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CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH

TECHNICAL ADVISORY COMMITTEE

Ninth Meeting, Rome, 3-7 February, 1975

RESEARCH ON POST-HARVEST TECHNOLOGY

(Agenda Item 11)

TAC SECRETARIAT

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

ROME 1974

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POST-HARVEST FOOD GRAIN SYSTEMS

BACKGROUND

This paper, together with its appendices, is addressed to the Technical Advisory Committee and, if the TAC so decides, to the members of the Consultative Group on International Agricultural Research. It was written following a suggestion by, and subsequent discussion during the 1973 CGIAR meeting in Washington, with Sir John Crawford, the Chairman of TAC.

The paper will argue that more serious attention and material support be given to improving post-harvest grain systems, and will recommend certain courses of action for consideration by TAC and the CGIAR.

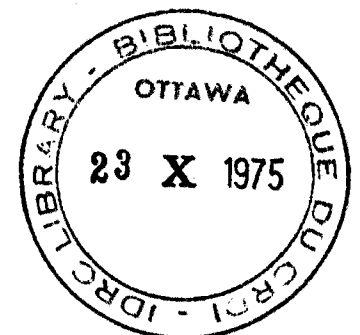
There are three appendices:

- A. report of a study on Post-Harvest Rice Technology in four countries of Southeast Asia written by Dr. Dante de Padua of the University of the Philippines, Los Banos;
- B. the report of a mission from the University of Alberta which studied the Post-Harvest Food Grains Industry in several semi-arid areas of Africa;
- C. the report and recommendations of a Rice Processing Advisory Group which met at IRRI.

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Financial support for each of these three activities was provided by the International Development Research Centre.

Only two crop producing regions are covered by this report but it is recognized that greater attention to post-harvest difficulties is necessary in many other areas of the less developed world. It is hoped that if and when created, ICARDA will give adequate concern to post-harvest research either within its core program or through encouragement to existing research institutions in the region it will serve.



It is probable that a working group on post-harvest research in Latin America will meet in the region during the summer of 1975.

THE PROBLEM

The overriding preoccupation of the international agricultural research centres (IARCs) is to create improved food crop varieties and to implant these varieties in farmers' fields. An equally important, yet largely ignored problem for the whole international agricultural community is how to protect and transport more efficiently food crops from the point of harvest to the needy consumers; how to convey food crops surplus to the farmers' own needs from the regions and seasons of abundance to those of scarcity.

It is to the post-harvest problems as they relate to subsistence grains¹ that this paper is addressed. "Post-harvest"² refers to the system of activities which occur from the place and time of harvest until the edible portion of a crop reaches the point of consumption.

¹It is recognized that tropical root crops, fruits and vegetables, fish and animal products, also suffer from inadequate post-harvest research. Since the TAC and the CG have assigned highest priority to cereal grains and food legumes, these crops are exclusively the subject of this report.

²Perhaps "post-production" would be more accurate than "post-harvest" since the techniques of harvesting are themselves a critical component of the system. However, since it is the term most accepted, "post-harvest" will be used in preference to "post-production" throughout this text.

Many scientists, technologists and others have examined various individual components of existing or imagined post-harvest systems. Entomologists have studied insect control; engineers - storage structures and crop drying; food technologists - transformation processes; economists - pricing and marketing; nutritionists - general estimates (e.g. food balance sheets) of food grain availability. The findings reported in Appendices A and B and in the published literature strongly suggest that, for the most part, post-harvest research has concentrated upon components of rather than upon the whole post-harvest system. The research has tended to be widely fragmented rather than integrated.

Communication and cooperation could have been better among different scientists studying the same component of a post-harvest system in the same or similar geographic regions. To some extent this is the result of inadequate cooperation among multilateral and bilateral agencies who have sponsored post-harvest projects. In one African country the mission encountered three grain storage techniques each significantly different in principle and design, being promoted by three different agencies to essentially the same subsistence grain farmers. Such competitive diversity is more likely to confuse than to enlighten the intended beneficiaries.

It is appreciated that any single technical problem may be solved in more ways than one, and that different solutions may satisfy different circumstances. The mission reported more than 100 different small farm grain storage designs in use in East Africa. Hence, before proposing

one or more new techniques it would seem logical to compare, technically and economically, the new alternatives with what is already in use to determine which is best suited to the post-harvest system which exists or is planned.

The development of new storage, drying and processing techniques should not be undertaken without a prior investigation of the total system. The de Padua report refers to rice milling technologies unsuited in scale, versatility, labor demand and cost of operation to the system into which they were placed. It refers to drying mechanisms ill-designed and located too far from the point of harvest. A number of innovations proposed for or introduced into post-harvest rice systems reveal an innocence of the difficulties of threshing, storing and milling high moisture rice crops harvested during rainy seasons. Rice harvested with a moisture content in excess of 25% deteriorates rapidly and may be completely spoiled if the nearest dryer is located at a rice mill several days journey from the point of harvest.

The reports from Africa and Asia testify to the inadequate concern given to the economics and logistics of post-harvest systems, and to the climatic, social and political environment in which the systems must function.

The de Padua report specifies post-harvest difficulties resulting from the replacement of traditional varieties with new high yielding and early maturing rice varieties. It refers also to the difficulty of adapting imported milling machines designed to process well-graded rice of uniform grain size, to the widely heterogeneous mixtures of different rice varieties which are delivered to many small Asian rice mills.

Additional post-harvest problems may be anticipated if and when more productive multiple cropping systems are adopted by Asian and African farmers. In fact, the extent to which technologically superior production technologies are adopted by farmers will be largely influenced by the worthiness of the coexistent post-harvest system.

The African mission report lays stress upon the interdependence of pre- and post-harvest systems and the influence of each upon the other. In essence, it asserts that subsistence farming will continue as the dominant pattern of agricultural life in semi-arid tropical Africa until post-harvest systems come into being which encourage farmers to produce food grains surplus to their personal needs. It was the concensus of those interviewed by the mission that farmers in the Sahel could have grown more sorghum and millet during the recent years of drought. The Sahelian subsistence farmers were discouraged from growing more grain by the absence of an organized post-harvest system including markets in which the farmers could have confidence.

The present average yields of food grains in semi-arid tropical Africa are of the order of half-a-ton per hectare. ICRISAT's scientists offer promise of technologies which will yield ten times or more the present average. It can be predicted that in much of Africa, ICRISAT's ingenuity will be utterly frustrated unless it is matched by an equally imaginative investment in appropriate post-harvest systems, systems which provide the mechanisms and offer the incentives necessary to enable farmers to deliver food crops to a profitable market.

Both the de Padua and African mission reports emphasize the dependence of the grain production system upon the marketing component of the post-harvest system. Markets exist to serve customers and consumers as well as producers. It appears that more sympathetic attention could profitably be given to the needs and demands of consumers since they are the end point of every post-harvest system.

In part, many of the frustrations of the past result from an oversimplified concept of the transfer of technology. Various agencies and advisers have sought to translocate post-harvest technologies of drying, storage, preservation, processing, etc. between environments widely dissimilar in climate, and with diverse economic, technical and human resources. Coincident with this ill-conceived attitude to the "transfer of technology" one finds remnants of the philosophy that "research precedes extension by two years". This has led to machines, devices and techniques being elaborated in research institutions far distant physically, philosophically and intellectually from the farmers and other peoples of the LDCs they propose to serve, presumably in the expectation that local extension services will adapt all to work satisfactorily.

Several of the IARCs have demonstrated the benefits of planning and pursuing their production research objectives in close cooperation with the farmers whom the results are intended to benefit. A parallel approach to post-harvest research appears eminently desirable. Most farmers have gained centuries of collective experience and their opinion is worth seeking before any research project is formulated.

More effective communication and cooperation between agricultural production technologists and post-harvest technologists was urged by a recent meeting of Asian scientists sponsored by the International Union of Food Science and Technology (IUFoST). It cannot be too greatly emphasized that post-harvest research be closely associated with pre-harvest production research, since the two are entirely interdependent.

One could overburden this text with countless examples of technological efforts wasted because the relevant post-harvest system was neither defined nor understood. It is not the purpose of this paper to point the finger of blame but rather to encourage the community of international development agencies and governments of the LDCs they seek to serve, to take a serious look at post-harvest problems and to create mechanisms which can significantly strengthen existing systems and design and implement more reliable post-harvest grain systems wherever they are needed.

This document is addressed to the TAC. It might also be referred to the governments of many LDCs. The appended reports draw attention to developing countries in which comparatively efficient post-harvest systems exist for export crops while the food crops for their indigenous peoples are almost totally ignored. Many LDCs rely heavily upon imported cereal grains, which in large part are processed to feed expanding urban populations. If they are to reduce their dependence upon foreign grain supplies, LDC governments must assign higher priorities both to increased grain production and to effective post-harvest grain systems.

One somewhat delicate matter which concerns the governments of the LDCs deserves brief comment. A number of Asian and African nations have established research institutions whose mandate includes some components of the post-harvest system. Unfortunately, in common with similar institutions in developed countries, they do not all address themselves to the urgent practical post-harvest problems with which their farmers, small processing factories and distribution channels are confronted. Rather, some appear to opt for research which appears more scientifically ingenious than pragmatically useful. This point is made not as a scornful criticism, but because it has relevance to facilities which exist in the LDCs but which are inadequately used for urgent, relevant post-harvest technology research and training.

The meeting of Asian agricultural and food research scientists which stated the need for a closer cooperation between agricultural production research and post-harvest research, also drew attention to the need for better regional communication and information systems. Scientists in the LDCs are often better informed on scientific progress in North America and Europe than on what has been achieved in neighbouring countries. Information and training services are as important as research and development in programs which seek to improve post-harvest systems.

THE BENEFITS OF EFFICIENT POST-HARVEST SYSTEMS

An inefficient post-harvest system is a deterrent to food grain production; an unreliable or quixotic post-harvest system confronts the grain farmer with a greater risk than he can contemplate. Conversely an orderly post-harvest system creates the climate of confidence essential if subsistence grain farmers are to be persuaded to produce grains in excess of their subsistence needs.

Each of the three appended reports presents estimates of post-harvest losses. It is recognized that these figures are approximations. Nevertheless, the most conservative estimates suggest annual post-harvest grain losses of the order of millions of tons. Whether viewed in economic terms or in terms of human nutrition in the LDCs, such losses are intolerable. Consequently, the principal gain from more efficient post-harvest systems would be a substantial increase in the food grains available in the LDCs. In turn, this should serve to improve nutritional well-being, reduce outflow of foreign currency and result in general economic benefit. Post-harvest systems, rationally conceived and administered, promote consistency of supply, and discourage cycles of regional and seasonal surpluses and deficiencies with their resultant pendulistic price fluctuations. They permit a more uniform and economic distribution and utilization of food grains.

It is submitted that these potential benefits justify a considerably increased investment in post-harvest research, development, information and training.

In developed countries where less than 10 percent of the population are farmers, many millions are employed in the component activities of the post-harvest system. An orderly post-harvest system offers many opportunities for increased rural and rural-urban employment: employment in harvesting, grading, storing, transportation, processing and marketing the grains; employment in constructing the facilities and distributing the machines necessary to the various post-harvest activities. It is urged that, in future, more attention be given to designing post-harvest machines and devices which can be built in the LDCs using local materials and labour, and to identifying the means by which to encourage such indigenous manufacture.

Appropriate post-harvest processing technologies reduce spoilage, and enhance the acceptability, utility and nutritional quality of food grains. Urban populations in the LDCs display an increasing demand for processed foods. The demand for North American and European types of bread is increasing in Africa in almost perfect correlation with increase in urban population. Much of this bread is made from imported wheat. Cereal-based weaning and infant foods are also imported in substantial quantities by many LDCs. There is ample evidence to suggest that technologies can be developed to permit significant proportions of indigenous sorghum, millet, maize and tropical legumes to be used in place of the imported cereals. These technologies, if commercialized, would provide employment opportunities and, perhaps more important, a comparatively stable and consistent year round demand for locally produced food grains. Thus, they would constitute an incentive to increased food grain production.

The missions' reports suggest the potential advantages of dispersing a number of versatile, labour-intensive grain processing units among rural communities in preference to one or two large, centralized, comparatively inflexible, capital-intensive grain mills.

SUMMARY AND RECOMMENDATIONS

In both Asia and the semi-arid tropics of Africa, the need is urgent for increased research, development, information facilities and training in post-harvest food grain systems.

It is not recommended, however, that any new research institutions be created. Rather, it is recommended that existing international, regional and national facilities for post-harvest research, training and information be considerably strengthened, that their individual efforts be more effectively coordinated, and that adequate mechanisms for technical guidance, cooperation and exchange of information be created.

International action is necessary to help governments in LDCs to a better understanding of what steps are necessary to create efficient post-harvest systems. Individual components of such systems, including crop drying, storage, processing, transportation, and marketing can each benefit from imaginative applied research. But unless the relevance of each component, relative to the total system, is understood, imagined improvements in component technologies may prove more detrimental than beneficial to the system as a whole.

It is recommended that more attention be given to the economic, human and social factors within each post-harvest system, particularly as they relate to the attitudes and demands of the consumers to whom the post-harvest system is ultimately directed.

It is recommended that more of the applied research in post-harvest systems, and the components of these systems, be undertaken under real-life rural conditions, rather than within laboratories. Where laboratory or experimental station research is necessary, it is recommended that the problem be defined in consultation with, and the proposed solution tested by, the relevant farmers, processors and consumers.

Where the result of a research project is a new or modified machine, following apparently successful prototype development and testing, it is recommended that the project be pursued to the point of determining the feasibility of manufacture in the country or region of proposed use. Feasibility studies should take account of engineering, economic and marketing factors, and the means by which local manufacture and distribution would be encouraged.

SPECIFIC PROPOSALS

Earlier, it was stated that the creation of new post-harvest research institutions is not recommended either for Asia or for Africa. Nevertheless, in each region a central coordinating advisory and information service is believed to be necessary. It is recommended that such a service be created through international action and be supported through multi-donor participation. It is requested that the Technical Advisory Committee give consideration to the following specific proposals and, if in agreement, recommend to the Consultative Group on International Agricultural Research that the necessary financial resources be sought from among the CGIAR membership.

SOUTHEAST ASIA

It is desirable that post-harvest research and development programs be clearly associated with production research facilities. It is therefore recommended that a Post-Harvest Technical Support Team to serve the rice-producing nations of Asia be established at IRRI. The Team would include, initially, four or five persons each a specialist in one of the technical or economic components of post-harvest rice systems. It is recommended that this proposed Team be provided sufficient funds for travel and necessary supporting services.

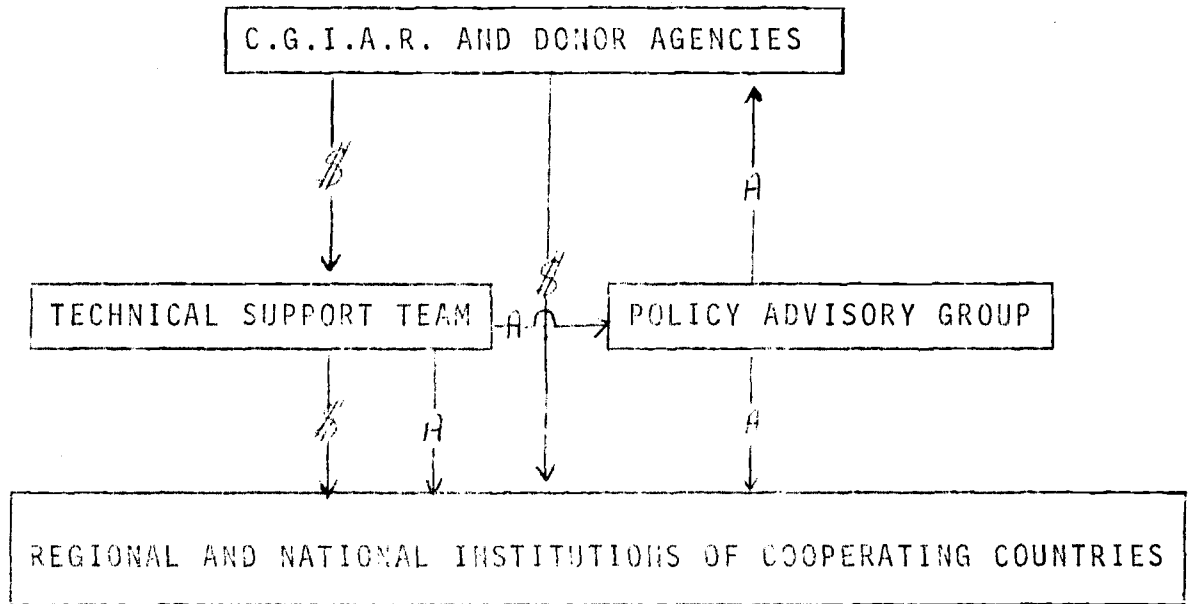
It is not implied in this recommendation that IRRI's core research program be greatly expanded. Rather, the Team would assist appropriate government and academic institutions to identify the problems of their existing or needed post-harvest systems, and formulate practical research, demonstration and training programs to solve the problems identified. The Team would be available to provide guidance in the conduct of these activities. The Team would also recommend which institutions within the regions are best equipped to undertake specific research, demonstration and training programs.

The Team would be able to draw on the considerable experience of existing IRRI staff and facilities and upon the scientists and facilities at the University of the Philippines for additional support and advice. It should have access to other technical competence throughout the region and be enabled to employ specialist consultants as required. The services of the Team would be available to any rice producing country of the region. The Team would collect, evaluate and disseminate relevant information among the cooperating countries.

To ensure a well-coordinated program with a minimum of duplication of effort, it is urged that an Asian regional Policy Advisory Group of senior administrators and scientists from each of the participating countries be created. The nucleus of an Asian post-harvest rice committee, composed of senior administrators and technical officers from several governments already exists and has met on at least one occasion. The expansion of this committee could be the mechanism for creating the Policy Advisory Group. The Policy Advisory Group, having representatives from each of the cooperating countries' national organizations, would be the body through which agreement could be reached on the distribution of research effort among the cooperating countries. The Group, in cooperation with the Technical Support Team could also make recommendations to donor agencies concerning bilateral aid needed by countries within the cooperating network.

The diagram on the next page provides a schematic representation of the envisaged interaction among (a) the CGIAR and donor agencies, (b) the Technical Support Team, (c) the Policy Advisory Group, and (d) institutions in cooperating countries.

Clearly a variety of administrative arrangements for the proposed Policy Advisory Group and the Technical Support Team are possible. The Technical Support Team activities could be financed by a special grant from the CGIAR to the Board of Governors of IRRI who would administer the grant. It might also be necessary to provide for a small secretariat to serve the needs of the Policy Advisory Group.



\$ = FUNDS

A = ADVICE

The direct involvement of a Policy Advisory Group drawn from the cooperating countries is considered essential to the style of the program proposed. In proposing that the research be guided by the Technical Support Team, but undertaken largely by the existing national institutions, it is believed that the program would address the problems common to many countries, thus minimizing duplication of effort. At the same time it would serve to strengthen national post-harvest systems and national research and development capacities.

It is considered that the bulk of the research financing for the proposed post-harvest program would come in the form of bilateral aid from donor agencies to the cooperating government agencies and research institutions. An exact budget for the total program proposed has not been worked out but it is believed that the annual budget for the Technical Support Team should not exceed \$750,000.

SEMI-ARID AFRICA

The magnitude and scope of the post-harvest program needed in semi-arid Africa is more difficult to define but again it is desirable that any post-harvest research and development program be clearly associated with production research facilities. It is recommended that a multidisciplinary, post-harvest team be established on a long term basis to engage in post-harvest systems research, to be available for advice and technical assistance into regional pilot development projects and to provide relevant advice to government agencies and institutions. This team could serve as a channel of communication and an information resource for the African countries of the semi-arid tropics and also as a link with actual and potential donors.

The site in Africa from which such a team might best operate is less clear than is the case in Asia. The IITA at Ibadan is not concerned with the crops of the semi-arid tropics and there is no international agricultural research centre in Africa which is. It is important, if it is to be functionally mobile, that the post-harvest team be located near to a reliable international airport, at a place where an active agricultural research program is in progress and where facilities for post-harvest research and training are available.

Of all the locations considered, it is the opinion of the authors that Senegal offers the most attractive choice. At Bambey, within easy reach of Dakar, the CNRA maintains a lively program of semi-arid crops research and has facilities for activities related to post-harvest systems.

The Institut de Technologie Alimentaire (ITA), located in Dakar, is equipped to undertake processing research and has established contacts with both the rural community and local food and agricultural industries. Residence in Dakar would also encourage the formation of a bilingual team, an absolute necessity if the team is to serve all of the countries of potential interest.

To maintain the international scope and character of the work without being associated with an international institution, it will probably be necessary to establish a small regional policy and administrative body in addition to the proposed technical team.

It must be emphasized that no discussion of this suggested program has taken place with the Government of Senegal, or any of its officers. This suggestion must therefore be regarded as exploratory and tentative.

It should also be recorded that the extent of potential interest among possible cooperating African countries needs to be explored before any final detailed recommendations can be made. In this respect the suggested program is much less advanced in Africa than in Asia.

If the TAC approves in principle the foregoing recommendations, it may wish to consider the creation of a sub-committee to examine the proposals in more detail. If so, the members of the missions which prepared the appended reports, and the author of this report, will be glad to offer whatever assistance the TAC members deem appropriate.

J.H. Hulse
Program Director
Agriculture, Food and Nutrition Sciences
International Development Research Centre
Ottawa, Canada
K1G 3H9