Enhancing Postharvest Technology Generation and Dissemination in Africa

Sasakawa-Global 2000

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Proceedings of the Workshop on Enhancing Postharvest Technology Generation and Dissemination in Africa, held at the Sheraton Hotel, Cotonou, Benin, 26-28 October 1998

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Contents

Foreword

In 25 to 30 years, it is likely that more Africans will live in cities than on the land. This demographic shift must bring major changes in smallholder agriculture, if the needs of urban food consumers are to be served. In the next century, African agriculture will be increasingly market-oriented. This requires a commercial agriculture that is more diversified, more efficient, and assures greater food safety.

Most smallholder farmers have inadequate grain storage structures, which adds pressure to sell at harvest, despite prevailing low prices. Cost-effective postharvest storage structures and pest management methods are needed. Increased crop surpluses also give smallholders new incentives to add economic value to their produce through food processing and sale in the marketplace.

African governments also need to promote the development of agro-industries that can manufacture much of the equipment and machinery needed in small-scale postharvest enterprises. Governments need to ensure that steel, bearings, motors, and other components needed to manufacture agricultural machinery and equipment are available as cheaply and easily as possible.

Some important questions and challenges:

- How do we build financial and technical partnerships—with donors and clients—to accelerate the development and dissemination of improved postharvest technologies?
- How do we strengthen the entrepreneurial capacity of small-scale food processors and manufacturers to make their operations more efficient and profitable?
- How do we encourage the development of local agro-industrial companies, capable of manufacturing small machinery and equipment needed to improve farm incomes and reduce farm drudgery?

The objectives of the workshop were appropriate and helped participants to deliberate relevant issues related to these challenges. I believe the information generated, experiences shared, and recommendations offered will go a long way to improve the postharvest sector.

I would like to acknowledge the International Institute of Tropical Agriculture for hosting the 2-week training session at its headquarters in Ibadan and for agroprocessing field visit, including lunch, at its Calavi Station, near Cotonou. A special acknowledgment go to Dr. Y. W. Jeon and Mrs. Leonides Halos-Kim, Postharvest Engineering Unit, IITA, both for their leadership in agroprocessing development and for handling most of the logistical details associated with this workshop.

I would also like to recognize the leadership and contributions of SAA Program Leader for Agroprocessing

Development, Mr. Toshiro Mado, Technical Officer Antoine Aoga, based in Benin, plus the SG 2000 project staff in Cotonou. All contributed to the success of this meeting.

Finally, thanks goes to Dr. Joe Kwarteng for his assistance as an instructor and facilitator in the postharvest training session at IITA, Ibadan, for his assistance with the small groups discussions during the workshop, and last, but not least, for editing these proceedings.

Christopher R. Dowswell
Director for Program Coordination
Sasakawa Africa Association

Glossary

ADB	Agricultural Development Bank
¢	Cedi
CIAT	Centro Internacional de Agricultura Tropical
CIP	International Potato Center
CIRAD	Centre de Cooperation Internationale en Recherche Agronomique pour le Développement
COSCA	Collaborative Study of Cassava in Africa
FAO	Food and Agricultural Organization of the United Nations
GTZ	German Development Cooperation
IFPRI	International Food Policy Research Institute
IITA	International Institute of Tropical Agriculture
INPhO	Information Network on Postharvest Operations
KARI	Kenya Agricultural Research Institute
MOA	Ministry of Agriculture
MOFA	Ministry of Food and Agriculture
NARO	National Agricultural Research Organization
NGO	Non-Governmental Organization
NRI	Natural Resources Institute
PHMD	Post-Harvest Management Division
PRAPACE	Regional Potato and Sweetpotato Improvement Program in Eastern and Central Africa
RPM	Revolutions per minute
SAA	Sasakawa Africa Association
SG 2000	Sasakawa-Global 2000
t	tonne (1,000 kg)
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development

Meeting Summary

Opening Address

Cosme Akpodji, Directeur de cabinet of the Republic of Benin, delivered the opening address on behalf of Saka Saley, the Minister of Rural Development of the Republic of Benin. In the address, he welcomed participants to Benin and expressed his delight that the theme of the workshop was in consonance with one of the objectives of the Government of Benin's Plan of Action to achieve food security. The Minister said that food production had been increasing in Benin since 1990, but noted that the increase was not sufficient to satisfy domestic needs and meet the increase in external demands brought about by the government's trade liberalization policy. This imbalance was a challenge, and the Government had decided to address it by promoting more food crops such as maize, cassava, sorghum, rice, and their derived products in the same way traditional cash crops had been promoted. Akpodji indicated that the Government also intended to considerably reduce the estimated 20-30% postharvest losses in the country. He emphasized the need to organize better food supply and distribution systems in order to maintain reasonable prices for consumers of local agricultural products. The Minister commended the postharvest initiatives of such organizations as Sasakawa-Global 2000 and the Food Technology Laboratory in Benin and challenged the Workshop participants to come out with recommendations that would improve the living conditions and income of hardworking rural populations.

Welcoming Address

The workshop participants were welcomed by Christopher Dowswell, Director for Program Coordination, Sasakawa Africa Association (SAA). He emphasized the importance of the postharvest sector by drawing participants' attention to the projected growth of the populations of sub-Saharan Africa from about 600 million today to nearly 1.2 billion by the year 2025. Half of this population, he said, were expected to live in cities and large towns. Dowswell noted that today 70-80% of all food produced in Africa was consumed by those who produced it. He indicated, however, that this state of affairs was expected to change due to increased rural-to-urban migration and an expected rise in family incomes. Urban families, in keeping with existing trends, would eat more processed foods 25 years from now.

Dowswell observed that these huge changes in African food consumption patterns would have enormous implications for food industries, agricultural production, and food safety. These were challenges which, he suggested, could be met by broadening our thinking to cover research systems that satisfied both the wants and needs of farmers and consumers. He said that the development of agro-industries could serve as an important cornerstone for healthy rural economies, but noted that this would be difficult without substantially greater investments in rural infrastructure. Unfortunately, he said, little—or only fragmented—attention was today paid by most governments, donor agencies and research institutes to the food processing and distribution systems needed to deliver food from rural to the urban markets. He encouraged the participants to think of dynamic partnerships between farmers and public, private and NGO organizations that could lower the costs of agricultural production and marketing, help African agriculture compete more effectively in international markets and, perhaps, most importantly, help the poor have access to the food required for a healthy and active life.

Postharvest Management and Africa's Food Security

Ruth Oniang'o regretted the current state of affairs where Africa, a continent well endowed with enormous human capital and rich natural resources, was unable to feed itself and continued to be increasingly dependent on food aid and imports. She bemoaned the fact that the whole area of postharvest had been largely neglected, noting that as we headed towards the next century, it was clear the past had yielded little for Africa in terms of technological advancement and the ability to feed itself.

While opportunities had been lost, Oniang'o was of the opinion that it was not too late to reverse trends and that Africa could restore its agricultural productivity by tackling the food chain at all its key stages and not in a piecemeal fashion. She contended that there was still enormous potential on the continent and many opportunities yet untapped in the area of food processing.

Oniang'o indicated that strategies to address the recurring food security problems in Africa must involve postharvest practices and management. She outlined several issues which she said had implications for the postharvest sector in Africa today. These included:

- rapid population growth and the consequent rural to urban migration
- food quality and food safety
- time women spend on food processing
- lack of access to profitable markets
- the need to put in place value adding mechanisms to absorb yields that were in excess of immediate family use

Oniang'o noted that value-added foods could facilitate trade between rural and urban areas as well as between countries. She urged all stakeholders in the postharvest system to play their rightful roles, if the entire area of postharvest management was going to be promoted and streamlined in sub-Saharan Africa. Some of the recommendations she made were:

- Governments should formulate policies which support the food industry and address consumer needs.
- Governments should promote the establishment of agro-industries in the rural areas.
- Training should be offered in food quality and control.
- There should be food fortification programs that address the needs of poor people.
- Food should be protected from contamination and packaging practices that address consumer appeal should be encouraged.

CIP's Sweetpotato and Potato Improvement Systems

Vital Hagenimana, a postharvest scientist at the International Potato Centre (CIP), discussed CIP's postharvest research pertaining to sweetpotato and potato and said that the overall objective was to improve the welfare of the rural poor through the diversification and expansion of the crop. He stated that in Africa, the fresh root market and on-farm consumption were still dominant, but noted that opportunities for income generation existed by adding value to the crops through processing and by using the vines and other by-products as animal feed. He said lessons could be learned from Asia where 85% of global sweetpotato production was concentrated and where shifts in utilization from fresh root consumption towards feed and processed products such as starch, chips and flour were in progress.

Hagenimana said studies had shown that baked products incorporating sweet potato as an ingredient and products containing cooked and mashed sweetpotato were particularly accepted by consumers. Consumers, he said, were prepared to pay the same prices for sweet potato-based products as for similar products they had been buying. He said studies had shown that sweet potato improved the taste, texture, freshness, appearance, sweetness and color of local foods such as buns, "chapatis," and "mandazis."

Hagenimana outlined the strategic principles guiding CIP's postharvest research activities on sweetpotato and potato as including:

- Focus on primary processing of potato and sweetpotato into value-added products such as chips, crisps, starch and flour.
- Focus on uses of potato and sweetpotato (including vines) as animal feed, especially for high producing animals such as pigs and dairy cattle.
- Use of the product development methodology developed by CIP, CIAT and IITA. This methodology comprises opportunity identification, market and technical research, pilot enterprise feasibility and commercial expansion or replication of enterprises.
- Placing emphasis on small-scale technologies that are both efficient and produce quality products, or link small-scale producers to industrial-scale processors.
- Paying attention to basic research where necessary, to resolve problems or realize opportunities identified as important for target beneficiaries (e.g., starch functional properties as related to baking quality).
- Linking up with centers of expertise not available locally.
- Collaborating with the private sector, NGOs, national agricultural research systems and other international agricultural research centers involved with work in roots and tubers, where necessary, to achieve project objectives.

IITA's Role in Promoting Improvements in Postharvest Systems

Mpoko Bokanga, a biochemist and food technologist at the International Institute of Tropical Agriculture (IITA), discussed IITA's role in improving postharvest systems in Africa. He indicated that IITA's postharvest project consisted of a program to develop simple and low-cost machinery for harvesting, processing and transportation, and also involved efforts to expand the utilization of crops by developing and promoting new products for household and commercial use. To achieve the goals of the project, Bokanga said IITA used results from characterization studies of existing technologies and mode of utilization of crops to identify existing constraints and select priority areas for research and interventions.

According to Bokanga the development of postharvest technological solutions at IITA fell into four categories: quality improvement in new variety development; product and process development; postharvest equipment development; and improvement in storage systems. In addition to technological solutions, Bokanga said IITA undertook activities that aided the transfer of postharvest technologies. Such activities included conducting degree and non-degree training programs, demonstration of technologies and participation in exhibits and agricultural trade fairs.

Using IITA's experience with soybean and cassava as examples, Bokanga emphasized that the improvement and use of postharvest technologies could increase the utilization of crops and thus stimulate their production. Postharvest technologies, he said, provided the tools needed by farmers to convert their harvest into commodities that would attract the income farmers deserved.

Ghana's Experience with Postharvest Technologies

Kwaku Nicol, head of the PostHarvest Management Division (PHMD) of Ghana's Ministry of Food and Agriculture (MOFA), presented a paper addressing advances in the development of postharvest technologies in Ghana. He noted that, in the past, the Ghana Government, as well as donors, had focused their attention on increasing food production without giving much thought to storage and preservation. This, he said, created a situation where whatever benefits new technologies in production offered were eroded by postharvest losses due to lack of storage facilities, insufficient processing facilities and underdeveloped marketing infrastructure.

Nicol discussed the efforts being made by the Ghana Government to tackle the problem of postharvest losses and said that, at the national level, the MOFA, with a three-phased installation program, had provided grain storage and handling facilities in strategic locations for efficient postharvest management of grain surpluses. He added, however, that any lasting improvement in the areas of postharvest losses must involve education and subsequent adoption, by the small scale farmer, of affordable, technologically and culturally appropriate storage, preservation and processing practices. Nicol explained that the postharvest system instituted by the Government of Ghana through the PHMD of MOFA was centered mainly on storage and processing to reduce losses, increase storage life, refine crop quality and add value to primary produce. He listed some improved postharvest technologies that had been introduced in the country and identified some of the problems encountered in Ghana as lack of coordination, duplication of efforts, poor markets and weak linkages between research, extension and farmers.

Postharvest Technologies for African Conditions

Leonides Halos-Kim, research specialist, IITA Postharvest Engineering Unit, presented a paper co-authored with Y. W. Jeon, postharvest technologist, IITA, on characterizing the desirability of postharvest technologies for African conditions. In the presentation, Halos-Kim noted that a number of innovations and technologies introduced into Africa since the 1970s had met with little success because the technologies often did not fit users' needs. To overcome this, the authors suggested that technology development approaches should be re-oriented to fully integrate social, economic and technical considerations. Such strategies, they believed, would lead to the proper targeting of technology users and also contribute to the full understanding of the constraints and opportunities for developing appropriate technologies.

In designing and manufacturing postharvest technologies for African conditions, Halos-Kim said it was important to pay attention to such factors as the pattern of crop production, the type and nature of food processing and consumption, the available resources, the technical and economic capability of the farmers, the marketing opportunities available, special requirements for specific food preparations and taste preferences of consumers.

Halos-Kim discussed the features of IITA postharvest technologies that were developed after careful analysis of the African condition. These pieces of equipment, she said, were being disseminated by the Sasakawa African Association (SAA) in some West African countries such as Ghana, Benin and Nigeria.

Information Network on Postharvest Operations

In her presentation, Carolin Bothe, visiting scientist from GTZ to FAO, addressed the issue of postharvest information. She drew attention to the importance of postharvest by indicating that world food security was largely dependent on the efficiency of the post-production systems. While alluding to the fact that information had a vital role to play in the management of the post-production sector, she noted that such information was not always available. The reason, she said, was that a large amount of literature accumulated by projects developed by research institutes and development institutions remained inaccessible or unknown to those who needed it. Also, post-production information tended to be placed under the general heading of agriculture or farming, or rural development and, therefore, got easily immersed and dispersed in a sea of literature. It was to address this issue and make postharvest information more easily available and accessible that the FAO, in collaboration with a small group of organizations (GTZ, CIRAD, and USAID) started INPhO - the Information Network on Postharvest Operations.

Bothe described INPhO as an international reference facility and a network for the exchange of information and experiences in the post-production sector. She said the basic purpose of INPhO was the collection, collation, development and dissemination of useful information regarding various elements of post-production systems, giving particular emphasis to products and technologies relevant to developing countries. According to Bothe, INPhO comprised three major components: (1) a database—a comprehensive collection of information on the post-production sector (including, for instance, the full text of selected documents, decision support tools for entrepreneurs and a list of research and training organizations); (2) an interactive communication service for expert consultation and exchange of information and (3) linkage with other databases and libraries. She said information from INPhO was accessible through the Internet, as well as on CD-ROM for wider dissemination.

Capacity Building

Charles Ofori Addo, a business advisor for TechnoServe, threw some light on the capacity building activities of TechnoServe, a private, non-profit, non-sectarian international development agency founded in 1968 and operating in Ghana since 1971. TechnoServe's mission, he said, was to improve the economic and social well-being of low-income rural people in developing countries through enterprise development. He explained that TechnoServe used an integrated approach that provided technical and managerial assistance as well as training to foster the establishment and growth of small to medium-scale community based agricultural enterprises.

On TechnoServe's operations in Ghana, Addo explained that the agency was mainly assisting organized groups of rural farmers and food processors to add value to agricultural products. He said TechnoServe believed that the key to promoting dynamic growth in the agricultural sector in Ghana is to develop small-scale and medium-scale rural enterprises based on a thorough understanding of international and domestic market realities. In many instances these small-scale and medium-scale businesses would be best positioned to grow and prosper if they were able to establish marketing agreements with larger, more dependable buyers and firms. Thus, TechnoServe acted as an honest broker to nurture such linkages. He emphasized TechnoServe's belief in commitment and said potential business owners working with the agency were required to demonstrate a strong sense of commitment to the process of enterprise development by making "up front" contributions in cash or "in kind" payments such as land, labor, materials or agricultural produce.

Addo said TechnoServe was currently assisting 180 community-based rural enterprises throughout Ghana with a combined total membership of 8,334, of whom 48% were women. He added that in implementing its activities, TechnoServe collaborated with institutions and organizations such as the International Institute of Tropical Agriculture (IITA). As part of the presentation, he discussed an organizational model for a small-scale palm oil processing and assessed its impact and cost effectiveness.

Participatory Postharvest Technology Development and Transfer

Stephanie Gallat, In-Country Co-ordinator for the NRI-Ghana Postharvest Development Program, presented a paper, co-authored with Andrew Westby of the NRI, on the development of cassava chip processing in Ghana. The paper highlighted the use of a participatory systems approach in postharvest research and development on roots and tuber crops in Ghana. The authors noted that postharvest systems were highly complex in nature because of the interaction of technical and economic constraints faced by small-scale farmers and cautioned against seeing postharvest problems as wholly technical phenomena requiring only technical solutions. They described a systems approach which covered production to consumption and included needs assessment to determine farmers' needs, market analysis to understand which markets farmers could access and systems analysis with all stakeholders to identify solutions to bottlenecks. The advantages of the system, according to Westby and Gallat, were that it involved a close interface with beneficiaries; it made technology transfer a part of the research and development process; it was faster than some alternatives; it allowed for the fact that not all constraints were technical in nature; and it was multidisciplinary in approach. The disadvantages of the system included difficulty in predicting the final product or technology since the system used a process approach. Also, the results could be location specific and expectations could be raised if the process was not followed through to an end point.

Collaboration for Agro-industries Development

In his presentation, Toshiro Mado, the program officer for SAA in Ghana, emphasized the important role of postharvest processing in ensuring food security in an era of growing populations in Africa. He noted that farmers, especially those producing surplus food, required postharvest technologies to derive maximum benefits from their efforts. Postharvest technologies for agro-processing, he said, provided a major avenue for generating income for rural farmers, especially women in African countries.

Mado highlighted the weak linkages between agriculture and industry, pointing out that metal workshops were located in urban areas while rural farmers had little information about available technologies and equipment. He described the effort being made by an SAA project to disseminate available postharvest agro-processing technologies to farmers, manufacturers and operators. He indicated that the effort had been collaborative, involving SAA, IITA, National Agricultural Extension Agents, metal workshops, NGOs and farmers. Mado described the role of the collaborators and indicated that the major activities in the collaboration were in the areas of Research and Development, agro-industries extension and training of manufacturers.

Mado said collaboration with Research and Development was necessary to ensure that equipment design took into consideration crop characteristics, as well as agricultural and human engineering factors. Such considerations, he believed, yielded good designs which were easy to fabricate, easy to use and were durable. He said the purpose of agro-industries extension was to demonstrate agro-processing equipment to farmers and other potential users and to convey farmers' comments to engineers for subsequent modification and improvement of designs. Manufacturers' training, he said, was aimed at introducing new designs to manufacturers and to improve the fabrication skills of technicians. He concluded by calling for greater participation and better co-ordination among stakeholders to improve and expand the agro-industries sector.

Bringing the Pieces Together

In his closing remarks, Chris Dowswell reminded participants that increasing urbanization in Africa would bring about changing patterns of food consumption. He wondered whether urban dwellers who would be eating more processed foods, would obtain their food from domestic producers and food processors or from imports from abroad. His opinion was that the final decision would be influenced by quality and quantity considerations.

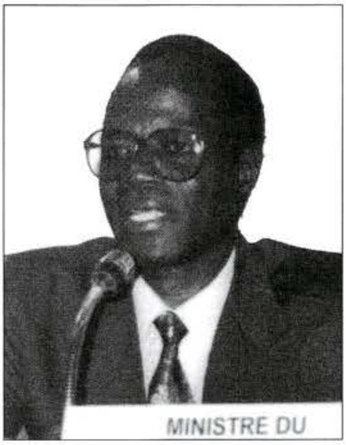
Dowswell shared the opinion that governmental and non-governmental organizations should be involved in supporting and strengthening emergent private sector micro-enterprises. He suggested they could do this by taking the leadership role to help organize and train them. Dowswell, however, believed that not-for-profit development organizations which would be involved in this effort should adopt a clear businesslike orientation in their advisory services and interventions. He said the goal must be to offer services and interventions that allowed farmers and small-scale entrepreneurs to make significant profits. In this direction, he emphasized the need for market information through the development of a more robust market intelligent systems.

On the need to influence policy to promote the development of modern agricultural systems and, especially, small-scale agribusiness, Dowswell encouraged NGOs and participants to become activists for change by lobbying parliamentarians and the executive branch of government for a favorable environment for the development of rural industries and enterprises.

Dowswell advised ministries of agriculture and NGOs to plan careful strategies to engage the private sector agribusiness in development partnerships that would be mutually beneficial. On strategic and adaptive research, he said we should be focusing more effort on the diffusion of what was already available, perhaps with some adaptive research for small design changes, where necessary. Finally, Dowswell encouraged participants to implement recommendations that emerged from small group discussions to help improve the development and delivery of postharvest technologies. These included: recommendations for strengthening the entrepreneurial capacity of small-scale agro-processors and manufacturers; recommendations for building sustainable partnerships for postharvest technology development and dissemination and recommendations for financing postharvest technology development, manufacturing and agro-processing enterprises.

Opening Address

Cosme Akpodji



I wish, first of all, on behalf of the Government to welcome you to the Republic of Benin. It is a real pleasure for me to be with you for the opening of this workshop on "Enhancing Postharvest Technology Generation and Dissemination in Africa."

You will agree with me that for African countries in general and for Benin in particular, a sound economic policy must be based on agricultural development. You will also agree with me that food security will assure lasting social peace.

The choice of Benin as host for this workshop is evidence of your confidence in our country, and I am delighted that the theme of this workshop is in consonance with the objectives of the Government's Plan of Action to achieve food security. Indeed, food security is one of the key components of the Government's program of development.

In its Statement of Rural Policy (*déclaration de la Politique de Développement Rural, LPDR*), Benin has set itself the following priorities among other objectives:

- to control food and nutritional insecurity through specific actions targeted at the most vulnerable areas and periods
- to seek profitable markets and thus promote agricultural diversification
- to increase export earnings in order to compensate for the weakness of the domestic market by diversifying and improving agricultural production both in quality and quantity

Benin's food production was over the set target in 1990. Thereafter, the trend in annual food production (5% in 1990) compared with the population growth of 3% showed an increase in net food production. Unfortunately, this increase has not been enough to satisfy both domestic demands and an expanded external demand brought about by the almost total liberalization of our economy. This has created a structural imbalance between the current levels of supply and demand which is likely to continue to maintain pressure on domestic markets. In order to somehow lessen this imbalance, the Government of Benin, through the Ministry of Rural Development, has decided to promote food crops such as maize, cassava, sorghum and rice and their products in the same way as cash crops,

Cosme Akpodji is Directeur du cabinet of the Ministry of Rural Development in the Republic of Benin.

and to considerably reduce postharvest losses which are reported to be close to 20 - 30%.

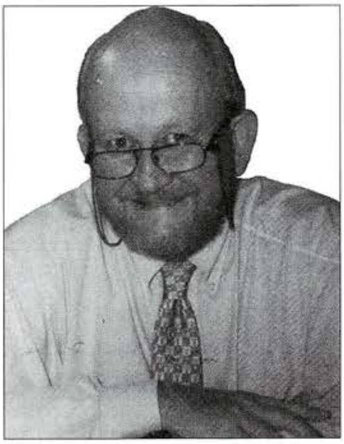
In the light of demographic projections which estimate the population of Benin to increase from 5.9 million in 1998 to 12.6 million in 2019, there is an urgent need for improved postharvest technologies that will make it possible to improve productivity and increase the availability of food stocks by reducing postharvest losses. Postharvest technologies will also encourage the processing of some of our crops in order to add value and consequently improve the income of our farmers.

We also need to better organize food supply and distribution systems in urban and peri-urban areas in order to reduce, as much as possible, the number of intermediaries so as to maintain reasonable prices and quality for the consumers of local agricultural products. As we enter the 21st century which will be characterized by globalization, the prospects for the development of Agriculture in Africa are bright.

The objectives for this workshop constitute a covert agro-industrial revolution for Africa, especially rural Africa, and you have the support of my Ministry. I am aware of postharvest initiatives in this country by organizations such as Sasakawa-Global 2000 and the Food Technology Laboratory. These initiatives are commendable. Over the next three days you will discuss issues related to food security for the entire African continent. I am confident that your deliberations will yield pertinent recommendations towards the improvement of the living conditions and income of our hard-working rural populations. These recommendations, I am sure, will be endorsed by the representatives of our development partners for their effective implementation by researchers, experts and extensionists. I declare this workshop open and wish you a successful meeting.

Welcoming Address

Christopher Dowswell



I am honored to welcome participants to the first session of the SAA/IITA Workshop on Enhancing Postharvest Technology Generation and Dissemination in Africa. Our meeting today has been preceded by a two-week in-service technical training course conducted at IITA, Ibadan, Nigeria, which was attended by 14 postharvest practitioners from seven countries of sub-Saharan Africa. I will like to congratulate them on a job well done in the classroom, machine shop, and agro-processing enterprises where they have worked these past two weeks.

In our discussion over the next three days I would like us to consider the following facts and figures. First, the population of sub-Saharan Africa is projected to double within the next 20-25 years, from roughly 600 million today to nearly 1.2 billion in 2025. Perhaps surprising, at least it was to me, is the projection that most of this population growth will be in urban rather than rural areas. Indeed, the United Nations Population Agency anticipates that by 2025, more than 50% of the SSA population will reside in cities and large towns, twice the proportion now.

While today in Africa 70-80% of all food is still consumed by those who produce it, in 25 years more than half will be consumed by urban dwellers or exported abroad to commercial markets far away from production centers. As African cities grow, both through natural increase and rural-to-urban migration, and as family incomes rise, patterns of food consumption will change. Urban families will eat more processed foods such as bread and pastas, and less hand-ground or pounded cereals and starches. FAO forecasts that 20-25 years from now sub-Saharan Africans will eat three times more meat and seven times more poultry than they do today.

These huge changes in African food consumption patterns have enormous implications for food industries, agricultural production, and food safety. To meet these challenges, we must broaden our thinking from research systems that only concern themselves with identifying and satisfying the wants and needs of farmers, to those that also consider the needs, wants, and requirements of consumers.

Unfortunately today, little, and only fragmented, attention is paid by most

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governments, donor agencies and research institutes to the food processing and distribution systems needed to deliver food from rural producers to the urban markets. For example, the Consultative Group for International Agricultural Research invests less than 1% of its total budget (now more than US$300 million annually) in post-production systems and technologies.

And yet, in the developed nations of North America, Europe, and Asia it is the agro-industries that add 75% of the value to food products and employ the most people. In the United States, only about 2% of the population is directly engaged in farming and ranching, while more than 20% earn their livelihoods in food processing, distribution, marketing, catering, and related services.

Professor G. Edward Schuh, SG 2000's senior economic policy advisor, is constantly reminding us that the most important contribution of agriculture over the past 50 years in the industrialized countries, and in parts of Asia and Latin America, has been in lowering the real price of food. This benefits everyone in society, because we all consume food, but especially the poor since they spend a larger portion of their income on feeding themselves.

There have been two main forces driving lower real prices for farm goods. The first is technology, and the second is marketing (Donovan 1996). Improved technology allows farmers to receive more income even when real prices are falling, because they produce more for each unit of land and labor. More efficient marketing—defined here as what happens to products between farmers and consumers—including transport, storage, processing, buying and selling, is actually doubly important, since it affects the prices farmers pay for inputs as well as what they receive from their crops.

In sub-Saharan Africa, the poor organization and performance of the transport sector has affected all aspects of the rural economy, including access to markets, use of inputs and improved technology, farm productivity, access to social services and mobility (Doyen 1996). This has led to a decline in sub-Saharan Africa's participation in world trade, held back progress in the development of domestic food markets, and increased overall food insecurity.

Poor transport systems have especially affected women, who bear an overwhelming share, often more than 80%, of the transport activities of rural households. For example head loading by women occupies 20-30 hours per week (Doyen 1996).

Many agro-industries are most efficiently located near the source of raw materials needed to process crops and livestock into various types of consumer food products. Thus, their development call becomes a cornerstone of healthy rural economies. However, without substantially greater investments in rural infrastructure it is difficult to see how urban consumers will have access to safe and nutritious food at affordable prices. Similarly, it is difficult to see how healthy rural economies can develop, especially expanded off-farm employment opportunities, or how the natural resource base can be protected.

As we explore the ways and means to enhance postharvest technology generation and dissemination in Africa, I ask workshop participants to keep the word "partnership" in the forefront of their minds. How can dynamic partnerships between farmers and public, private and NGO organizations lower the cost of agricultural production and marketing? How can such partnerships help African agriculture compete more effectively in international markets? And perhaps most important, how can more effective partnerships help the poor have access to the food required for a healthy and active life?

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Postharvest Management and Its Effect on Africa's Food Security and Livelihoods

Ruth K. Oniang'o

Most economies in sub-Saharan Africa depend on agriculture. However, agriculture has not received the necessary attention, in terms of development expenditure, to reflect this important role the sector plays. Within the last two decades, this region of the world has moved from being a net exporter of food to a net importer of food. In addition, the region has increasingly become dependent on food aid.

Currently, a greater proportion of rural Africa faces major economic, general welfare and survival challenges. Structural adjustment policies, which were meant to positively reform the economy, have dealt a heavy blow to the agricultural sector as these policies have, to a large extent, not worked. Although the extreme poverty in the region cannot be entirely attributed to structural adjustment policies, consumers continue to blame their economic woes on their respective governments for adopting insensitive macro economic policies.

Poverty and Food Security Challenges

The food insecurity, hunger and malnutrition which can be seen in many African countries are clearly linked to poverty. For example, most of the rural population in Southern African countries live in poverty, with up to 80% in Zambia and 85% in Malawi. Rural poverty has fueled a migration to urban areas and it is estimated that the urban population is likely to more than triple between 1995 and 2020 (IFPRI 1997). By the year 2020 it is expected that more than half the region's population will be living in urban areas. New strategies are needed to both revitalize the African economies and address problems such as food security, hunger and malnutrition. Most countries, including the so-called economic tigers of Asia, have industrialized through the development of agriculture. Africa can learn from the experiences of these countries.

Post-Production Dilemma

Even as sub-Saharan African countries continue to experience worsening food deficits, the sad fact is that a considerable proportion of currently produced foods is wasted. The reasons for this wastage are not difficult to find and include: inappropriate policies that fail to address the

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changing socio-political and economic environment; failure to develop policies to promote marketing and distribution of agricultural produce; failure of rural development policies which have resulted in accelerated rural to urban migration and the inability of governments to stimulate rural economies.

An estimated 25% of all food produced in Africa is lost through rotting as well as insects, rats and other pest damage (Latham 1997). Some observers argue that if most of what is lost was saved or preserved, Africa's food crises that are so much publicized would assume a different face. With traditional granaries gone in some areas, the capacity to store cereals at the farm level is substantially reduced. Information on how to store new types of grains is not consistently relayed to the farmers so many fruits and vegetables rot when in season for lack of adequate transportation and food processing facilities.

Postharvest Practices and Management

Strategies to address the recurring food security problems such as poverty, hunger and malnutrition in Africa must involve postharvest practices and management. The postharvest sector is supposed to fulfil a number of objectives including to:

- reduce food losses
- enhance food security at household, community and national levels by providing affordable preserved food, especially during the off-season
- promote economic growth for the nation especially through exports
- serve as a generator of income especially for households
- stimulate local production
- encourage and stimulate the industrial sector
- facilitate participation in international trade

Indigenous Technologies

Africa has had indigenous technologies to preserve food at the household level. Some of these technologies continue to thrive to date, especially in West Africa. The primary aim of traditional food processing was mostly to preserve the excess food for household use and not necessarily for economic reasons. In some cases grains were preserved to provide seed for the next season's planting.

There are two main traditional methods of food preservation and processing for specific food products in Africa. These are drying (using solar energy and wood or charcoal smoke) and fermentation. Drying is used for foods such as grains, meat, fish, insects, fruits, roots and tubers, and green leafy vegetables, while fermentation is used mainly for cereal flour and roots and tubers. Some examples of foods preserved through traditional methods include:

- Preservation of ensete (false banana) by fermentation in Ethiopia. The product is usually kept for 3-4 months but can be kept for up to one year or more (FAO 1989).
- Traditional preservation of dairy products such as ghee, fermented milk and yoghurt.
- Preservation of green leafy vegetables by sun drying. This process minimizes the loss of vitamins A and C which occurs when other processing methods are used. (FAO 1990a).
- Preservation of meat by smoking and drying. Biltong, a traditional dried meat product of Southern Africa and other game meat are particularly well suited for preservation by this process (FAO 1990b).

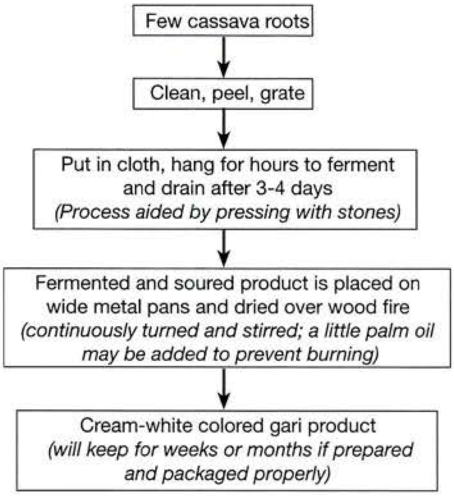

Fig. 1. Stages in gari preparation at household and community levels using traditional technologies.

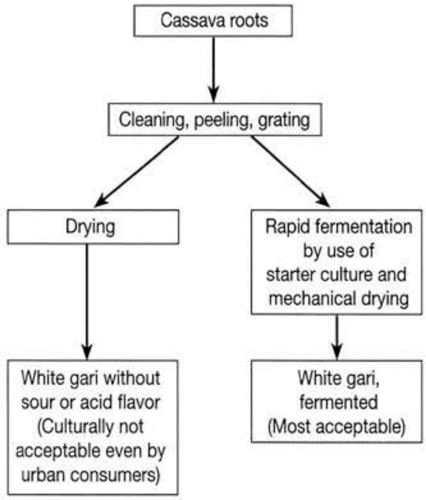

Fig. 2. Stages in commercial production of gari.

With regard to packaging, traditionally preserved foods such as milk were stored in local containers such as gourds and meat was wrapped in leaves such as banana leaves. Therefore, the whole aspect of the modern food chain that involves large scale processing, packaging, labeling, marketing and distribution is fairly new. Even more new and challenging, is the whole idea of quality control and assurance.

Despite the important role traditional food processing methods play in food security, these methods are time consuming and labor intensive. While the drudgery and time spent can be reduced with improved technologies, care must be taken to ensure that the desired characteristics associated with the product are maintained. Illustrations of home and commercial production of gari, a popular cassava product (figs. 1 and 2), reveal the extent to which drudgery and time associated with traditional processing can be reduced. They also show how the end product can be altered in terms of desirable characteristics if great care is not taken when replacing traditional processing technologies with modern ones.

Issues and Concerns

There are several issues which have implications for the postharvest sector in Africa today. First, populations have increased several fold, and it is no longer like the historical past when most Africans remained in their traditional rural communities and derived livelihood support, including food, from community groupings to which they belonged. Today, there is an active rural to urban migration due mainly to the youth fleeing rural poverty. This urban population have acquired urban tastes and are eating more processed foods instead of consuming traditional staples in their raw forms.

Secondly, food quality and food safety are real concerns within food systems at all levels including households, community, national and international levels. Some of the factors that affect food quality and safety in African markets, shops, and homes include: poor physical quality, chemical contamination, bacterial and parasitic contamination, mycotoxin contamination, rapid rotting and contamination by other biological agents such as rodents and insects (Latham 1997).

Thirdly, in the development arena, there has been a great concern for the amount of time women spend on various chores including food processing. Although numerous attempts that have been made to introduce improved technologies to reduce the labor drudgery on women, the benefits have not always been fully realized by women because men tend to be more inclined towards mechanization than women and usually seize the money-making opportunities mechanization presents. Extension efforts aimed at addressing this problem and reaching women with simple, affordable, improved postharvest processing equipment have been limited.

Fourthly, lack and access to profitable markets have limited production in certain cases. Roots, tubers, bananas and plantains account for some 40% of total food supplies in terms of food energy for about one half of the population of sub-Saharan Africa. Although production of these staples could be increased to meet future needs, farmers tend to limit production in order to minimize the risk and uncertainties associated with farming. For example, when farmers in the North West province of Cameroon produced potatoes as a cash crop, they limited their production to the estimated quantity that would be marketed before the roads were closed by floods from the rain (FAO 1987). Farmers would increase production if they had access to improved postharvest processing technologies and guaranteed markets for their produce.

Finally, with the use of improved technology to increase production yields, it is important to put in place viable value adding mechanisms to absorb the yields that are in excess of immediate family use. The new products would stabilize food supplies, minimize losses and increase family incomes.

Adding Value to Foods

Value adding in the food sector refers to the conversion of commodities into processed goods which are usually more stable and more marketable than the raw unprocessed commodity. Raw foods are processed to:

- improve their digestibility
- enhance availability of foods beyond the area and season of production, thus stabilizing supplies and increasing food security at various levels
- permit diet diversity
- provide opportunity for nutritional improvement e.g., through fortification and enrichment

For a nation, value adding can serve the following functions:

- enhance household food security
- put food in a form which can ensure regular and sustained supply of food
- facilitate easy movement of foods from production points to non-producing areas and market
- facilitate regional and international trade

Value-added foods can facilitate formation of trade links between rural and urban areas. The growth in urban populations and the likelihood that urban incomes will improve serve as indicators that there will be a rapid demand for value added foods for non-food producing urban populations. As standards of living increase and awareness about food quality is created, so will there be need for food producers to enforce the highest food quality standards possible.

There is also the need for efficient

urban-rural food distribution linkages. An area of entry could be the street food sector, which is expanding in response to increasing rural to urban migration. Street food vendors could be used as a means of introducing new food products to consumers. The FAO estimates that there are 100,000 vendors in Malaysia whose collective total and sales amount to over US$2 billion! (Dawson and Canet 1991).

Value-added food products could also be used to promote trade between countries. There is clearly a need to promote regional trade by harmonizing and implementing existing regional trade agreements on taxation, pricing, and cross-border regulations. Infrastructural and institutional barriers should be eased or removed to facilitate easier movement of food.

An example of value adding is a project in Kenya by the Kenya Agricultural Research Institute (KARI) which is funded by the International Centre for Research on Women. This project introduced orange fleshed sweetpotatoes rich in a-carotenes in a Kenyan community as a way of combating vitamin A deficiency. The project has been so successful that sweetpotato is now being used as a blend in a number of marketed already prepared food products (Low et al. 1997).

Value adding has implications for consumers. In most situations value added products cost more than the raw products. These extra costs, which are passed on to consumers, arise from processing costs, taxes and expected profit margins. With increasing urban poverty in sub-Saharan Africa, the majority of the urban population can only afford the very basic of value added food products such as refined cereal flour, cooking fats and oils, tea leaves, bread and tomato paste.

Certain conditions such as cost-effective energy sources and potable water are pre-requisites to value adding activities. For example, a reliable source of potable water is required to clean the produce and maintain cleanliness and sanitation of the workers and premises. Potable water is also needed for processing activities and refuse disposal.

Recommendations

There are a number of key players or stakeholders who need to assume their rightful roles if the whole area of postharvest management is going to be promoted and streamlined in sub-Saharan Africa. Several things can be done:

As a necessary first step, governments, who are the custodians of food systems in many countries, should work to formulate policies that support the food industry while addressing consumer concerns. Issues such as taxation and pricing which ultimately affect the ability of consumers to afford value added products must be taken into consideration in the formulation of policies.

Second, Governments should pursue policies which promote the establishment of agro-industries in the rural areas. The private sector as a whole needs government support to respond to such policies. Such a move is likely to not only improve rural incomes, but to also provide affordable foods for the rural poor. It is clearly an important route to industrialization for any agricultural country in sub-Saharan Africa.

Third, training in food quality control and handling is required in the form of pre-service training or as in-service training courses on the job. It is the failure to observe the simplest food handling rules that leads to extremely serious episodes of food contamination and poisoning. It is essential to establish a culture of the highest sanitation and hygienic standards possible.

Fourth, food fortification programs should address the needs of poor people. A challenging undertaking is the identification of appropriate food vehicles that are affordable by and culturally acceptable to the majority of people in developing countries who continue to be at risk of micronutrient deficiencies.

Fifth, food needs to be protected against contamination at the home level, community, country and within international trade. The media should play a positive role in informing and educating the public and in promoting the image of the agro-industry sector in general and the food industry in particular.

Sixth, packaging practices that address consumer appeal need to be put in place.

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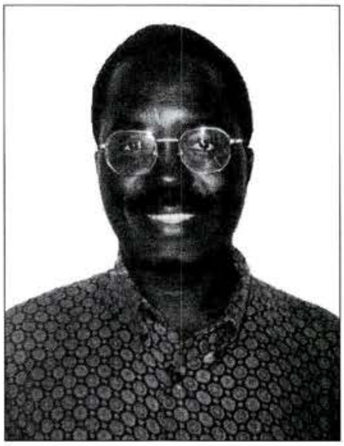
Micro-Scale Enterprise Approach to Sweetpotato and Potato Improvement Systems

Vital Hagenimana



Sweetpotato Production and Harvesting

Sweetpotato (*Ipomoea batatas*) is an important subsistence food security crop grown on a small-scale in the densely populated, mid-elevation areas (1,200-2,000 m) of East Africa. It is a major staple food in Uganda, Rwanda, Burundi, and Eastern Democratic Republic of the Congo, and a secondary food crop in the grain-based food systems of Eastern and Central Africa. The crop is vegetatively propagated, requires low inputs for cultivation and produces modest yields of storage roots (Ewell 1993). The storage roots have a low dry matter content (30% of the root), with starch being the major component (Hagenimana 1994) (table 1). Like other root and tuber crops, fresh sweetpotato does not store well because of its high moisture content. The high moisture content also makes the crop bulky and therefore costly to transport over long distances. These attributes have made sweetpotato and other root and tuber crops essentially crops for rural consumption, in settings where the chain from the producer to consumer is short.

The sweetpotato storage roots are usually harvested a little at a time as needed over an extended period. Harvesting this way provides a flexible source of food for households (Smit and Ocitti p'Obwoya 1994).

Storage

In the fresh form, there is no long-term or even intermediate-term postharvest storage of sweetpotato roots in East Africa. The only kind of storage regularly practiced in the region is in-ground storage whereby farmers keep unharvested mature sweetpotatoes in the field until they are needed for consumption or sale. This practice, however, has problems because after maturation, pest infestations by sweetpotato weevils (*Cylas* spp.) become severe and cause production losses up to 50% (Ndamage 1988).

Sporadic use of rudimentary storage systems in traditional Kenyan communities (Karuri and Ojijo 1994) and storage consisting of underground pits in Uganda (Devereau and Bockett 1994), Malawi, and elsewhere in southern Africa (Woolfe 1992), and covering with grass, on platforms or in baskets (Onwueme 1982), have

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Table 1. Chemical characteristics of fresh sweetpotato roots (variety Tanzania).

Moisture content (%)	67
Dry matter content (%)	33
Starch content (%)	23.5
Dry starch extracted (g/100 g fresh root)	17.0
Total sugars content (%)	3.3
Total protein content (%)	1.65
Lipid content (%)	0.3
Ash content (%)	1.0
Total fiber (NSP[a] + lignin) (%)	3.0
Vitamins & other components (%)	0.3

a/ Non-starch polysaccharides.

been reported. Sprouting and spoilage are, however, common with these storage methods and the roots cannot be preserved well for a long time (Onwueme 1982).

Improvement Efforts

Sweetpotato has a broad genetic base, with tremendous variability (Woolfe 1992), and many characteristics, such as storability, processing quality, and postharvest resistance to pests and diseases differ from variety to variety (Scott et al. 1992; Gatumbi et al. 1992). However, most of the characteristics listed are still unknown for many varieties and therefore calls for continuous screening. Collaborators and CIP's breeding programs have been developing recommendations for appropriate cultivars and practices which improve root quality and extend fresh shelf-life, in the relative short-term. Efforts also include developing an understanding of the physiological mechanisms involved in the deterioration process to enable the development of improved cultivars in the long-term for East and Central Africa and other areas of the world. Since 1993, research on integrated pest management for sweetpotato weevils has been undertaken in Uganda as a collaboration between the National Agricultural Research Organization (NARO) sweetpotato program and CIP.

An integrated crop management program which includes integrated pest management, variety improvement, fresh storage, management of storage pests in dried chips, and broadening the market base of the crop through processing into flour and other products would help farmers improve marketing and utilization of sweetpotato.

Potato Production

Forty percent of the total potato (*Solanum tuberosum*) production in sub-Saharan Africa is produced by countries belonging to the Regional Potato and Sweetpotato Improvement Program in Eastern and Central Africa (PRAPACE) (see table 2). The production is concentrated in densely populated highland areas. The reported average yields are very low, about 5.4 t/ha. As food, potato has less postharvest constraints compared with sweetpotato. The major problem lies with its production. However, accelerated adoption of production technology is often contingent on market outlets, consumer acceptability and storage capacity.

Current Utilization of Sweetpotato

Sweetpotato utilization is remarkably narrow in East Africa. In the fresh form, the crop is most often consumed boiled or roasted. Vines are fed to livestock, particularly in areas like central Kenya where small-scale dairying in zero grazing management systems, is well developed. The crop is also being used as starter feed and partial milk replacer for young calves (Orodho et al. 1995). The limited range of ways in which sweetpotato is utilized in the region seriously undermines the potential benefits of the crop to farmers and consumers. However, there are many products that can be made with

Table 2. Area, production, and yield of potato and sweetpotato for PRAPACE countries, 1995/97.

Country	Population (millions)	Potato Area (000 ha)	Potato Production (000 t)	Potato Yield (t/ha)	Sweetpotato Area (000 ha)	Sweetpotato Production (000 t)	Sweetpotato Yield (t/ha)
Burundi	6.2	14	42	3	111	673	6.1
D.R. Congo	46.8	7	40	5.9	109	409	3.8
Eritrea	3.3	5	40	8.2	0	0	-
Ethiopia	58.2	45	358	8	20	158	7.9
Kenya	27.8	75	205	2.7	74	633	8.5
Madagascar	15.4	49	278	5.7	84	469	5.6
Rwanda	5.4	25	98	3.9	150	1,050	7
Tanzania	30.8	36	242	6.8	250	386	1.5
Uganda	20.3	53	367	6.9	513	1,927	3.8
PRAPACE	214.2	308	1,669	5.4	1,311	5,706	4.4
SSA (1995)	n.a.	483	3,722	7.7	1,322	5,942	4.5

Source: FAO.

sweetpotato as a major ingredient. For example, Collins and Abdul-Aziz (1982) testing the effect of sweetpotato flour as an ingredient on quality of yeast-raised doughnuts, found the overall quality not significantly lowered by the addition of sweetpotato. Gakonyo (1993) and Omosa (1997) have shown that sweetpotato could, with a high degree of success, partially replace wheat flour in processing of baked and fried products. Odaga (1992) has shown that sweeter varieties of sweetpotato can save on sugar and wheat flour in baking.

In some parts of Uganda, farmers also harvest, chip, and sun dry the roots as a way to preserve and store the crop. The dried sweetpotatoes have become a very important staple during the long dry season due to the emergence and increasing severity of the African cassava mosaic virus (ACMV) (Hall 1995).

Current Utilization of Potato

Potato is a staple food and a cash crop in highland producing areas and a highly preferred food in fast growing urban areas. It provides on-farm and off-farm employment and critical income to poor households as most of the potatoes for the urban market are produced by small-scale farmers. Marketing channels have been developed between producing areas and urban areas primarily by small, independent traders and shippers.

The processing of potato into French fries and crisps, particularly for urban markets has provided employment opportunities in cities as chips are in high demand in restaurants and snack bars (Walingo et al. 1997). Processing reduces the bulkiness and perishability of the potato crop and consequently contributes to reducing marketing costs and consumer prices. However, the low processing quality of fresh potatoes is still a major constraint to processors. Other problems facing processors include the high capital investment required to purchase modern processing equipment, constant electrical power failures and water shortages that result in high losses.

Priority for Interdisciplinary Research

Few farmers in East Africa currently manage sweetpotato and potato for maximum yields. Research designed to increase productivity must be accompanied by research designed to increase market demand. In most parts of Africa, this means identifying opportunities for totally new uses for sweetpotato and potato, while enhancing traditional uses

Table 3. Major constraints to increasing production and productivity of potato and sweetpotato in PRAPACE countries.

Type	Constraint	Strategy
Socioeconomic & policy	Lack of policy for the production and supply of seed or planting material Lack of market studies and weak distribution systems Poor linkage between research, extension and private sector Lack of credit system and inability to purchase inputs	Policy and market studies Widening partnership Loan and credit policy
Seed/planting material	Lack of good quality seed/planting material of improved varieties and timely available	Informal farmer-based seed systems
Postharvest	Lack of storage & processing technology Opportunity for utilization & marketing not well developed Qualified human resource not available (all levels)	Selection of better varieties for postharvest characteristics Transfer of storage/processing technologies Product development, processing techniques and market studies Training
Biotic	Late blight, Bacterial wilt Viruses Weevils	Integrated management
Abiotic	Declining soil fertility and natural resource base Lack of early maturing, drought resistant, high dry matter & beta carotene contents materials	Varietal development Integrated nutrient management

and transferring proven technologies from one place to another, where conditions are similar. It also means dealing with production and post-production constraints, including marketing opportunities (see table 3). As a starting point appropriate product and processing technologies from Asia and Latin America can be tried and adapted to African conditions. The theoretical potential of sweetpotato and potato as a raw material can, however, be realized only through creative and flexible interdisciplinary research.

Objectives of Postharvest Research

The overall objective of CIP's postharvest research is to improve the welfare of the rural poor by diversification and expansion of sweetpotato and potato utilization. Working to attain this goal involves reducing processing costs, making more effective use of potato tubers and sweetpotato vines and roots, identifying new uses and markets, and facilitating the adoption of improved germplasm by identifying materials with superior postharvest traits. Specifically, CIP's postharvest research efforts aim to:

- Increase incomes and provide greater opportunities for women through the addition of value to the raw produce during primary processing. For example, obtaining desirable flour from sweetpotato roots and chips from potato, through technical and socioeconomic research.
- Enhance food security by taking advantage of the nutritional qualities of sweetpotatoes in fresh form.
- Analyze CIP's germplasm collection to identify clones with the most promising postharvest traits for starch, flour, and feed.

- Reduce rural poverty and improve food security by promoting a more efficient use of potato tubers and sweetpotato roots, and by using the vines and other by-products as animal feed.
- Strengthen and develop capabilities in potato and sweetpotato postharvest utilization through training.
- Build linkages with the private sector, policy makers, and other interested parties (e.g., rural development projects) for the purpose of generating policies and programs that support the diversification and expansion of sweetpotato utilization.

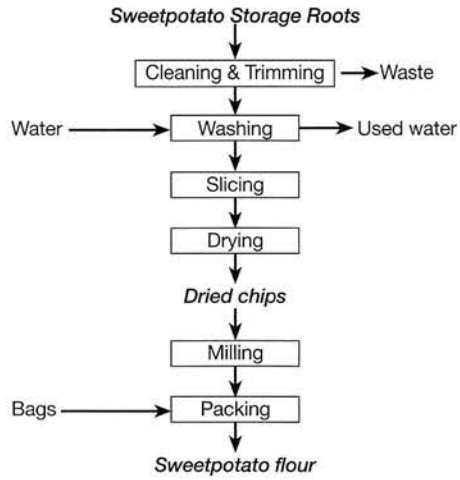

Fig. 1. Process flow diagram for producing dried sweetpotato chips and flour.

Strategy

In Africa, the fresh root market and on-farm consumption is still dominant. However, small-scale processing enterprises have been emerging in recent years that offer lessons for the future. Adding value to sweetpotatoes through processing, and using the vines and other by-products as animal feed, offer opportunities for income generation which can improve development for poor communities in many areas. Lessons can be learned from Asia where 85% of global sweetpotato production is concentrated and where shifts in utilization from fresh root consumption towards feed and processed products such as starch, chips and flour are in progress. It is important to focus postharvest utilization research on processed products like chips, crisps, starch and flour (see fig. 1) as well as animal feed from vines and roots. There must also be a continuous effort to develop new uses for the crop in the fresh form (Hagenimana et al. 1998a; Hagenimana et al. 1998b).

Ex-ante analyses of the potential markets for baked products (bread or buns, chapatis, and mandazis) with sweetpotato as an ingredient in Kampala and Lira, Uganda, indicated high acceptability and good competitiveness of the products, especially in small urban trading centers close to the sweetpotato production centers. Products containing cooked and mashed sweetpotato were exceptionally accepted by consumers who expressed a high level of willingness to pay the same prices for sweetpotato-based products as for similar products they have been buying. It was found that sweetpotato improves the taste, texture, freshness, appearance, sweetness and color of local foods such as buns, chapatis, and mandazis (Hagenimana and Owori 1996).

The nutritional value of sweetpotatoes (especially high levels of vitamin A) offer an added benefit to processed products. For example, studies have been conducted to assess the potential for improvement of the vitamin A status of people in western Kenya through the dissemination and promotion of the use of orange-fleshed sweetpotato varieties. The results of these studies suggest that the introduction of orange-fleshed sweetpotato varieties along with training on processing, marketing and nutrition, could significantly contribute to alleviation of vitamin A deficiency in parts of Africa where sweetpotato is grown (Low et al. 1997; Hagenimana et al. 1998b; K'osambo et al. 1998).

Taking the above into consideration, CIP's postharvest research activities are guided by the following strategic principles:

- Focus on primary processing of potato and sweetpotato into value-added products such as chips, crisps, starch and flour.
- Focus on uses of potato and sweetpotato (including vines) as animal feed, especially for high producing animals such as pigs and dairy cattle.
- Use of product development methodology developed by CIP, CIAT and IITA. This methodology comprises opportunity identification, market and technical research, pilot enterprise feasibility and commercial expansion or replication of enterprises.
- Placing emphasis on small-scale technologies that are both efficient and produce quality products, or link small-scale producers to industrial-scale processors.
- Paying attention to basic research where necessary, to resolve problems or realize opportunities identified as important for target beneficiaries (e.g., starch functional properties as related to baking quality).
- Linking up with centers of expertise not available locally.
- Collaborating with the private sector, NGOs, national agricultural research systems and other international agricultural research centers involved with work in roots and tubers, where necessary, to achieve project objectives.

Technology Transfer

With respect to technology transfer, studies in Lira, Uganda, have shown that at least four steps are required to transfer an identified technology to users in food product and rural-based enterprises: market and consumer evaluation of the product, technical evaluation at the piloting scale, adjustment of the technology to the users' need, and invitation of enterprises to use the developed technologies through technical and financial training. The technical training should relate to potato and sweetpotato while the financial training should relate to loans and book keeping.

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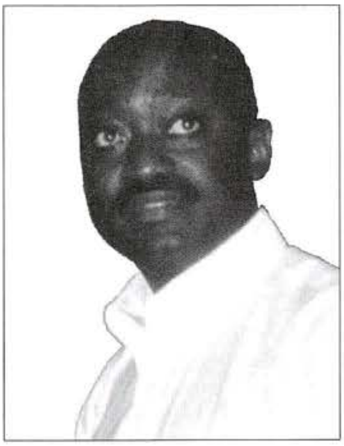
Promoting Improvements in Postharvest Systems in Sub-Saharan Africa: The Role of IITA

Mpoko Bokanga



Over the past 30 years, IITA has contributed to the agricultural development of Africa mainly through the development of high yielding, disease- and pest-resistant varieties of six major African food crops, and through the development and application of biological control methods to protect crops from pest damage. Between 1966/68 and 1996/98, Africa's population experienced a 222% change. During the same period, the production of cassava, yams, cowpea and soybean exceeded this change by 21%, 25%, 56% and 729% respectively (see table 1). Despite these positive changes, poverty and food insecurity continue to be on the increase in some areas in Africa.

In the mid-1980s, it was realized that some improved varieties of crops were not being adopted by farmers either because these varieties did not have the right taste or could not be used to prepare traditional food products. —armers also complained that they did not have profitable markets for the extra produce arising from increased production. In addition, the drudgery involved in processing crops into food products, particularly by women who had almost total responsibility for processing, was seen as an impediment to increasing crop production. To respond to these challenges, IITA, in the late 1980s, decided to increase its capacity in postharvest research and technology by recruiting a postharvest engineer and two food technologists. The engineer embarked on a program to develop simple and low-cost machinery for harvesting, processing and transportation while the food technologists focused on efforts to expand the utilization of crops by developing and promoting new products for household and commercial use.

Improving Postharvest Systems

The research agenda of IITA is subdivided into 16 projects including one postharvest project called "Improving Postharvest Systems." The overall goal of this project is to increase the income generating capabilities and improve the nutritional status of farmers, processors and consumers in the rural and urban communities of sub-Saharan Africa. The project's aims include:

- identifying market opportunities

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Table 1. Changes in Africa's population and in production of IITA mandate crops between 1966/68 and 1996/98.

Period	Population (millions)	Production (million t)					
		Cassava	Maize	Yams	Plantains	Cowpea	Soybean
1966/68	337.3	35.0	20.3	12.1	11.2	0.8	0.08
1996/98	745.6	85.0	41.0	29.9	21.9	2.4	0.79
% change	222	243	202	247	196	278	951

Source: FAO.

within the postharvest system and generating a range of technologies which will enhance food security and provide competitive options for farmers, processors and consumers in the food, feed and industrial sectors

- enabling regional networks, national agricultural research systems, non-governmental organizations (NGOs) and community-based organizations to evaluate and disseminate new technology packages to increase the commercialization of IITA mandate crops
- strengthening IITA's partners' capability to carry out postharvest research and development projects.

Project Outputs

The first expected output from this project is a characterization of postharvest systems found in the region. This characterization covers products made from IITA mandate crops, in terms of quality, cost of production, consumption patterns and trends, supply and demand potential, existing and potential markets, and processing methods and machinery. Results from characterization will reveal existing technologies and mode of utilization of crops, and enable the identification of constraints and the selection of priority areas for research and interventions.

The second expected output is concerned with the development of technological solutions to identified constraints and opportunities. These solutions fall into four categories: quality improvement in new variety development, product and process development, postharvest equipment development, and Improvement in storage systems.

The third expected output is the transfer of postharvest technology through degree and non-degree training programs, demonstration of developed technologies, and participation in exhibits and agricultural trade fairs. New technologies are tested in various countries through collaborative research with local institutions. The modes of information dissemination used by the project include scientific publications, publication of a newsletter, organization and participation in workshops and conferences, and interactions with visitors throughout the year. In this manner, the project contributes to the dissemination of postharvest technology know-how and to the strengthening of human resources involved in the postharvest sector.

In the area of impact assessment, baseline studies are conducted to provide a basis for measuring impact, and to identify existing technologies developed at IITA or elsewhere which can readily be tested as possible solutions to identified constraints. Ex-post impact assessment shows improvements in the postharvest system and indicates when it is most appropriate for IITA to disengage and devolve responsibility to collaborating local organizations or partners.

The improvement and use of postharvest technology can increase the utilization of crops and thus further stimulate their production. IITA's experience with soybean and cassava will serve to illustrate this point.

Expansion of Soybean Utilization in Nigeria and Impact on Production

Soybean cultivation was introduced in Nigeria in the 1940s as an export crop. There was therefore no attempt to encourage local processing or consumption of the crop. By the 1960s, soybean export had reached 15,000 tonnes / year. The level of export dropped sharply in the 1970s, and almost came to a halt in 1977 because of the civil war in Nigeria.

By the early 1980s, IITA had achieved several research breakthroughs in soybean production: breeding of high-yielding soybean varieties that could nodulate with bacteria found in African soils; curbing the tendency of pods to shatter and disperse the beans before they could be harvested; and reducing the time requirement for the crop to mature, to suit rainfall patterns in savanna areas. Despite these breakthroughs, little interest was shown by farmers towards the cultivation of the crop. This was because there was no market for the grain, and most people had little idea of how to cook soybean for home consumption.

In 1983/84, a severe drought reduced the availability of the locust bean (*Parkia clappertonia* and *P. filicoides*), which was traditionally used in the preparation of dawadawa, a local seasoning ingredient. Producers of dawadawa began substituting the locust bean with soybean, thus creating a small local demand for soybean. This small but new demand for soybean encouraged IITA to start a small Soybean Utilization Project in 1985. The hope was that with appropriate research and linkages with industries, women's groups, extension services and other relevant organizations, an increased demand for the crop could be fostered which could in turn lead to the development of a market for the soybean grain. Working in collaboration with the Institute for Agricultural Research and Training (IAR&T), at Moor Plantation, Ibadan, and with the support of the International Research Development Centre of Canada, the project developed and propagated soybean processing technologies, such as extrusion-cooking and screw press technology, for producing soy products for both human food and livestock feed.

The Soybean Utilization Project also developed a wide range of food products that incorporated soybean into traditional maize and cassava food products; examples are "soyvita," "soygari" and "soylafun." New products such as soymilk, sorghum / soy biscuit, and "soyamusa" were also developed and commercialized. During this time, various NGOs (e.g., UNICEF) were promoting soybean consumption for its nutritional value. Between 1987 and 1989, the number of markets selling soybean products in the city of Ibadan increased from 2 to 19, while the number of retailers went up from 4 to 419 (Ogundipe and Osho 1990). Before 1985, only one of the current enterprises in Nigeria had been producing soybean oil and feed cake, with an annual capacity of 500 metric tons. By 1989, six companies were producing oil and feed cake, with over 117,000 metric tons per year capacity. The production of oil / feed cake from soybeans accounted for 95% of the total capacity for the industrial use of soybean. Between 1987 and 1997, soybean production in Nigeria increased three-fold from 107,000 to 361,000 tons per annum, while from 1961 to 1986 production had stagnated between 60,000 and 80,000 tons per annum.

The case of soybean in Nigeria shows clearly that increasing industrial demand

and home consumption have driven the expansion of soybean production. The increased demand for soybean has been supported by a conducive policy environment and the availability of appropriate postharvest technologies.

Cassava's Potential for Commercialization and Impact on Production

In Africa, cassava is used mainly for human consumption and has become the most important contributor to food security on the continent. Production has kept up with population increase. In Nigeria, the annual per capita cassava production has gone from 150 kg in 1980 to about 250 kg in 1994 (Ouraga-Djoussou and Bokanga 1998).

In addition to its traditional uses, cassava can be promoted as a modern food ingredient, comparable to wheat in some of its applications in the food industry, and as a modern input in the growing agro-industrial sector. In order to absorb excess supply and increase farm income, the highly perishable cassava roots have to be transformed into a more stable product with a longer shelf life than the fresh roots, and with the physico-chemical characteristics desirable in the baking industry. IITA has developed a simple process for producing high quality cassava flour suitable for the baking and other food industries. The process has been tested and adopted by women and farmers' groups in the rural areas of Oyo and Ogun states. These rural-based cassava processors are currently supplying cassava flour to urban-based biscuit manufacturing companies, bakeries and fast food manufacturers. The demand for cassava flour is growing, as new end-users are made aware of the possibility of using cassava flour in their products and processes.

The opportunities for cassava flour include uses not only in the baking industry, but also in the alcohol and starch manufacturing industries. A large alcohol manufacturing plant in Nigeria has successfully switched from sugarcane molasses to cassava flour as a raw material for alcohol production.

Some simulations of alternative uses of cassava flour in various industries have been made, and these have indicated that Nigeria could save significant amounts of foreign exchange earnings, which could be transferred to cassava processors and farmers. For instance, if wheat was substituted with 15 percent cassava flour, Nigeria would save $14.8 million in foreign exchange. These savings could partly be transferred to cassava processors ($12.7 million) and cassava farmers ($4.2 million). The benefits are even higher when a 20% substitution of cassava flour for wheat is considered (Ouraga-Djoussou and Bokanga 1998).

The development of high-yielding, disease- and pest-resistant varieties, and the biological control of introduced pests of cassava, have set the stage for a tremendous increase in cassava production in Nigeria and elsewhere in Africa today. In addition, IITA has developed cassava processing technologies that reduce the drudgery of traditional processing methods and produce high quality food products and ingredients for industry. There is the need for favorable socio-economic policies and dedicated extension mechanisms to push further the utilization of cassava, in a manner that will enhance the income-generating capacity of cassava farmers and processors.

Development of Tools for Improved Postharvest Systems

With increased agricultural production, there is a need for greater efficiency in handling and processing the harvest into value-added forms which are easier to store. One focal point of the IITA postharvest project is to increase the efficiency and capacity of postharvest operations as well as reduce the drudgery experienced by postharvest operators. Traditional postharvest systems have been analyzed with a view to identifying gaps and inefficiencies which have enabled the development of technological solutions. IITA's processing systems have improved technical features: simple and affordable, high product recovery, less labor input and improved storage and quality. For example, the collaborative study of cassava in Africa (COSCA) revealed that in sub-Saharan Africa, women were involved in 95% of cassava processing operations. An engineering analysis of traditional cassava processing in Nigeria showed that labor input for the processing of 10 tons of fresh cassava roots amounted to 295 man-hours of which women contributed 87% and processing losses were over 22%. A modern processing center equipped with simple machinery such as a grinder, a manually operated screw press, sifters and energy-conserving fryers could reduce the labor requirement by 70% and the processing losses to only 10% (Nweke 1996).

Conclusion

The cases of soybean and cassava discussed above are good examples of the catalytic role that postharvest technology can play in increasing the utilization of crops and in stimulating their production. They also show that postharvest technologies provide the tools needed by farmers to convert their harvest into commodities that will attract the income they deserve. IITA has been at the forefront of agricultural research and development in Africa and is now heralding a new approach to agricultural research, one that is holistic and embraces the production-to-consumption continuum. The project for improving postharvest systems will continue to generate technologies that will promote increased utilization of crops for greater income and better nutrition and serve as an engine of growth for increased agricultural production in sub-Saharan Africa.

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Advances in Postharvest Technologies and Systems Appropriate for Sub-Saharan Africa: The Ghana Experience

Kwaku Nicol

The crop sub-sector dominates the agriculture sector in Ghana and comprises about 85% of total agricultural sector production. The remaining 15% is accounted for mainly by livestock, fisheries and forestry. The main food crops include cereals such as maize, sorghum, millet and rice and the non-grain starch staples like cassava, yams, plantains and cocoyams. Even though the non-grain starch staples are the most important in terms of contribution to the overall agricultural production, cereals cover probably some 25% of total cultivated area and thus give important cash income opportunities to a great number of farmers. They are also important food security items as evidenced by the large imports of cereals, especially rice, into the country.

The major technical factors constraining the achievement of increased agricultural production are to be found more in the off-farm than the on-farm areas. Considerable attention has been given to increasing food production through development of high yielding varieties and increasing the availability of growth promoting factors such as fertilizers and water. Much less effort has however been put into the postharvest sector, where the need is to ensure that all the food produced is safely harvested, preserved, processed and distributed to meet the requirements of consumers.

A priority for action to reduce losses of food after harvest lies in the development, adaptation and communication of efficient and appropriate technologies. These technologies must address harvesting, handling, storage, drying, processing and distribution practices, particularly in the rural areas. This paper looks at how the Ghana Government is tackling the problem of postharvest loss reduction.

Government Food Security Policy

An important policy objective of the Government is to accelerate increased food production to reach self-sufficiency in the shortest possible time. In this regard, several efforts are being undertaken to comprehensively tackle the problems, both through immediate measures directed towards eliminating crucial bottlenecks and failures, and through improving medium and long

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term prospects through more effective and feasible agricultural policies and planning. In the area of crop storage, preservation and processing, efforts have been taken by the government to comprehensively tackle the problem. At the national level the Ministry of Food and Agriculture, in a three-phased installation program, has provided grain storage and handling facilities in strategic locations for efficient postharvest management of grain surpluses. This is aimed at minimizing postharvest losses and maintaining adequate grain reserves for both price stabilization and emergency purposes.

Even though the provision of bulk storage facilities should be sufficient to satisfy the demand for food storage in the short run, any lasting improvement in the areas of postharvest losses must involve the education and subsequent adoption by the small scale farmer, of affordable, technologically and culturally appropriate storage, preservation and processing practices. Some considerations in this direction include:

- proper application of insecticides during on-farm storage which would reduce storage losses due to insect attack
- introduction of improved structures that will not only store but will also be able to dry harvested produce while in storage
- promotion of traditional pest control methods (e.g., use of plant materials and fire smoking)
- improvement of traditional handling and storage methods

Post-Harvest Management Division

The Ghana government and donors have in the past, focused so much on increased food production without giving much thought to storage and preservation. Thus, whatever benefits new technologies in production offered were eroded by postharvest losses as a result of lack of storage facilities, insufficient processing facilities and under-developed marketing infrastructure. The picture is now different, as The Ghana government, having realized the enormity of the postharvest problem established the Post-Harvest Development Unit which is now known as the Post-Harvest Management Division (PHMD), in 1986 to fulfil the following functions:

- improve the diets of people in the country by increasing the availability of food through the reduction of postharvest losses
- improve the quality of food by enhancing handling, transportation, processing and storage
- increase income generation capacities of farmers through the adoption of improved grain storage technologies
- introduce mechanization into the processing system to reduce the drudgery on especially women and children who tend to be mostly involved in postharvest activities
- help establish agro-based industries to generate income and employment.
- diversify exports by adding value to products and to conserve foreign exchange through import substitution
- train extension staff in the use of improved postharvest technologies

The Postharvest System

The Postharvest sector embraces many research and other activities designed to improve on food production by reducing losses, increasing storage life, refining crop quality and adding value to primary produce. It therefore involves a wide range of functions between production and consumption. These functions have to be fulfilled efficiently by the different actors or stakeholders in the postharvest chain in order to supply good quality food, keep transaction cost low and at the end of it all, raise domestic welfare or standard of living.

At the moment postharvest development activities or interventions have been centered on researching into the traditional systems of storage and processing and improving upon them. Since a majority of Ghanaian farmers are engaged in small holdings, any intervention to improve the system, takes into consideration the ability of the farmer to afford the new system. Any intervention put in place in the development of postharvest system is assessed holistically, in order to make the system efficient in reducing losses.

Storage

In Ghana, most postharvest activities are centered around storage and processing. It is not exactly known how much of the food produced is used for home consumption, but on-farm storage is essential for food security at the farm level. The Ministry of Food and Agriculture, in collaboration with some non-governmental organizations and some international organizations, is developing and promoting improved on-farm storage facilities. Also an integrated control strategy or system which combines chemical and biological control with other methods such as storage hygiene, the use of resistant varieties and appropriate storage structures, is now being recommended for the safe storage of, especially, grains and legumes.

For chemical control, the specificity of each agro-ecological zone needs to be taken into consideration. For the humid zone EC formulation is recommended while dust formulations are recommended for dry zones. Fumigation can be carried out in all zones but should be under the strict supervision of a highly trained person.

The use of biological control measures is being tried in Ghana and is being incorporated into the national plant protection program. For example, *Teretriosoma nigrescens*, a predator, is being used to control the Larger Grain Borer, a very destructive insect on maize and the release of such a predator or biological agent should be carried out in a systematic manner, including pre and post-release monitoring. Other methods such as storage hygiene, best harvest dates, good storage structures and resistant varieties are also essential to protect the harvested crop.

Processing

Another area of postharvest development that has been intensified is processing. The objective here is to add value to primary produce using a range of technologies and techniques to preserve the produce to make it available at all times of the year. Processing primary produce leads to significant improvement in its postharvest handling properties and a considerable increase in its market demand.

Recently, there has been the need to train local manufacturers and artisans in the fabrication of simple processing equipment. Where such equipment have been designed and fabricated in international research organizations or universities, it is necessary for the equipment to be tried and if necessary, modified to suit local conditions. It is only after successful local trials and necessary modifications have been effected that the equipment should be disseminated to end users within a country. Below are some of the improved technologies that have been disseminated in the country:

- protection of grains against insect pests
- improved drying of grains
- improving grain quality by cleaning, sorting and grading
- improved rice parboiling
- construction of improved ventilated narrow crib
- harvesting of plantain and banana
- harvesting of tomato and other vegetables
- packaging of fresh horticultural produce
- storage of fresh cassava
- use of an iceless cooler
- use of solar dryer
- improved gari processing
- cassava puree production

Marketing

While most staple foods are consumed in all parts of the country, their production is carried out only in certain areas. The movement of commodities from production areas to consumption centers is accomplished through a marketing chain made up mainly of farmers, wholesalers (both sedentary and itinerant), retailers and transporters. According to participants in the marketing chain, the main constraints facing them are inadequate credit facilities, poor market infrastructure, spoilage and poor handling of produce.

Challenges

Most of the research and development work, relating to a number of postharvest aspects, have been found to be uncoordinated. There are many instances where efforts are duplicated and the available resources are not being used effectively. Moreover, the linkage between research and farmers is weak and the research findings on postharvest developments are not reaching farmers. As the PHMD could not effectively carry out its functions without research support, it will have to institute regular workshops and seminars to update research and extension workers on new developments in the postharvest sector, and to initiate and establish continuous exchanges of information between institutions and field workers.

Characterizing the Desirability of Postharvest Technologies for African Conditions

Y. W. Jeon and L. Halos-Kim

L. HALOS-KIM

Postharvest technology research and development in Africa may be said to still be in its infancy. While this may be so, it offers an opportunity to learn from previous experiences of early technology development and extension efforts. Since the early 1970s a number of innovations and technologies had been introduced into Africa with limited success because the technologies often did not fit the users' needs. This state of affairs was due to the fact that early development efforts were based on the classical piece-meal technology development approach that satisfies the whims of the designers, but not the expressed needs of end-users. Also, imported technologies introduced through development aids, grants or loans failed to consider the technical requirements for operating the technologies.

The preceding observations on technology development and introduction in Africa, suggest that technology development approaches should be re-oriented to fully integrate social, economic, and technical considerations. Agriculture in Africa has unique characteristics that necessitate careful planning and a strategic approach to technology development. Strategies that have been found to be useful are those that used holistic and participatory technology development approaches. Such strategies lead to the proper targeting of technology users and also contribute to the full understanding of the constraints and opportunities for developing appropriate technologies.

This presentation summarizes recommendations by Jeon and Halos-Kim (1997) on improving postharvest technology development in Africa. First, it is important to look at the characteristics of agricultural production and post-production systems critical to the development of postharvest technologies. These characteristics are important because they form the basis for identifying desirable attributes of postharvest technologies that are suitable under the given conditions.

Crop Production and Food Processing Patterns

Agriculture in sub-Saharan Africa is characterized by small, fragmented,

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resource-poor farms on which multiple food crops are mainly for family consumption. One of the major crops grown is cassava, a root crop important in the diets and livelihoods of many small farm holders. About 80% of the cassava grown is consumed by the producing household. Harvesting of cassava for consumption is usually done weekly while processing is done throughout the year by women and children using rather slow and sometimes unhygienic traditional methods.

Cereals and grain legumes are also grown extensively with about 75% being consumed by the producing household. Maize is mainly grown as a cash crop, while sorghum, millet, and cowpea are grown for family consumption. Each crop has a brief harvest period, but the harvested crop is processed into food products in small quantities throughout the year.

Handling Efficiency

Production increases resulting from improved growing practices are diminished by improper handling of the crops after harvest. In cassava, post-production losses can be as high as 45%, with about 14% occurring during harvesting and 22% during processing. Qualitative and quantitative post-production losses in cereals and grain legumes have been estimated at 30 to 50%. These losses result from field and environmental conditions, varietal characteristics, untimely harvesting, improper drying, insect damage, consumption by livestock, operators' attitudes, and lack of processing tools and equipment.

Gender Roles and Status in Crop and Food Production

Division of land resources among adult family members is common in Africa. Land allocation distinguishes each family member's role and status in crop and food production. Men and women perform distinct roles in crop and food production. The division of labor is based more on the physical difficulty of the task than the magnitude. Men are generally involved in production activities, while post-production activities, in addition to household chores, are reserved for women. The woman's role in processing is also to a large extent, dictated by social and cultural norms.

Farmers also tend to differentiate tasks by the type of crops grown. Maize is considered a cash crop and is controlled mostly by men from production to marketing. Sorghum, millet, and cowpea are crops grown by women for family consumption. In many cases, women and children provide the labor required for activities ranging from crop care and management to processing.

Labor Requirement

Most traditional postharvest operations are slow and therefore time-consuming. For example, Jeon and Halos-Kim (1994) estimated that it normally takes 663 laborer-hours to harvest and process 10 tonnes of cassava roots harvested from a 1-hectare field. In addition to being involved in harvesting and processing, which require the most labor, women contribute 87% of the time required to process food for family consumption, (Jeon and Halos 1991).

Labor input for harvesting, handling, drying and processing cereals and grain legumes (217 laborer-hours/t) is provided mainly by the family members—20% is contributed by the husband, 62% by the wife, and about 15% by adult sons or daughters (Jeon and Halos-Kim 1994).

The timing of harvesting and consequent operations for cereals and grain legumes is critical. This is because safe processing and storage can only be ensured when the crop is gathered quickly before severe deterioration and pest damage occur. This urgency places a heavy load on the women and children who normally perform most of the postharvest activities.

Implications for Technology Development

The issues raised above suggest that postharvest operations, including food processing, are mainly the responsibility of women. A majority of these women use inefficient traditional methods which necessitate the development and introduction of improved postharvest technologies. The pattern of crop production, the type and nature of food processing and consumption, the available resources, the technical and economic capability of the farmers, and the marketing opportunities available are among important criteria affecting design and capacities of postharvest equipment. In addition, the special requirements for specific food preparations, as well as taste preferences of the consumers, must also be taken into account.

In Africa, gender roles and status in crop and food production are distinct and can not be ignored in the technology development process. Men and women tend to have different production objectives that should be addressed. More enterprising individuals, generally men, and groups require technologies that will address their income generation objectives, while most women, representing individual or family units, require technologies that will provide more and better food for the family with less labor input.

To enhance productivity, the development objective is to provide appropriate tools and equipment that overcome excessive losses, high labor input, and poor product quality. Consequently, the technologies should create opportunities to increase the income and save the time of processors, which can then be devoted to other productive activities.

Technology Attributes Desirable for African Conditions

The application potential of postharvest and agro-processing technologies introduced under African conditions should be based on whether these technologies are simple enough to be operated and maintained, even by women. This, and other desirable characteristics of postharvest technologies for African conditions are summarized in the following sections should be given increasing attention in technology design and development.

Characteristics Related to Technology Design

To address the diverse nature of African farming systems and to satisfy the taste and food preferences of consumers requires different types of technology packages or package components having the following attributes and advantages:

Simple, easy to operate and maintain

— Makes technologies manageable, even by women processors
— Reduces technical problems, i.e., mechanical breakdowns

Technology level based on existing technologies and indigenous knowledge

— Adapts existing technologies already known to users
— Relates to compatibility and transferability of existing and new technologies
— Facilitates adoption of technologies

Ability to handle different crops

— Allows farmer to diversify and expand production

Dual, or multiple application

— Reduces investment cost
— Ensures utility continuum

A range of capacity for different levels of operation
— Addresses user's production objectives: for consumption and/or marketing

Balanced technology mix
— Matching capacities of each component technology in the system
— Eliminates voids and clots in the processing chain

Uses locally available materials for construction and operation
— Eliminates importation costs
— Has low investment, operation and maintenance costs
— Encourages the participation of private sectors

Characteristics Related to Technology, Economics and Social Science

The ultimate goal for introducing technology into any social system is to improve the economic and social well being of the target users. User's attitudes and economic status affect decisions and investments with regard to technologies. Technologies addressing these concerns are characterized as:

Affordable
— Requires low investment, operation and maintenance costs

Equally beneficial to farmers, processors and consumers
— Makes available good and nutritious foods
— Creates additional source of income
— Better allocation of resources
— Improves economic scale of the farmers and processors at all levels

Gender-sensitive empowering farmers and processors in their own rights
— Eliminates dependency on vested groups
— Allows farmers and processors to manage their time and operations effectively

Characteristics Related to Technology and Utilization

Adoption of new products developed to expand the market potential of a crop may be hindered by consumer preference for traditional processes and products. New high quality products should therefore be similar to existing products and preferred qualities to ensure a high level of acceptability. The nutritional attributes of the crops must be considered along with other desirable features when planning expanded utilization alternatives for value added products. Therefore, technologies developed should provide for:

Product diversification
— Allows the production of more food and non-food products
— Opens market opportunities

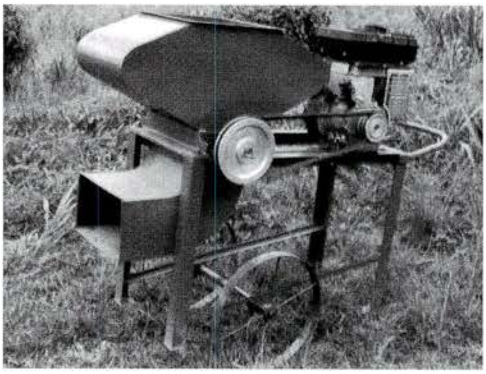
New products similar to existing preferences
— Improves the chances of being accepted

Improve nutritional attributes
— Improves the health status of particularly children
— Increases market-competitiveness of the product due to the new value-added state

The Challenge

Technologies proven to work in other developing countries may not prove effective under African conditions. African agriculture has its unique characteristics that make technology development and adoption more complicated. Thus, a careful process that analyzes the socio-cultural and economic characteristics of rural farm families, their attitudes and food preferences as well as the technical criteria must be used in the development of technologies for Africa. Some postharvest equipment developed by IITA after careful analysis of the African conditions is shown below. These pieces of equipment are being promoted by the Sasakawa Africa Association in some West African countries such as Ghana, Benin and Nigeria.

GRATING MACHINE



Power Drive: 3.5 Hp Petrol Engine.

Capacity: Up to 1.0 t/hr.

Fuel Consumption: 1.2 l/hr.

Installation: 4 anchor bolts (for stationary operation) or a pair of transport wheels (for mobile operation).

Advantages

- Oval-shaped hopper reduces spillage & increases cassava/rasper contact.
- Has high capacity.
- Does not require much power for operation.
- Produces pulp of uniform size.
- Can be adjusted for different fineness of grating.
- Allows easy collection of grated pulp.
- Lightweight design allows easy mobility of equipment.

Repair & Maintenance

- Requires regular engine check-up.
- Requires rasper replacement every 1000 hr of use.

Application Potential

- Can be used for grating cassava.
- Can be used for mashing fruits and vegetables for juice extraction.

FERMENTATION RACK

Capacity: 5 to 8 bags of grated pulp per loading; or approx. 0.5-tonne per batch in 2-3 hours.

Advantages

- Provides a hygienic way to hold fermenting cassava.
- Has a convenient starch collection feature to collect good starch expelled with water during the first 3 hours of fermentation.
- Features a simple compact design which minimizes processing space requirements.
- Easy to move around.

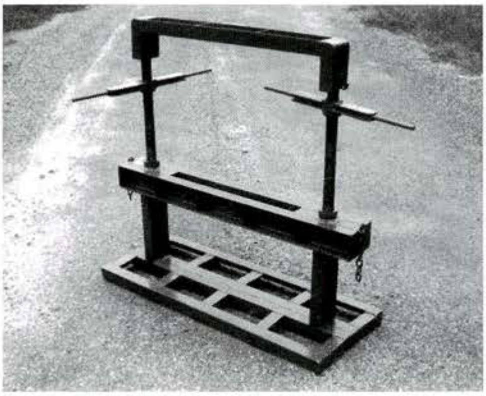
Repair & Maintenance

- Requires regular washing.

Application Potential

- Drain rack can be used for starch collection and similar applications.

DOUBLE SCREW PRESS



Capacity: 200 to 350 kg, or up to 5 bags per batch.

Rate of Dewatering: Pulp with an initial moisture content of 70 - 80% can be reduced to 40 - 45% moisture content in 4 hours.

Oil Extraction Rate: 1.50 l/kg; or 300 l per batch.

Advantages

- Improves compressive force with less strain to the structural frame of the press.
- Has an adjustable press bar which allows varying loading capacity.
- It is movable; base construction needs no special footing design.
- Can be tilted to allow easy cleaning and draining; or to collect expelled water or oil.
- Easy to operate.

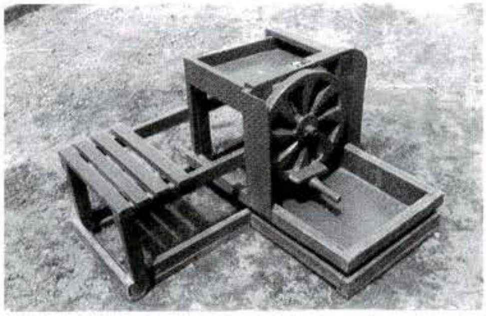
Repair & Maintenance

- Requires regular washing.
- Requires greasing of screws.

Application Potential

- Multipurpose batch type press can be used for commercial scale operation.
- Can be used for dewatering cassava pulp in the preparation of "gari."
- Can be used for palm oil extraction.

CHIPPING MACHINE (Manual)



Capacity: Up to 200 kg/hr.

Operating Speed: About 60 RPM.

Advantages

- Provides efficient cutting even with very fibrous roots.
- Eliminates de-fibering operation.
- Produces uniform sizes of chips with minimum stumps.
- Lightweight construction makes it easy to move around.
- Simple to operate.
- Produces thin chips which dry and/or ferment faster to produce a better quality product.

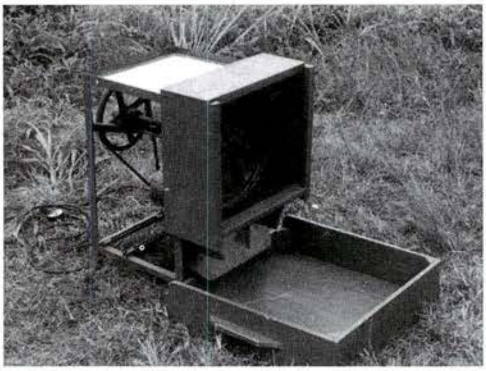
Repair & Maintenance

- Requires occasional sharpening of blades.
- Requires washing after use.

Application Potential

- Can be used for chipping root and tuber crops (cassava, yam, potato, sweet potato); also plantain.

CHIPPING MACHINE (Power driven)



Power Drive: 3.5 Hp Petrol Engine; or 0.5 Hp Electric Motor.

Capacity: Up to 1.2 t/hr.

Fuel Consumption: 0.8 l/hr.

Operating Speed: 250 RPM.

Advantages

- Does not require much power for operation.
- Provides efficient cutting.
- Produces uniform sizes of chips with minimum stumps.
- Eliminates the need for de-fibering operations.
- Produces thin chips which dry and/or ferment faster to produce a better quality product.
- Lightweight construction makes it easy to move around.
- Simple to operate.

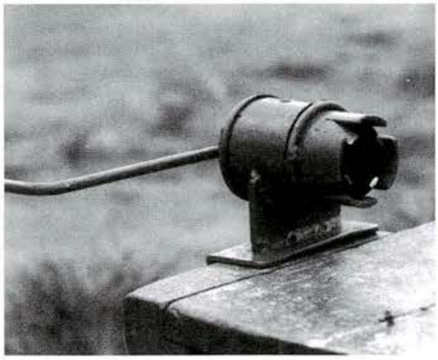
Repair & Maintenance

- Requires occasional sharpening of blades.
- Requires washing after use.
- Requires regular engine check-up.

Application Potential

- Can be used for chipping root and tuber crops (cassava, yam, potato and sweet potato); can also be used to chip plantains.

MAIZE SHELLER (Manual)



Capacity: Up to 30 kg/hr.

Advantages

- Adjustable threshing teeth suit varying cob sizes.
- Reduces grain breakage.
- Simple to fabricate using local materials.
- Portable, can be mounted on any table or bench.

Repair & Maintenance

- Requires occasional greasing.

Application Potential

- Can be used for shelling relatively dry maize.

MECHANICAL THRESHER

Power Drive: 5.0 to 7.0 Hp petrol engine.

Capacity: 800 kg to 1000 kg/hr (depending on crop type).

Advantages

- The design is compact and portable.
- It is easy to operate and maintain.
- Has grain collection feature to minimize spillage.
- Has adjustable straw thrower/chute for easy collection of biomass.
- Design ensures minimum breakage.

Repair & Maintenance

- Requires changing of pegs as necessary.
- Requires cleaning machine from debris after use.
- Requires regular engine check-up.

Application Potential

- Can be used for threshing maize (with or without husk).
- Can be used for threshing rice, soybeans, cowpea.
- Can be used for threshing sorghum, millet.

GRAIN POLISHER (Abrasive Type)

Power Drive: 3.5 Hp petrol engine.

Capacity: 5 to 10 kg per batch.

Polishing Time: 15 to 30 min, depending on degree of polishing or whiteness required.

Advantages

- Eliminates soaking and pounding operations.
- Allows collection of good quality bran for animal feed.
- It is easy to operate.
- It is portable and can be moved around.

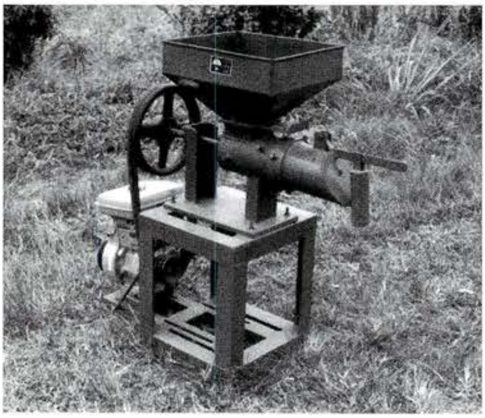
Repair & Maintenance

- Requires replacement of worn-out discs.
- Requires regular engine check up.
- Requires brushing of discs immediately after use.

Application Potential

- Can be used to polish rice, maize, millet, sorghum, other grains.
- Can be used for grinding cassava and yam chips into flour.

GRAIN POLISHER (Auger type)



Power Drive: 3.0 Hp electric motor, or 5.0 Hp petrol engine.

Capacity: Hulling/Polishing 120 kg/hr; Kernel cracking = 250 kg/hr.

Advantages

- Has high recovery rate for whole grain, and/ or nuts.
- Can be operated in multiple passes.
- Discharge counterweight controls efficiency of hulling or cracking.

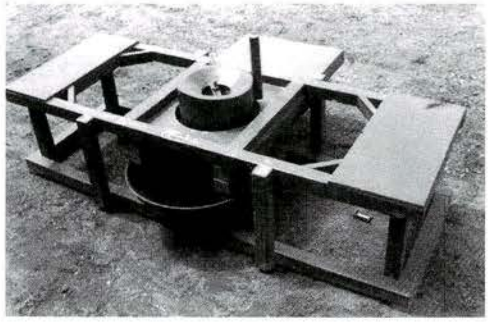
Repair & Maintenance

- Requires dusting off machine parts particularly auger every after use.
- Requires regular engine check-up.

Application Potential

- Can be used for hulling/polishing rice, especially parboiled rice, maize, sorghum, millet.
- Can be used for cracking palm kernel and digesting oil palm digesting.

GRINDING MACHINE (Manual)



Capacity: Up to 5 kg/hr of wet or dry grinding.

Advantages

- Easy to fabricate.
- Has adjustable plate clearance to suit grinding requirement.
- Multi-pass operation produces fine grind.
- Can be operated by one or two persons.
- Reliable for family food processing.

Repair & Maintenance

- Requires brushing and washing after use.
- Requires occasional checking of bolts and other joint fasteners.

Application Potential

- Can be used for grinding cassava, yam and, plantain chips into flour.
- Can be used for dehulling soybeans and yambean.
- Can be used for wet and dry grinding of maize, cowpea, soybeans, sorghum, millet.
- Can be used for wet and dry grinding of vegetables (pepper, tomato, okro, etc.).

GRINDING MACHINE (Abrasive type for wet grinding)

Power Drive: 5.0 Hp petrol engine, or 3.0 Hp electric motor.

Mechanism: Pair of grinding stone plates.

Capacity: Up to 50 kg/hr.

Advantages

- Has adjustable grinding plate clearance to suit required fineness of grinding.
- It is easy to mount and install.

Repair & Maintenance

- Requires washing after use.

Application Potential

- Can be used for grinding wet materials.
- Can be used for grinding maize, millet, sorghum, soybeans, cowpea.
- Can be used for grinding cassava for starch production and other related applications.
- Can be used for grinding vegetables such as pepper and tomato.

OIL PRESS (Screw type)

Capacity: 10 to 30 kg paste per batch.

Oil Extraction Rate: 0.75 to 1.0 l/hr.

Advantages

- Has convenient oil collection feature.
- Easy to operate.
- It is movable.

Repair & Maintenance

- Requires washing after use.
- Requires greasing of screw.

Application Potential

- Multipurpose batch type press appropriate for small scale operation.
- Can be used for oil extraction: groundnut oil, palm oil.
- Can be used for starch pressing: cassava and maize.
- Can be used for dewatering cassava pulp and soybean curd.
- Can be used for soy milk extraction.

The technological know-how of farmers and processors is often limited to the traditional system. This means that the introduction of new techniques will require a lot of investments in system arrangements and training of human resources. It is important for these investments to be made. Finally, all technological innovations should be enhanced with farmers' traditional knowledge to facilitate the transfer and adoption of the technology.

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INPhO - The Information Network on Post-Harvest Operations

José Venancio Machado and Carolin Bothe


CAROLIN BOTHE

The FAO considers information as a public good that is "non-rival in consumption," which means that one person's consumption does not reduce the amount available to everybody else, and "non-excludable in provision," which means that nobody can be denied access to the good once it has been provided. While information is clearly "non-rival in consumption," it is not necessarily "non-excludable in provision," because the information considered a public good may not actually be in the public domain.

Many factors have contributed in the past to the reduced access to available information. In the post-production sector, for instance, a large amount of literature accumulated by projects developed by research institutes and development organizations remain inaccessible or unknown to those who need it. Also, information on post-production is sometimes difficult to access because it is placed under the general heading of agriculture, or farming or rural development and is therefore immersed and dispersed in a sea of literature.

Post-production Losses and Food Security

Information has a vital role in the management of the post-production sector. This sector includes a wide range of heterogeneous operations or functions such as harvesting, handling, transportation, storage, processing, marketing and distribution which occur between crop maturity and consumption. All these operations have to be performed competently and efficiently by the different actors involved, in order to reduce food losses and supply food of good quality at appropriate times and at reasonable cost.

World food security is largely dependent on the efficiency of the post-production systems. To supply food for a global population expected to reach 8.3 billion in the next twenty-five years, and with increasing pressure on available land and other resources, the world will need substantial increases not only in agricultural productivity, but also forcibly in the improvement of post-production management and distribution systems. This is a challenge in the coming years for most

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developing countries and to the international organizations that are assisting them to achieve this goal.

In fact, even though the technical conditions for increasing production have all been met, the increase may not take place because of post-production constraints and food losses. Food losses represent both a considerable waste of labor and inputs and a significant reduction in the availability of food. For instance, a FAO field project on improvement of rice post-production in Sierra Leone verified that losses can be reduced by 10%, from the present 25% to 15%, through the adoption of improved post-production methods, thus reducing rice imports by one third.

Post-production Development Efforts

FAO has endeavored to improve post-production in developing countries, particularly since the launching of its Special Action Program on Prevention of Food Losses in 1977. Since then, almost two hundred projects have been executed in developing countries, out of which 50% are located in Africa. These projects have been active in fields varying from loss assessment and consequent introduction of improved post-production technologies, to national policy development.

During the past decades, significant contributions have also been made by other United Nations agencies, bilateral and multilateral institutions and NGOs working in the postharvest sector. Appropriate equipment for reducing drudgery in postharvest operations, improved techniques for drying, storage and conservation of crops are a few examples of the achievements of those projects. Many workshops have provided a forum for experts and farmers to share experiences and discuss project achievements.

It has been recognized, however, that the relevant information and literature produced and gathered by those projects, which is vast and useful in various aspects, needs to be widely disseminated so that it can gain usefulness. Among other things, it may, for instance, guide researchers and development agencies in formulating future projects and help avoid unnecessary and costly attempts at introducing into a country technologies, equipment or policies that have proven unsuccessful elsewhere.

Furthermore, the introduction or improvement of a particular post-production technology takes several years for full implementation, since the approach is generally composed of various steps: 1) assessment of the post-production system; 2) creation of awareness of the postharvest problem; 3) setting up of a pilot project to test and compare the improved technology and its costs; 4) institution building for extending the successful results of the pilot project on a larger scale; 5) training of personnel involved in extension of the improved technology; 6) tailoring of extension activities to each target group; using incentives to encourage target groups to adopt the new technology; and 8) making available needed inputs (including equipment and credit).

Notwithstanding all the inputs, efforts and time spent in the implementation of these projects, the adoption of the improved technologies or equipment by the target groups may be, and has been, restricted and limited. As a result, the expected progress in the postharvest system development may be very disappointing.

Learning from Experiences

Experience has led to the widespread understanding that post-production constraints were not only of a technical nature, but part of the global environment (economic, social and legal) affecting agriculture production. The *system approach* was then advocated to analyze the constraints that hinder post-production development. The post-production system could be defined as the set of operations, operators, tools and markets, as well as the complex interrelations (often in opposition) between these components of the agricultural post-production sector.

The system approach envisages the understanding of the interdependency and association between these components with a view to developing effective strategies to achieve specific goals. Although the application of this concept proved to be more difficult than initially envisaged, it has at least built up awareness of the need for an interdisciplinary approach to post-production issues and focused on the inter-linkages among the various operations, actors and support services involved in post-production.

Information dissemination in support of the system approach for effective improvement of postharvest systems and consequently *food security*, is the key issue underlying an initiative taken by FAO, in collaboration with a small group of international organizations (GTZ, CIRAD, and USAID) working in the postharvest sector, to establish a specialized database on postharvest and a network for the exchange of information. It has been dubbed Information Network on Postharvest Operations (INPhO)[1].

Objectives of INPhO

The basic purpose of INPhO is the collection, collation, development and dissemination of useful information regarding various elements of post-production systems, giving particular emphasis to products and technologies relevant to developing countries. This information is mainly accessible through the Internet, but, as access to Internet is limited in some parts of the world, selected information will be downloaded on to diskettes and CD-ROMs for wider dissemination.

The ultimate goal of INPhO is to contribute to food security and economic and social development of the member countries in the developing world. Target users would be entrepreneurs in post-production and members of the support environment, including governmental services, universities and research centers, NGOs, co-operation and development agencies, and professional organizations. The final beneficiary is the small farmer, processor, and entrepreneur.

Elements of the Information Network

The Information Network comprises three major components: a post-production database, a communication and interactive services and a linkage to other databases and libraries (See Fig. 1).

Post-productive database

This a comprehensive collection of information dealing with postharvest issues. It contains information collected and synthesized from literature and the experiences of the participating organizations. The database comprises three sub-components: archives, post-production facts and decision-support tools.

In the archives, users will find bibliographic references, document highlights, new books, magazines and other documents in the field of postharvest issues. An additional feature will be digital

[1] The INPhO Secretariat is located at FAO Headquarters, and is managed by the Post-Harvest Management Group of the Food Industries and Post Harvest Management Services, Agricultural Support Systems Division, in collaboration with the World Agricultural Information Centre. The Network can be accessed through the Internet at www.fao.org/inpho.

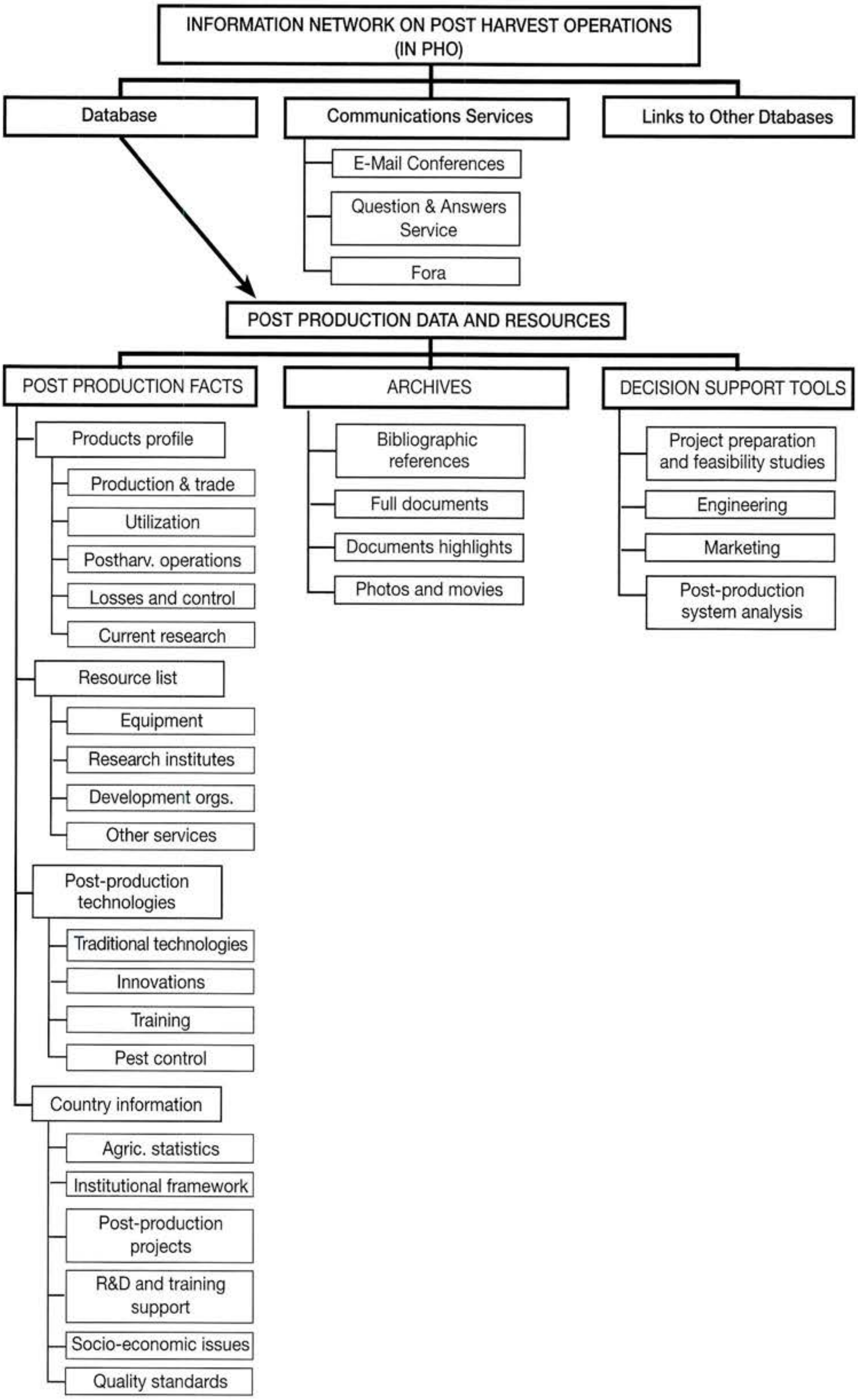

Fig. 1. Information network on postharvest operations (INPhO).

photographs and short video films on post-production operations.

The post-production facts sub-component is divided into the following sections: products profile, resources lists, country information and post-production technologies. The *products profile* will cover subjects such as world production, trade and consumption statistics, post-production operations, post-production losses and current research. The *resources lists* will provide users with information necessary for the planning, implementation or maintenance of post-production programs or projects. The country information will be mainly composed of agricultural statistics, institutional framework, projects, postharvest support, socio-economic issues food quality standards. The section on *postharvest technologies* is reserved for information on training opportunities and available training manuals.

The component on decision-support tools will have a *project preparation and evaluation* section, an *engineering section*, a *post-production system analysis* section and a *marketing* section. The section on project preparation and evaluation is envisaged to provide tools that can assist entrepreneurs in investment and decision-making, such as guidelines, checklists, procedures, simple computer programs to evaluate costs/benefits, and standard format for project presentation. The engineering section will provide information on simple construction techniques, post-production tools, equipment and costs. the section on post-production system analysis will provide tools useful for analyzing, evaluating and assessing post-production systems or sub-systems. Finally, a section is dedicated to the marketing aspects of an investment or project.

Communication Services

INPhO facilitates an interactive Communication Service with the view of enhancing the exchange of information and making available the expertise that exists in various aspects of postharvest. In principle, three types of communication services have been anticipated: E-Mail Conferences, Questions and Answers Service, and Fora.

The E-Mail is a cost-effective medium of communication currently available in both developed and developing countries, and therefore ideal for exchange of ideas among people who reside in different regions of the world. E-Mail Conferences will be regularly organized by the INPhO Secretariat on relevant topics.

In the Questions and Answers Service, which is not yet available, users would be able to ask questions or search through past questions. Some answers may be contributed by resource experts or institutions.

The Fora is a particular site where INPhO users can make comments, suggestions or exchange ideas on selected topics. The Network will provide lists of topics for established fora and instructions for accessing them. One of the fora will be restricted for use by institutions participating in INPhO for exchange of ideas and information.

Links with Libraries and Databases

This is another feature of INPhO. It will offer the possibility of accessing the electronic libraries and databases dealing with postharvest issues of partner institutions.

Conclusions

The objective of the information network (INPhO) established through a FAO partnership with some international organizations working in the field of postharvest is to contribute to the improvement of the post-production sector and to food security. This can be achieved by providing to actors in the post-production system, information that can contribute, directly or indirectly, in a holistic approach, to the efficiency of the postharvest system.

The information provided is selected, collated and harmonized to ease consultation and utilization. The impressive strides made world-wide and in many developing countries in the development of information systems, and the increasing opportunities of communication offered by the Internet, will hopefully facilitate the task of information transfer and exchange. It is hoped that other postharvest web-sites on postharvest would be effectively linked to promote the exchange of information being undertaken through INPhO.

Strengthening the Entrepreneurial Capacity of Small-Scale Palm Oil Millers

Charles Ofori Addo

TechnoServe is a private non-profit, non-sectarian international development agency founded in 1968. Its organizational mission is to improve the economic and social well-being of low-income, rural people in developing countries through a process known as enterprise development. Specifically, TechnoServe fosters the establishment and growth of small to medium-scale community based agricultural enterprises. It does so through an integrated approach aimed at assisting rural communities directly by providing them with managerial and technical assistance and training; and indirectly by providing similar services to various development institutions, government ministries, banks, technology centers and non-governmental organizations.

Working throughout Ghana since 1971, TechnoServe assists organized groups of rural farmers and food processors to add value to agricultural products and, in so doing, to increase family incomes and local employment opportunities.

TechnoServe's Approach

TechnoServe believes that the key to promoting dynamic growth in the agricultural sector in Ghana is to develop viable small- and medium-scale rural enterprises, based on a thorough understanding of international and domestic market realities. TechnoServe believes that small-scale producers will only be motivated to increase their production and productivity, and to supply products to local industries and exporters, if they are confident that they can sell their produce at a reasonable profit to dependable buyers. While this statement may seem obvious, there are relatively few organizations promoting such linkages in Ghana today.

TechnoServe and its development partners in Ghana believe that the following services, among others, are essential to overcome the existing constraints to improved market linkages and increased growth:

- carry out in-depth analysis of potential agricultural subsectors to determine appropriate commodity/product focus and interventions, based on detailed market information
- development of viable, replicable business models, based on such analysis
- provision of practical advice and assistance to small-scale farmers/

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processors on how to improve the efficiency and quality of production to meet local industry and international standards

- increased access to post harvest technologies to improve enterprise productivity and the quality of goods
- training for micro enterprise owners and staff in business management and simple record keeping
- development of innovative financial mechanisms that can provide credit, advances from the private sector, and/or venture capital to rural entrepreneurs in a relatively low cost and low risk manner
- training and incentives for relevant financial institutions to operate such financial schemes
- formation and/or strengthening of producer and business associations in order to supply larger-scale dependable buyers in a reliable and cost-effective manner

TechnoServe also believes it is essential for potential business owners to demonstrate a strong sense of commitment to the process of enterprise development. Therefore, it requires prospective rural clients to make "up front" contributions, in the form of cash or "in kind" payments such as land, labor, materials and produce. In addition, prior to any TechnoServe assistance, enterprise owners or members are required to attend regular meetings to plan enterprise operations and sign a management agreement, which includes a commitment to pay a modest management fee to TechnoServe. This is done not only to underscore the mutual commitments involved, but also to prepare the businesses to pay for outside services when TechnoServe eventually discontinues its support.

Finally, TechnoServe also believes that in many instances these businesses will be best positioned to grow and prosper if they are able to establish marketing agreements with larger, more dependable buyers and firms. In this regard, TechnoServe seeks to act as an "honest broker" to ensure that such linkages provide positive incentives for both parties and can therefore endure and grow.

In Ghana, TechnoServe is currently providing assistance to small-scale farmers and food processors in the following agricultural subsectors:

- non-traditional exports, with a focus on cashew nut, shea nut, kola nut and pineapples
- palm oil processing, with a focus on oil for local food consumption and traditional soap manufacturing
- grain storage and marketing, with a focus on community-level storage for local food sales and consumption

TechnoServe is currently assisting 180 community-based rural enterprises with a combined total membership of 8,334, of whom 48% are women located throughout Ghana.

Collaboration with Development Partners

In order to build the capacity of rural producers to enable them to transform their operations into viable ventures, TechnoServe has been collaborating with other development partners. Prominent among such partners are the International Institute for Tropical Agriculture (IITA) and community development associations in Nigeria with which TechnoServe has collaborated to promote cassava and palm oil processing technologies.

TechnoServe also co-ordinated a one year postharvest pilot project; a component of the larger Village Infrastructure Project, a major donor-funded initiative in Ghana. The pilot project was implemented in conjunction with Sasakawa-Global 2000 (SG 2000), the Sasakawa Africa Association (SAA), the Self-Help Foundation (SHF), the Ministry of Food and Agriculture (MOFA), the Department of Co-operatives, the Agricultural Development Bank (ADB) and four rural banks in Ghana's so-called "maize triangle" located in the Brong Ahafo and Ashanti Regions. The organizations involved each provided a range of promising technologies to farmers and food processors.

TechnoServe provided basic business skills and records keeping training with groups which accessed inventory credit loans from the ADB to store and market maize. SG 2000 and the Ghana's MOFA promoted the use of a package of agricultural inputs and provided training for participating farmers to plant in rows and construct maize storage cribs and storing patios.

SHF provided access to multi-purpose power tillers for farmer groups and provided training in their use and maintenance while SAA promoted a range of small-scale post harvest technologies including cassava grating and pressing equipment and maize shellers and threshers developed by the IITA. The Department of Co-operatives provided training in cooperative principles and bookkeeping to participating cooperatives while ADB provided loans for agricultural inputs and inventory credit.

An Organizational Model for Small-Scale Palm Oil Processing

In 1985, a group of 10 farmers established a co-operative in Ntinanko to seek solutions to their oil palm fruit marketing problems. The group came into contact with TechnoServe and an agreement was signed for TechnoServe to provide assistance in identifying solutions to their problems. The first step was the undertaking of a subsector study of the palm oil industry, with the dual aim of determining the potential for small-scale producers and food processors to add greater value to their produce and identifying the constraints that would need to be addressed to make this possible. The study concluded that there was significant potential for increasing production and incomes through the introduction of enhanced technology and the adoption of appropriate management and organizational structures.

The decision was made to proceed, and an appropriate small-scale, labor-intensive palm oil processing plant was identified. TechnoServe provided assistance to the group in areas of organization, business management, and record keeping and also helped with the preparation of a business plan for the processing plant.

Members made their prescribed equity contributions of 25 percent of the projected total capital costs, both in cash and in kind contributions in the form of labor and materials used in constructing the building to house the processing equipment. The members were also required to buy a minimum of one share each in the business and to agree to purchase additional shares in future. During this period, group membership increased and was expanded to include local palm oil processors, all of whom were women.

Even though TechnoServe assisted the group to develop a credible, financially viable business plan, the group was unable to secure local bank financing. TechnoServe was convinced that the processing plant could be profitable and, as a last resort, decided to provide loan financing to the group in order to demonstrate the potential of the concept, and the plant was eventually commissioned in October 1987.

Despite thorough planning, initial

operations were not encouraging. The original business plan was for group members to purchase palm fruit from local producers and then process and sell the palm oil collectively. However, the labor costs involved in purchasing and processing the palm fruit turned out to be much higher than projected. In addition, local farmers had a tendency to sell low-quality fruits to the mill while selling their high-quality fruits to larger institutional buyers. Furthermore, an unexpected increase from 10 to 25 percent in sales tax on edible oils had a negative impact on plant revenues.

Thanks to the maintenance of timely and accurate financial and production records, these key problems were identified at an early stage. The owners held a special meeting with TechnoServe staff and made several key decisions regarding corrective action. They decided to:

- cease fruit purchases and instead to offer processing services to growers and processors on the basis of a fixed fee per ton
- move to the use of a higher capacity hydraulic press.

Impact and Cost-Effectiveness

Both of these measures reduced the group's labor requirements significantly, simplified management operations, and eliminated the tendency by processors to supply poor quality fruit, as the individual processors were now responsible for marketing their own palm oil. The changes also had an immediate positive impact on plant throughput. The volume of fruit processed at the plant rose from 11 tons in January 1988 to 45 tons in June of the same year. The plant subsequently processed between 60 and 80 tons of fruit per month during the fruiting seasons, reaching a maximum of 93 tons in March 1989. By the end of 1990, the plant recorded a net profit of ¢820,785 ($2,350).

The net income accruing to the processors and their employees during the first three years of operation was ¢6.64 million, while the Ntinanko mill employees received ¢1.27million in wages (a total of ¢7.9 million or $22,595). In addition, a number of business have been established in the village to provide food, clothing and various services as a result of the increased volume of commercial activity in the community.

Net income increases accruing to farmers during the first three years of the project have been calculated at ¢14.4 million ($41,150). However, these figures assume that all oil palm production would have been sold on the fresh fruit market if the plant had not been established. In fact, given the irregular fruit purchases in the area prior to the mill's establishment, it can be conservatively estimated that about 40 percent of the potential fruit sales would not have taken place. If these incremental sales are considered, the net value added increases to ¢18.8 million ($53,700).

The plant now operates profitably without any outside assistance. Further technological upgrading has been undertaken and a 30-acre oil palm plantation and oil palm nursery for improved-variety seedlings has been established. To diversify its operations, the co-operative has also recently become a buying agent for a large cocoa purchasing co-operative in Kumasi.

As might be expected, the costs associated with establishing the Ntinanko model were high and financial analysis showed costs exceeding benefits. However, analysis of the first replication of the model found that benefits exceeded project costs by a factor of more than five to one.

Replication of a Successful Experiment

Based on the success of the Ntinanko model, TechnoServe expanded its assistance to four similar mills in different regions of the country. In 1992, the program came to the attention of the Ghana Government which awarded TechnoServe a contract with funding from the World bank to establish 23 palm oil processing mills in communities outside the buying catchment areas of the large-scale palm oil mills under the Intermediate Technology Small-Scale Palm Oil Mills Project.

These community mills have come together to form a national association of palm oil producers, the Co-operative Palm Oil Millers Association, which currently has four regional chapters to which TechnoServe is providing assistance. It is anticipated that as the association develops, it will increasingly take over many of the roles that TechnoServe staff have played.

During the 1996 season, the Association's regional chapters started stockpiling palm oil in central locations in order to attract larger industrial buyers, such as soap manufacturers, who pay higher prices than local traders for palm oil, if they can be assured of purchasing large volumes conveniently. The Association is also promoting the development of village level oil palm nurseries to produce high-yielding, disease-resistant varieties, both to increase members income in the short term and to improve the quality and quantity of palm oil to enhance future earnings.

Future Role

In July 1998, TechnoServe began the implementation of a five-year Microenterprise Development Assistance Program. Under this new program, TechnoServe proposes to strengthen its Business Support Services to small enterprises. These Business Support Services generally consist of the following assistance provided in the following sequence in order to overcome the barriers and constraints which small agro-processors face:

- Explanation of group dynamics and business principles for agro-processing groups either already involved in a given sub-sector or with good potential for involvement.
- Explanation of the roles and responsibilities of group enterprise executives.
- Calculation of current cost of production technologies to micro-enterprises where relevant.
- Introduction of simple bookkeeping and financial analysis.
- Development of business plans.
- Assistance in mobilizing investment and working capital, if necessary
- Assistance in obtaining, installing and operating equipment, if necessary
- Provision of marketing assistance and advice.
- Provision of on-going training and assistance in simple records keeping and financial analysis.

Cassava Chip Processing in Ghana: Participatory Postharvest Research and Technology Transfer in Response to New Market Opportunities

Andrew Westby and Stephanie Gallat

STEPHANIE GALLAT

Postharvest systems are highly complex in nature because of the interaction of technical, social and economic constraints faced by small-scale farmers. The use of an appropriate and effective postharvest research and development approach is the key to ensuring that post-harvest research and technology transfer activities have impact on poor people. At the Natural Resources Institute, working in collaboration with a number of national programs in Sub-Saharan Africa, we have seen an evolution of our approach from one that was very scientist-orientated (termed hypothesis testing) to one that is participatory in nature. We believe that by involving beneficiaries at all stages of the project cycle—from problem/opportunity assessment to testing and adaptation of new technology—the chances of achieving a positive impact on livelihoods are improved.

This paper describes the use of a "systems" approach to the development of a processing system to meet an identified market opportunity. The processing of cassava chips for the domestic animal feed market in Ghana is used as an example of the application of this approach. The "systems" approach brings together a variety of tools including needs assessment and market analysis, and requires the involvement of all key stakeholders in the system.

The "Systems" Approach

As opposed to the "hypothesis testing" approach which is based upon understanding how biological systems work and then applying the results of research to have an impact, the "systems" approach takes an integrated view of the post-harvest system from production to consumption. Using a multidisciplinary approach, the systems approach also recognizes the social, economic and technical factors that influence farmers' decision making and capacity for adopting new technologies.

The "systems" analysis approach

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(Westby 1999) has drawn on: needs assessment to determine needs of farmers, market analysis to understand which markets farmers can access, and a systems analysis with stakeholders to identify solutions to bottlenecks.

Needs Assessment

Needs assessment is a term used to describe a range of qualitative diagnostic survey methods such as rapid rural appraisal (RRA) and participatory rural appraisal (PRA) (Cropley and Gilling 1993). Their essence is that they facilitate communication between researchers and beneficiaries and they represent the start of a collaborative interaction between the two.

Needs assessment relies on the use of a basket of tools that facilitate discussions between researchers and beneficiaries. It relies upon an attitude on the part of the researcher of being informal, open minded and analytical. Beneficiaries are active participants and not just respondents. The principal tool used is semi-structured interviewing which is a form of guided interviewing where only some of the questions are predetermined and new questions are introduced during the interview. At most, it uses a checklist of questions as a flexible guide. Other tools that can be used as required include: reviews of secondary data, direct observation, various forms of ranking, scoring and diagramming exercises (see Thesis and Grady 1991, Kleih et al. 1997).

The needs assessment approach has become a central feature of how post-harvest research on root and tuber crops at NRI is undertaken (e.g., Westby et al. 1998; Hall et al. 1998).

Market Analysis

Matching research effort directly to the needs of the market is another recent feature of NRI's work on root crops. This principle which is not unique to NRI, is one of the central features of the International Fund for Agricultural Development-led Global Cassava Development Strategy (Plucknett et al. 1998) and is, for example, a strong feature of the approach being adopted by the Eastern Africa Regional Root Crops Network. The concept can be carried through to such a degree that inputs from a wide range of disciplines can be arranged around the needs of the market. This approach has been applied in, for example, work on markets for high quality flours and starches in Ghana (Graffham et al. 1998)

Cassava Chip Processing in Ghana

The following account of work on cassava chip processing in Ghana describes an example of the application of the "systems" approach to participatory post-harvest research, technology development and transfer.

Firstly, there was rural needs assessment. Rural needs assessment studies (Kleih et al. 1994) conducted in Ghana in 1994 identified the need of farmers to sell their cassava into new markets as a means of increasing incomes.

Secondly, there was market analysis. Market analysis (Graffham et al. 1998; Barton et al. 1996) indicated a need for high quality cassava flour and cassava in the animal feed sectors. Rural communities can prepare these products as a means of increasing incomes.

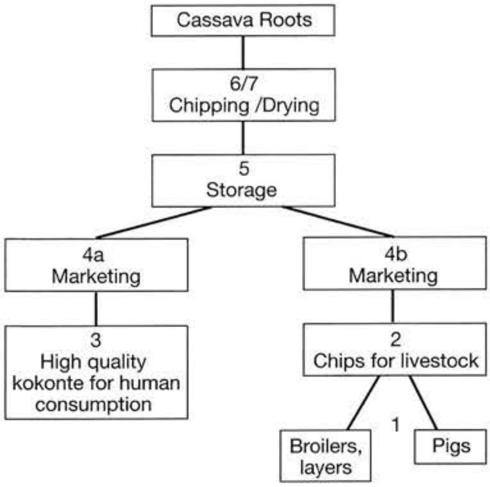
Thirdly, there were stakeholder consultations. Stakeholder consultations (involving, for example, farmers representatives, feed millers, researchers, extension staff, members of the poultry feed association) were held throughout the work to present findings and discuss future work and priorities.

Fourthly, studies were undertaken to understand and develop various parts of the chain from producer to consumer (systems analysis). The experimental work focused on the production of spaghetti-shaped chips called "minichips." The investigations were undertaken in the order agreed in the stakeholder consultations. The chain from the field to the consumer is shown in Figure 1. The studies undertaken are also indicated in Fig. 1 and summarized in the following sections.

1. Market-price competitiveness compared with maize for animal feed

Following the needs assessment study, an initial rapid assessment was made of the potential market for cassava in the poultry feed sector (Barton et al. 1996). It was estimated that assuming a potential 50% replacement of maize in the diet there was a potential demand for 58,000 tonnes of cassava.

The technology selected involved chipping cassava into small spaghetti like pieces that could be dried quickly to produce a good quality product. The system was based upon a chipping machine developed by the International Institute of Tropical Agriculture in Nigeria (Jeon and Halos-Kim 1991) and imported into Ghana by an NGO. A range of prices for minichips was established (Collinson 1997) based on the costs of production and using the same rates of return to labor as those for cassava chips produced for export. This gave a range of prices from ¢121 and ¢137/kg assuming real interest rates of 0 and 15% respectively. This price is higher than for chips produced for export (¢90/kg) reflecting the increase in labor required. When compared with the price of maize on an equivalent basis (same protein content) cassava would have been competitive for 13 out of 24



1. Market-price competitiveness
2. Fitness for use: on-farm participatory trials
3. Consumer and market acceptability
4a. Marketing for human use
4b. Marketing for livestock use
5. Storage
6. On-farm participatory development of technology
7. Availability of credit

Figure 1. Cassava chip production system and studies undertaken.

months in the 1995/96 period at ¢121/kg. Chip production is seasonal and optimum drying conditions occur in January - March when maize prices are high.

2. Fitness for use: on-farm trials

In a workshop with stakeholders in the livestock sector, a major issue was fitness or suitability of cassava for use as animal feed. On-farm broiler, layer and pig trials were undertaken using cassava as a partial replacement for maize. Diets were reformulated to account for the lower protein content of cassava and comparisons of performance were made with farmers' own diets. Pigs came to market weight (60 kg) in 7 months on the cassava based diet compared with one year (or more) on the conventional diets (Fleischer 1998). Poultry showed no significant loss in performance with 20% cassava in diets (Osei et al. 1998).

3. Consumer and market acceptability

Minichips can be substituted for traditional cassava chips known as "kokonte." Kokonte has a reputation for being a low-priced, low-quality staple for lower income consumers. In a survey it was suggested that kokonte is well liked by a significant proportion of urban-based, higher income consumers, but many do not eat it because of its unhygienic nature and food safety concerns (Media Majique and Research Systems 1998). These urban-based consumers may pay more for a high quality product. Sensory evaluation panels have shown a preference for minichips by certain consumers.

4. Marketing

Trader acceptability: Quality assessment by trader panels showed superior quality of minichips (good color and reduced mould and insect infestation). Minichips are however new and unfamiliar, and traders are therefore uncertain about how to price it. Commercialization of the minichip is a challenge facing the introduction of this new high-quality, high-value product onto the market.

Marketing for livestock feed: PRA studies have shown that farmers will produce the chips if there is a market. Feed millers and livestock producers have indicated that they will use cassava if there is a regular supply. The challenge is to link these two ends of the chain.

5. Storage of chips

The storage of minichips and kokonte were evaluated in traditional storage structures. The results showed that minichips stored significantly better than kokonte. After 3 months of storage, kokonte became moldy and infested with insects. Under the same storage conditions, minichips remained in good condition (white and free from insect infestation) for 6 months. Levels of physical loss are shown in Table 1. Minichips therefore have potential to be a valuable food security reserve. They can also be stored and sold for higher income when prices are higher. From the point of view of the feed millers, its means that minichips have an acceptable storage life.

Table 1. Storage losses for "kokonte" and minichips in traditional storage structures in Brong Ahafo in the 1997 season.

	Losses (%)	
Month	"Kokonte"	Minichip
May	4.4	0.3
July	10.5	4.1
Nov	38.5	4.4

6. On-farm participatory development of technology

The chipping and drying system was developed with farmer groups in the Brong Ahafo Region, Ghana. Roots were chipped using a chipper initially developed by IITA. Some improvements were made in participatory trials to improve performance (McNeill and Westby 1999). The combination of the chipper, drying on trays for one day and on Polythene sheeting for one day produces a high quality product at minimum cost (Hector et al. 1996). Microbiologically, the chips were low in coliforms. They were also low in ash. The process was evaluated with farmer groups over two seasons.

7. Availability of credit

The availability of credit for agro-processing in the Brong Ahafo Region has been investigated (Akintade 1997). It was found that formal and informal sector credit existed for agro-processing, but informal systems were more important, especially for working capital. Seven different lending practices were identified. It was observed that commercial banks were decreasing lending to the agricultural sector and, therefore, an increased reliance on the informal sector was anticipated. There was evidence of lending to groups, but little evidence that it was always successful. Individual entrepreneurs were often excluded from credit.

Stakeholder Participation

In the example given above, stakeholders participated in the process at three levels. During the needs assessment study initial contact was made with farmers. The adaptive research and technology transfer program was initiated on the basis of farmers' needs. The majority of the research work was done in collaboration with end-users. The chipping/drying system was adapted in collaboration with end-users to meet the quality requirements of the industry. The "fitness for use" trials were carried out on-farm with active participation of groups of farmers and the commercial feed compounding companies.

In addition to undertaking the research work on-farm with people who would use the technology, a series of workshops brought together all stakeholders in the post-harvest chain to report results and decide on issues such as next priorities. Work on the development of cassava chips and studies into the fitness for use of the chips was only initiated following stakeholder workshops.

Benefits of the Approach

The systems approach ensures a close interface with beneficiaries because of its participatory and multi-disciplinary nature. It makes technology transfer a part of the research and development process and is faster than some alternatives. In addition, the systems approach makes allowance for the fact that not all constraints within a system are technical in nature. On the other hand, the approach is dependent on a process approach where the final technology or product is not always predictable. Also, the results can be location specific and expectations can be raised if the process is not followed through to an end point.

Approaches that encourage researchers to work more closely with beneficiaries are clearly going to be more likely to achieve impact; the systems analysis, market orientation and needs assessment are tools to achieving this. There is still, however, the need to still draw out and make more widely available the generic issues from these interventions. This may mean particular issues might have to be thoroughly and rigorously investigated (an integration of adaptive and strategic research). It has also to be recognized that the best approach with certain problems may be to come back to more basic research in the laboratory that can later be fed into adaptive research. Such strategic research is essential for the development of new methods and techniques.

Conclusions

It is important to recognize that postharvest research and technology transfer involves people and it cannot be wholly conducted in a laboratory or on a research station. It is proposed in this paper that strategies and tools such as needs assessment and on-farm research are needed to assist scientists to interact with their clients. The complex nature of postharvest systems demands that interventions are not only technically appropriate, but also are economically viable and fit within the social and cultural circumstances of those who are going to use them. This means that a multi-disciplinary approach is required to ensure that postharvest research and technology transfer interventions have an impact.

The use of market-orientated research is critical in order to ensure that the technology that is developed is relevant and will have an impact on the livelihoods of poor people. In responding to a market opportunity it is important to have an understanding of the whole postharvest system and the wide range of stakeholders within them. It is only by involving the full range of stakeholders in the system, including the private sector, and linking them to other stakeholders that it will be possible to enable the adoption of new technology.

From a research perspective, a key issue is the balance between strategic and adaptive research. If impact is required then there is the need for more participatory approaches. The problem (particularly for international research organizations) is how to do this without losing the work's generic value. One answer to this is to view adaptive and participatory activities as part of a wider strategic picture. Strategic in the sense that these more "near client " oriented activities can inform strategic biological research. Clearly if the lessons from these near client activities are not made widely available then the widespread adoption of new technologies will be delayed.

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Collaboration for Agro-Industries Development: An Agro-Processing Project Approach

Toshiro Mado

Over the past ten years, efforts aimed at increasing the production of staple foods have been intensified in many African countries. These efforts have been in direct response to the food security challenges posed by growing populations. In several areas appreciable increases in the yields of staple foods can be seen as a direct result of these efforts. These increases have been obtained largely from the expansion of farm size and the use of improved agricultural technologies. In some instances, the adoption of yield increasing technology has enabled farmers to grow more and even produce surpluses. As farmers intensify production efforts in response to food security challenges, the need for postharvest technology cannot be overemphasized.

The critical features of grain and root crops which affect postharvest management are their short durability in storage and the tendency to change their chemical and physical characteristics. However, through appropriate processing, additional value can be added to these products to enable farmers earn more income from their efforts. Agro-processing is seen as a major income generating activity for rural farmers, especially, women farmers in African countries. Currently agro-processing activities are done manually and in a labor-intensive way. The manual processes are time consuming and possess a large element of drudgery.

Adopting a good agro-processing technology can reduce drudgery, improve processing quality and productivity, and encourage farmers to produce more. This paper describes a project which is a collaborative effort between organizations to make agro-processing technology available to agro-metal workers and rural farmers.

The Agro-Processing Project

In 1994, the International Institute of Tropical Agriculture (IITA), Ibadan, and the Sasakawa Africa Association (SAA) reached an agreement to collaborate in a common effort to disseminate agro-processing technology developed by the Postharvest Engineering Unit of IITA. Since then, IITA and SAA together with national agricultural extension agents, metal workshops, NGOs, and farmers have worked together to disseminate agro-processing technologies. The collaboration may be viewed as an inter-sectoral effort involving the industrial and agrar-

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ian sectors. The major activities of the collaboration include research and development of postharvest technology, agro-industries extension and manufacturers training. Each stakeholder plays specific roles to facilitate the diffusion of available postharvest technologies in the country (see table 1). The stakeholders are bound by the common desire to succeed and so maintain close communication and share information.

Research and Development

One of the important elements to consider in the selection and use of postharvest equipment is design. A good design contributes in a major way to the extent to which a piece of postharvest equipment is easy to fabricate, easy to use and durable. However, a common problem in the design and manufacture or agricultural equipment has been the tendency to design such equipment without taking into consideration the characteristics of crops and human engineering factors. This major lapse has been one of the main reasons for the low performance of such equipment.

The major advantage of agro-processing equipment designed at IITA lies in their design. Each piece of equipment is designed taking into consideration the characteristics of crops as well as agricultural and human engineering factors. Some of the postharvest machines are manually operated while others use a small petrol engine as a power source. IITA's postharvest equipment is portable, easy to handle, has good mobility, and is therefore suitable for women. Mobile equipment is easy to move around when there is a need to expand the business area. They also offer an opportunity for the reduction of the cost of farm structures since they do not have to be installed in a stationary position in an enclosed area.

Table 1. Stakeholders' roles and activities.

Stakeholders	Role and activities
Research institutes	Designing, testing and modification
Technicians	Training of manufacturers and quality control
Manufacturers	Production and sales
Extension	Dissemination/demonstration and mobilization of farmer groups
Farmers/users	Agro-processing business

Agro-metal manufacturers using such good designs can become more competitive and improve their earnings.

Agro-Industries Extension

The weak linkage between agriculture and industry can be seen quite often. On the one hand, many metal workshops are located in urban areas with the urban population as their target. Most of these workshops undertake mainly the repair of parts with only a few (the agro-metal manufacturers) fabricating agricultural equipment. On the other hand, most farmers are based in the rural areas, do not have access to the agro-metal manufacturers and do not know what kind of technologies and equipment are available. There is a gap between farmers and agro-metal manufacturers which obstructs the integrated business development interests of both parties.

Agro-Industries extension work is aimed at filling the gap between agriculture and industry through field training and demonstrations. Under this system extensionists visit villages to demonstrate to farmer groups the operation and performance of agro-processing equipment. The people are then allowed to have a turn at trying out the equipment after which there is an interactive discussion. This participatory approach usually succeeds in creating awareness and generating interest and a desire to adopt.

For extension personnel and manufacturers, the participatory field demonstration is an important opportunity to observe a direct response of users and obtain first-hand comments and recommendations which can form a basis for engineers for design improvement.

Manufacturers Training

Having a supply capacity of metal manufacturers is crucial to making adequate postharvest equipment available for use. Supply capacity must be considered in terms of both quantity and quality. Product quality is a crucial factor not only users but also for manufacturers as a promotion factor for their own products. Having equipment operators who are satisfied with the equipment they are operating in a rural area is good advertisement for the manufacturer who is likely to attract more customers. Farmers and other customers make their capital available during some particular period, for example, after harvest. Manufacturers should therefore have a stock of the equipment ready during these periods.

Manufacturers training is aiming at introducing new designs to manufacturers, and to improve the fabrication skill of technicians. However, our experiences show that training can not make a good enough impact if the manufacturer does not have an internal quality control system.

Impact on Final Beneficiaries

This joint effort aims at improving the productivity of the final beneficiaries, agro-metal manufacturers and agro-processing farmers. Agro-metal manufacturers in African countries are generally small-scale and quite often, have less than a staff of ten workers many of who possess no formal technical qualifications. They also tend to be low-skilled and serve mostly as apprentices. In most cases apprentices may be lucky to be trained by a highly skilled master. The training given improves the competencies of the agro-metal manufacturers and enables them to manufacture equipment of competitive quality for sale at profitable margins.

Many agro-processors now using the improved agro-processing equipment have been engaged in the business for a long time. The switch from manual or low-productive methods to improved equipment has reduced labor requirements and at the same time improved product quality. For example, in the manufacture of cassava flour, the most crucial operation is drying and milling. Cassava pieces chopped using the traditional method take about 4-5 days to dry while chips prepared with an improved cassava chipper take 1-2 days to dry because of their reduced size. Also, because of their reduced size, well dried chips are easier to mill and store better. These advantages present agro-processors with a better quality product and better prices.

The technical impact can be summarized in terms of durability, reduced labor input, high product recovery and improved storability. The socio-economic impact may be summarized in terms of reduced workload for women and employment and income generation.

Challenge

As mentioned earlier, the agro-processing project is a joint effort among the stakeholders. To enhance this collaboration and further strengthen existing linkages, there is the need for open communication and the sharing of mutually beneficial information. There is also the need for an effective co-ordination mechanism that will ensure that stakeholders are making the best use of available information and resources in order to maximize the benefits from postharvest technologies.

Improving the Development and Delivery of Postharvest Technologies: Small Groups Summaries

1. Participatory Development and Dissemination of Appropriate Postharvest Technologies

The major issues considered by this group were:

- identification of stakeholders/partners in participatory development and dissemination of appropriate postharvest technologies
- identification of roles of stakeholders/partners
- social, economic (including markets) and technical considerations
- balancing strategic and adaptive research
- promotion or dissemination of technologies
- monitoring and impact assessment

Recommendations

- Stakeholders/partners in participatory development and dissemination of appropriate postharvest technologies should be identified and documented. This may be done through such methods as meetings, networks, observations, word-of-mouth recommendations, workshops and review of relevant reports and other secondary sources.
- The roles of stakeholders/partners should be clearly identified through such methods as meetings, surveys, observations and report reviews. Some Government development agencies such as research and extension organizations may do this in collaboration with NGOs involved in postharvest development.
- Farmers should be encouraged to form partnerships with other stakeholders to work together.
- Farmers should be fully involved with other stakeholders to identify and prioritize existing postharvest problems, and participate, with researchers and extension, in tests and trials to solve these problems. All stakeholders should be involved right from the beginning. Efforts should be made to ensure genuine participation by promoting equality in the partnership.
- Donors should work together to provide funding for development, technical assistance, training and information sharing.
- Donors should, in addition to funding, play an advocacy role to influence policy towards enhancing the dissemination of appropriate postharvest technologies.
- Governments should enact policies that provide support for the development and dissemination of appropriate postharvest technologies.
- Governments should create the en-

abling environment (e.g., infrastructure) to support postharvest work.

- Governments should demonstrate commitment to the postharvest sector by providing funding for postharvest work including postharvest training and extension work.
- Projects should apply true participatory approaches in project planning, implementation, monitoring.
- Researchers should ensure farmer and end-user participation in the generation of technologies.
- Researchers should develop, test and refine technologies based on user needs and the socioeconomic environment.
- Researchers should identify and test already existing technologies which hold promise to avoid reinventing the wheel. There should be a balance in adaptive and strategic research.
- Extension should provide information support for postharvest activities. This may be in the form of print media, radio broadcasts or audiovisuals.
- Communication methods for dissemination should put farmers at the forefront.
- Baseline surveys should be conducted to enable subsequent assessment of impact to be carried out in a valid manner.
- Evaluation should be multi-disciplinary and participatory.

2. Strengthening the Entrepreneurial Capacity of Small-scale Agro-processors and Manufacturers

The major issues considered by Group Two were:

- identification of marketable commodities and products
- national policy
- sources of credit
- technical and managerial training
- linkages
- trade associations

Recommendations

- Stakeholders should collect and collate information on marketable commodities and products. This should include information on volume of produce or products, market prices, production cost, quality, demand and supply channels. This can be facilitated by NGOs and Governments. Networking should be encouraged at facilitate sharing of experiences.
- There should be a systematic effort to gather and share market information.
- Stakeholders should create multi-disciplinary teams to bring together different views and ideas for a national policy to support entrepreneurial capacity building. The responsible government agency, assisted by other agencies such as trade associations should collate and harmonize ideas into a policy document for discussion and adoption. NGOs can play an advocacy role.
- A high priority should be placed on the post-production sector in national agricultural policy.
- A post-production national agricultural policy should incorporate important aspects such as food quality standards, nutrition standards and hygiene.
- Government agencies and NGOs should train entrepreneurs in the development of business plans and effective management practices.
- Government agencies, trade associations and NGOs should assist and encourage the formation of viable groups of small-scale agro-processors and manufacturers. The groups, operating as co-operatives, stand a better chance of obtaining loans from lending sources.

- NGOs and relevant government agencies should provide training in acquisition and proper use of loans.
- Governments and NGOs should support the establishment of entrepreneurial training schools and centers to offer "training of trainers" courses and also to train entrepreneurs.
- Governments, with the assistance of NGOs, donors and the private sector, should provide information support using the mass media and other forms to disseminate information on technologies in local languages.
- Stakeholders should be brought together in workshops or conferences to share information. This can be facilitated by NGOs, the private sector or government.

3. Building Sustainable Partnerships for Development and Dissemination of Postharvest Technologies

The main issues considered by Group Three were:

- harmonization
- postharvest information management and dissemination among stakeholders
- linkages between development and dissemination of technology

Recommendations

- Linkages should be created and networking fostered among International Agricultural Research Centers, National Agricultural Research Systems, NGOs, Universities, National Agricultural Extension Systems and Donors.
- The postharvest system should be addressed in an integrated manner. Clear linkages should be developed between fundamental research, adaptive research and technology transfer. The process should involve all stakeholders in a participatory manner.
- Donors, NGOs and host governments should complement each others efforts and not work in competition with each other.
- Governments should meet their research obligations.
- There should be an effort to collect, collate and share postharvest information among stakeholders on a regular basis.
- Stakeholders should work together in promoting technology fairs and in monitoring and evaluation of the postharvest sector.
- Efforts should be made to harmonize working conditions by encouraging NGOs and donors to work within existing frameworks.
- Stakeholders should meet at regular intervals, share experiences and learn from each others successes and failures. There should be an effort to document and share information on successful projects.

4. Financing Postharvest Technology Development, Manufacturing and Agro-processing Enterprises

The main issues considered by Group Four were:

- ineffective linkages between Research and Development
- inadequate knowledge and capacity to access donor support
- insufficient financial provisions
- inadequate technical skills

Recommendations

- Emphasis should be shifted to postharvest programs that will benefit most of the population.
- There should be better communication between Research and Development
- Governments, donors and NGOs and

researchers should collaborate to offer training in project formulation.

- There should be more collaborative demonstrations of technologies by stakeholders.
- Governments, donors and NGOs should create awareness and conduct training in proposal writing to increase access to donor funding.
- There should be effective linkages for capital sourcing.
- Access to affordable credit should be provided by governments, financial institutions and donors for postharvest research, development, manufacturing and agro-processing enterprises.
- Governments should live up to their financial obligations with respect to the postharvest sector.
- Stakeholders should enter into partnerships to be able to pool financial resources together to support postharvest research, development, manufacturing and agro-processing enterprises.
- Stakeholders should provide adequate technical and financial support for monitoring and evaluation activities.

CLOSING REMARKS

Bringing the Pieces Together

Christopher Dowswell

Growing Importance of Value Added Agriculture

A distinguishing feature of commercial agriculture is the importance of value-added activities after primary production. The urban shift in sub-Saharan Africa, from a historical situation when only 20-30% of the agricultural production entered the market to one in which 40-60% will enter organized markets will have enormous implications for agricultural research, extension, production, food storage, processing, and transportation.

Urbanization will bring about changing patterns of food consumption. The food chain will lengthen and become much more complex. With trends in globalization, Africa's urban food consumers are likely to also have increasing choices. Will they obtain their food from domestic producers and food processors? Or will these food products be imported? Quality and quantity considerations will influence the final decision.

Business and Economic Perspective

Is it logical to expect not-for-profit governmental and non-governmental organizations to play key roles in micro-enterprise development? As Rosetta Tetebo rightly said, if such publicly funded organizations don't take the lead to help organize, train, and strengthen these emergent private sector micro-enterprises, "who will do it?" I agree with her.

What is really important, then, is that these not-for-profit developmental organizations adopt a clear business-like orientation in their advisory services and interventions. Potential agro-processing and other postharvest technology and equipment must be evaluated against standard business criteria. Is there a market? Can the enterprise become a competitive player? Can they mobilize the human, physical and financial capital requirements to enter the market? What is the potential for profit? What are the risks?

In the end, farmers and micro-enterprise owners are really more concerned about "income" rather than prices, per se. As such, they are interested in the ratios between input costs and the potential revenue from their output. Where profit potential is significant, and the technical expertise is available and can be assimilated, the chances are good that small-scale entrepreneurs (including farmers) will take up new technologies and prosper.

And as Ruth Oniang'o pointed out,

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however, we should not be dogmatic about whether these enterprises are run through collective action groups or by private entrepreneurs. Indeed, in many cases, the small family business may be the best organizational structure to ensure success.

We should be especially sensitive to identifying what is the "real" demand, or potential demand, and not lead farmers and micro-enterprise collaborators down the primrose path of purchasing a bunch of postharvest equipment to handle and process some crop or another, and then start looking for markets. This is also true in crop production. How often do supply and technology considerations drive the interest of researchers and extension workers in a crop rather than a real assessment of demand? Most of us have this "supply" bias. Farmers and food processors take up our recommended technologies, expand their production, only to be disappointed when they find out that the market is very thin. As a consequence, they have little hope of repaying their debt for inputs and equipment—and we often say the "farmer is not credit worthy." In fact, it is we who are not "credit worthy."

Greater access to market information will help us move from our current "supply-in-search of demand" mentality to one that looks at the food production propositions from a business perspective. Farmers are very concerned about markets and prices, yet all too frequently researchers and extension officers, especially the men, don't seem to know the current prices of almost anything. They don't know market prices for the main food and cash crops, inputs, oxen, traction equipment, or transportation. When one asks, one usually gets a blank stare. If there is a response at all, it is usually last year's price! It really is incredible!

How can we advise farmers and micro-entrepreneurs on business decisions, whether in food production or in postharvest marketing, when we are so poorly informed about the key prices of inputs and outputs. We simply must do a better job in this area, if we are to do our duty in serving the small-scale, emergent commercial farmer. There is much scope for MOAs, in partnerships with NGOs, to develop much more robust market intelligence systems. Developments in telecommunications and data processing can help us greatly in such work.

Policy Interventions

Those of us working in ministries of agriculture, universities, research and extension organizations and NGOs also need to become more active in trying to influence national policies that affect the agricultural sector. We cannot just accept the status quo. We need to point out to our clients and bosses the effects particular policies have in holding back the development of modern agricultural systems and agro-businesses, especially for small-scale agriculture. For example, national import tariff policies often discourage the importation of raw materials needed to make small-scale machinery or to can or package food products. As a result, it is cheaper to import such equipment and intermediate products than produce them locally. Is this what governments really want? I think not.

It is one thing for governments to charge high tariffs on the importation of luxury goods and fancy cars, but what is the logic of slapping a big import duty on a 5-7 hp motor, or metal alloys needed to make a machine or even a tin can?

We must get involved in these issues, and begin to lobby parliamentarians and the executive branch of government to create a more favorable environment for development of rural industries and enterprises. We are too quiet! We must become activists for change.

Food Quality and Safety

Issues of food quality and safety, such as spoilage and carcinogen residues will grow in importance as we move from subsistence to commercial production, and as the chain from rural producer to urban consumer lengthens. Obviously, we need to maintain perspective in how we approach these issues. We don't want to paralyze farming or food industries with excessive and unrealistic rules and regulations. At the same time, longer-term storage and added processing of foods will make issues like aflatoxins and salmonella increasingly important.

Engaging the Private Sector

Market economics is the current rage in development circles. Strident market fundamentalists think that the private sector can solve almost every economic problem. Obviously, where markets work, we should rely on them. Where they don't, we should intervene in the market, through various forms of public and quasi-public (e.g., NGO) sector interventions. Governmental and non-governmental organizations are still in a mating dance with the private sector. Few solid marriages have resulted.

Many international donors today doubt that publicly funded institutions are capable of developing real partnerships with private enterprises and NGOs. They believe that public civil servants are so threatened by the rise of alternative types of organizational structures that they will never agree willingly to work in effective partnerships with either the private sector or NGOs. Can we prove the critics wrong? I hope so.

In particular, we need to be more imaginative in seeking ways for publicly funded research, extension, and educational institutions to reach out to agribusinesses for help and support. It may be unlikely that these big firms will be very interested in partnering with most small-scale producers and agro-processors, for the reasons that Charles Ofori of TechnoServe gave us, e.g., problems of small suppliers meeting quality standards and sufficient supply volumes.

But perhaps the Nestles and UACs could help in training government and NGO subject matter specialists in technical and business development skills; in supporting various research and development initiatives to develop small-scale equipment, perhaps even in some forms of micro-finance support to some micro-enterprises. We need to develop concepts of corporate citizenship and perhaps offer some tax incentives to sweeten the deal.

One thing is sure. We must get our act together in MOAs and NGOs before we approach private sector agribusinesses asking for assistance. Usually, we are too vague in our requests, and appear like we are just looking for hand-outs rather than forging real development partnerships.

In private sector strategic alliances all parties must derive some benefits. We won't be any different in the partnerships that we seek. What do we have to offer in terms of potential benefits to our partners?

Strategic and Adaptive Research

I thought that Stephanie Gallat made an important point about the balance between strategic and adaptive research in postharvest technology. As with many fields of research, there is often a considerable amount of good technologies already available. Some of these technologies might only need slight modification, if at all, to be appropriate for many postharvest enterprises. As my boss, Dr. Borlaug, is fond of saying, "the perfect is often the enemy of the good" in plant breeding.

A similar analogy can been drawn in the development of small-scale equipment and machinery. In many cases, it seems that we should be focusing more efforts on the diffusion of what we already have available, perhaps with some adaptive research for small design changes where necessary. Let's get on with it.

The small group meetings have made several excellent recommendations to improve the postharvest sector. We should work together to ensure the implementation of these recommendations.

In closing, I quote Mahatma Gandhi who said, "We must be the change we wish to see in the world." We shouldn't wait for someone to take the initiative. We should start the ball rolling, starting where we are, using what we have, and doing what we can.

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