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REPORT ON THE PLANNING MEETING FOR AGRICULTURAL TECHNOLOGY SYSTEMS IDENTIFICATION FOR AFRICA

20 August 1986
Washington, D.C.

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PURPOSE AND GOALS

Purpose

The Communication for Technology Transfer in Agriculture (CTTA) communication program can have impact only where appropriate, adapted, and otherwise viable technologies are available that can be beneficially adopted by farmers, taking into consideration their own constraints and within the existing institutional framework. It will not create new or improved technologies. Therefore, CTTA places strong emphasis on the identification and assessment of technologies that will be disseminated to its target farmers.

The purpose of the Agricultural Technology Identification and Utilization activity, funded by Dr. Nyle Brady's Small Activities Fund, of which the Planning Meeting for Technology Systems Identification in Africa is part, is to survey technologies appropriate for Africa -- indigenous or otherwise -- available from agricultural research systems in the region to identify and categorize those which are:

> Ready for diffusion: those which can be beneficially adopted by farmers within the present institutional framework and within the farmers' own constraints.
>
> Proven technologically: those which can be adopted by farmers with only moderate institutional modification and support.
>
> Promising for the future: those which will require substantive institutional modification before they can be adopted and used beneficially by farmers.

Recommendations to improve the diffusion process for ready and proven technologies also will be developed.

Scope

Major institutions involved with technology generation and diffusion in up to four selected African countries will be surveyed. For technologies considered to be ready and proven, the survey also will identify issues that must be analyzed and how information can be obtained with respect to each.

Sequence of activities

1. Planning meeting on 20 August 1986 to:

   - review analytical approaches currently used in technology and technology systems research and development relevant to Africa, and

   - identify critical institutional, agricultural, and socio-economic elements that should be included in the analytical framework for surveying available agricultural technologies appropriate to the African countries selected for the study.

2. Synthesis Panel meeting on 3 September 1986 to:

   - develop an analytical framework for the Africa survey, using as a major resource insights and conclusions from the 20 August meeting;

   - suggest African countries to be surveyed; and

   - identify critical disciplines to be represented on the survey team.

   (The Synthesis Panel subsequently met as scheduled and the analytical framework now is in draft form.)

3. Survey the selected African countries, in cooperation with the Office of Agriculture and Rural Development of AID's Africa Bureau.

4. Prepare a report for each country surveyed that contains a discussion of available technologies and recommendations for their diffusion, and an additional overview report which integrates those findings.

Anticipated outcomes

1. Identification of ready technologies available for diffusion in the countries surveyed. This also will help determine countries which meet the available technology criterion for selection of CTTA collaborating countries.

2. Determination of issues to be addressed to move proven technologies to the ready stage.

3. Although not a specific CTTA objective, the study should also provide information of high value to national programs and donor agencies concerning institutional and related issues that must be addressed to move promising technologies to the proven and ready stages.

OPENING REMARKS

Dr. Howard Ray
CTTA Project Director

The CTTA communication process

The impact of a communication program in support of agricultural technology transfer can be no greater than the relevance, importance, and appropriateness of information being disseminated to farmers. Therefore, the CTTA Project places strong emphasis on the identification and assessment of the technologies that will constitute its messages to those farmers.

CTTA will not create technology, but the project must be fully involved in selecting technologies that it will communicate to farmers. Therefore, the identification and assessment of appropriate technologies for a given situation is a high priority activity.

Particularly in Africa, a preliminary review of agricultural technologies and technology systems has confirmed their great diversity, leading to problems in determining those most appropriate to include in a communication program.

We have been fortunate, and are most appreciative of receiving support from Dr. Brady's Small Activities Fund to make a survey of available agricultural technologies and technology systems--from international agricultural research centers (IARC), other collaborative research programs, and national programs. The objective of this study will be to identify technologies --indigenous or otherwise -- in up to four selected African countries, that are:

> Ready for diffusion.
>
> Proven technologically, but which require modest institutional modification and/or support to enable farmers to adopt them.
>
> Promising for the future, but which will require substantive institutional modification before they can be adopted and used beneficially by farmers.

The first step in preparing for this study is to develop an analytical framework for technology identification and assessment that includes the critical institutional, agricultural, and socioeconomic elements to be addressed. This meeting will begin this process, taking advantage of the insights and experience gained through several currently used approaches.

Following today's discussions, a smaller group comprised of

Ans Burgett	-	AID/AFR/TR/ARD
Kenneth Swanberg	-	AID/S&T/RD
Raymond Meyer	-	AID/S&T/AG
David Thurston	-	Cornell University
Howard Ray	-	CTTA Project Director, AED
Anthony Meyer	-	AID/S&T/ED

will synthesize the insights and conclusions from today's meeting into an analytical framework to be used for the study.

We expect the survey to provide not only information needed by CTTA, but also information that will be valuable in designing and implementing programs to alleviate present non-communication constraints to the use of technologies in the second and third categories.

We also plan to incorporate this framework into the CTTA process for determining technical message content in all countries in which we operate -- in Latin America, Asia and Africa.

Thus, we place high importance on today's deliberations, and are looking forward to animated and frank discussion which will lead to synthesis of a serviceable and valid analytical framework for identifying and assessing technologies.

Meeting format

The remainder of today will be directed toward achieving the meeting's specific objective:

> To identify critical institutional, agricultural, and socioeconomic elements that should be included in the analytical framework for identifying and assessing the stage of readiness for diffusion to farmers of appropriate agricultural technologies.

To facilitate our task, we would like to begin discussing the critical elements in the context of three potentially viable technologies for Africa. Then, we would like to broaden the framework to make it more generally applicable to identifying and assessing a wide range of technologies appropriate for use in any country.

As indicated in the agenda, we will separately address each of the three technologies. To provide a common basis of understanding, each technology will be briefly described. Then, to open the discussion and focus sharply on the socioeconomic, institutional, and agricultural issues relevant to that technology, we have asked three persons to highlight some of the issues relevant to each as related to the technology or technology set. From that point, we hope everyone will contribute freely to the discussion.

I would request the moderators of each session to keep us on track -- to use the technology as a basis for identifying critical elements in the three types of analysis, rather than concentrating on trying to make an assessment of the technology.

Dr. Ruth Zagorin
Director, Office of Human Resources
AID/S&T/HR

Good morning. On behalf of the Bureau for Science and Technology, Dr. Peter McPherson, and Dr. Nyle Brady, who could not be here today, I welcome you all to this exciting exercise.

A hallmark of the CTTA Project is its interdisciplinary nature. It is heartening to see that many perspectives are represented here, especially as Dr. Brady, through whose Small Activities Fund is making this activity possible, and I share a special interest in the coming together of agricultural and social sciences to address problems of the nature being discussed here today.

The CTTA Project is developing a methodology to provide communication support for technology transfer. Ideally, the Project supposes there are ready technologies available to extend. This has been more the case in Latin America and Asia than in Africa. Often technologies are more "almost ready" than ready, and the CTTA Project can be a catalyst for the decisions and activities required to make them ready. Some technologies require significantly more research or institutional adjustments and are not ready for diffusion in the short term. Because there may be few technologies that are absolutely ready for broad transfer to farmers, I would urge that you not be too conservative in your identification and classification of ready technologies.

This meeting will develop an analytical framework for determining the degree of readiness of technologies for diffusion, with Africa as the primary focus. The examples of drought resistant crops, response farming, and alley cropping are well chosen and discussing them should provide valuable insights for developing the analytical framework desired from today's meeting.

Africa has great need to increase food production. I genuinely hope this exercise and the communication methods of the CTTA Project will have an impact there.

Dr. Anthony Meyer
CTTA Cognizant Technical Officer
AID/S&T/ED

CTTA's objective is to develop a methodology to provide optimal communication support for technology transfer in agriculture.

The Project is attempting to go beyond the common ad hoc use of audio visual aids in extension to more comprehensive multiple channel systems that apply the best of what we know from the behavioral sciences, instructional design, and social marketing. Farmer feedback and local institutional capacities have a primary definitional role in the methodology.

Well, all this is well and good if there are technologies to transfer.

In this regard, Africa is an exciting challenge. As our colleagues in the Office of Technical Assessment and many of you in the room have pointed out, Africa is rich with appropriate, low-resource technology. How to integrate these technologies with the necessity to increase food production and income is not completely understood. In fact, as a project like CTTA learns of these low resource technologies, or of technologies to improve their impact, it is not always clear which are ready for broad diffusion and adoption and which require further testing and adjustment.

As the CTTA Project began to work with a variety of other projects and activities in Africa, this common problem appeared to need addressing. It is for this reason that we are meeting today to develop an analytical framework, using a few example technologies, for addressing the readiness of various technologies in Africa.

I want to thank Dr. Howard Ray and the Academy for Educational Development for organizing this meeting, along with CTTA subcontractors Cornell University and Applied Communication Technology, and collaborating institutions.

DROUGHT RESISTANT CROPS

Moderator:	Dr. D. Thurston
Technology Presenter:	Dr. R. Meyer
Discussants:	Dr. H. Ray
	Dr. G. Honadle
	Dr. J. Axtell

Drought Resistant Crops: The Technology

Dr. R. Meyer

Drought resistance in crops is a complex of various morphological and physiological plant factors that interact with climate and soil characteristics. The primary site of drought stress on plants has not been carefully defined; there is no one factor that is dominantly important in all crops, in all soils, or all climates.

The variety component

It is important to put the variety component (in the broadest sense) in perspective with regard to improved production. Analyses of production increases in crops such as barley, maize, wheat, and rice show that the variety component contributes less than half to production increases -- the major influence coming from higher fertilizer rates and better agronomic management.

Information for sorghum indicates that about one-third of the crop production increase in the U.S. is due to genetic change. The concept that breakthroughs in production in developing countries depend on new high yield varieties is restricting and not true in stressful environments. In stressful environments, yield stability is highly important, and the first limiting component is often not the variety but agronomic factors such as soil moisture management, nutrients, timely planting, and weed control. Traditional varieties frequently are very responsive to improved management, indicating that the variety yield potential does not restrict production. Improved agronomic practices can have immediate effects while plant breeding results have a longer time horizon.

Assured moisture supply and reducing risk to make investments in inputs feasible provided the interaction with high yielding variety potential necessary for large payoffs in the classic green revolution wheats and rices. Those basic factors do not apply to sorghum, millet, or other dryland crops. For these, potential production must be measured against other factors.

In most dryland countries, improving varieties rather than producing hybrids may be a good strategy, and one which does not divert limited resources to building the infrastructure necessary for hybrid seed production. It has been shown that large increases in production can be obtained by small-scale farmers in dryland conditions by integrating improved varieties with improved agronomic practices that do not need tractors or heavy chemical fertilizer applications.

It must also be remembered that plant breeders have not made significant strides in increasing biomass production potentials. Grain production potentials have increased because of changes in harvest index. It is questionable whether this is the best strategy for livestock-based agricultural systems.

Crop improvement and drought resistance

One approach for developing material capable of performing under soil water deficit conditions is based on the premise that the relative ranking of genotypes for yield ability is similar across environments. Selection programs based on this concept are usually conducted under optimal conditions because heritability of

yield and yield components is relatively high and selection is more efficient.

A second approach contends that potential yield is irrelevant. Superior cultivars must be developed and selected in the environment in which they are expected to perform. Cultivars developed in such manner show a very narrow environmental adaptability and exhibit extremely large genotype x environmental interactions.

A third, evolving, approach depends on strong interaction among breeders, geneticists, physiologists, and soil scientists. Large differences exist in available germplasm for almost any characteristic desired. By defining the relationships between developmental, morphological, and physiological characteristics and drought avoidance and tolerance, vast improvement in total drought resistance can probably be achieved.

Other crops

Indigenous crops such as amaranth, quinua, winged bean, and tarwi frequently are recommended as drought resistant crops but the information base for them is limited and it is frequently difficult to make viable recommendations for specific environments.

It is important to note that while some of these crops may be drought resistant under subsistence management, at higher management and yield levels they may be greatly affected by drought. The bases for making decisions concerning investments in developing new or indigenous crops rather than better known commercial crops are not really available at this time.

Conclusions

The need to improve drought resistance and thus productivity of crops grown in drought-prone environments is obvious, but the approach to the task is less so. No single mechanism will convey drought resistance to green plants under all drought conditions. The type of drought which is most likely to exist at a particular site must be carefully defined. The type or types of mechanisms most likely to allow the plant to remain productive must then be incorporated into germplasm destined for that environment. Until one can adequately define the most probable type of drought, little success will be made in increasing drought resistance in a measurable quantity.

The hope is that almost any mechanism that is desired currently exists and can be exploited for use in crop improvement. A high degree of genetic variability exists in the limited germplasm evaluated at this time. There is real promise for improvements to be rapid. If we can incorporate water conservation mechanisms such as increased photosynthesis per unit conductance with tolerance mechanisms such as more effective roots and osmotic adjust-

ment, we can make great varietal improvements in a crop's use of its water resource.

Progress will be made. The rate of improvement will depend upon the degree and extent of cooperation between several disciplines.

Drought Resistant Crops: The Socioeconomic Perspective
Dr. Howard Ray

Three elements -- economics, behavior, and social marketing-- will be reviewed briefly as background for suggesting the following illustrative list of questions regarding drought resistant crops from the socioeconomic perspective. All assume the new technology -- crop or crops selected -- is adapted to the region under consideration and is biologically superior to the farmer's present practice.

1. Is there enough unsatisfied demand for the produce -- commercially or for home consumption -- to justify a program to significantly increase production of the crop?

2. Is the product price stable and sufficient to permit the farmer to realize a reasonable profit from its sale, taking into consideration all production costs?

3. Will production of the crop decrease the risk of crop failure or economic loss in comparison to crops presently being produced? No change? Increased risk?

4. Can adequate seed supplies and other needed inputs be made available to farmers at the time needed and at prices consistent with question 2?

5. How complex is the production technology for the new crop? Are production practices for the new crop sufficiently similar to those presently used to enable farmers to produce the new crop successfully without learning new management skills?

6. Do the farmers have the necessary labor, materials, implements, etc., needed to produce the new crop?

7. What benefits will the farmers derive from planting the new crop in comparison to crops they are presently growing-- greater monetary return, less labor, lower risk, higher community status?

8. Are there potential negative consequences to the farmers who plant the new crop? If so, what are they?

9. Is the new crop acceptable to farmers in the area? Are there cultural or other hidden constraints to adoption from the farmer's viewpoint?

10. Among the various drought resistant crops that may be biologically appropriate, which one or ones are most viable, taking into consideration issues suggested by the questions posed above?

Many other issues and questions are equally relevant, and must be considered. Some will be raised by those looking at drought resistant crops from the institutional and agricultural perspectives -- and some of these suggested here will undoubtedly be repeated. The objective is to stimulate discussion and sharpen the meeting's focus on elements to be included in an analytical framework for identification and assessment of the stage of readiness for diffusion of appropriate agricultural technologies, with initial emphasis on selected African countries.

Drought Resistant Crops: The Institutional Perspective

Dr. George Honadle

Institutional analysis of the potential of a new agricultural technology for widespread adoption requires a high level of two-way, interactive, communication. From an institutional perspective, the potential for adoption of a new technology, such as drought resistant crops, depends on answers to questions from four different viewpoints: 1) development and selection, 2) technology production, 3) delivery methods, and 4) absorption.

Development and selection

1. Can the technology be privately owned and managed?

2. What resources -- capital, education, management -- are required for developing and testing the technology?

3. Who within the institutional system for which the technology is designed will set the decision-making priorities for technology development, testing, and introduction?

4. Are there appropriate sites within a locality for technology development and selection to take place -- laboratories, research farms, test plots?

Technology production

1. Are there capital and labor resources available for producing the new technology -- for instance seed multiplication facilities for new varieties?

2. Are production units of appropriate scale for producing enough materials for the technology to be introduced?

3. Are governmental and private institutional policies favorable for technology production?

4. Does the legal system and do legal requirements favor or allow production of the desired technology?

Technology delivery

1. Is the new technology deliverable through public or private contracts or both?

2. Must users of the new technology participate interactively with the technology delivery system or is it one-way delivery?

3. Does delivery of the new technology require concentrated or dispersed resources?

4. Can the current transportation and communication infrastructure meet the demands for delivering the new technology?

5. Will existing institutions be capable of delivering the new technology, or must new institutions be created?

Absorption

1. What are the boundaries of the areas within which a new technology may be absorbed?

2. How will traditional values (prices) affect the introduction of a new technology?

3. Will widespread adoption of a new technology change local cultural and social balance? What groups have an incentive to stop the introduction of a new technology?

4. Are incentives for adoption of a new technology for groups or individuals?

5. What will be the physical impact of the adoption of a new technology on the farmers who use it?

6. What behavior change will be necessary for a technology to be absorbed by the target audience? Is there a large gap between current behavior and that required by the new technology? Is a new behavior required?

Drought Resistant Crops: The Agricultural Perspective

Dr. John Axtell

In addition to those questions raised regarding the agricultural suitability of technologies during Dr. Meyer's description of drought resistant crops, I would emphasize the following considerations in judging their appropriateness for widespread adoption in Africa.

1. What are the soil requirements and related water regime requirements of the new technology? And, how will the new-crop(s) affect current soil status?

2. What level of agronomic management is required by the new technology? New crop varieties often need management different from that needed by traditional varieties. Case studies can help answer these questions.

3. How stable are the yields of the new crops? This is particularly important because subsistence farmers are highly risk aversive.

4. Introducers of drought resistant/tolerant crops should beware that this aspect of plant breeding is relatively new and limited to only a few crops and regions.

5. The utility of a new crop and its food value should be considered. For example, in one study African villagers preferred sorghum to maize because they were familiar with sorghum milling and cooking practices. An urban population in the same country preferred maize for the same reason. There is a substantial lack of research to identify local crop/food utilization practices.

Drought Resistant Crops: Open Discussion

During open discussion of drought resistant crops, the following questions were identified as important in determining the suitability of the technology for transfer to farmers. The questions are grouped by perspective -- agricultural, institutional, socio-economic.

Agricultural perspective

1. Where does the seed come from? Will enough be available at planting time? How is seed produced and who produces it? How is seed stored, treated, and distributed? What does seed cost farmers and who sets the prices? What is government seed policy?

2. Is there, and what public and private agencies are conducting, multidisciplinary testing of requirements and consequences of new varieties and crops; for example, soil testing, insect pest monitoring, disease monitoring.

3. What are the sources of new and improved agricultural technologies? Are they the international agricultural research centers? public institutions? private organizations? external aid agencies?

Institutional perspective

1. What incentives are there for farmers to adopt a new variety or crop?

2. What are the policymaker motivations for desiring adoption of a new technology, and what are the motivations of farmers to adopt the technology?

3. To encourage creation and adoption of new and appropriate agricultural technologies, where are the most important areas for institutional investment -- research and development? transfer? definition of existing technologies? improvement of management of existing technologies?

4. How can the presently available vectors of change within a culture be harnessed to speed introduction and adoption of new technologies? Is the decision-making frame of the society in which a new technology is to be introduced traditional or changing?

5. What are the input requirements of the new technology and what impact will they have on delivery systems and the environment?

Socioeconomic perspective

1. What are the cultural expectations of the technology? Is the new technology readily usable by a broad range of farmers?

2. What is the cultural class of the variety or crop to be introduced? Some cultures rate cereals higher than tuber crops, and vice versa.

3. Are farmers dissatisfied with the current agricultural situation, and thus more willing than might be normal to experiment with a new technology?

4. What are the risks of adopting versus not adopting a new technology? In a risk aversive society, the lack of negative consequences to the adoption of a new technology may be more important than the presence of positive consequences.

5. How long is the payoff period of adopting a new technology?

6. What are the labor constraints of a new technology? Labor should be viewed in the following contexts: family, hired, family + hired, sex, culture, the larger economic situation, and within subsistence and commercial farming contexts.

7. What are the target audiences of the change in technology--public, private, group, individual, etc.?

RESPONSE FARMING

Moderator:	Dr. K. Prussner
Technology Presenter:	Dr. I. Stewart
Discussants:	Dr. J. Woods
	Dr. D. Porter
	Dr. A. Burgett

Response Farming: The Technology

Dr. I. Stewart

Response farming means farmers receive better information than they now have as to the expectation for rainfall in their specific locality during the approaching cropping season, and that their decisions are influenced by the improved knowledge. A complete response farming system will additionally provide farmers better information as to how best to respond to any rainfall forecast.

Response farming uses the research activities and findings of others rather than replacing them. However, it is also true that I and colleagues at the University of California, Davis, Western U.S. Universities, and in Kenya have, during 20 years, elaborated a specific package of research methodologies termed <u>water production function research</u>, designed to generate a maximum of response information in the shortest time possible with the least input of effort, research resources, and money.

Therefore, the response research and teaching program is appropriate wherever agricultural research in general is appropriate. The appropriateness of the rainfall forecasting portion depends on the degree of improvement in forecasting that can be achieved in the given locale, using the crop specific rainfall analyses developed for this purpose. In Kenya, where response farming was developed, the level of rainfall predictability is only moderate, but nevertheless sufficient to provide a wealth of useful information for better matching of practices with actual rainfall. On-farm validation trials over four growing seasons were totally successful.

Equal predictability to that in Kenya has been demonstrated in a transect across the Mediterranean including Morocco, Cyprus, and Jordan. Still better predictability has been found in the Lower Terai of Nepal, on the border of northern India. I now believe the approach to be sound virtually everywhere, but there is no doubt that both the degree and nature of usefulness will vary from place to place.

Key points for preliminary analyses are:

- Availability of long term (15 years) daily rainfall records. A cluster of analyses reveals more information than a single analysis and establishes a basis for interpolating into areas where meteorological data are not available. Note that in tropical Africa few additional meteorological data are required.

- Where programs to improve agricultural production are seriously considered, a survey is required of present farming systems, key soil characteristics, and important socioeconomic and institutional factors.

Salient characteristics of response farming

Response farming employs newly developed rainfall analyses oriented to producing specific crops in designated localities to quantify criteria for predicting a narrowed range of possible rainfall amounts, and of possible rainy period durations, in the approaching or just beginning rainfall season.

Simple analyses suffice to assess rainfall predictability. More sophisticated analyses employ transferable equations from water production function research to go back through the record and assess for each past season how much rainfall should have been utilized by the study crop in the study locality (considering other meteorological parameters, soil characteristics, and accepted management practices), and how much yield should have resulted. This process may be done for any number of different crops whether actually grown or simply proposed.

Most important farm management decisions/practices affect both crop water use and yield. The response farming system in its completed form includes a <u>water production function research package</u> to be conducted in the developing country, to quickly ascertain optimal management responses to different rainfall forecasts.

Potential benefits

One of the greatest potential benefits is maximum food security at least cost in low rainfall seasons. Stewart and Faught (1984) found that in Eastern Province, Kenya, total crop failures with maize can be reduced from the conventional one season in two to

one season in seven with medium level management guidance (response farming guidance without the use of commercial fertilizers or other costly inputs), and to one failed season in nine with high level management (inputs included).

Another benefit is excess production to market, thus breaking the poverty syndrome, in high rainfall seasons. Better forecasting of the rains accompanied by more fitting fertilizer, etc., recommendations, will reduce risks to normal farming levels, thus making farmers willing to invest, and lenders willing to back them.

Potential constraints

Potential constraints include unavailability of rainfall data, which may be overcome by regional correlation studies and interpolation and research. Inadequate infrastructure or supply systems to handle inputs with demand possibly changing radically in short time periods.

Response Farming: The Institutional Perspective

Dr. John Woods

When analyzing a technology such as response farming from an institutional perspective it is essential to identify and keep in mind the institutional goals for introducing the technology, the technology receivers, and the strategies for technology introduction. Following are some questions and considerations that have impact upon institutional appropriateness of a new technology.

1. What organizations are involved in introducing the technology and what are their roles in the introductory process--research, regulatory policy, credit generation, feedback? How do they decide to introduce a new technology? What are the incentives for the organizations to successfully introduce the technology?

2. What are the policies and procedures that influence the introduction of a new technology?

3. What problems are being encountered in introducing the technology, and what strategy, if any, is being used to introduce it? Are there markets for the new technology or its product?

4. Are there gaps in the agricultural research-extension-farmer continuum, and where in the continuum is the source of the technology? Is the technology globally based, scientifically based, or technologically based?

5. Is there a diagnostic framework in place for evaluating new technologies or must such a framework be developed?

6. For successful transfer of new technologies, there must be an unbroken chain of activity between the developing agents and the farmer. Links in this chain likely will include technology generation, progressive research, planning and management, production and distribution inputs, communication support, and human resources.

7. Developmental projects must be treated as a social system with interaction at national, regional, and local levels. Developing a conceptual view or organizational inventory of the developmental infrastructure may help trace linkages between institutions that are part of the system and identify those linkages which are not functioning interactively.

8. It is essential to remember that organizations are administered by people for people and that they depend upon the four Cs -- capability, coordination, communication, and commitment.

Response Farming: The Behavioral Perspective
Dr. Douglas Porter

We know there are certain factors, such as positive or negative reinforcement, that control human behavior. Behavior is shaped, maintained, and altered based on consequences. Therefore, when a new technology is introduced, a range of behavior factors must be considered.

1. If there are possible negative consequences to a new technology, how can they be avoided or removed?

2. Are benefits (reinforcement) of adopting the new technology immediate or delayed, and if delayed, for how long?

3. Positive consequences reinforce adoption of a technology. However, if benefits are medium-term or long-term, other, scheduled methods of reinforcement may be needed to maintain interest in a new technology.

4. Behavior is shaped by experience, which is equivalent to intermediate positive or negative reinforcement over time.

5. Current behavior can contribute to farmer attitudes andchange. For example, farmers may place high value on leisure time. If a new technology, although it may produce greater crop yields, requires more labor, farmers will not adopt it if they value their leisure above the added product.

6. Before a technology is introduced, a behaviorist would record what farmers normally do -- on both seasonal and annual

bases, and on and off the farm. What are habits, consumption patterns, consumption preferences?

7. With this information, a behaviorist could begin to decide what technology characteristics, taken from an individual, family, and community viewpoint, might encourage the maintenance of behavior.

Response Farming: The Agricultural Perspective

Dr. Ans Burgett

In addition to those agricultural requirements identified by Dr. Stewart as necessary for the adoption of response farming, I would like to emphasize the importance of the farmer. The focus of all new agricultural technologies must be the farmer. And in Africa, the focus should include women farmers and consider household as well as individual income.

Additionally, again in the Africa context, response farming must be evaluated in terms of soil types and soil depth and in a wide variety of environments.

Response Farming: Open Discussion

Agricultural perspective

1. Existing agricultural technologies that may be similar and/or complementary to those being introduced should not be ignored.

2. Are enough years of rainfall data readily available for successful use of the technology?

Institutional perspective

1. The mid-level operational dynamics of a technology such as response farming should be considered. An organizational agenda should be identified and an institutional interaction matrix prepared that identifies direct exchanges between institutions, resources required from other suppliers, clients, markets, and shared targets of messages and technologies.

2. How do the results of research reach the farmers?

3. Where in the decision-making hierarchy do the farmers fit? Is there a centralized or decentralized approval process for technologies, and what do the institutions that approve technologies consider in their approval process?

Socioeconomic perspective

1. Response farming requires the substitution of one crop for another, depending upon rainfall status. What implications do such massive crop changes have on local, regional, and national markets and marketing infrastructure? What are the implications for seed and other input suppliers and distributors?

2. Is the level of education, experience, and management ability sufficient for introducing response farming?

3. Is the technology too behaviorally complex for successful introduction and maintenance? What are the positive and negative aspects of the technology?

ALLEY CROPPING

Moderator:	Dr. K. Swanberg
Technology Presenter:	Dr. C. Martin
Discussants:	Dr. R. Porter
	Dr. J. Thompson
	Dr. D. Osburn

Alley Cropping: The Technology

Dr. Charles Martin

Agroforestry cropping systems (alley cropping) is a system where foodcrops are grown in alleys formed by hedgerows of fast-growing trees or shrubs. Alley cropping is a modification of the bush fallow farming systems practiced by many farmers in the humid and subhumid tropics.

Woody species in alley cropping systems provide:

- prunings for green manure or mulch for companion food crop(s), or for livestock fodder;
- favorable climatic conditions for soil macroorganisms and microorganisms;
- soil erosion barriers on sloping land;
- firewood and wooden stakes; and
- biologically-fixed nitrogen for companion crops.

Agroforestry systems are generally developed by using fast-growing suitable leguminous woody species such as Leucaena and Flemingia congesta. Although a few woody species have been tested at the farm level, more research work at the station and farm levels is needed. Alley widths currently being tested in Africa range from 2-4 meters. Pruning of woody species is necessary to avoid shading companion crops.

Potential benefits and constraints

Trees and shrubs facilitate weed control by providing mulching material and by shading soil during the off-growing season. Leucaena, for example, grown at 4-meter spacing, has produced 15-20 tons of fresh prunings (5.0--6.5 tons dry matter) per hectare with 5 prunings per year. Enhancement of soil properties resulting from prunings increases soil organic material and soil nutrient content, but does not increase soil acidity. Additionally, mulching increases soil moisture holding capacity.

Nitrogen-fixing leguminous trees eventually release nitrogen to companion crops through decomposition of prunings, especially when the leaves are incorporated in soil. Experiments have shown that after six years of continuous cropping using Leucaena prunings, maize yields remained at 2 tons per hectare.

Prunings, which can be used fresh or dried for later use, also provide high protein fodder for small ruminants.

Labor constraints to operate an agroforestry system have not been thoroughly investigated, nor is there research on the extra level of management needed to implement an intensive alley cropping system.

Little research on agroforestry systems in arid and semiarid regions exists, although it is being initiated. Also, farm level analysis needs to be conducted to determine the economic benefits of alley cropping to farmers, if any.

Conditions most appropriate for alley cropping technology adaptation by small farmers in Africa

Based on current technology in the humid and subhumid regions, farmers in these regions may find alley cropping most appropriate. Farmers practicing mixed crop/livestock systems may stand to gain more from agroforestry systems than those practicing monocropping. Alley widths can be arranged to fit farmer commodity interests -- for example, maize, maize + cowpea, and roots and tubers.

Alley Cropping: The Social Marketing Perspective

Dr. Robert Porter

Social marketing is the application of marketing thinking and tools to programs in social change. It is based upon consumer oriented analysis and responds to the wants and needs of target groups. Through social marketing, products (technologies) can be designed to appeal to and satisfy the wants and needs of the target population. To be successful, social marketing must rely upon

adaptation and coordination of product, pricing, distribution, and communication.

If I were to develop a marketing plan for alley cropping, I would consider the following strategic issues.

1. The target market must be studied and defined. Small farmers are not all alike. Which characteristics are most important in defining the target audience?

2. What marketing tools are available? How should they be deployed? Consider product, price, distribution, and communication.

3. What are the resources for distributing the technology? Can intermediaries and farmers' organizations and associations be utilized as distribution resources?

3. Alley cropping seems most appropriate for subsistence farmers. What effect do the following have on market decisions: access to land, sex-specific duties, home and market consumption, short-term and long-term benefits of the technology, etc.?

4. How will the land tenure system affect technology adoption?

5. What is the division of labor and how will alley cropping affect labor use patterns?

6. Is there market segmentation?

7. How difficult will it be to help farmers develop an accurate perception of costs (direct and indirect) and benefits of adapting the new technology?

It seems that the key feature of the alley cropping technology, at least for farmers practicing shifting cultivation, is that it involves major changes in the time-space organization of agricultural activities.

A study of small farmers in southeastern Ghana indicates that they can spend three or four hours each day walking from their villages to dispersed work sites. Time and labor spent headloading harvested crops from scattered farms to villages is considerable. Moreover, shifting cultivation often makes it impractical to build roads between farms and villages. As long as footpaths are the only links between households and farms, improvements in transportation (and associated time and labor efficiencies) are simply not possible.

Alley cropping, however, could help farmers to farm more continuously on holdings closer to home, thus reducing time spent travelling to work and increasing time available for farming. Reducing

energy expenditures associated with commuting could significantly increase the productivity of farm labor. The impact of alley cropping on the time-space organization of farming might thus involve key consumer benefits.

The related recommendation vis a vis market segmentation is to look for farmers who are cultivating widely scattered plots and who consequently spend substantial time walking to work; these farmers might be especially open to any new technology which would allow them to farm closer to home.

Alley Cropping: The Institutional Perspective

Dr. James Thompson

Following are some key institutional considerations that relate in general to the introduction of any new agricultural technology in Africa.

The institutional constituency for agricultural technologies in semiarid Africa includes:

- land tenure party rights
- tree tenure
- rule making, rule changing, and rule enforcing authority and costs
- markets and prices for products and by-products of a technology
- market and finance institutions
- general institutional infrastructure
- risk aversion structures.

The land tenure situation in Africa is particularly complex in that it can be individual, common, or change depending upon the season of the year. Land tenure has crop and livestock aspects, and perhaps is one of the most important considerations in identifying the appropriateness of a technology such as alley cropping.

Alley Cropping: The Agricultural Perspective

Dr. Donald Osburn

In addition to those points emphasized by Dr. Martin in his description of alley cropping, I would stress the value of knowledge in the following areas.

1. Know the resource base available for adoption of the technology.
   - Who has access to and control of land? Can an individual or a group have title to land? What are the rights of squatters?

- How much labor is available? What are the important cultural aspects of labor use and availability? What are the seasonal aspects of labor availability?

- What capital considerations are important? Is there external capital rationing. What is the external or market availability of capital?

2. Know the performance of the system.

   - What are the products of the system? Are they commercial, for home consumption, or a combination thereof?

   - What are the production and market risks of the system?

   - What is the sustainability of the system?

3. Know the enterprise mix in the interrelationships within it.

Alley Cropping: Open Discussion

With a complex system such as alley cropping, it is extremely important to fully understand the new system and its interaction with existing systems and practices. The following considerations were identified as some of the most important questions regarding the suitability of introducing alley cropping technology to subsistence farmers.

1. Study and clearly identify the requirements of the crop mix within the alley cropping system, including existing off-season land use.

2. Is the new technology environmentally, economically, and socially sustainable? Understand and communicate the limits and constraints, as well as the benefits, of the technology.

3. What are farmer priorities? Are they interested in the technology because it can reduce erosion? Provide animal feed? Produce a cash crop?

4. Study the farmers. How do they respond to risk? Is the area undergoing change that might be harnessed to assist in the introduction of a new technology? What is the level of local agricultural knowledge? Do women participate actively in agricultural activities? What activities? What is their role?

5. How will national policy influence the adoption and sustainability of the technology? Is the legal-political-institutional system flexible to change? Can institutions or individuals change national policy?

6. What is the capacity of the system to promote learning and entrepreneurship? Must farmers receive education to help them make better decisions?

7. Is there a research system -- national or international-- that will continue to support the new technology through ongoing research in areas such as entomology, pathology, soil science, etc?

As a conclusion to the discussion, Swanberg asked the four discussants each to identify their four priority considerations in terms of the suitability for transferring alley cropping technology to farmers.

C. Martin, agriculture, identified:

- identification of labor constraints and local division of labor
- evaluation of economics, risk aversive safety nets, and markets for inputs and products
- development of a framework to help farmers understand the technology

B. Porter, social marketing, identified:

- institutional requirements for sustainability
- rapid implementation
- identification of local labor practices to develop a product mix to effectively use labor
- risk aversion

J. Thompson, institutional, identified:

- incentives for adoption, including a local capacity to structure new rules to allow and encourage adoption of the new technology and to continue to serve it
- ready and sustained availability of local and imported technologies to support the technology system
- economic considerations, including available institutions to support the new technology and markets for its products
- property rights that favor the adoption of a new technology

D. Osburn, agriculture, identified:

- availability of markets for inputs and products
- knowledge of the public and private farmer information-gathering and decision-making process
- existence of information systems to serve farmers.

CONCLUDING REMARKS

Moderator: Dr. H. Ray

In a brief concluding session, Ray solicited general remarks about the day's activities and regarding the Africa technology identification survey.

E. Chetwynd emphasized that the CTTA mass communication project must have good agricultural technologies to transfer to farmers and that every effort must be made to identify technologies that are in that context foolproof. At the same time, he questioned the availability of ready and appropriate agricultural technologies for transfer to African farmers.

J. Axtell emphasized the necessity of local research capability, and commented that national agricultural research staffs have developed many technologies for appropriate for local situations, but that they are generally frustrated with extension services and their apparent inability to communicate technologies to the farmer.

Possible technologies to be examined in the context of the survey include: technology for erosion control and water conservation; the International Institute of Tropical Agriculture cassava research, particularly in disease and insect resistance, and including biocontrol measures;

C. Martin suggested the survey countries might be chosen from those African countries categorized by AID as technology producing. From the four ecological zones of Africa they are: Cameroon, Kenya, Malawi, Senegal, Sudan, Zambia, Zaire, and Zimbabwe.

K. Swanberg asked that the framework, in addition to identifying technologies, consider how those technologies identified as future technologies might be moved to ready technologies.

K. Prussner suggested that the survey framework consider questions from the country USAID Mission level, including:

- What kinds of technology is the country ready for and wanting?
- How does the local Mission approach technology dissemination and diffusion?
- What are the benefits of participating in a communication project?
- Consider the mandate of local Mission activities.

A. Meyer concluded the discussion by asking that participants, synthesis panel members, and members of the agricultural technology survey team remember the ultimate purpose of the tasks -- to improve the quality of life of people.

In closing the meeting, Ray thanked the participants for their excellent contributions toward developing a framework for the Agricultural Technology Survey, and suggested that participants might contribute additional thoughts about agricultural technology analysis, the survey framework, and appropriate countries to be included in the survey by the following week. The notes from today's meeting and those suggestions will then form a basis by which the Synthesis Panel will devise a final framework for use in the survey. A meeting of the Synthesis panel was scheduled at the Academy for Educational Development for 3 September 1986.

PARTICIPANTS AND OBSERVERS

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AGENDA

PLANNING MEETING FOR
AGRICULTURAL TECHNOLOGY SYSTEMS IDENTIFICATION FOR AFRICA

Envoy Room, Embassy Square Hotel, Washington, D.C.
20 August 1986

8:00 - 8:30 Arrival and Coffee

8:30 - 9:00 PLENARY SESSION
Howard E. Ray, AED, CTTA Project Director, Conference Chairperson

Introductions
Anthony J. Meyer, CTTA Project Manager AID/S&T/ED, and Kenneth G. Swanberg, CTTA Project Co-Manager AID/S&T/RD

Purpose
Ruth Zagorin, Director, Office of Human Resources, AID/S&T/HR

Objectives
Howard E. Ray

9:00 - 10:30 TECHNOLOGY I - Drought Resistant Crops

Moderator
David Thurston, Plant Pathology Department, Cornell University

Technology Presenter
Raymond Meyer, Soil Scientist, AID/S&T/AGR

10:30 - 10:45 Break

10:45 - 12:30 TECHNOLOGY II - Response Farming (Water Management)

Moderator
Kenneth Prussner, Chief, Agriculture and Rural Development, AID/AFR/TR/ARD

Technology Presenter
Ian Stewart, Agro-meteorologist, AID/ANE/TR/ARD

12:30 - 1:45 Lunch

1:45 - 3:45 TECHNOLOGY III - Alley Cropping

Moderator
Kenneth G. Swanberg

Technology Presenter
Calvin Martin, Assistant Director, Office of Technical Resources, AID/AFR/TR

3:45 - 4:00 Break

4:00 - 5:00 PLENARY SESSION
Howard E. Ray