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STAFF SUMMARY REPORT

WORKSHOP ON POSTHARVEST FOOD CONSERVATION

New Delhi, India
December 3-7, 1979

Sponsored by

The Indian National Science Academy
The Republic of India

and

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NATIONAL ACADEMY OF SCIENCES

Washington, D.C.

1981

This is a staff-prepared summary of the Workshop on Postharvest Food Conservation, held in New Delhi, India, December 3-7, 1979, under joint sponsorship of the Indian National Science Academy and the National Academy of Sciences-National Research Council (NAS-NRC) of the United States. Participation by the NAS-NRC was made possible through funds provided by the Office of Science and Technology, Bureau for Development Support, Agency for International Development (AID), under contract AID/ta-c-1433.

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I. INTRODUCTION

For more than a decade, the Board on Science and Technology for International Development (BOSTID) has maintained ties with India's scientific and technological community through a series of activities carried out in cooperation with the Indian National Science Academy (INSA). The first workshop, held in 1970, was "Management and Organization of Industrial Research," and its principal objective was to identify ways to improve management of applied research laboratories. The second workshop, "Water in Man's Life in India," held in 1971, considered the interrelationship of water resources and environmental factors.

For several years thereafter, BOSTID maintained contact with INSA but no projects were carried out. In early 1979, BOSTID staff met with INSA and USAID/New Delhi and agreed to undertake the first in a possible ongoing series of collaborative activities. INSA expressed interest in the following subjects: (1) postharvest food losses; (2) underexploited plants; (3) reforestation, with emphasis on firewood production; and (4) alternative energy sources.

Because BOSTID had already explored the growing problem of postharvest food losses in developing nations, INSA decided, with the concurrence of the Ministry of Agriculture and Irrigation, that the first activity would be a workshop on postharvest food conservation. BOSTID's study, Postharvest Food Losses in Developing Countries, had highlighted the need for conserving food and had suggested a number of general approaches for reducing food losses. Further, since the food industry is the single largest industry in the United States, INSA felt that sharing U.S. expertise on this subject through a workshop would be useful.

INSA and the Ministry offered to host the workshop, and established a steering committee to plan and organize it. In July 1979, BOSTID staff met with this committee and both agreed that the broad objective of the workshop was to review the food situation in India and make recommendations for reducing postharvest losses, with emphasis on increased utilization of foods and agricultural by-products. It was also agreed that the workshop would focus on postharvest conservation technologies in three food categories: food grains, roots and tubers, and fruits and vegetables.

Other workshop objectives included:

1. Encouraging Indo-U.S. consultation on postharvest food loss problems

2. Reviewing government programs (actual and proposed) aimed at reducing postharvest food losses
3. Recommending technologies and policies for increasing the utilization of foods through improved harvesting, transportation, storage, processing, and marketing programs
4. Recommending research and development activities aimed at reducing postharvest food losses
5. Assisting the Government of India in strengthening its planning and management capacity to deal with food loss problems

II. RECOMMENDATIONS AND CONCLUSIONS

The recommendations and conclusions that emerged from the three working groups--food grains, roots and tubers, and fruits and vegetables--are listed below. Since each group made a number of similar recommendations, these are listed first as "General Program Recommendations."

General Program Recommendations

1. Establish an interministerial Commission on Postharvest Food Conservation. The Commission should be an integral part of the government and could be organized according to different ecological zones, food commodities, or other appropriate groups. The tasks of the Commission might include:

- -- Identifying and monitoring different types of losses in order to assess their economic impacts
- -- Reviewing taxation policies on processed foods
- -- Arranging technical collaboration with NAS, Tropical Products Institute, and other organizations dealing with food conservation
- -- Monitoring research, teaching, and extension programs dealing with food conservation
- -- Establishing study groups to review the results of the workshop and other postharvest food conservation programs

Major projects for initial consideration are:

- -- Develop education and extension programs to meet the government's goals in postharvest technologies
- -- Integrate pest management practices in both pre- and postharvest programs
- -- Develop and implement benefit-cost analyses of food conservation programs, especially for the processed food industry

-- Study the use of crop residues and forest products for animal feeds
-- Integrate village-level storage and transportation programs
-- Develop new processed foods using surplus products, oil extraction, and by-products, especially for infant foods

2. Establish extension programs that will transfer appropriate conservation technologies to food handlers. Considerable expertise and research results are available on postharvest conservation technologies in India, and in most cases these technologies are available to solve many of the problems facing the individual farmer and villager. For that reason, an extension project of national magnitude that utilizes existing extension programs is needed to translate the available information into action. Both men and women must be involved in developing and carrying out such an extension project. Demonstration projects can play an important role in training programs for this purpose.

It is recommended that postharvest action programs be developed to cover all agricultural and fish products. Activities similar to the current "Action Programme to Reduce the Farm Storage Losses in India" should receive serious consideration.

3. Facilitate exchanges between and among trade associations and scientific institutions. Closer cooperation between Indian and U.S. scientific institutions, industry, and trade organizations is necessary to provide the latest proven technologies for efficient, economical production and marketing of fresh and processed products. Furthermore, trade associations play an important role in U.S. extension activities, and the Indian food industry should be encouraged to do the same in its country.

4. Develop education programs that stress conservation practices within secondary schools and universities. There is an urgent need to introduce postharvest food conservation at the bachelor's degree level in the agricultural universities and institutes, either as an elective course or as an important segment of existing courses. Conservation concepts (food, water, energy, etc.) should also be introduced throughout the educational system.

5. Promote the use of processed foods. Present policies inhibit the development of food preservation by excessively taxing and regulating processed food items. Increased employment in the food industry and a reduction of food losses due to spoilage, etc. could result.

6. Augment research on postharvest technologies, especially those dealing with postharvest physiology of perishables. Some existing laboratories addressing these technologies need more equipment and

staff. These laboratories can also serve as training facilities for people dealing with postharvest conservation.

Widespread drought affected food production in India in the 1979-1980 crop year. The workshop considered the three-pronged strategy developed by the Government of India for managing the adverse impact of widespread drought. Its three components are: (1) insulating the human population in the drought-affected areas from hunger through "Food for Work" and "Food for Nutrition" programs, and making arrangements for the supply of potable drinking water; (2) promoting maximum crop production in areas with adequate soil moisture or irrigation facilities; and (3) conserving and effectively utilizing all agricultural and animal products. Participants in this workshop wish to stress the need for greater postharvest food conservation in the context of widespread drought by including the following specific recommendations on this subject:

1. Mobilize existing extension services for launching a nationwide food conservation movement.

Currently, a number of extension programs such as "Save Grain Campaign," "Training and Visit," "Rodent Control," etc., operate throughout the country. Within these programs, added emphasis should be placed on the dissemination of postharvest conservation technologies. Agricultural universities, home science colleges, and the Gram Sevak and the Gram Sevika Training Centers should play leading roles. The Indian Council of Agricultural Research (ICAR), the Department of Food, and the Extension Directorate of the Department of Agriculture and Cooperation should draw up a strategy for these institutions.

2. Harness the potential of the National Service Scheme (NSS) and the National Adult Education Program (NAEP) for promoting an intensive food conservation movement.

The University Grants Commission (UGC) should immediately convene a meeting of appropriate representatives of the Ministry of Education, ICAR, Council of Scientific and Industrial Research (CSIR), Department of Food, Department of Agriculture and Cooperation, Ministry of Rural Reconstruction, and selected vice-chancellors and leaders of the NSS and NAEP programs in order to develop an action plan. The enormous human resources available within the NSS and NAEP programs could be an invaluable asset in the food conservation movement if volunteers and teachers receive the proper training. The message conveyed--mainly to rural women--should be simple and in keeping with the socioeconomic and sociocultural milieu of the villages. The Ministry of Rural Reconstruction should include this program under the Integrated Rural Development Project.

Audio-visual aids and extension literature in the local languages are needed for extension workers, NSS volunteers, and NAEP teachers,and such aids and literature will likely have to be produced by the Human Science Colleges in their respective areas. The ICAR and the Directorate of Extension in the Ministry of Agriculture and Irrigation should take the necessary steps in cooperation with the Department of Food and CSIR.

The workshop suggested that a task force composed of Dr. P.K. Kymal, chairman; Dr. K. Krishnamurthy; and Dr. J.C. Anand prepare a draft action plan for the UGC.

Working Group on Food Grains

India currently produces about 80 million tons of paddy, 35 million tons of wheat, 20 million tons of coarse grains, and 11 million tons of pulses valued at Rs14,000 crores* (US$18.5 billion). Some data on quantitative losses are available, but data on qualitative losses are generally not. The monetary value of quantitative losses has been estimated at Rs2,000 crores (US$2.6 billion).

There is, therefore, an urgent need for a comprehensive assessment of qualitative food losses. The problems of depletion of energy and nutritive values during storage, processing, handling, and transportation have not been thoroughly studied. The toxic and deleterious effects of the consumption of damaged grains by man and animals have not yet been fully recognized.

Rice is the most important food industry in India, and is valued at over Rs6,000 crores (US$7.9 billion). A systematic modernization program, introduced in 1965 with technical assistance from the Ford Foundation, USAID, and Louisiana State University, has spearheaded a movement for modernizing postharvest handling and processing of rice. The purposes of this program--which includes precleaning, mechanical drying, rubber roll shelling, improved parboiling, improved storage, and other components of modern technology--are to derive a higher milling recovery of rice, a superior quality of milled products, and cleaner by-products of greater monetary value. Modern equipment is now manufactured in India; training programs have been initiated for mill engineers, managers, and operators; and research, development, and extension programs have been promoted. As a result, 4,000 mills have been modernized, a rice bran oil industry has developed, and rice husks are being utilized as an energy source.

* 1 Rs = $0.13, and 1 crore = 10 million.

About 4-5 million tons of wheat are processed in 200 roller flour mills to yield maida (flour), semolina, atta, and bran. The balance is converted into whole meal atta in small stone or burr mills and consumed in traditional preparations. The equipment used in these small units needs modernization.

Coarse grains are largely processed by hand in the home or by small community grinding units. Pulses are traditionally processed dry or wet using simple equipment. Some technological advances have been made and more modern equipment has been developed by India's research institutions. However, it was noted during the workshop that even more improved equipment and processes are needed.

After considering papers presented by participants on these issues, the working group arrived at the following conclusions and recommendations:

Rice

1. Indian industry should be encouraged to manufacture and promote the development of improved drying equipment. Drying at both the farm level and mills is one of the most important postharvest operations. Research institutions in India have developed a wide range of equipment and instruments, which should be tested for performance efficiency.

2. The mini rice mills of different designs that have been developed should be evaluated. The milling manufacturing industry should be encouraged to replace inefficient hullers in order to obtain higher yields and better utilization of bran and husk.

3. Further studies on standardization of parboiling processes and equipment should be undertaken, as significant advancements have occurred in these technologies.

4. Because rice husks may meet the energy requirements of parboiling systems if the technology is properly harnessed, there is a need to identify and promote more efficient systems. Husks can also be used as an insulating material in cold storage facilities, and in the production of cement, silica, and refractory materials. However, further studies should be initiated.

5. Currently, rice bran oil is obtained through solvent extraction in comparatively large and expensive plants. Efficient small-scale plants need to be developed.

6. The opportunities available for breeding rice varieties that have better milling qualities, higher oil content, lower silica

content, and low shattering characteristics should be pursued jointly by Indian breeders, scientists, technologists, and engineers.

Wheat

1. Existing burr mills (chakkis) must be modernized to improve product quality, efficiency, and economics.

2. Presently, the unloading, cleaning, quality determination, pricing, bagging, weighing, and stitching operations in the grain markets are inefficient and time consuming, creating bottlenecks in marketing operations. Phased mechanization of the grain handling system, suitable for different markets, must be developed.

Storage

1. A national program should be formulated and implemented to promote improved grain conservation practices and to provide the necessary incentives for rural communities to adopt the new conservation technologies. Indians have considerable experience at both the farm level and commercial level in grain storage. Government field extension units are popularizing the use of bins; small storage structures; insect, rodent, and pest control; and other improved conservation practices. However, there is still the need to train farmers, village technicians, and rural women in grain protection. The recommended program should cover grain cleaning and drying and the development of technologies suitable for rural areas. Commercial storage designs must also be improved and made suitable for bulk and bag storage. Designs should also include forced aeration, natural ventilation, and mechanical handling systems.

General

1. Concerted efforts must be made toward gathering reliable data on postharvest food losses. Generally, such efforts will involve surveys, collection of information, evaluation of techniques under field conditions, pilot projects, commercial trials, development of equipment, and training of personnel. The state and central governments should formulate appropriate action programs that include the scientific communities, rural women, farmers, and village-level workers. These programs should be integrated into India's national development plans.

2. Regional postharvest technology research and development extension units should be established, with at least one in each of

India's eight agro-climatic zones to develop technologies suitable to the different crops and crop varieties grown in these areas.

3. A system of testing and certifying newly developed equipment, machinery, and processes should be established in recognized national and regional institutions to ensure that industry and users adopt efficient equipment and processes.

4. The knowledge and experience gained in India and elsewhere in postharvest conservation of food should be documented and published for the benefit of users in India and in other countries facing similar problems. Some of the areas that have been identified include rice milling, husk utilization with emphasis on energy systems, rice bran oil, parboiling, grain drying, farm-level storage, and commercial storage and warehousing.

5. Grain harvesting produces enormous quantities of straw that can be used as an animal feed following heat treatment or enrichment with molasses, urea, and other ingredients. Studies have already produced encouraging results, but further research is needed.

Indo-U.S. Collaboration

Vast opportunities for Indo-U.S. collaboration exist in such areas as:

- -- Equipment design for extraction of bran oil
- -- Quality control equipment
- -- Small wheat grinding mills and bakery equipment
- -- Small dryers
- -- Demonstration and training aids for extension workers
- -- Monographs on technological and engineering developments in postharvest food conservation
- -- Utilization of forest products and agricultural wastes for feed
- -- Testing and standardization of equipment and processes
- -- Exchange of biological, chemical, and engineering pest technology for food grain and seeds
- -- Exchange of technology on bulk storage of grain
- -- Product development in coarse grains to make low-cost processed and blended foods, particularly for children

Follow-up

Both INSA and the NAS-NRC may initiate follow-up actions to the workshop to brief their respective governments and promote further collaboration. Collaborative projects involving U.S. and Indian consultants and institutions should be encouraged.

Working Group on Roots and Tubers

The problems of handling root and tuber crops from harvest to consumption under India's tropical and subtropical conditions were presented in two papers by Dr. Mukhtiar Singh and Dr. N. Hrishi. Professor Walter C. Sparks made a presentation on the evolution of storage and postharvest handling methods practiced in the United States.

Because of their wide acceptance, nutritive value, and high production potential, potato, cassava, and sweet potato were given the highest priority for postharvest programs. On the basis of group discussions at the workshop, the following recommendations were made. These recommendations are listed in chronological order from harvest to utilization.

1. The injuries to and losses of root and tuber crops currently occurring in India must be minimized. Efforts should be made to design, develop, and improve the machines and implements used in harvesting, handling, and grading roots and tubers. A great deal of the necessary expertise and technology is presently available in India, and every effort should be made to expedite the implementation of this recommendation.

2. There is an immediate need to develop, implement, and popularize suitable on-farm, low-cost storage facilities. Proper storage at the farm level is currently almost nonexistent; however, most of the technology needed to accomplish this objective is presently available in the country. In addition, cold storage facilities should be augmented.

3. It is suggested that the number of handling operations be reduced, which should result in a considerable reduction of losses. A study should be initiated on bulk storage procedures following the initial field sorting. Local women should also be trained to help implement this program.

4. It is essential that appropriate grading systems be developed and adopted according to the local needs. Two types of grading systems should be considered: (1) portable grading machines that can be transported from farm to farm; and (2) centralized grading facilities, preferably in cooperatives, to serve groups of farmers in producing areas. Local women should also be trained to help implement these operations.

5. There is an urgent need to develop adequate and efficient transportation systems that are consistent with the needs of the perishable and semi-perishable root and tuber crops. Presently, the transportation system is both inadequate and inefficient.

Consequently, the efficiency of handling, packaging, marketing, and utilizing commodities is impaired.

6. Improved marketing systems should be implemented as soon as possible. A considerable amount of produce does not enter the marketing channels in a desirable form. Thus it is recommended that produce be inspected more closely before it is transported to the terminal market.

7. Various modes of processing and utilization should be considered to increase consumption of roots and tubers. Processing at both the farm and commercial level should be examined closely. The portion not presently used directly for human consumption should be processed to make it usable. This does not limit the growing of these crops for only direct human consumption, but suggests that some roots and tubers may be grown solely for processing. The by-products from the processing industry could be used as valuable materials for livestock feed and other industries.

8. In view of the problems of seasonal production fluctuations and periodic gluts, resulting in wide price variations, an appropriate strategy is necessary to maintain the tempo of development of these crops through a multi-pronged approach that includes organized storage, processing, transportation, and support price incentives.

Working Group on Fruits and Vegetables

Fruits and vegetables have always provided variety, color, and vitamins in the Indian diet. Until now, the postharvest problems of India's fruits and vegetables have not been examined because the more urgent problems of adequate cereal crop production were being addressed. As long as immediate consumption by subsistence farmers was the rule, there was little need to consider postharvest losses in transportation and marketing. But now that subsistence consumption has been complemented by marketing in urban areas, losses are incurred and usually average 30 percent, or more than Rs1,100 crores (US$1.5 billion). The major challenges are to minimize losses and extend shelf life so that, with increasing production and processing, fruits and vegetables can become available to all segments of society.

1. Persons involved in harvesting and handling fruits and vegetables should be taught the proper procedures to minimize losses; otherwise, subsequent care of fruits and vegetables is of little value.

2. Extension workers should acquaint growers and consumers with the nutritional properties of fruits and vegetables. Alternative uses and preparations should also be taught, bearing in mind that an adequate supply of fruits and vegetables also reduces the demand for food grains.

3. Extension services should develop a program that will demonstrate the value of proper handling and processing of fruits and vegetables. Small-scale processing centers in villages should be established for local producers. Since extension programs have been directed traditionally toward production practices, extension programs with new slants are essential.

4. Fruit and vegetable community cooperatives and other organizations should be expanded and strengthened. A demonstration center with the following functions should be set up in each production area:

-- Procuring packages and other supplies
-- Accumulating fruits and vegetables from small growers
-- Packaging fruits and vegetables and eventually moving into provision of fungicides, grading, sizing, etc.
-- Selling fruit and vegetables
-- In time, providing appropriate storage using every possible energy-saving device (evaporative cooling, night air intake, underground storage, etc.)
-- Utilizing damaged, blemished, or inedible parts of fruits and vegetables to produce by-products, i.e., pectin, animal feed, and energy

Small producers are not in a position to buy packaging supplies economically or to sell small quantities of produce advantageously. Their best hope for a sound business operation lies in cooperation.

5. For both processed and fresh products, suitable, economical containers must be developed that make minimal use of wood. Such containers should be rigid enough to protect fresh fruit from damage and processed products from corrosion, damage, and contamination. Currently, fresh fruit containers are made of wood, which is in increasingly short supply. Containers for processed products depend largely on imported tin plate or petroleum products such as polypropylene.

Processed foods must no longer be regarded as luxury products, although current taxation policies tend to keep prices high. Government policies should encourage development and manufacture of any type of container for all types of produce. Over 50 percent of the processed food produced in India enters the export market and, since container costs continue to increase, alternative technologies that are more efficient and less costly must be explored. Only then can the essential nutrients in fruits and vegetables be made available to low-income consumers.

6. Both road and rail facilities for moving produce from rural to urban areas and between rural marketing areas must be improved. Unlike other aspects of fruit and vegetable marketing, this must depend largely on an infrastructure regulated, and perhaps subsidized, by the government.

It is not likely that grower cooperatives will be able to acquire their own fleets of suitable highway trucks or railway vans in the foreseeable future. The government will have to use its regulatory, and perhaps financial, powers to see that adequate transportation is available for distribution of fruits and vegetables.

7. A study must be instituted to determine the most efficient means of distributing processed and fresh products from cooperatives to wholesale, retail, military, and export channels. Hauling vast amounts of produce into a few entrepôts (of which Delhi is the largest) wastes energy and results in enormous losses.

8. To meet the advanced technical requirements of the processing industry engaged in production for the export market and institutional requirements, the latest technical know-how--that is, aseptic processing, retortable pouches, bulk storage and transportation, etc.--should be obtained.

III. OBSERVATIONS AND COMMENTS

The formal and informal meetings held at this workshop provided an excellent atmosphere for a free exchange of information, ideas, possible areas of research, and general problem solving in the field of postharvest food losses.

Overall attendance at each formal session was 50-60 people. Most working groups included 8-10 people, but the working group on fruits and vegetables involved about 20, which was generally recognized as too many. Nevertheless, there was an open, lively, and useful discussion within that working group as well as within the others.

The failure of the monsoon earlier in the year served to highlight the need for greater postharvest conservation measures. Currently, India has a grain storage problem with more than 18 million metric tons of wheat and rice. The drought will reduce the reserves by about 10 million metric tons. While there are adequate stocks, the memory of the recent past grain deficits looms over the country. Therefore, the government is focusing on greater conservation, and the workshop added to these efforts. In fact, one of the workshop recommendations calls for an ad hoc committee to draft proposals, based on the workshop recommendations, to the Indian government. Dr. M.S. Swaminathan, Secretary to the Government, Agriculture, said that he will make

certain the report is reviewed and, where necessary, acted upon by appropriate departments.

The workshop brought together a wide range of U.S. and Indian officials concerned with postharvest technologies and revealed the need for greater cooperation and coordination. It is anticipated that the workshop will increase the Government of India's commitment to programs for reducing postharvest food losses.

IV. AGENDA, PARTICIPANTS, AND WORKING GROUPS

The workshop was held December 3-7, 1979, at the Indian National Science Academy, New Delhi, India.

The first day was devoted to a review of background papers prepared by Indian specialists at the request of the workshop steering committee. On the second day, three working groups--food grains, roots and tubers, and fruits and vegetables--met to identify specific problems within their areas of concern. On the third day, the participants divided into two groups to visit the Indian Agricultural Research Institute in New Delhi and the Grain Storage Institute in Hapur, U.P. Each NAS panelist gave a lecture/slide show at the institutes, observed the facilities and food conservation programs, and met with researchers and graduate students.

On the fourth day, the working groups met again and prepared reports that were presented at a plenary session on the final day. Following the formal workshop meetings, some participants traveled to the National Dairy Research Institute at Karnal, U.P., the Punjab Agricultural University, Ludhiana, the Delhi Wholesale Fruit and Vegetable Market, and a fruit processing plant. Additional activities during the workshop included evening lectures, movies, a cultural program arranged for NAS participants, and discussions among representatives of industrial firms dealing with food processing and pest control.

A detailed workshop agenda follows.

Agenda

Monday, December 3

Registration

Inauguration

Presentation of papers and discussions

Tuesday, December 4

Meetings of working groups

Reception by INSA

Cultural program

Wednesday, December 5

Visits to the Indian Agricultural Research Institute and the Grain Storage Institute

Lecture by Dr. S. Varadarajan, Chairman, Indian Petrochemicals Corporation, Ltd.

Dinner hosted by Pest Control (India), Pvt. Ltd.

Thursday, December 6

Meetings of working groups

Plenary session: discussion of working group reports

Lecture by Dr K.G.K. Menon, Director, Hindustan Lever, Ltd.

Friday, December 7

Plenary session: presentation and review of reports

Concluding session: adoption of reports and general recommendations

Saturday and Sunday, December 8-9

Visits to Delhi Wholesale Fruit and Vegetable Market, Fruit Processing Plant, National Dairy Research Institute, Punjab Agricultural University

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Roots and Tubers

K. Kirpal Singh (Co-Chairman)
W.C. Sparks (Co-Chairman)
N. Hrishi (Rapporteur)
E.S. Ayensu
S.S. Chandan
Mukhtiar Singh

Fruits and Vegetables

Kailash Nath (Co-Chairman)
Philip E. Nelson (Co-Chairman)
J.C. Anand (Rapporteur)
Robert P. Bates
B.S. Bhatia
M. Bhatia
A.N. Bose
K.K.S. Chanhan
Rajammal P. Devadas
William Grierson
H.C. Lal
S.R. Mudambi
Harbans Singh
J.R. Solanky