will serve at the session for discussion.

- Group III    Room 500C    Chairman: A. Huysmans; Rapporteur: E. Ayensu

Discuss issues and make recommendations related to food loss interventions. Issues should include policies and mechanisms for food conservation needed at national and international levels, R&D priorities in relation to reduction of food loss, sociocultural implications related to interventions, mechanisms for better sharing of experience and information concerning food conservation, ways in which financial and technical assistance agencies can help in reducing food losses.

November 3

Plenary Session      Room 200A  
Chairman: E. R. Pariser

- 09:00 a.m.      - Report of small group discussions by spokesman for each group.
- 10:45            - Coffee Break
- 11:00            - Presentation with slides on food loss reduction activities  
                  in People's Republic of China (Edward Ayensu)
- 12:00 noon      - lunch (no special arrangements will be made)
- p.m.             Plenary session for discussion of major conclusions and recommendations  
                  for the report.

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September 16, 1977

MEMORANDUM

TO : Participants in Working Meeting  
NAS Study on Post Harvest Food Losses

FROM : *mw* G. C. McDonald Dow, *JM* John Hurley, Robert Morris, NAS

SUBJECT : Working Meeting

Those of us connected with the Academy study on post harvest food losses are pleased that you will be able to participate in the working meeting to be held in Washington, D.C., October 31 - November 3. The purpose of this memorandum is to outline in greater detail the major issues likely to be addressed at the meeting as well as the general structure of the daily sessions.

The working meeting is intended to facilitate an exchange of experience by participants who have worked with food loss problems in the field and to air various points of view related to the major issues to be addressed by the Academy report. The meeting is not a formal seminar but rather is designed to provide useful input to the staff and steering committee members ultimately responsible for the report.

Although the working meeting will constitute one of the major inputs into the final report, the process of consultation and revision will continue for several months after November. Participants in the November meeting will be invited later to comment on draft versions of the final report, as will other appropriate specialists and institutions. Moreover, a review committee will be established by the Academy to comment upon the logic and clarity of the report and to be alert to such matters as whether conclusions offered are adequately supported by accompanying data or narrative.

Audience

The food loss report will be widely distributed in developing countries and among development assistance organizations and will be designed to reach several major audiences:

1. Non-agriculturists involved with decisions that affect activities related to reduction of food loss - economic planners or central bank officials, for example.

2. Program and project officials and workers directly responsible for food loss reduction activities. Frequently, however, such persons will have no previous direct experience or training related to food loss.

3. National or international organizations with potential impact on the reduction of food losses. Such organizations might include financial or technical assistance agencies, research institutes, and training centers.

With the differing needs of the audience in view, the NAS report will need to be presented in a manner and format that is useful to the broad needs of the intelligent layperson as well as to the more specific needs of the project worker in the field.

### Major Issues

Certain major issues are likely to be addressed by the NAS report and need to be discussed at the working meeting. These issues are indicated as a result of analysis of the subject, the state of the existing literature, and the interests of the financial sponsor of the study, the U.S. Agency for International Development (A.I.D.).

Key issues or questions include the following:

1. What is the best or most reasonable estimate of the extent of losses among the major food commodities? Is it useful and possible to arrive at generally agreed loss estimates for the major foods? The commodities to be discussed will include grains and food legumes, roots and tubers, fruits and vegetables, and fish. Losses occur within a whole system of processing, storage, transportation, and distribution, of course, so that the discussion should highlight the points in the system at which losses occur.

2. What is being done about losses? What sort of loss reduction programs have been or are now in operation? Does this experience provide useful guidelines for future programs? What research and development is being carried out that relates to food losses?

3. What is the state of the literature concerning food loss?  
In response to this question, the report will include a comprehensive bibliography prepared by Dr. Robert Morris. The bibliography will indicate the gaps and weaknesses in the literature presently available.

4. What are the important economic factors related to food loss and conservation? Are good data available comparing the costs of food loss reduction with the costs of increased food production? How do national financial and agricultural policies relate to food conservation? Can conservation of food be an effective means of generating increased rural

incomes? Has experience provided good indicators for the levels of loss reduction that can be achieved with relatively modest investment and beyond which only marginal reduction can be achieved? To what extent is investment in food loss reduction justifiable (bankable) in simple economic terms?

5. Does the magnitude of the food loss problem warrant additional efforts to reduce losses? Are present efforts to reduce food losses reasonable and adequate? Are extraordinary additional efforts needed to have a significant impact on loss reduction? Are regional or world-wide efforts needed as complements to national activities?

6. How can the analysis of food loss problems be improved? What is the state of the art of the methodology for estimating food losses? What are the personnel requirements related to loss estimation? What has experience shown about the cost and benefits of loss estimation in different situations? How do political, economic, and cultural factors relate to the analysis of food loss problems?

7. What is the state of knowledge about interventions to reduce food loss? What technologies warrant wider application? What is known about the social and cultural constraints related to interventions? What is the role of incentives or disincentives in intervention programs? What research or development is needed to provide improved intervention mechanisms? What training is needed to provide adequate personnel for loss reduction activities?

8. In light of what is known about the extent of food losses, the analysis of food loss problems, and the possibilities for intervention, what conclusions can be drawn? Are new policies and mechanisms for food conservation needed at national and international levels? What are the research priorities in relation to reduction of food loss? What needs to be done about personnel training programs? What are the most effective ways in which financial and technical assistance agencies can help reduce food losses? Is there a need for better sharing of experience and information concerning food conservation activities?

Obviously, the issues just described do not constitute a comprehensive listing of those that should be discussed at the working meeting, nor are they necessarily ordered in the most appropriate manner. They do, however, indicate many of the matters participants should be prepared to discuss. Any additions and improvements you may suggest are most welcome, as are reports or data that can illuminate or support particular major issues or conclusions.

#### Structure of the Working Meeting

The working meeting will consist of a mixture of plenary and small group discussions. Participants will be asked to join particular small groups on the basis of their experience and interests. Steering Committee members and MAS staff members will be dispersed throughout the various groups to participate and to record the main points of discussion.

The tentative agenda follows:

October 31 Plenary Session

- Opening comments on the working meeting agenda and format and subsequent activities in the NAS study.
- Presentation on methodologies for estimating food loss.
- Presentation on economic implications of food loss.
- Presentation on personnel needs and training for loss reduction activities.
- Presentation on sociocultural implications of food loss and loss reduction activities.

November 1 Small Group Sessions

- One-day session for discussion groups on major food commodities grains/legumes, roots/tubers, fruits/vegetables, and fish.

November 2 Small Group Sessions

- One-day session for discussion of major issues that apply broadly to all food commodities; topics will include economic factors related to food loss, socio-cultural implications and constraints, research needs and priorities, government policies, personnel and training needs.

November 3 Plenary Sessions

- Presentation of summaries of small group discussions.
- Discussion of major conclusions and recommendations for the report

Before October 31, participants will receive draft versions of papers to be presented at the working meeting and rough drafts of possible chapters of the final report. Additional information on the administrative aspects of participation in the meeting - travel, hotel and daily expenses, etc. - will be sent in the near future.

All of us associated with the study look forward to working with you and having the benefit of your personal experience and perspective.

POSTHARVEST GRAIN LOSS ASSESSMENT METHODOLOGY

K. Harris

Nothing could be easier than the job that I have before me this morning. I am charged with explaining a methodology for estimating food losses and I have with me a Manual for the Estimation of Post-Harvest Losses to Grain. All that I have to do is take you through this manual step by step and say "There it is. There is where the U.S. Agency for International Development/L.I.F.E./American Association of Cereal Chemists project thinks the answers to that one part of the subject lies".

Yet nothing could be further from our joint needs this week. Nothing could be less helpful. And I would sit down 30 minutes from now - for I am not going to talk for an hour - feeling, knowing, that I had not done what should be done.

And, yet, I might ask you what is to be done?

One need only glance at the list of prospective participants to recognize that there are many in the audience who know as much - more - about the subject than I. There are those who are packed to the brim with sophisticated technological know-how on food preservation. There are those who are saturated to exhaustion with knowledge of the unsolved problems of food preservation in the developing world. There are those that can bridge the gap, and those that cannot. There are also experienced and thoughtful individuals who come to this meeting from their respective organizations well imbued with plans and philosophies of action that have served us all satisfactorily in the past and may, or may not serve us well in the future.

Am I to challenge all of this? Am I to say that somewhere down the line we have missed the trail and that we need to re-group and begin again? I think that I shall not go that far, but I think also that I shall say that what has been good enough, "satisfactory" is the term I have just used, may not be adequate for the needs of now and the future. But before I get to those matters, and I do

mean to get to them, let me go back to the title of my talk as presented in the Provisional Agenda.

I do this for two reasons: One is that the conveners of this meeting have asked that I talk on that subject. The other reason is that I propose to use it as an example of an action program that might just be useful to us in the next few days.

There was and is an acute need for a methodology for postharvest grain losses. If you remain to be convinced that some of the figures that we have all banded about were pretty far-fetched I would be glad to tell you how some of them came into being. Just ask the question here in this session or later when we have a chance to talk privately.

Meanwhile the Tropical Stored Products Centre of the British Tropical Products Institute has published a bibliography of durable foods loss estimates that classifies the available information according to the methods used to arrive at the estimates. There are mighty few figures that are based upon known, let alone scientifically arrived at, procedures. Yet these are the figures that have served us well. Without them there might not be a recognition that post-harvest grain losses were and are serious and that the reduction of such losses will make it possible to feed more people. On the other hand, unless viable alternatives are provided, these are the kinds of figures that will be used to satisfy the resolution of the Seventh Special Session of the United Nations General Assembly that stated in 1975 "the further reduction of post-harvest food losses in developing countries should be undertaken as a matter of priority, with a view to reaching at least 50% reduction by 1985."

Fifty percent of what? Following the Seventh Special Session, an Interdepartmental Sub-committee of the FAO on Reduction of Post-Harvest Food Losses in Developing Countries was appointed. In its position paper released at the close of 1975 the Sub-committee reviewed past and current activity and concluded: "There is no agreed methodology of post-harvest loss assessment.... There can be no agreed single figure for the percentage of post-harvest losses on a global scale or even on a national basis."

For one recognize that the old figures have served some useful purposes. There are practical requirements for figures to justify appropriations without spending years obtaining information that changes as quickly as it is gathered.

I for one recognize that there may be large amounts of monies to be spent on public works, or to build a more sophisticated technology, or to save lives no matter what the economics of the picture might be; that it may matter only a little whether or not it "pays".

I for one also know that there are no longer the same vast amounts of monies available unchallenged, that there are serious doubts about the wisdom of building more sophisticated technologies in Third World Countries merely for the sake of building, or on the assumption that this is the correct and useful route to follow. There are priorities being placed on where, when, and how to save lives by reducing starvation.

I am also one who has been challenged in the field by a cultivator who wants, demands, to know if it will pay.

Those of us who have worked in the Third World, especially those who have worked in a multidisciplinary mission, know that there are nutrition advisors, and seed specialists, and fertilizer experts, and water resources technicians, and integrated pest control scientists, and food preservation and storage advisors all

competing for the time, attention, and resources of the cultivator-food producer. And we all should know that if the cultivator took the advice of all of us, he would have the best seeded, best fertilized, best watered, best protected crops possible, on a farm that he has just lost to his unpaid creditors.

When a farmer looks critically down his nose, or up from where he is squatting on the ground seriously ruminating on your suggestions for improvement, and wants to know what he will see in the way of benefits, he is not thinking in terms of feeding the world, in terms of national averages, in terms of five-year fiscal depreciation. He means "If I spend \$10 for a metal bin now, what will I have to show for the \$10 in terms of feeding my family or selling the grain during the storage season ahead, period. And remember, too, that we are competing for the development dollar in a very tough competition.

Practicality is at that point the order of the day.

When the American Association of Cereal Chemists, working through the League for International Food Education, contracted to prepare a post-harvest grain loss assessment manual, there were five important decisions made at the outset:

1. That the need was urgent and that the job could and would be done within two years. Practicality.
2. That enough was known at the time to do the job, and that what was to be put down would be in terms of the present state of the art and that no developmental research would be done as part of the project. Practicality.
3. That the job would be done by an individual under contract to an established organization - the AACC - but one without any loyalties to established, or yet to be established dicta. Practicality.
4. That it would be a general manual, broad in scope and perspective and one that could be used as a guide in developing countries. Practicality.
5. That publication would be part of the contract. Practicality.

These decisions are important to us here today. However, Before I get into the "whys" and "wherefores" let me throw out a challenge:

I am currently reading the 17th book written by John Kenneth Galbraith. He has titled his review of economic thought and published economic ideas "The Age of Uncertainty". In this volume Galbraith does many things. What interests me now is his focus on the effect of ideas; ideas the very existence of which has shaped man's life on this earth. As Galbraith spells it out, knowledge is not always the factor on which decisions are made. Often both sides of an issue have access to the same information, yet each will come out 180° from the other. Several of his examples come from World Wars I and II and the economic thinking of the age of uncertainty that began with World War I. One example is devastating: With the same set of facts in the hands of the British and German officers, the British sent 690 against the German machine guns and in 40 minutes 684 of the British were dead. This is 17 human beings a minute, and is certainly a supreme example of how a system uses information, of what a system will ask its fellow creatures to do, and what its members will deliver. But I recall it for you today mainly as an example of the original point: of leadership's use of the information at its disposal.

We can use the information that we bring to this meeting well or badly. The choice is ours.

In the same volume is a recounting of the economic thinking of Adam Smith, Voltaire, Ricardo, Malthus, Marx, Lenin, and many others. Some wrote. Some talked. Some held conferences. Lenin as an expatriate in Switzerland held conferences and laid the foundation for taking over the 1917 Revolution. In this context Galbraith says:

{ Conferences need to be understood. Some, of course, are purely recreational. Men and sometimes women gather at the expense of a corporation

or a foundation. The purpose is free or tax-paid enjoyment. The justification is the exchange of ideas, and the value of this is fiercely proclaimed. It is very difficult to say in criticism of such a conference that no ideas were exchanged.

Of serious conferences, very few are to exchange information and fewer still are to reach decisions. Most are to proclaim shared purposes, to reveal to the participants that they are not alone and thus to reinforce confidence. Or they are to simulate action where action is impossible. By occurring, they persuade the participants, and often others, that something is happening when nothing is (actually being done).

We now have the technical information not only to measure post-harvest losses, but we ~~know~~ know how to reduce their severity. In addition to knowing "how" we, who are here in this room know where the emphasis might best be placed.

We are brought together for just that purpose. The next few days are ample enough time for us to determine when, where, and how.

1. It is urgent.
2. We know how to do it.
3. We know who is available to get it done.
4. We can prepare a guide to reducing post harvest losses in developing countries.
5. The Academy is in a position to report on our deliberations.

Lest the point is unclear, these are decisions that parallel those that were made at the start of the L.I.F.E./AACC manual preparation.

I have not yet reached the end of this talk. To get to a successful end-point I need to go one step further, but to get there I need to add one more observation. It is a point that is necessary in order to spell out my work philosophy.

In post-harvest grain loss prevention, and in stored products biology, there is more to do than there are trained professionals and technicians to carry out. We can no longer afford duplication of effort, and we can no longer afford the luxury of decisions being made so as to protect one's own ways of getting the job done. Training and cooperation may be the necessary order of the day, and we here in this room have the power to order it to come true.

If a U.S. institution has a technological and academic competence in grain storage that needs to be supplemented by the earthy practicality of a British field competence, then it is time to stop bringing trainees to the United States for training and to combine efforts so that the training is brought to and becomes a part of the country where it will be practiced.

If a lending institution is having trouble in justifying the construction of a facility in a country where there is not the technical infrastructure to keep it working, then it is time to either enlarge its thinking to include training, or to work cooperatively so that a training input is made by those that have it as a part of their function.

Just as the L.I.F.E./AACC contract was a small specific effort to meet a specific need, so training should focus on the practical and specific. The need is not for a general conference on grain storage in East Africa. The need is for an assessment of specific and local losses and how they might be reduced by the application of culturally effective techniques and then training the working field people in the basic skills that will make cost- and culture-effective changes acceptable and productive.

I well know that the paperwork for a series of small workshops to solve local storage problems could be greater than that for a \$2,500,000 elevator or warehousing program. But if the need is for training, that is where the effort

should go. Justification is more difficult--how easy it is to multiply fertilizer x increased yields to prove cost-effectiveness--but all the more reason for this meeting to say just that, to spell out priorities so that budget makers and development officers will begin to cooperate in our difficult area.

It is time to make some of our loss-prevention dreams come true.

To return to the Manual: Carl Lindblad and I did the basic pick and shovel work on this manual. He is here this week and we would both be glad to have your comments especially after you have read it. A final draft edition will be forthcoming in the spring, so let us hear from you soon.

The manual has a strong interdisciplinary base. It stems from an interdisciplinary workshop in June 1976 and has built into it more than a modicum of anthropology, sociology, economics, political science, statistics, and management in addition to the expected grain storage science and biology. Many of its sections were individually written in and after a joint effort at the Tropical Stored Products Centre, Slough, England, by those who were willing to give of their time. Giving of one's time--the most precious commodity one has--is what it takes to get our job done.

**Without going through the entire manual item by item let me simply read for you the titles of the working sections:**

**After the usual amenities including an Introduction and Terms of Reference we have the following:**

**II. Terms of Reference**

**III. Representative Sampling, Interpretation of Results, Accuracy, and Reliability**

**IV. Loss Measurements as Related to Situations Where They Occur**

V. Standard Measurement Techniques

- A. Losses Caused by Insects and Mold
- B. Losses Due to Respiration of Grain, Molds, and other Microorganisms
- C. Losses Caused by Rodents
- D. Losses Caused by Birds (which is to be added)
- E. Moisture
- F. Manipulation of Samples in the Laboratory

VI. Operations Standardization and Control

VII. Application and Interpretation of Results

Appendices

References.

So this is a small start, but the larger challenge remains. It is within our power to do as Dr. Galbraith expects us to do and "proclaim shared purposes (and) to simulate action." The choice is ours and ours alone. Will we simulate rational and feeling individuals, or be rational and feeling individuals who will pick up the challenge and thrill to the feeling of doing what has to be done and doing it well. Again, the choice is ours.

## PERSONNEL NEEDS AND TRAINING FOR POST-HARVEST FOOD LOSS REDUCTION ACTIVITIES

P. F. Prevett

### Introduction

Considerable attention is currently being focussed, by national Governments and by multilateral and bilateral agencies, on the need for action to reduce post-harvest food losses. A major resolution of the Seventh Special Session of the UN General Assembly in September 1975 was that every effort should be made to achieve a 50 per cent reduction of these losses by 1989. Subsequently, the Seventieth Session of the FAO Council authorised the preparation of a specific proposal for a \$20 million fund to finance an assistance programme to reduce pre-harvest, harvest and post-harvest losses. This proposal was presented to the Committee on Agriculture which met in Rome during April this year; the Committee was informed that action under an FAO Programme of Food Loss Reduction, after an initial build-up period, would involve expenditure of about \$10 million per year.

The potential would seem to exist, therefore, for a concerted effort to reduce post-harvest food losses throughout the developing world; do we, however, possess the necessary resources to embark upon, and sustain, a programme of this magnitude?

### Components of a National Programme and its Personnel Requirements

Our objective is to initiate and/or develop and sustain national post-harvest (or post-maturity) food loss reduction programmes, embracing the whole post-harvest system.

It is of paramount importance that all post-harvest planning and activity within the framework of a national programme should be closely integrated and coordinated, and that authority for this should be invested in the appropriate Ministry (normally the Ministry of Agriculture). In our view, the most effective way to achieve the necessary action, in the long term, is through the setting up of a national "Post-harvest Research,

"Training and Advisory Unit" with the following objectives:-

- i) To ensure efficient post-harvest operations through the application of known technology and continuous evaluation and follow-up.
- ii) To establish programmes of adaptive research to determine the extent to which available technology may be applied to local conditions and, where appropriate, to undertake research and investigations on local problems for which a solution is not evident.
- iii) To assist in the establishment of on-going in-service training for staff of storage, marketing and processing organisations and others active in the post-harvest field.
- iv) To assist in the development and maintenance of an effective extension service to farmers, farmers' cooperatives, traders and local marketing agencies.
- v) To assist and liaise with government departments and organisations concerned with the planning of agricultural policies and programmes.

It is envisaged that, in order to establish a Unit of this type with a responsibility for durable crops, professional staff experienced in the following fields will be required:-

Head	- senior technologist with wide experience in food grain technology and storage
Biologist	- experienced storage entomologist/biologist
Processing Engineer	- cereal technologist with milling experience
Storage Engineer	- agricultural engineer experienced in grain drying, handling and storage and storage structure design
Training Officer	- agricultural educationalist trained in storage technology
Extension Officer	- agricultural extension worker trained in storage technology

/In many cases

In many cases the first step will be to conduct an initial survey to identify the component parts of the system (ie harvesting, threshing, drying, handling, storage, marketing and processing), to determine their inter-relationships and relative importance, to identify areas in which immediate remedial action is justified and those in which loss assessment or other studies are needed in order to determine the appropriate course of action. It is envisaged that for any such survey a team of three specialists will be required: a grain marketing economist, a grain storage specialist with broad experience in analysing causes of grain losses and controlling them and a grain storage and processing engineer. Projects involving loss assessment need to be serviced by personnel having suitable technical expertise in relation to the part of the system under study, coupled with 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 successful 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. Our long-term objective, through training, must be to upgrade 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, aid 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 this 'expert' manpower.

#### Expert Manpower

Much thought has already been given by a number of aid agencies towards meeting this need. The FAO has, for a number of years, operated an

/'Associate Expert'

'Associate Expert' scheme whereby qualified technologists who are lacking in field experience may gain that experience through an association with experienced personnel in field projects. The Tropical Products Institute also sees this as a mechanism whereby junior graduate staff may acquire the capability to fully participate in projects overseas.

A possible approach to this problem, put forward by FAO at the recent meeting of the Committee on Agriculture, might be for agencies to enrol men with ample technical experience, though not in the tropics, and place them as assistants to experienced managers of marketing boards in developing countries for periods extending over a procurement season or a storage season. Perhaps we should also be seeking to draw upon the expertise of returned volunteers who have appropriate technical skills and have acquired some experience of living and working in a tropical environment.

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 initiate post-harvest food loss reduction programmes.

At the 1975 meeting of the FAO Committee on Agriculture FAO was requested to carry out in its regular programme a survey of available technical expertise for agricultural development, both in developed and developing countries, and to establish and update from time to time this inventory. As the second part of such a study, an evaluation should be made, both at national and international level, of long-term demands for skilled manpower. Training capacities of both developed and developing countries should be adapted so as to be capable of meeting these demands. Attention is also being focussed on this question by the Group for Assistance on Systems relating to Grain After-harvest (GASGA), the members of which are FAO, IDRC, IITA, IRAT, KSU and TPI.

/National Training  
Programmes

National Training Programmes

There is a basic need for training programmes in post-harvest technology 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-distribution-marketing system and this is seen as one of the most crucial of the functions of a "Post-harvest Research, Training and Advisory Unit" as described above.

Courses need to be designed to meet the special needs of those responsible for procurement, quality control and 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, storage and processing organisations should be given sufficient technical knowledge to increase their awareness of the problems involved in decisions made by them and their technical staff. However, the training need which requires the greatest inputs both in terms of national commitment and expert assistance is the establishment of in-country training aimed at the lower cadres of staff of government and quasi-government marketing agencies, produce inspection and pest control services, extension services, etc.

Many aid agencies are active in providing training both through the provision of courses for graduate and senior level staff in technical institutions in their own countries and in assisting national training programmes through overseas courses. However, these programmes require consolidation and active follow-up in order to make them more effective. For example, the TPI has recently prepared a project proposal to assist

/a national

a national grain marketing and storage organisation in the training of all levels of staff concerned in store management, quality control and pest control. Its objectives are:-

- i) To initiate and establish, through the assignment of a Training Specialist (Storage Technologist) and provision of a training school with necessary equipment, an on-going programme of in-service training and career development for all grades of staff concerned with store management, quality control and pest control.
- ii) To provide, as an adjunct to a basic in-country training programme, the opportunity for selected staff to receive specialist overseas training, in Britain and through "third-country" training arrangements.
- iii) To consider the need for improvements to quality and pest control procedures with a view to formulating improved procedures, on which the training programme will be based.
- iv) In relation to the broader needs for storage training, to consider the possibility of mounting, with short-term assistance from appropriate specialists, special short courses for staff concerned with storage improvement at farmer and village level.
- v) To ensure, before withdrawal of long-term assistance, that an on-going programme can be sustained with local staff and to determine any future needs for overseas training and short-term consultancy inputs.

All too often the time scale for the imparting of skills and experience to local staff has been inadequate. Withdrawal of expert support before a local programme is firmly established can result in its early collapse.

/Conclusion

Conclusion

Our objective in focussing attention on the reduction of post-harvest food losses is to adequately feed an increasing world population. We are concerned with people and I submit that it is in people that we can find our greatest resource - provided that we can take up the biggest challenge which this problem presents to us, that of improving the technical capability of those who are concerned with preserving the fruits of our agricultural production.

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## ECONOMICS OF POSTHARVEST FOOD LOSS REDUCTION

M. Greeley

FOREWORD: For November meeting only.

Guided by some introductory comments on sectoral resource allocations, the major economic perspectives presented here have direct application to post-harvest operations concerning cereal staples in mixed but predominantly small-holder production units in regions endowed with comparatively high man-land ratios. In fact, this is not as narrow as it may seem at first reading; although, significantly, ignoring crop and climate, it is also applicable to some situations not displaying all the features listed. Thus, whilst the analysis is valid to a greater or lesser degree in other situations it is hoped that the approach will provide a support or guide to planners/executive officers in most situations through displaying the breadth of the issues under consideration. It is believed that the emphasis upon a particular set of conditions is more valuable in describing an approach to a socio-economic assessment than simply presenting a global overview; the major advantage of the emphasis is an attempt to present a fairly detailed guide to a sub-sector which constitutes the most widespread post-harvest situation. A more global approach would entail examining in broad terms the key features of a multitude of situations reflecting interrelationships between crop, diet, factor endowment, climate, government and practice. The major disadvantage inherent in this is a degree of abstraction that threatens relevance through a lack of specificity. The types of comparison that would



arise therein in describing those interrelationships are considerably less valuable to planners than an example of how certain universal features of a socio-economic assessment can be identified in practice.

The fact that key parameters of post-harvest situations are very much location-specific is a planning problem alleviated more by attempting to describe their collective import in a specific situation than listing their variability, of which planners and politicians are only too well aware. Specifically, the breadth of the analysis required to obtain a full socio-economic evaluation is more clearly spelt out by a situation specific approach. By emphasising the diversity of the factors under consideration rather than discussing particular factors in more general terms the approach may help avoid too narrow a focus on one or other consideration; an occupational hazard of research directors and planners alike. The emphases to date in research and planning on marketing issues and on technical efficiency testify to the strength of these hazards.

To the extent that the report does compare situations and comment on their potential significance in order to establish regional and sectoral priorities it must be emphasised that the situation described here is the most pervasive circumstance for post-harvest activities in LDCs. Moreover, as discussed in the first part of the chapter, it is typically this situation which is primarily

concerned with non-market food grains, that has been most neglected. The chapter also stresses the critical role in an evaluation of the effects on what maybe termed secondary target groups, the owners of the food being the primary target group. These secondary groups are those whose livelihood is dependent upon their employment in the post-harvest sector and, especially in the rural non-market sub-sector, is dependent upon a specific technique.

\* \* \* \* \*

A case study is considered to be an important element in the economics section of the report. However, the case study ought to be a unifying factor in the report and one or more case studies from research initiation to post-implementation evaluation which exemplify the suggestions of each chapter are likely to be a briefer and clearer element in the report than a multitude of piecemeal examples. This approach to case studies will also assist brevity which whilst possibly at less of a premium here than in other purposive presentations is nevertheless a considerable virtue much recognized by intelligent but busy planners. Actual case studies of recommended/non-recommended approaches would be ideal but if necessary simulations should be considered.

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Summary:

This chapter is concerned with the use of social cost-benefit analysis in evaluation of post-harvest loss reduction programmes.

In the first few pages some definitions and a discussion of aspects of the technique are presented, placing emphasis upon the role of employment and distribution effects of an investment. The chapter then addresses the problem of defining intra-sectoral priorities. Six sub-sectors within the post-harvest sector are identified and a case is made for concentration of resources upon the rural non-market sub-sector. In the ensuing discussion of the application of social cost-benefit analysis to this sub-sector several reasons are given why labour-intensive and local skill and raw material intensive investment programmes are likely to be the most profitable. The role of research work on the sub-sector permitting proper project evaluation is considered. Finally, mention is made of the particular extension requirements for labour-intensive programmes and how this affects the cost-benefit analysis.

## Economic Evaluation of Programmes to Reduce Post-Harvest Food Losses:

### 1.1. Introduction

The first part of this chapter is concerned with the broad issues determining the returns to programmes to reduce food losses in the post-harvest sector. Before discussing the question of allocation within the sector we first define certain terms that are recurrent in economic evaluation. The definitions, although of general application, are presented in a manner directly meaningful for programmes to reduce post-harvest losses; their more technical elements are discussed in an appendix. Subsequently, a detailed description of the considerations relevant for one type of programme is provided; the evaluation approach described in detail is one concerned with reducing post-harvest losses in the rural non-market sub-sector. Reasons are given both for an emphasis on the rural non-market sub-sector and why this emphasis has tended to be weak in the past. The choice is not casual. There are a priori grounds for assuming that social and economic benefits from programmes in this sub-sector will be greater than programmes aimed at other sub-sectors.

### 2.1. Definitions

The returns measure the value of an investment programme; obviously it is crucial to measure them in a manner that reflects the priorities underlying the investors' decisions.

In the case of a private entrepreneur this is usually just the rate of growth of his capital stock (money). The money costs of an investment by an individual are termed private costs and similarly private benefits measure for an individual the gross money returns. The ratio of these elements is called the private benefit - cost ratio and this measures the private profitability of the investment. For example, a mill owner may invest in a new grain grading machine; the costs are the purchase price, installation and extra running costs and the benefits maybe better quality milling, higher yields and less admixture, which result in higher prices for his product. In other words the benefits are the increase in the quantity and quality of food availability as reflected in the income received from the output of the mill.

- 2.2. For a public sector investment these purely financial considerations are only one element in evaluating the investment. Whilst increasing food grain availability is a primary objective of the investment programme, other objectives (of the government) are effected by the investment decision. Rather than any financial or other measure of the returns to a project, social cost benefit analysis, under a number of limiting assumptions, aggregates these objectives in monetary terms to measure the effect on aggregate consumption over time (see appendix). It is not important here to describe how this is actually computed; all it involves is a conversion of all inputs and outputs into social accounting prices which reflect the overall

objective of development seen as increased aggregate consumption. This is an altogether different and more all embracing approach than a private evaluation; especial features are the measurement of the employment effects, the distribution effects (and the balance of payments effects). We shall use the example of a grading machine cited above to illustrate these effects.

### 2.3. Employment effects

The new machine may use more electrical energy and less labour, for example by being linked to conveyor belts. Now labour employment is often a major objective of public sector investment and this is recognised in social cost benefit analysis generally by using a wage rate below the market rate in computing labour cost. Crudely, the reason is that the social costs of an investment are equal to the value of output foregone elsewhere by employing the resources necessary. Now because of market imperfections the costs which a private investor pays are different to these social costs; labour which is in surplus (unemployed or underemployed) tends to be overpriced and capital which is scarce tends to be underpriced. Thus the market wage rate of labour is higher than the real social cost (output foregone) of employing it. By using social prices, labour use becomes more economically viable which is consistent with a concern for increased employment. For LDCs converting market prices into social accounting prices (see appendix) invariably involves a reduction in labour wage rate, as assumed here. All prices are adjusted

in a like manner although there is scope for flexibility in the exact manner in which this adjustment takes place. A specific premium can be put on employment by putting a higher weight on current consumption (wages) compared to future consumption.

A mill owner in buying his grading machine uses market prices of capital and labour. In this case the social profitability of the mill will be lower than the private profitability as far as labour and capital are concerned in that the investment is capital-intensive. Additionally, an estimate of the social value of consumption foregone - somewhat less than the social wage rate - by displacing labour has to be included as a cost of the investment. Technology change in post-harvest operations is often evaluated only with respect to users of a technology who might at a cost increase by five percent or more that part of their income effected by use of the technology. The labour displaced by a technology or the producers of the old technology, for example the weavers making bamboo storage baskets or threshing tubs, are rarely included in the evaluation even if the technology change threatens their whole livelihood. These groups we refer to as secondary target groups.

#### 2.4. Distribution effects

Prior to the installation of the new grading machine broken grains may have been part of the wage of the labour

employed who then sieved and graded and resold the whole grains that came with the brokens when the old machine was used. For those still employed, payment continuing to be made in brokens subsequent to the investment will represent a lower real wage even if the quantity of brokens has not changed. This is a distributive effect removing income from unskilled poor labour and transferring it to an entrepreneur; equitable distribution of incomes is another common objective of public investments so the evaluation must include the worsening of income distribution as a social cost. This is usually achieved by using income weights inversely proportional to income; i.e. the social value of increasing large incomes is less than increasing small incomes by the same amount.

- 2.5. The employment and the distribution effects in this example tend to make the investment less attractive socially because in comparison with the pre-investment situation they reduce employment intensity and increase inequality of income but expand employment of capital. Both effects are primarily concerned with the distribution of purchasing power; as is all too evident now the physical availability of food stocks does not alleviate hunger or malnutrition unless it is distributed which requires purchasing power. Because food grain availability is such a crucial issue it is all too easy to ignore the employment and distribution effects (of purchasing power) and to concentrate on a loss-reduction programme which is technically highly

efficient. The most technically efficient programme, i.e. the one in which a given level of food saving is achieved with the minimum resource allocation, may not be the most socially profitable when distribution and employment effects are considered.

## 2.6. Balance of payments effects

The balance of payment effect is the change in the foreign reserve situation consequent to the investment. Now if the grading machine is imported this is a drain on foreign reserves which is a social cost to the project. A social benefit may occur if the increased availability of food resources reduce imports. Neither of these effects are measured in the private benefit-cost ratio. In fact social cost-benefit analysis does not single out these direct effects either because all inputs and outputs are measured in social accounting prices which are international (or border) prices. However, for an imported grading machine these costs are invariably higher in social terms than market terms because of subsidies and licences with preferential credit terms. Unskilled labour, on the other hand tends to be overvalued at market rates in terms of the consumption effects incurred and measured through international prices. By using international prices as social accounting prices, projects which import less and export more are by definition more preferable than projects which are expensive in foreign exchange. Through minimising direct effects on the balance of payments, by switching from imported

to domestic products, therefore a project will increase its social profitability. At the same time it will also reduce direct demand on scarce foreign exchange which under certain pre-devaluation conditions is also measured in social cost-benefit analysis.

In fact, a narrower balance of payments effect of post-harvest investment is more commonly discussed, namely a move towards self-sufficiency: a goal independent of social cost-benefit analysis in the sense that it cannot be priced. Here we should emphasize that self-sufficiency in food is a recurring theme of priority in public policy that gives a general support to investment programmes in post-harvest loss prevention. The implications of this priority are essentially to be determined politically and with some reservations can be seen as effecting the size of the loss prevention programme rather than its direction.

- 2.7. Policies meeting basic needs, of which food is one, are similarly priority objectives. However, the priority of food as a basic need strengthens the emphasis on issues of distribution and employment, both creating food purchasing power, and makes the requirement of careful socio-economic evaluation yet more pressing.
- 2.8. In summary, the technical efficiency of public investment designed to reduce post-harvest losses measures the financial cost of achieving a certain level of loss-reduction.

This is only one element, and not necessarily the most important, in evaluating the investment; others are the employment effect, the distribution effect and the balance of payments effect. These are integrated in the social cost-benefit ratio and are expressed in social accounting prices which are international (as opposed to domestic) prices.

### 3.1. The Sectoral Issue

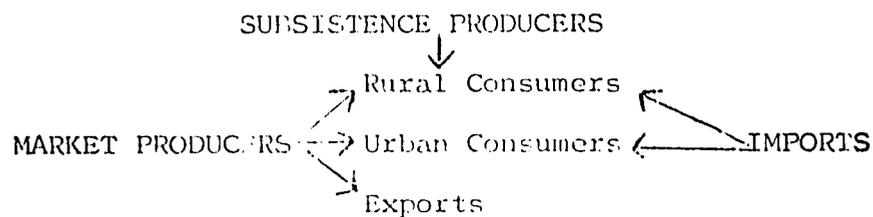
Reducing food losses in the post-harvest sector is a method of increasing food availability that for a variety of reasons, has been comparatively neglected in public resource allocation. There is increasing recognition of the social costs of neglect of this sector especially in unstable food production environments. Opportunities for reducing post-harvest losses exist in export-orientated commercial production units just as they do amongst the poorest farmers. The emphasis in utilising these opportunities clearly must be on dietary staples especially of the poorest.

Like any other public sector programmes, planned post-harvest technology change has to be identified through a careful evaluation of alternatives in order to maximise the social benefits from the resource allocation decision. The effect on food grain losses is only one of the consequences of initiating such a programme.

Improving post-harvest practices to reduce food grain losses through an ill-conceived programme can negate through extra social costs the benefits derived from any reduction in food losses that has been achieved in a loss-reduction programme. A careful evaluation can help avoid this if that evaluation recognises the full social and economic effects of the loss-reduction programme.

3.2. We can characterise the post-harvest sector through six flows depicted below. There are three broad sources of food and three broad types of consumer.

Post-Harvest Food Flows



Each arrow represents an element (a sub-sector) of the post-harvest sector. Whilst the elements are not independent always in physical terms, e.g. a rural miller may obtain custom from subsistence and market

producers, they are independent in programme planning to varying degrees. An emphasis in one sub-sector will have repercussions elsewhere but the implications for the primary and secondary target groups where most of the direct costs and benefits are realised prescribes the type of programme to be adopted, and the style of its administration and execution. The division into sub-sectors facilitates the identification of target groups. The definitions of the sub-sectors presented below are almost self-evident and the purpose here is to establish priorities amongst them for programme planning. In so doing it is important to recognise that the post-harvest sector has often suffered an overall neglect and the emphasis here is within an overall need to upvalue the resource allocation to improving post-harvest operations.

### 3.3. Subsistence producers to rural consumers

This part of the post-harvest sector is concerned with small-scale non-market activities. It can be defined as the rural non-market sub-sector. The rural consumers are the producers themselves, and labour and service employees of the producers paid in kind. The level of capital input is typically very low and even moderately capital-intensive items are custom-operated. This sub-sector is dominated by on-farm operations, threshing, drying and storage especially, of staple food grains. It is invariably the largest sub-sector accounting for 60 - 90 percent of both population and of production.

General reports about food loss levels are without meaning but commonly poor conditions of housing, drainage and sanitation combined with low access to knowledge and material resources, especially capital, create a situation where food loss levels can be very high indeed. However, the ingenuity learnt over generations in maintaining the value of subsistence food stocks between production and consumption mitigates against very high losses; the emphasis on this sub-sector arises for three straightforward reasons.

(a) It is generally by far the largest so there are substantial gains to be made even when losses are relatively low.

(b) The producers/consumers within it are the largest very poor group. Any poverty-focus, whether within the framework of a basic needs strategy, or through weighting of income groups in project evaluation or through broad sectoral or regional priorities, will be realized directly through concentration in this sub-sector.

(c) Opportunities exist for utilising locally available raw material, labour and artisan skills. For example, through using the skills of a village mason to construct a rodent-proof storage bin from stone slabs quarried locally. These are part of a country's resource endowment, material and human, which, whilst often relatively cheap and abundant, are not easily incorporated in programmes above

the village-level. Thus the opportunity cost - or the value of these local resources in alternative investments - is relatively low; moreover, direct social benefits, through generating employment and distributing income amongst poor rural artisans and labour, are realized in addition to food loss reduction for poor consumers. The benefits are also unlikely to be restricted to the non-market consumer as there are important overlaps in some operations, e.g. milling, between this and other sub-sectors.

#### 3.4. Market producers to rural consumers

This part of the post-harvest sector is concerned with large-farmer commercial activities characterised by a profit-earning orientation rather than by food need, the dominant feature of the previous sub-sector described. It can be defined as the rural private market sub-sector. Dominated by staples, the timing and quality of post-harvest operations are determined by price expectations. Unlike the non-market sub-sector where most of the operations are performed by the producer himself, this sub-sector is subject to varying degrees of division in operation. Buying agents, millers (and other processors), wholesalers and retailers all participate. The level of losses may be high compared to the non-market sub-sector because of the additional transport and handling and because the participants in the sub-sector are not usually the actual consumers so quality defects, if hidden, are not

a major concern. The overall scale of operations is relatively small compared to the non-market sub-sector but to a degree it would benefit from programmes aimed at that sub-sector through overlap in operations.

### 3.5. Market producers to urban consumers

This part of the post-harvest sector represents surplus from the overall rural sector and so far as staples are concerned usually represents only 10 - 15 percent of production. Often dominated by public corporation activities in distribution, it can be defined as the home-produced urban sub-sector. Fairly consistently the major allocation of resources in post-harvest research and development are directed towards this sub-sector. This domination is even more marked in actual public resource allocation and to degree this must have been at the expense of the rural non-market sector.

Buffer stocks are held within this sub-sector and their size is one of the key variables determining the level of activity within the sub-sector as a whole. Significantly, loss levels are very closely related with variations in the size of buffer stocks in relation to norms. Stock management capability, in particular concerning temporary, usually seasonal, emergency arrangements to meet demands upon the infrastructure above normal capacity are often more important determinants of loss-levels than the choice of technology question as such.

3.6. Market producers to export

This, the smallest part of the post-harvest sector, defined as the export sub-sector, is included largely for completeness; varying from small to non-existent, the major type of operation is the export of exotic varieties/products that can generate foreign exchange in theory permitting purchase of larger quantities of traditional consumer preferred varieties; in physical terms the operations are generally similar to the home-produced urban sub-sector to the extent that processing occurs though important regional differences may exist. The significance for domestic food grain availability is minimal and there is no relationship between foreign exchange earnings from food exports and food import patterns.

3.7. Imports to urban/rural consumers

These two parts of the post-harvest sector defined as the import sub-sector can dominate in times of shortage, especially for urban food supply. Quality control and handling at ports are potential high loss areas but the central issue with regard to imports is the degree of flexibility within the distribution system. Food imports are highly variable and within an overall goal of self-sufficiency are not central elements in a long-term strategy. Thus the real problem is that organisation of transport and handling facilities to meet imports may

make a whole post-harvest infrastructure redundant in times when imports are no longer necessary. Medium and long-term expectations of the urban supply mix between imports and home-production are high-level policy decisions reflecting fundamental development strategies. It is crucial that the evaluation of short-term but expensive loss-prevention programmes for imports reflects these decisions in developing the distribution infrastructure. The activities of donor agencies concerned with the distribution of Food Aid is sometimes a source of systematic bias of resource allocation in favour of the import sub-sector.

- 3.8. The sectoral breakdown into six sub-sectors provides an approximate conceptual overview and establishes the broad priority of the rural non-market sub-sector. Often however, this priority will inevitably be in conflict with articulated short-term needs. Losses occurring in the import to urban sub-sector and the home-produced to urban sub-sector tend to be overt and to effect vocal political elements; factors which intensify the urgency of preventing losses in these sub-sectors. The rural non-market sub-sector is systematically under-represented because of this emphasis on distribution to the cities and pressure from commercial interests accentuates this urban bias. However, this under-representation can be more accurately described perhaps as an omission in planning rather than as a conscious decision to concentrate on other sub-sectors. This is because in practice the sectoral choice may not be so broad as described since two sub-sectors are of

predominant importance, the rural non-market sub-sector and the home-produced urban sub-sector. In physical terms post-harvest operations especially storage, are separable for these two sub-sectors so there is an apparent question of priorities here in a situation of resource scarcity. Even this allocation decision is constrained in practice because of the common division within the administration into Agriculture and Food. The Agriculture Department is usually restricted to the production aspects of food availability and the Food Department to the marketing of it, particularly to the urban sub-sector which is often the responsibility of a separate specialised public sector undertaking. The rural non-market sub-sector is neglected through this division into production and distribution. It is the Agriculture Department by virtue of its extension service commanding access to the farm-level which ultimately has to recognise responsibility for this sub-sector. In this way village-level loss-prevention programmes compete with the provision of other agricultural inputs for funds, rather than with other post-harvest sub-sectors. Post-harvest programmes within Agriculture Departments have been few and failure to recognize responsibility for this area is common. One of the chief reasons for this is the absence of research to generate appropriate village-level technological innovations.

- 3.9. Research results in post-harvest technologies tend to emphasise the potential benefits from capital-intensive innovations aimed at the marketed proportion of production.