Technology Development and Dissemination in Agriculture: A Critique of the Dominant Model

Erasmus D. Monu*

Résumé: *Bien que beaucoup d'attention et de ressources aient été consacrées au développement et à la diffusion de la technologie agricole en Afrique, la grande majorité des paysans, notamment des petits paysans, usent de techniques culturales traditionnelles. Selon l'auteur, le fait que la technologie qu'utilisent les paysans ne s'est pas améliorée d'une manière significative est due à la manière dont les produits de la Recherche - développement - diffusion sont utilisés. L'analyse que fait l'auteur des points faibles et de l'impact du modèle de la Recherche - développement - diffusion sur l'évolution de la recherche, la diffusion et l'usage de la technologie agricole est destinée à suggérer des changements positifs.*

Introduction

One of the greatest challenges facing agricultural scientists, policy makers and project implementors is how to enable small-scale (resource-poor) farmers to increase their production. This is important because as the World Commission on Environment and Development (1987) points out, much of sub-Sahara Africa is characterised by low-resource agriculture.

This type of agriculture relies on uncertain rainfall rather than on irrigation and is found in more marginal areas (dry lands, highlands and tropical forests). The areas are vulnerable to degradation and typically have limited infrastructure to support agricultural development. Normally, the farmers in these areas have neither had adequate access to information generated by research nor the organisational support to bring pressure to bear in research systems (Merrill-Sands *et al.* 1991; Frankenberger 1992). The rain-fed small scale farming system in these areas are much more internally complex in comparison to industrial farming systems. As Chambers (1991) points out poor people in these areas seek to multiply their enterprises, raise their incomes and reduce their risks. The production system is driven by the multiple objectives of consumption and production. Thus, there is a constant balancing of competing needs of asset preservation, income generation and present and future food supplies (Frankenberger 1992).

For some time now, technology (new or improved) has been identified as one of the most important factors that would contribute to increased

Africa Development Vol. XX, No. 2, 1995, pp21-39

agricultural production. To this end most African countries have set up agricultural research institutes or stations. In addition, a number of international agricultural research institutes have been located in African countries. Technology in this paper is defined broadly to include ideas, practices and tools.

However, the majority of African farmers continue to rely on their traditional farming practices. This led the Association for the Advancement of Agricultural Sciences in Africa in 1975 to declare:

> The lag between knowledge and practice is usually long, but in some parts of Africa it has seemed to be infinite. The value of research findings, however great, remains potential only until they are transmitted to him who will use them in production practices (OECD, 1975:iii).

A decade later Carr (1985:142) in a review of the impact of technology on rural areas of Africa concluded:

> The technologies that have gained a moderate foot-hold in the rural areas have had a very limited effect in terms of improving the well-being of all members of the community; the spread of many potentially beneficial technologies has been so very limited; a great deal of money and effort has been wasted on developing technologies that are neither acceptable nor useful to the potential end user or that do not meet a high priority need.

The situation today is not that different from the descriptions above. In many areas of Africa either there are no available new/improved technologies, or where they exist, they are unacceptable to the farmers. In cases where useful technologies exist, their spread have been very limited and in those areas where the technology have been adapted, the benefits seem to accrue to only a small segment of the community.

The logical question to ask is, Why and how do we find ourselves in the current situation? In the past the answer to the above question has been sought in the characteristics of the farmer, namely the ignorance, illiteracy and unwillingness of the farmer to change.

This paper takes the view that in order to fully understand why the available technologies have remained largely at the research institutes and centres, we need to examine the whole process of research, development, dissemination and utilisation of technology. In doing this, we need to investigate the structural constraints under which those involved in the processes work, their motivations as well as the interactions between the different groups involved in the processes. The three major sub-systems involved in the development, dissemination and utilisation of technology are the information/technology generating sub-system (researchers and inventors), the linking sub-system (extension agents) and the information/technology user sub-system (the farmers).

The Information/Technology Generating Sub-system

The inability or failure of the research institutes to generate useful and acceptable technologies are sometimes attributed to lack of adequate resources and poor general agricultural policies. However, it is our view that the unacceptable level of performance of the research institutes could largely be traced to the model of development followed in these institutes.

Most of the research institutes and research stations have adopted the Research, Development and Diffusion (RDD) model (Lakoh and Akinbode 1981; Whyte 1981; Chambers and Jiggins, 1986). The RDD looks at technology development from the viewpoint of the originator of an innovation, who bases his/her innovation on a presumed receiver's needs. The initiative of identifying the problem areas is therefore taken by the researcher of the innovation who focuses on the design and development of a potential solution. This is followed by the dissemination of the solution to those who are supposed to implement it (Chambers and Jiggins 1986; Matlon *et al.* 1984; Monu 1982a).

This model is not unique to the Third World. In fact, the model is adopted from the industrialised world, especially from the Land Grant Colleges of the United States of America (US). Recently, Everett Rogers, one of the exponents of the model, has summarised the major elements of the model as practised in the US as follows:

1. A critical mass of new technology, so that the diffusion system has a body of innovations with potential usefulness to practitioners.
2. A research sub-system oriented to application, as a result of the incentives and rewards for researchers, research funding policies and the personal ideologies of the researchers.
3. A high degree of user control over the research application process, as evidenced through client participation in policy determination, attention to user needs in guiding research and extension decisions and the importance accorded feedback from clients in the system's effectiveness.
4. Structural links among the technology transfer system's components, as provided by a shared conception of the system and by a common sense of mission.
5. A high degree of client contact by the linking sub-system, which is facilitated by reasonable agent-to-client ratios and by a relatively homogenous client audience.
6. A spannable social distance across each interface between components in the system. Social distance is reflected in professionalism, formal education, technical expertise and specialisation.

7. Evolution of extension as a complete system for technology transfer, rather than a research utilisation system grafted on as an additional component of an existing research system.
8. A high degree of control by the system over its environment, enabling the system to shape the environment rather than passively reacting to changes in this environment (Rogers 1989:147-148).

Even a cursory review of the agricultural technology development and dissemination systems of African countries would reveal that most of the eight major elements mentioned by Rogers (1989) are non-existent within these systems.

We submit, therefore, that the weakness of the technology generating sub-systems in Africa could be partly attributed to the adoption of the RDD model without making sure that the assumptions on which the model is based are met. The situation is even made worse because the RDD model adopted in Africa is an adulterated one.

First, in the RDD model practised in most African countries, the receiver of the research results is a passive partner so far as the identification of the problem and the research and development of the solution to the problem is concerned. Thus, in many cases, policy makers and scientists determine research priorities and then scientists design and conduct the experiment under controlled conditions. The results are then handed over to the extension organisation for transfer to the farmers. One would expect the extension service, as the intermediary between the farmers and the researchers, to provide feedback to the scientists concerning the problems, expectations and motivations of the farmers. Unfortunately in many cases very little feedback is provided.

According to Rogers (1989), there is a high degree of user control over the research process; 'as evidenced through farmers' participation in policy determination, attention to user needs in guiding research and the importance accorded to feedback from farmers on the system's effectiveness'. However, in Africa the farmers, for whom the technology is presumably developed, have no input into the process and yet it is expected that whatever technology is developed, they must adopt it (Matlon *et al.* 1984; Chambers and Jiggins 1986; Monu 1989).

The resultant effect is that in many cases the technology generated by the scientists do not fit the needs and priorities of the users and/or the users may not have access to the resources required for the adaptation of the technology.

In the Kadawa irrigation scheme area in Northern Nigeria, when wheat was introduced, farmers were advised to plant wheat by mid-November. However, in order to plant wheat on time, the farmer must have cleared his/her land in preparation for project tractors by October. If the land was

used to grow guinea corn (the food crop of the area) in the wet season, the land could not be cleared until December. Although the farmers were well aware that yields would be below expected levels if planting was not done on time, they ignored the recommended date for planting wheat in order to ensure adequate supply of their staple food crop, guinea corn (Monu 1981a).

Had the scientists involved the farmers in the area, they would have discovered that the planting date specified for wheat was in conflict with growing guinea corn and that the farmers' priority was producing enough food (guinea corn) for the family. Indeed, it is conceivable that the scientists could have developed a variety of wheat which would be compatible with growing guinea corn.

It is suggested that the above could be partly explained by the fact that, in Africa, agricultural scientists are output-oriented rather than client-oriented. In industry, client-oriented scientists are educated and trained in market and user-participation research, thus scientists are more likely to be responsive to user concerns (Chambers and Jiggins 1986). Thus some companies, recognising the value of user resources, have created special programs to identify and encourage user innovation and to incorporate those found worthy into company product lines. IBM, for example, estimates that one-third of all its leased software originated from such user innovations (Gamser 1988).

Second, the RDD model reinforces the view that scientists know more than the potential users of the technology and that the knowledge of the former is superior. Research and experimentation are the domain of those trained in colleges and universities. Many agricultural researchers are surprised by the idea that smallholder farmers in Africa are active experimenters (Richards 1985). Yet many observers have noted that farmers undertake research and experimentation and that these are necessary for farmers to survive and/or adapt to new conditions (Briggs 1986; Johnson 1972; Chambers and Jiggins 1987; Briggs and Clay 1983).

The agro-forestry project in the Mampong Valley in the Eastern Region of Ghana is an example.

The technicians of the project advised the farmers to establish their hedgerows four meters apart. However, one farmer after establishing four hedgerows realised that the distance between the hedgerows was too short, given the type of crop grown in the area. Cassava, the main crop grown in the area, could have tubers beyond two meters in length. The farmer felt that the short distance between the hedgerows would lead to a situation where the cassava tubers could entangled with the roots of the hedgerow trees.

He therefore decided to experiment with three different distances between the hedgerows, the 4 meters suggested, 6 meters and 8 meters. After harvesting the crops he concluded that the 6 meters was the appropriate distance. While the four meters did not provide enough space for

the cassava tubers, the 8 meters was too wide and this resulted in inefficient use of the land.

Indeed, even the proponents of the RDD model implicitly acknowledge the ability of farmers to conduct experiments. However, since in their view only university and college graduates could perform experiments, they label the activities of the farmers as trials rather than experimentation.

This feeling of superiority has blinded the scientists to recognising the useful knowledge that farmers have that could assist scientists in their work. Although recently, there seems to be an acknowledgement of this fact, one wonders why it has taken so long. As far back as 1936 Leakey (1936:122) remarked:

> The habit of regarding African methods of agriculture or of any other activities as inherently bad because they are different from our own is most unwise. I do not suggest that the methods used by different native tribes are all perfect. Doubtless the methods of agriculture employed by the Kikuyu could almost certainly be improved in many details, but this could only be done if European methods of research were employed in trying to develop the African method of cultivation which is a very different thing from trying to substitute European methods of planting for those which have evolved out of research by trial and error.

Leakey's (1936) remarks are substantiated by the case of the improved cotton technology in Northern Nigeria (Norman *et al.* 1974). Had the scientists taken the time to understand why the farmers did not plant cotton in June and July, which technically proved to be the most appropriate time for planting and why they practised mixed cropping rather than sole cropping, the nature and direction of their research would have been different. As it were, for farmers to accept their technology, they had to change many of their recommendations including the date of planting, which led one of the scientists to exclaim; 'I have wasted 20 years of my professional life'.

In the light of the above we concur with the Botswana Government when it states:

> Not only....should the agricultural research strategy strengthen technology development at various research stations, but should forge more productive links with extension and farmers. Strong and continuous farmer participation in technology development has generally proved beneficial and sometimes cost effective. A research strategy in agricultural development that does not take into account the objective physical, economic and institutional problems faced by farmers is unlikely to pay off in the long-run (Ministry of Agriculture 1991:24).

Moreover, it is evident that the farming systems of small-holder farmers are very complex and not amenable to the manipulation of few variables. Indeed, to fully understand small-holder farming systems, both biological

and socio-economic variables must be examined. It is true that this is exactly what the Farming Systems Research and Extension model (FSRE) calls for. The FSRE model is an improvement over the RDD model in that:

> The concept FSRE explicitly recognises the value of the farmers' experience and their traditional experimentation as inputs into strategies for improving the productivity of existing farming systems (Gilbert *et al.* 1980).

However, within the FSRE model the scientist remains the one who determines what to research and who does what (Monu 1993).

Moreover, the cooperation between social scientists and agricultural scientists which is necessary for a successful implementation of FSRE is hard to come by. As Rhoades and Booth (1983:2) have observed:

> Differences in perception and role definitions between biological and social scientists result in a mutual respect that is miserably low...the upstart of this disciplinary tribalism (is) that social and biological scientists tend to line up on opposite sides of the fence and throw spears.

The fact remains however, that where the agricultural scientist is prepared to cooperate with the social scientist, the latter has not measured up too well. As Cernea (1991:14) has suggested in terms of applied sociological research:

> It entails that the work to be done by sociologists, the methods used and their order of use should differ substantively in a policy perspective from what is habitual in a disciplinary perspective. When guided by an inward looking disciplinary perspective, applied sociological work begins and ends with sociology and may not fully serve the specific purpose of policy (applied work).

The fact is that the conventional methods of social investigation have not produced the relevant, useful and timely information required. In the desire of the social scientist to have a comprehensive data base, the agricultural scientist could be frustrated with the endless process of socio-economic data collection. Indeed, in some cases, the project had already come to an end while the base-line data were still being analysed as an input into the project. Fortunately, recently a series of data collection techniques referred to as Rapid Rural Appraisal (RRA) has been proposed to overcome some of these problems. It is yet to be seen whether the academic community will give it its blessing.

Furthermore, in most rural development planning and research, efforts have been concentrated on the individual (mostly the male head of the family) as the unit of analysis. However, there is a growing evidence which indicates that to fully understand the decision-making process among small-scale farm families, the unit of analysis must be the farming household.

Using the household as the unit of analysis allows us to examine the distinct roles and multiple goals of individuals within the household, in addition to the recognition that farming is only one of several strategies within the household economy. This approach also enables us to analyse how the household adjusts to different demands in order to satisfy its multiple goals which may compete with one another at times. However, in focusing on the household as a unit of analysis, we must not make the assumption 'that the household is a unit of convergent interests where the costs and benefits of (technology) will be shared evenly by members of both sexes' (Agarwal 1985:105). Thus, for example, the introduction of certain technologies could lead to an increase in workload for women without necessarily any increase in their income.

Reviewing an upland rice project in Ivory Coast, Dey (1984) shows that the major obstacle to the success of the project was the lack of recognition and attention to the traditional sexual division of labour within the farming system.

Traditionally, women are responsible for producing food crops including upland rice which is used to feed the family, and where surplus exists, this is sold to generate income for the women. Men are responsible for cash crops and any income generated is solely controlled by them.

However, the upland rice development project targeted men rather than women. The men however, turned the rice plots into personal cash crop, which meant they alone benefited from it. On the other hand, the men, based on tradition, demanded unpaid labour from the women of the household.

The result was a gender conflict which undermined the success of the project. It is reported that women refused to apply the fertiliser provided by the project since this would increase their workload in weeding and harvesting while the benefits went to the men exclusively.

On the basis of the above, it is suggested that in order to better understand the technology development process and to make sure that the technology developed is relevant and applicable to the conditions of the intended users, we must always seek answers to the following questions in area specific situations:

1. What are the values, norms and rules peculiar to the technology development agency?
2. What are the constraints within which the scientists work?
3. What are the values and attitudes of the scientists, especially their perception of the small-scale farmer?
4. To what extent are the intended users involved in the process?
5. Does the technology conflict with the intended users' aim of maximum profit?

6. What are the likely social costs of the technology?
7. Whose interest is served by the technology?

The Linking/Dissemination Sub-system

Two groups of reasons have been offered for the poor performance record of the extension services in the Third World countries (Monu 1988). The first group of reasons are related to the conditions of work of the extension agent and the extension service as an organisation, while the second group of reasons point to the characteristics of the extension worker.

According to Uphoff and Vandusen (1984), extension agents are provided with little information by their agency to transmit to the farmers, and in some cases there is little information available that could improve the farming system of the small-scale farmer. Secondly, extension agents are often isolated from or ignored in the decision-making process because of their location in the hinterland.

In addition, the conditions of work for extension workers are often difficult while transportation and communication facilities are often inadequate. Extension workers are also often burdened with many tasks beside agricultural extension work and have many bureaucratic duties to fulfil.

It is also noted that in most African countries, there is a large shortfall in the numbers of the necessary personnel with the relevant skills and the willingness to work at the village level. Furthermore, quite often small-scale farmers and extension workers tend to have divergent world views. If extension agents are to assist small-scale farmers, the view points of the farmers and the extension agents need to be brought together. The extension worker needs to have a good knowledge and respect for both traditional and modern techniques. The successful extension agent must not only understand what and how the new technology is applied, but must also know the farming practices of the locality where the technology is to be applied (Uphoff and Vandusen 1984; Axinn 1985; Monu 1989).

As valid as these reasons are, we believe that the more important factors which explain the success or failure of the extension service in disseminating technology amongst small-scale farmers are associated with the 'Diffusion of Innovation' model used by the extension service.

A review of the extension services in most African countries would indicate that most of them continue to operate within the Research, Development and Diffusion model. According to this model, members of a social system can be rated on how soon and how often they adopt new ideas introduced into the social system. A new idea is initially adopted by a very small but highly innovative group. These individuals are able to take the necessary risk because of their high economic status while at the same time their position in the social system allows them to ignore tradition and social

control. From these innovators, those with high social and leadership status learn and adopt the idea. The new idea then spreads throughout the social system until most of the members adapt. Innovators are said to be different from late or non-adapters on a number of socio-demographic and psychological factors (Monu and Omole 1982).

The above generalisation has provided an ideological support for the Progressive Farmer Strategy in agricultural extension in most Third World countries. The strategy assumes that innovations trickle down from progressive farmers (farmers who are more innovative and socio-economically advantaged) to non-progressive farmers. Thus, the extension agent is to work with the progressive farmers whose adoption will create a multiplier effect throughout the system. The innovation will spread out at an accelerated pace in a snowball fashion until most people in the social system adopt it. Thus, the strategy is said to maximise the extension worker's output and his/her direct and indirect impact (Monu 1982).

The question often asked by the practitioners of this model, is 'How do I get them where I want them?' (Rolling 1985:272). The assumption implied in this question is that the change agents have knowledge that is considered essential for the benefit of a category of people. The problem therefore is how to find the effective communication system to transfer this knowledge to the group which needs it. When it becomes obvious that even when the most effective communication method was used the information was not transformed into action, a different question is raised, 'Why don't they do what I want them to do?' Why do people resist change although the change agent is sure they would benefit from what is offered?

Thus, the strategy concentrates only on the receiver group to account for non-adoption. There is an assumption that the technology is good and beneficial to the receiver . The result is that in many cases no attempt is made to examine how suitable and practicable the recommendations are. In other words, the diffusion model does not make room for rational rejection.

Had the propagators of the improved cotton technology in Northern Nigeria (Norman *et al.* 1974) examined the applicability and suitability of the technology to the farmer's field, they would have expected the rejection of the technology. The cost associated with the adaptation of the technology (fertiliser and spraying) was too high for the small-scale farmer. Secondly, the improved cotton was recommended as a sole crop while the farmers were practising mixed cropping. Moreover, the average net return from the improved cotton technology was only 13 per cent better than cotton grown in mixtures. If we consider the benefits the farmers could derive from the other crops on their mixed farm, it is conceivable that the farmer could incur losses by adopting the improved cotton technology, not to mention the risk involved in depending on only one crop, especially a non-food crop.

Another serious problem of the diffusion model is the assumption of a social system which is homogenous with respect to the technology introduced. Thus, the technology is assumed to be equally relevant to all members of the social system, and yet the model differentiates between five categories of receivers within a social system with different socio-economic and psychological characteristics. The fact is that the adopter categories identified within the diffusion model are sub-groups within the social system with varying levels of access to resources necessary for technology adaptation. What is required is to determine which technology would be suitable to each of these sub-groups and the best way to disseminate the information within the group. Surprisingly, with few exceptions (Ascroft *et al.* 1973; Huizinga 1982) researchers and practitioners have not taken advantage of these research results by linking technology development and dissemination to the characteristics of the sub-groups within the target population.

The available evidence clearly shows that the often reported differences between small-scale farmers and the so-called progressive farmers (more well-to-do farmers) in technology adaptation are not due to differences in socio-demographic characteristics, inherent willingness to take risk or accept change and knowledge of the technology; but rather the differences can be traced to differential access to the resources required to adapt the technology, the suitability of the technology to the farmers' situation and the preferential treatment given to the progressive farmers by the extension service (Monu 1981a; 1981b).

Moreover, our experience shows that the 'trickle down' effect in information dissemination does not normally occur. The diffusion of innovation strategy assumes that the technology will 'trickle down' from so called progressive farmers to non-progressive farmers. Our analysis of the Funta Agricultural Development project in Northern Nigeria clearly shows that information does not trickle down from 'progressive farmers' to 'non-progressive farmers' (Monu 1983).

Only a very small proportion of non-progressive farmers derived their farm information from other farmers. Even for this small proportion of farmers, it should be remembered that second-hand information is unlikely to provide as specific or as reliable information as a message received first-hand.

In a way this finding should not surprise us. According to Rogers (1969:181):

> Communication is more effective when a higher degree of homophily is present; that is when source and receiver are more similar in certain attributes. An homophily pair share common meanings and interests; they are better able to empathise with each other because their roles are similar.

Unfortunately, the promoters of the diffusion strategy have ignored this logical common sense remark and continue to work on the trickle down strategy.

In addition, contrary to Roger's (1989) description of the US model, extension systems in Africa operate independently of research stations. In many cases not only are they physically separate from one another, but they also have different authority structures. Often there is very little interaction between the two systems. Any communication that takes place is a one way flow of information (from the research organisation to the extension system). Lakoh and Akinbode (1981) in their study of the agricultural research delivery system in Sierra Leone found that research and extension contacts are very limited. In fact, extension workers were largely dependent upon their immediate field supervisors for information about technological innovations. Our observations in Ghana and Botswana yielded the same results.

Additional factors which contribute to poor extension-research linkages are lack of clarification of roles and responsibilities of both groups in the technology development process, educational differences between research and extension officers and the lack of appreciation of one group for the validity of the tasks performed by the other group.

Moreover, a review of the strategies of information/technology/ dissemination in Africa shows a total reliance on the extension worker and the use of radio. On the other hand, research findings from the diffusion of innovation researchers indicate that a variety of information sources are involved in the adaptation process (Monu 1984).

What is needed therefore is a multi-media approach to technology dissemination. Although radio can reach a large number of people at different locations quickly and at a relatively low cost, the drawback is its inability to localise messages and tailor messages intended for specific groups such as small-scale producers.

In addition, some students of communication have argued that:

> despite all the technological advances in communications, it is becoming increasingly apparent that the mass media such as newspapers, broadcasting and film in their present form cannot greatly perform the roles defined for and expected of them by the development paradigms... The mass media do not reach enough of the Third World population with credible and relevant information (Valbuena 1986:2).

It is therefore argued that for communication to become truly an instrument of social change, it must be based on the existing value and belief system of the community as well as upon built-in respected and trusted communication channels, like the folk media. In this respect traditional dancing groups, and drama groups could be used as effective agents of technology dissemination.

As Date-Bah (1985) has suggested for Ghana, traditional songs or high-life songs could also be used for communicating ideas.

There is also a beginning of the development of a complementary system to the traditional extension system (Monu 1988). These attempts indicate that farmers are capable of disseminating new ideas/technology to their colleagues giving adequate training, sufficient and efficient technical support and follow-up. By this, we are not referring to the 'Training and Visit System' (T and V) which is merely 'Old wine in a new bottle'. So far, much of the evidence available comes from non-governmental organisations and universities. There is a need to research and experiment with the strategy in government departments of Agriculture.

It is important that the information dissemination system/extension be considered as a part of a knowledge system. In this perspective, the extension system interfaces with the technology generation/research sub-system and the user/farmer sub-system. This mode of thinking allows for the integration of ways in which interested users of the information can and/or exert control over the dissemination system or the way in which information from and about intended users is used in the information dissemination programming (Roling 1985). As noted earlier, we would be ignoring reality if we were to assume that knowledge is always generated by researchers and transferred by extension to the intended users. Intended users are also important generators of knowledge which could and should be utilised by researchers and extension officers.

The User Sub-System

As stated earlier, the blame for non-adoption of new/improved technologies, until recently, have been put on farmers. The explanation of non-adoption has been sought in the socio-demographic characteristics of farmers, their ignorance, illiteracy and unwillingness to change.

Although we do not deny the fact that certain socio-cultural beliefs and practices of farmers could hinder change, our view is that a more important factor is the non-involvement of farmers in the technology generation-dissemination process. Indeed, some of the socio-cultural beliefs and practices would not pose obstacles to the adaptation process if farmers were involved at the beginning of the technology development process. Cernea (1988) in his examination of twenty-five World Bank Projects found thirteen of them to be non-sustainable.

The major reason given for the non-sustainability of these projects is the neglect of socio-cultural factors, mainly farmer organisations and participation. Esman and Uphoff (1984) in their review of non-World Bank financed projects have come to the same conclusion.

However, it should be recognised that as individuals, the small-scale producers lack the resources and skills to participate effectively in the

process. As we indicated earlier, one of the reasons why the RDD has been successful in the United States is because of the high degree of user control over the research application process. It follows that if small-scale farmers in the Third World are to participate effectively in the technology development-dissemination process, effective and efficient farmer organisations are needed.

As we have pointed out elsewhere:

> One of the major problems of development projects in the developing countries is that adequate village level organisations are not created to sustain the project when the official term of the project expires. Thus, in many cases the official withdrawal from the project means the death of the project (Monu 1982b:261).

There is a need therefore to examine local organisations to determine which form of organisation best enables the intended user group to participate in the development process. Bratton (1986) in his attempt to develop a typology of farmer organisations, identified six categories ranging from single interest groups to multi-purpose groups.

What is important is to be aware that the type of organisation utilised at a particular time will depend on the capabilities of the people and local conditions. It should also be recognised that there are three possible situations that may face the technology development and the dissemination sub-systems.

In some situations local organisations may already be in existence and have the capability to identify problems and needs, to plan and to determine what outside help would be needed. Under such circumstances, it is advisable to work through existing organisations and provide such organisations with the assistance needed.

In other situations, although some organisations may exist, such organisations may be less experienced and thus less able to initiate activities on their own. Under such conditions, the technology development and dissemination sub-systems would have to play a facilitator role in helping to create and develop the capability of the local organisation.

Third, in some situations, local organisations may be non-existent or grossly undeveloped. Under such circumstances there may be a need to develop new organisations or use existing organisations set up for other purposes.

An important point made earlier is that the user sub-system should not be looked upon as only a receiver of knowledge but also as a contributor of knowledge.

As Chambers (1980:2) eloquently points out:

> Modern scientific knowledge is centralised and associated with the machinery of the state; and those who are its bearers believe in its superiority. Indigenous technical knowledge, in contrast, is scattered and

> associated with low prestige rural life; even those who are its bearers may believe it to be inferior. It is difficult for some scientists to accept that they have anything to learn from rural people, or to recognise that there is a parallel system of knowledge to their own which is complementary, usually valid and in some respects superior.

Both social and natural scientists, in cooperation with farmers must make efforts to codify the indigenous technical knowledge of small-scale farmers so that these could be incorporated into the technology development and dissemination process.

This cooperation between researchers and farmers could lead to the development of technologies that would contribute to sustainable development. Sustainability in agriculture has two dominant features, to ensure that increased cropping intensity and productivity do not affect negatively the quality of the land and water resource base; and secondly to ensure that, at least, some of the plant and animal communities are preserved in the face of increased demand for agricultural products and farmers' desire to increase their incomes. While the first deals with the development, dissemination and utilisation of technology, the second deals with social institutions that regulate access to the use of natural resources.

Building on indigenous technologies, improved technologies could be developed that would contribute to sustainable development. For example, a hybrid model combining modern external inputs and traditional organic practices is possible. Likewise, developing farming systems that combine cash crops with food crops would allow farmers to exploit crop diversity (Lynam 1992).

Earlier, we have also suggested that the units of analysis within the user sub-system should be farming households rather than individual farmers. As Norman *et al.* (1982:16) point out:

> The members of the farming household, in achieving a specific farming system, allocate certain quantities and qualities of certain basic types of inputs — time, labour, capital and management — to three processes, crops, livestock and off-farm enterprises — in a manner which given their knowledge, maximises the goals they strive to reach.

Three important aspects of farm households must be examined in relation to the development, dissemination and utilisation of technology. These are the goal structures of the family, the social organisation of the household and the organisation of the household economy (Sands 1986). A careful examination of the above will force us to seek answers to the following questions:

1. What are the important goals of the farm household with respect to agriculture and to what extent are they currently being met?

2. Are there solutions (information/technology) available to the farm household to meet these specific goals?
3. Do all members of the household share the same goals and have equal incentives to utilise the information/technology?
4. Who benefits from the adaptation of a particular technology?
5. Is any member of the household likely to be adversely affected by the adaptation of the information or technology?
6. What are the likely consequences of the adaptation of the technology on the attainment of other important household goals?

Conclusion

The attempt in this paper has been to show that the Research, Development and Diffusion model as practised in most African countries has not been successful in generating and disseminating the needed relevant, useful and acceptable technologies within agriculture, especially among small-scale farmers.

If technologies developed are to be relevant, useful and acceptable to the intended users of the technology, a new model of technology development and dissemination is needed. In this new model we need to see the farmer and not the scientists as the starting point for the development of agricultural technology. We need to discard the unilinear model of knowledge creation — diffusion and utilisation. What is needed is a more dynamic interactive model in which the three sub-systems consisting of scientists, extension agents and farmers work together as equal partners. For this to happen we must develop a mutual trust and respect between the partner groups.

As Acker (1992) suggests, it may be useful to conceptualise the technology development and dissemination process in terms of Thompson's (1982) concept of 'quality circles'. Within an organisation, quality circles refer to employees with similar job functions who come together as a team to improve productivity, encourage innovation and solve work related problems. All groups are fully involved in all the stages of problem identification, development of solutions, implementation and evaluation. The greatest advantage of quality circles is their flexibility in that the membership composition changes in response to changing circumstances.

Thus, in agriculture, depending on the issues involved and the circumstances, teams composed of any combination of farm-families, researchers, extension workers; input suppliers and policy makers could be involved in the process of technology development and dissemination.

References

Acker, D. G., 1992, 'Developing Effective Researcher — Extension — Farmer Linkages for Technology Transfer', pp.210-231 in *Proceedings of the Workshop on Social Science Research and the CRSPs*, Lexington, INTSORMIL Publication Number 93-3.

Agarwal, B., 1985, 'Women and Technological Change in Agriculture: The Asian and African Experience', in I. Ahmed (ed.) *Technology and Rural Women*, London, George Allen and Unwin.

Ascroft, J. M.; Roling, N.; Kariuku, J. and Chege, F., 1973, 'Extension and the Forgotten Farmer: First Report of a Field Experiment', *Bulletin Van de Afdelingen Sociale Wetennschappen*, 37, Lambouwhogeschool, Wageningenn, Holland.

Axinn, G. H., 1985, 'System of Agricultural Extension', pp.161-171 in IRRI, *Education for Agriculture Proceedings of the Symposium on Education for Agriculture*, IRRI, Manila, Philippines.

Biggs, S. D., 1986, 'A Farming Systems Approach: Some Unanswered Questions', *Agricultural Administration* 18:1-12.

Biggs, S.D. and Clay, E., 1983, 'Generation and Diffusion of Agricultural Technology: A Review of Theories and Experiences', World Employment Program Research Writing Paper, Technology and Employment Programme, Geneva, ILO.

Botswana Ministry of Agriculture, 1991, *Botswana's Agricultural Policy: Critical Sectoral Issues and Future Strategy for Development*, Gaborone, Botswana, Ministry of Agriculture.

Bratton, M., 1986, 'Farming Organisation and Food Production in Zimbabwe', *World Development* 14:367-384.

Carr, M., 1985, 'Technologies for Rural Women: Impact and Dissemination', in I. Ahmed (ed.) *Technology and Rural Women*, London, George Allen and Unwin.

Cernea, M. (ed.), 1991, *Putting People First* (Second Edition), Oxford University Press.

Cernea, M., 1988, 'Farmer Organisations and Institution Building for Sustainable Agriculture', *Development Dialogue* No.2.

Chambers, R., 1980, 'Understanding Professionals: Small Farmers and Scientists', *IADS Occasional Paper*, New York, International Agricultural Development Service.

Chambers, R., 1991, 'Complexity, Diversity and Competence: Toward Sustainable Livelihood from Farming Systems in the 21st Century', *Journal of the Asian Farming Systems Association* 1:79-89.

Chambers, R. and Jiggins J., 1986, 'Agricultural Research for Resource-Poor Farmers: A Parsimonious Paradigm', *IDS Discussion Paper 220*, IDS, University of Sussex.

Date-Bah, E., 1985, 'Technologies for Rural Women of Ghana: The Role of Socio-Cultural Factors', in I. Ahmed (ed.) *Technology and Rural Women*, London, George Allen and Unwin.

Dey, J., 1984, 'Women in Rice Farming: Focus Sub-Saharan Africa', *FAO Women in Agriculture Series*, No.2, Rome, FAO.

Esman, M. J. and Uphoff, M., 1984, *Local Organisations: Intermediate in Rural Development*, Ithaca, Cornell University Press.

Frankenberger, T. R., 1992, 'Farmer/Consumer Participation in Research and Development', pp. 195-209 in Collaborative Research Support Programs,

Proceedings of the Workshop on Social Science Research Support Programs, Proceedings of the Workshop on Social Science Research and the CRSPs INTSORMIL Publication Number 93-3, Lexington, Kentucky.

Gamser, M., 1988, 'Innovation, Technical Assistance and Development: The Importance of Technology Users', *World Development* 16:711-721.

Gilbert, E. H.; Norman, D. W. and Winch, F. E., 1980, *Farming Systems Research: A Critical Appraisal*, MSU Rural Development Paper No. 6, Michigan State University.

Huizinga, B., 1982, 'Rural Extension and the Search for Institutional Arrangements for Small Farmer Development: The Case of the Guided Change Project in Northern Nigeria', pp. 117-138 in Jones, G.E. and Rolls, M. *Progress in Rural Extension and Community Development* Vol. I, New York, John Wiley and Sons.

Johnson, B. F. and Kilby, P., 1972, 'Inter-relations Between Agricultural and Industrial Growth', Paper presented at the International Economic Association Conference on Place of Agriculture in the Development of Underdeveloped Countries, Bad Godesberg, Germany.

Lakoh, A. K. and Akinbode, I. A., 1981, 'Agricultural Delivery System in Sierra Leone', *Agricultural Administration* 8:289-305.

Leakey, L. S. B., 1936, *Science and the African in Kenya: Contrasts and Problems*, London, Methuen.

Lynam, J. K., 1992, 'Sustainability: The Challenges for International Agricultural Research', pp. 119-139 in Collaborative Research Programs, Proceedings of the Workshop on Social Science Research and the CRSPs INTSORMIL Publication Number 93-3, Lexington, Kentuky.

Matlon, P.; Cantrell, R.; King D. and Benoit-Cattin H. (eds.), 1984, *Coming Full Circle: Farmers' Participation in the Development of Technology* IDRC, Ottawa.

Merrill-Sands, D. M.; Biggs, S. D.; Bingen, R. J.; Ewell, P. T.; McAllister, J. L. and Poats, S., 1991, 'Institutional Considerations in Strengthening On-Farm Client-Oriented Research in National Agricultural Systems: Lessons from a Nine-Country Study', *Experimental Agriculture* 27:343-373.

Monu, E. D., 1981a, 'Transfer of Technology to Small-Scale Farmers in Nigeria', *Eastern African Journal of Rural Development* 14:237-247.

Monu, E. D., 1981b, 'Agricultural Extension Services and the Issue of Equity in Agricultural Development', *The Rural Sociologist* 1:281-288.

Monu, E. D., 1982a, 'The Contribution of Adoption and Diffusion of Innovation Research to Agricultural Development in Africa', *African Studies Review*, XXV:117-126.

Monu, E. D., 1982b, 'An Innovation in Small-Scale Farmer Credit Administration', *Agricultural Administration* 10:255-263.

Monu, E. D., 1983, 'The Diffusion of Innovation Model in Action: The Funtua Agricultural Development Project', *Agricultural Administration* 13:201-217.

Monu, E. D., 1984, 'An Appraisal of the Contribution of Rural Sociological and Agricultural Extension Research to the Transfer of Technology to Small Scale Farmers in Nigeria', *Development Praxis* 2:1-18.

Monu, E. D., 1988, 'Indigenous Specialists in Agriculture: The IIRR Experience', *Agricultural Administration and Extension* 29:221-237.

Monu, E. D., 1989, 'Dissemination and Utilisation of Research Results in Rural Development Projects', Prepared for the International Development Research Centre (IDRC, Canada), Singapore, Republic of Singapore.

Monu, E. D., 1993, 'Research: The Missing Element in Rural Reconstruction', in M.M. Keehn (ed.) Y.C. James Yen's, *Thought on Mass Education and Rural Reconstruction*, New York, International Institute of Rural Reconstruction.

Monu, E. D. and Omole, M. M., 1982, 'Sources of Farm Information Among Nigerian Cocoa Farmers', *Agricultural Administration* 9:81-89.

Norman, D., 1980, *The Farming Systems Approach: Relevance for the Small Farmer*, Rural Development Paper No.5, Michigan State University, East Lansing.

Norman, D. and Gilbert, E., 1982, 'A General Overview of Farming Systems Research', pp.17-30 in Shanner, W.W. Phillips, P. F. and Schmehl, W. R. (eds.), *Readings in Farming Systems Research and Development*, West View Press.

Norman, D. W.; Haywards, J. A. and Hallam, H. R., 1974, 'An Assessment of Cotton Growing Recommendations as applied by Nigerian Farmers', *Cotton Growing Review* 51:266-280.

Norman, D.; Simmons, E. and Mays, H., 1982, *Farming Systems in the Nigerian Savannah: Research Strategies for Development*, West View Press.

Organisation for Economic Cooperation and Development (OECD), 1975, Report of the Second Geneva Conference, Association for the Advancement of Agricultural Sciences in Africa. March 24-28, Dakar, Senegal.

Rhoades, R. E. and Booth, R. H., 1982, 'Farmer-Back-To-Farmer: A Model for Regenerating Acceptable Agricultural Technology', *Agricultural Administration* 11:127-137.

Rhoades, R. E. and Booth, R. H., 1983, 'Interdisciplinary Teams in Agricultural Research and Development', *Culture and Agriculture* 20:1-7.

Rogers, E. M., 1969, *Modernisation Among Peasants*, Holt, Rinehart and Winston.

Rogers, E. M., 1989, 'Evolution and Transfer of the US Extension Model', in J. L. Compton (ed.), *The Transformation of International Agriculture Research and Development*, Boulder, Lynne Reinner Publishers.

Roling, N., 1985, *Extension Science: Increasingly Pre-Occupied with Knowledge System, Sociologia Ruralis* 25:269-289.

Sands, D. M., 1986, *The Technology Application Gap: Overcoming Constraints to Small-Farm Development*, FAO Research and Technology Paper 1, FAO, Rome.

Thompson, P. C., 1982, *Quality Circles*, New York, Amacom.

Uphoff, N. and VanDusen, K., 1984, *Local Institutional Development for Agriculture*, Rural Development Committee LIP No.5, Cornell University, Ithaca.

Valbuena, V. T., 1986, *Philippine Folk Media in Development*, AMIC, Singapore.

Whyte, W. F., 1981, *Participatory Approaches to Agricultural Research and Development*, Rural Development committee ARE No. 1 Cornell University Ithaca.

World Commission on Environment, 1987, *Our Common Future*, Oxford, Oxford University Press.

---

* Department of Sociology, University of Botswana, Gaborone, Botswana.