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Technology information dissemination to improve vegetable production in the forest-savannah transition zone, Ghana[1]

Submitted By

DR. K. NSIAH-GYABAAH
SUNYANI POLYTECHNIC
P.O. BOX 206
SUNYANI
BRONG AHAFO
GHANA

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Introduction

The growing importance of vegetable production in the economy as a major source of employment and income for rural and urban poor, long neglect of this sub-sector in poverty alleviation strategies and the need for farmers to adapt their farming practices to the changing conditions under which they produce attracted the attention of UK's Department for International Development (DFID) to provide funding for the Integrated Food Crop Systems Project (IFCSP) in 1994. This project identified vegetable production as an important component and an entry point to disseminate technology in order to alleviate poverty and improve food security in Ghana.

Evolving from a primary subsistence-oriented farming system, vegetable production is faced with several constraints such as low productivity due to declining soil fertility, periodic overcapacity and low producer prices, high post-harvest losses due to limited opportunities for processing and inefficient information and technology strategies. Dissemination of appropriate technology is necessary to cope with increasing demand for vegetables, decreasing soil fertility, changing climate and market price. Strengthening the extension service and establishing strong linkages between farmers, research and extension are important strategies to facilitate technology disseminate and adoption of proven agricultural technologies to improve vegetable production, storage, processing and marketing.

This brief report is based on a survey and monitoring reports on technology dissemination strategies with reference to vegetable production in Brong Ahafo Region. It examines the mechanisms for effective technology dissemination in which farmers as beneficiaries play an active role. The approaches range from support to contact farmers to establish demonstration farms for participation of contact farmers in technology dissemination.

Technology Dissemination and Adoption

Efficient transfer of results of agricultural research and technology adoption by farmers depends on effective dissemination strategies. It is also the primary means for increasing agricultural production. However, in Ghana, many good agricultural technologies, often the fruit of costly scientific research remains unused by farmers to improve crop yields and income. Non-adoption of technologies by farmers has often been attributed to ignorance and farmers imperviousness to change even where farmers have found technologies unsuitable for local conditions.

Recently, it has become clear that many small-scale, poor illiterate farmers, especially those in fragile ecosystems, are looking out for technologies to improve soil fertility and crop yield. They are prepared to invest scarce resources in new technologies to improve their incomes. However, the vast majority of small-scale farmers have no access to new technologies and research findings are not communicated to them. More often than not, extension officers have not been able to communicate effectively the results of research to poor farmers who are risk averse. Weak, fragmented, and poorly coordinated extension services and lack of effective

technology dissemination strategies are therefore to blame for the poor attitude of farmers to new technologies.

The survey

Following the implementation of a research project to disseminate technology to improve soil fertility and vegetable production in the forest-savanna transition in Brong Ahafo region, a survey was conducted in the two pilot districts, namely Nkoranza and Jaman districts to examine the dissemination strategies used by agricultural extension agents with a view to making recommendations to improve technology transfer and adoption by farmers. The extension officers used for the pilot study included those who lived in the pilot districts and were knowledgeable in the socio-economic and cultural conditions under which vegetable farmers were operating. To prepare them to their tasks, workshops were organized for them.

During the survey, 30 vegetable farmers were interviewed in each district. In addition farmer associations were also interviewed as a group consisting of 5-6 farmers. Farmers' fields were surveyed, and monitoring reports of extension officers were also examined. It should be noted that all the respondents were known to the investigator because he had spend considerable time in the districts working with farmers and the extension agents and has through that established good rapport with the respondents. The interviews were based on a checklist that was used as basis for informal discussion, through which general information on problems associated with technology dissemination, local people's perceptions of extension service delivery and suggestions by farmers to disseminate technology and improve its adoption by farmers were gathered. The key issues, main findings and recommendations to improve technology dissemination and vegetable production are discussed below.

Vegetable production in Brong Ahafo Region

Vegetable production is an important economic activity in the forest-savanna transitional zone in Ghana's Brong Ahafo Region. It is successfully increasing food security and employment, especially women. Until recently, vegetable production was mainly female activity. Women produced vegetables as bases for soups and stews. Typically, the most popular vegetables grown by farmers include: Chilli peppers (Capsicum fructescens), onions (Allium cepa), tomatoes (Lycopersicon lycopersicum), garden eggs (Solanum aethiopersicum) and okra (hibiscus esculentus). Others are cocoyam leaves (Xanthosoma sp.) found mostly in the forest zone and leafy vegetables such as cowpea and Amaranthus sp., lettuce, carrots and neri (Citrullus lanatus), a type of melon that is common in the savannah areas.

In the last five years, vegetable production has become important male economic activity. This has been driven by its contribution as a source of employment, nutrition and income. Vegetables have become an irreplaceable dietary component, not only as a side dish to add flavour to soups and stews, but they also break the nutrition cycle by providing critical ingredients that build a healthy body. The high medicinal and nutritional value, high prices of vegetables, especially during the dry season and increasing demand for vegetable in the urban areas have attracted men into vegetable production.

Vegetables are a major source of most micronutrients and the only practical and sustainable way to ensure their supply to meet growing demand in the urban areas is to improve production methods, improve extension service to disseminate research information and appropriate technology to farmers. However, very little progress has been made by research and extension to improve production techniques, storage, processing and marketing of vegetables and to disseminate technology and research information small-scale farmers. Consequently, vegetable producers face many challenges:

Firstly, the soil is sensitive to soil erosion. Soil erosion affects yields and quality of vegetables. Some farmers have resorted to increasing use of chemical fertilizer to improve

soil fertility and agro-chemicals to control pests and disease in vegetable producing areas. Figure 1 shows a garden egg farm that has been eroded.

Fig. 1. An Eroded Garden Eggs Farm at Asuano in Nkoranza District- The White Patches Show Evidence of Soil Erosion on the Vegetable Farm

Inappropriate use of fertilizers and agrochemicals constitute a serious source of land and water pollution. The negative effects of agro-chemicals on human health and the environment have become a matter of concern, which require urgent measures to improve soil fertility and farming techniques. Secondly, there is limited education and lack of technical information on pesticide use. In many areas, lack of information and understanding about use of pesticides to control insects, pests and diseases in vegetable production have had negative effects on the ecosystem and human health. The need to disseminate technology information to vegetable farmers is particularly urgent now because it is known that excessive use of agro-chemicals to improve soil fertility and pesticides for spraying vegetables have serious health risks which can be avoided through technology development and information dissemination to farmers.

Role of research and extension

For many years, research and extension have focused on increasing crop production of high yielding crop varieties. Commercial crops such as cocoa, rice, yams, cowpeas and maize have received priority attention by the Ministry of Agriculture (MOFA), Universities, Council for Scientific and Industrial Research (CSIR) and Non-Governmental Organizations such as Ghana Organic Agricultural Network (GOAN). Much of the information required by farmers is generated from the Universities and research institutions, which pass on their research results to extension agents for dissemination to farmers.

While there have been some notable successes, the majority of small-scale poor subsistence oriented vegetable farmers in the fragile, forest-savanna transition in Brong Ahafo Region of Ghana, have remained largely unaffected by the new technologies they urgently need to improve soil fertility, storage, processing, packaging and marketing of vegetables especially tomatoes and garden eggs. Figures 1 shows tomatoes packaged in wooden boxes and baskets waiting to be transported to market on the Nkoranza-Techiman road.

Fig. 2 Tomatoes Packed in Wooden Boxes on the Nkoranza-Kintampo Road to be transported to the Market.

In Ghana, extension services of Ministry of Agriculture (MOFA) and Non-Governmental Organizations (NGOs) are the main media for disseminating agricultural information and transferring technology to farmers. However, in the past, MOFA has paid more attention to dissemination of research results of food and cash crops to benefit large-scale farmers. Substantial information has been disseminated and new technologies have been transferred to farmers to improve production methods and varieties for commercial crops such as cocoa, rice, cassava and maize. However, little attention has been paid in the past to development and promotion of technology to improve vegetable production by MOFA and the Research Institutes. The long neglect of research and extension in vegetable production partly accounts for the persistence of the problems such as high post harvest loses, marketing constraints, declining soil fertility, pollution and depletion of water resources that face vegetable farmers in the transitional zone.

The purpose of technology information dissemination

Small-scale farmers need information and new technologies to improve agriculture production. For poor illiterate farmers, information and technology are critical for improving production. Technology represents knowledge about how to do things in a sustainable way. Technology improves methods and enhances participation and efficiency. Technology provides a bundle of benefits that accrue to its users. The aim of technology information dissemination is to help poor farmers to experience an improvement in their living conditions. In Ghana, the Universities, research institutes such as Crops Research Institute (CRI), Soil Research Institute (SRI), Savanna Agricultural Research Institute (SARI) are responsible for developing new technologies through research. Research information and new technologies are passed on to extension officers of Ministries, Departments and Agencies (MDAs), Non-Governmental Organizations such as Ghana Organic Agricultural Network (GOAN) who disseminate research information and new technology to farmers.

However, extension officers have often faced the difficult task of effectively communicating their message to farmers. Although a wide range of extension approaches have been used to disseminate information to illiterate, poor resource farmers, many of the approaches have been ineffective. Consequently, technology adoption by small-scale farmers has been low and unsustainable farming practices used by farmers continue to accelerate soil erosion, soil fertility decline, low crop yields and productivity.

If information about new technologies is mismanaged, it can kill initiative and interest of small-scale farmers. Sometimes new technologies disseminated to rural farmers are suitable to local conditions but because information about the technologies are mismanaged, poor farmers who are risk averse refused to accept and adopt them to their benefit. Therefore, the major constraint to technology is inability of extension staff to communicate effectively to farmers and to convince them to adapt new technologies to suit their local conditions. Considering the problems of weak, fragmented and poorly coordinated extension services and the inefficiencies in extension delivery, it is important that simple ways to provide information to farmers are found.

The challenge of extension service in Ghana

Effective dissemination of technology and information to farmers is essential if investments in research can contribute to ensuring food security. However, in Ghana, there is a huge gap between available knowledge or technology and actual practice by farmers. Part of the problem is due to inefficiencies in the extension service and inability of extension officers to communicate effectively the results of research to vulnerable, poor small-scale illiterate subsistence farmers.

While adequate technology and information exist for the major crops such as cocoa, and information on production techniques have been disseminated to farmers through government special initiatives such as mass spraying campaigns, the situation with vegetable production is unsatisfactory. It is for this reason that in March 2000, the UK Department for International Development (DFID) initiated a research project to bridge the gap between knowledge and actual application by farmers. This was a collaborative effort between MOFA and DFID, whose trust was adaptive on-farm demonstrations to improve soil fertility and vegetable production in the forest-savannah transition zone.

The purpose of the research was to identify better methods to disseminate information and technology to vegetable farmers in the Brong Ahafo Region. In order to study the effectiveness of information and technology dissemination methods, MOFA extension officers worked with individual farmers, schools, farmer-groups and established community demonstration plots to transfer technology to farmers. Through the participatory learning process, farmers have learnt how to prepare and apply organic manure to improve soil fertility and methods to produce, store and market vegetables.

Main Findings of Research

For decades, subsistence farmers have been actively developing technologies for production, storage and processing of crops. They have shared their experience with their colleague farmers through informal discussions and farm visits. Through their initiatives, they have developed different farming systems and strategies to adapt to and cope with changing climate and environmental conditions and available resources. This valuable indigenous technical knowledge and capacity of small-scale and mostly illiterate subsistence farmers has not been well acknowledged by research and extension.

Experience from the field has revealed that in the process of technology dissemination, knowledge of indigenous farming systems has to be taken into account. It must be noted that, although indigenous technical knowledge has its limitations, new technologies that are imbedded in local farming systems provide a means to facilitate information flow for speedy adoption of innovations from outside. This is the rationale for promoting Participatory Technology Dissemination (PTD) as a practical means for bringing together the knowledge and dissemination capacities of farmers with that of research institutions and extension workers in an interactive way in the dissemination and transfer new technologies.

The research has generated a number of other significant findings. They include:

- The role of vegetables in livelihoods
- Seasonality of vegetable production and marketing
- Role of compost and animal manure in vegetable production
- Application of agro-chemicals
- Institutional strengthening and capacity building within MOFA

The role of vegetable in livelihoods

The study revealed that vegetable production is an important economic activity that serves as a source of employment and income to a large number of rural and urban people in the forest-savanna transition zone. Vegetables also form an important part of the regular diet of most households. Vegetables provide many forms of nutrition. The greater part of traditional therapy in the rural areas involves the use of plant extracts and vegetables. Consequently, vegetables are used in preparation of soups for sick people. More importantly, vegetables provide many people, especially women an important source employment and income.

Rural women, often overlooked by government and donors in extension, credit delivery and training, are important vegetable producers who are also involved in storage, processing and marketing of vegetables. Figure 3 shows women traders selling vegetable along the Sunyani-Kumasi trunk road. Considering the important role that women play in vegetable production, technology dissemination strategies that use local female opinion leaders and successful female vegetable producers are more likely to succeed.

Fig. 3: Women Traders Selling Vegetables Along the Sunyani-Kumasi Trunk Road.

Seasonality of vegetable production and marketing

There are two seasons for vegetable production, the wet season and the dry season. Farmers earn higher returns during the dry season, which begins from November to March. However, the critical constraint is inadequate supply of water for irrigation. During the dry season, crop failure is high and many poor farmers are not encouraged to invest in vegetable production. The limitations set by weather and climate result in higher demand over supply and consequently, high price of vegetables. During the rainy season (March to October), there is usually a glut because supply exceeds demand and lack of storage and processing facilities results in high post harvest losses.

Vegetable production is labour intensive and many farmers depend on family labour in land preparation and ridging. Most farmers are unable to obtain credit from formal financial institutions because of the risk of crop failure especially during the dry season. As a result, majority of farmers depend on personal savings and loan advances from women traders in the urban areas. The market women who trade in vegetables often pre-finance the farmers operations. However, they take undue advantage of production inefficiencies by paying farmers very low prices especially when there is a market glut.

Role of compost and animal manure in vegetable production

The region has a high potential for preparation and utilization of compost in soil nutrient management. Compost has the advantage of improving soil structure in addition to the supply of plant nutrients. For this reason, compost has a significant role to play particularly in intensive vegetable production. However, its bulky nature limits its contribution to soil fertility improvement. Currently, the preparation and use of compost is not widespread in the region because many farmers lack information and practical skills to prepare compost manure. However, with education and dissemination of information, farmers would come to appreciate the potential of compost in soil fertility restoration.

Although farmers have been introduced to the potential of animal manure (i.e. poultry manure and cow dung) to improve soil fertility, the limitations posed by animal numbers and the availability of cow dung show that manure would not be insufficient to sustain vegetable production on a long-term basis. Figure 4 shows animal manure that has been dumped at the

roadside on the Sunyani-Kumasi trunk road, waiting to be collected by farmers to improve soil fertility.

Fig. 4. Poultry Manure Dumped Along the Sunyani-Kumasi Trunk Road Waiting To Be Collected By Farmers To Improve Soil Fertility

Other constraints to overcome in order to realize the full nutrient value of manure include collection and storage and equipment for carting and spreading the manure on farmers' fields. Recently, poultry farmers in Kumasi have used the roadsides as dumping grounds for poultry manure to make it available and accessible to farmers who need it.

Application of agro-chemicals

Despite increasing fertilizer utilization and pesticide application, yields are declining. Farmers attribute low vegetable yields and poor quality to declining soil fertility, insects, pest and diseases. Consequently, farmers have increased fertilizer consumption for vegetable production. The survey results indicate that uncontrolled use of agro-chemicals and pesticides is becoming a serious issue of concern. Most non-cigarette smokers who are vegetable farmers probably receive their highest exposure to harmful chemicals from wrong application by farmers and the public from consuming vegetable sprayed with chemicals.

Recent research in vegetable growing communities in Ashanti Region has revealed that although farmers who use agro-chemicals are able to increase their yield, they often develop illnesses as a result. This means that farmers who have fallen sick can't produce vegetables and any profits they make have to be used for medical treatment. Consequently, agro-chemical users are often worse off both financially and physically.

Farmers need training and information on Integrated Pest Management (IPM) techniques. Extension officers also need to promote the use of traditionally natural pest control methods and viable traditional techniques such as the use of *neem* leaves and potash to control vegetable pests and diseases. The drive to improve vegetable production should therefore include an educational programme to reduce the indiscriminate use of potentially poisonous chemicals in vegetable production.

Institutional strengthening and capacity building within MOFA

The major weaknesses in technology transfer and adoption by farmers include weak extension system with poor training, which leads to poor capacity to diagnose farmers' needs and effective ways to communicate research results to them. The extension service has relied too much, even where it has been supported, on the Research Institutes for their technical recommendations and has often ignored the indigenous technologies developed by farmers themselves through trials. MOFA and some of the NGOs involved in the task of generating, testing and transfer of technologies to farmers lack qualified personnel and the technical skills required to effectively communicate the results of research to illiterate farmers.

In addition, there is lack of co-ordination between the several agencies involved in extension delivery. This results in duplication of efforts and waste of scarce resources. Moreover, the extension service is not well equipped to discharge its responsibilities effectively. MOFA lacks facilities for periodic training of extension staff; it has inadequate accommodation and transportation for staff. As a result, extension officers waste a lot of time commuting from urban centers to the villages to meet with farmers.

Major Problems Facing Dry Season Vegetable Producers

The greatest challenge that face vegetable producers include:

- Inadequate supply of water for irrigation.
- Soil fertility decline
- Inadequate storage, processing and marketing facilities.
- Lack of credit
- Lack of processing technologies
- High post-harvest loses

Inadequate supply of water

The over riding problems facing vegetable producers include inadequate supply of water. Declining rainfall coupled with increasing irregular pattern of rainfall distribution affect vegetable production especially during the dry season. The irregularity is most pronounced at the beginning and end of the rainy season. Irrigation through the provision of wells, boreholes and hand pumps in the transition zone, is a valuable investment to improve vegetable production.

In addition, rainwater harvesting in the forest transition zone, an area that is characterized by low and variable rainfall, would be an important strategy to improve vegetable production. They will also reduce competition for water and conflicts that arise from using community drinking water sources to irrigate vegetable farms. Moreover, pollution of drinking water sources would be reduced.

Inadequate storage, processing and marketing facilities

As a result of inadequate storage and processing facilities, seasonal glut occurs especially during the major rainy season. Seasonal glut leads to very low producer prices. During the dry season, farmers receive very high prices for vegetables especially tomatoes. However, dry season production is risky because of the possibility of crop failure. High post harvest loses during seasonal gluts is the result of inadequacies in storage, processing and marketing and generally indicative of underdeveloped post-harvest system and gaps in technology dissemination to farmers. Dissemination of technologies to improve storage, processing and marketing therefore remains essential tools of interventions if the results of research would be translated into improved productivity and higher incomes for farmers.

Decreasing soil fertility

Soil fertility has been decreasing as a result of over harvesting of the land resource base. In efforts to restore soil fertility, farmers have resorted to application of fertilizers. Lack of

access to credit means that many poor farmers have no alternative, but to continue the unsustainable practices of continuously deplete fertility of the soils. Some farmers, in order to avoid the risk of crop failure, plant only during the rainy season.

Lack of credit
Availability of capital is an important constraint that affects technology adoption rates of agricultural innovation. Most vegetable farmers have limited capital for financing farm operations. The low capital availability means that farmers find it difficult to adopt new knowledge and technologies disseminated. Better access and timely disbursement of credit are important issues that must be taken into account in strategies to disseminate technology to farmers to improve vegetable production.

High post-harvest losses
High cost of transport of vegetables especially tomatoes and high post-harvest loses affect pricing as well as farmers income. In order to improve the income levels of farmers, technology should be transferred to farmers so that they would be able to increase the shelf life of vegetables. The surest way to ensure that when there is a glut, farmers would be able to obtain a fair price for vegetables is to invest in processing technologies and disseminate new technology and information to them.

Dissemination Strategies
It is generally known that one of the main reasons for the poor adoption of technology by farmers include weak extension system and low capabilities of extension officers leading to low capacity to diagnose farmer's needs and disseminate appropriate technology effectively to them. In addition, weak research-extension-farmer linkages have been responsible for research results not being disseminated to farmers.

In order to overcome these constraints, a several measures were taken. From the start, a number of workshops were organized for researchers, extension staff and farmers. Extension offers were exposed to new technologies to improve soil fertility and their skills to communicate effectively to farmers were improved through training. The workshops brought together the stakeholders and helped to establish linkages between extension officers, researchers and farmers. The participant's enthusiasm and active participation in discussions at the workshops served as testimony that when farmers, researchers and extension officers work together, each is able to learn from the other and farmers gain more confidence to adopt new technologies.

The interest and willingness of farmers to establish demonstration plots on their farms and at the community level suggest that farmers would support special efforts to address their production constraints if researchers and extension agents involve them in technology development and dissemination. Although the emphasis is on vegetables, farmers have interest in technologies and information to improve crop production because majority of vegetable farmers also produced other staple crops such as cassava, plantain, yams, cocoyam, maize, plantain etc.

Another participatory extension approach that was adopted included home visits by extension officers to discuss with the farmers included in the pilot project their particular problems and opportunities. They also undertook field activities by visiting farmers' farms to solve farmers' problems. One of the major advantages of this approach is that it facilitated a dialogue in which the extension officer could learn from farmer's practice, as well as passing on new information to the farmer.

Demonstration plots were also established by the extension officers in the survey communities to teach farmers how to prepare and apply compost and animal manure to improve soil fertility. The contact farmers were also encouraged to establish demonstration

farms on their farms. Where individual farmer's demonstration plots succeeded, neighbours visited their plots to see and learn from the successful farmers. These extension approaches proved to be cost-effective, a faster way to reach many farmers and became a good channel for informal diffusion of innovations. This also provided an opportunity for extension officers to identify the production constraints of vegetable production and an important element ion the training of farmers.

Open community and group discussions were productive means of building the acceptance of new innovations and technologies among poor farmers. During the process of technology transfer and information dissemination, it is important to maintain a lot of direct relationship and feedback between researchers and extension staff, and between extension staff and farmers

When farmers were asked to indicate whether they or anyone in their household had heard about any useful agricultural technology to improve soil fertility from extension officers, the majority of farmers, over 80 per cent in the non-pilot project communities, stated that they had not received any extension service in the last two years. However, about 90 percent of the farmers in the pilot communities mentioned the use of organic manure. Those who had received extension advice mentioned that their sources of information are MOFA extension service and Women in Need Foundation, Ghana (WINFOG).

When they were asked whether they have themselves adopted the technology disseminated to them or know other farmers in the locality using the new technology to improve soil fertility, they answered in the affirmative. Overall, about 52 percent of those who were interviewed had heard about the use of poultry and green manures for improving soil fertility.

Farmers Assessment of Dissemination Strategies

The objective of agricultural research is to identify new farming practices and technologies that will improve farmers' production system and increase their productivity and well being in a way that can be sustained. However, most of research information and new technology often do not get to the farmer either because of weak research and extension and farmer linkages, or there are not effective mechanisms to transfer new knowledge and technology to farmers in a language that they understand. An attempt was therefore made to assess the effectiveness of information dissemination strategies used to transfer technology to farmers.

The technology dissemination strategies adopted included on-farm trials, village demonstration plots, farmer field schools, organized workshops, radio programmes and village group meetings. Farmers learn better and faster if the language of instruction is simple and easily comprehensible. Therefore, the extension officers used the local language as the medium of instruction in training farmers. The medium of instruction was '*twi'*, which was spoken and understood by all the farmers.

When the respondents were asked to rank their preferences of methods of technology dissemination including farmer contacts and discussions with extension staff, majority of them mentioned that the contact with MOFA extension officers was the most effective source of technology information. Timing of information delivery was also very important. Information was delivered at the time the farmer needed it. For example, information about pest management was transferred when it was time for farmers to spray their vegetables and after the village demonstrations, extension agents observed the farmers put the new knowledge into practice on their own farms.

When respondents were asked to indicate one choice of how they would like to receive agricultural information and technology, the respondents overwhelmingly indicated that the extension officer was their most preferred source. From the monitoring reports, the extension

officers were by far the most preferred source of agricultural technology and information to farmers in the pilot project districts. From the evaluation results, farmers' assessment of technology dissemination is positive. They were happy about the technologies and observed significant positive changes in yield, pest control, storage and marketability of vegetables through training received and contact with extension officers.

Lessons Learned

Firstly, farmers especially vegetable producers in the forest-savanna transition zone need knowledge and information about new inputs to increase output per unit area, they require information on improved production, storage, processing and marketing techniques. However, success of technology dissemination and adoption of technologies by farmers would depend on which groups within the community are contacted. Local female opinion leaders and successful female farmers within the community are important change agents ho should be used in addition to farmer groups to disseminate technology and research information to farmers.

Secondly, extension programmes to disseminate technology to poor resource farmers should be conducted by experienced communicators, especially females, who are fluent in local languages of farmers and who also understand the basic theory behind the improved technologies.

Other lessons learned include:

- Good communication helps to foster good relationships between researchers and extension officers and farmers, as well as a sense of trust, which has a positive knock-on effect on productivity. Extension information that consists of very clear messages of only a few lengths (leaflets) appeals to poor, illiterate farmers and can serve as a useful channel for transferring technology and disseminating information to farmers.
- Farmers are more likely to use information and adopt new technologies that are presented in a language that they understand. The use of local languages for leaflets is therefore desirable.
- Overall impressions of the revised Guidelines for farmers to improve vegetable production are positive and therefore financial support would be needed to print them for distribution to farmers and other stakeholders.

Areas of Future Research and Development

The major problems affecting vegetable production in the forest-savannah transition zone that should be the focus of future research and development include:

- Rainwater harvesting techniques- Practical rainwater harvesting technology is not available to farmers and technologies for prolonged in-situ moisture conservation are not recommended to farmers yet. Increasing the understanding of the interaction between water and fertilizers, both chemical and organic, would be necessary. Research and extension should therefore pay attention to simple technologies to make water available for small-scale irrigation by vegetable farmers.
- Declining soil fertility- this problem should be solved through increased education for farmers to use organic matter and green manures in vegetable production. The promotion and use of cover crops such as *mucuna* to improve soil fertility is necessary.
- High post-harvest losses- this involves dissemination of appropriate technologies for storage, processing and marketing of vegetables.
- Training of farmers in proper handling and application of agro-chemicals to improve soil fertility, control pests and diseases
- Short, practical and user-friendly manuals are needed to guide farmers and extension officers. The manuals to be developed should be very well-illustrated, precise and

small in volume (e.g. two sides of a sheet of paper), suggest answers to major questions and presented in such a way that illiterate farmers can understand.

Although useful information and technology have been made widely available to farmers to improve vegetable production, many farmers have not been contacted by extension officers. Therefore extension officers need to intensify information dissemination in the rural areas. Publication of lessons learnt and formation of dissemination networks are important to promote improved vegetable production. As part of the strategy to improve the knowledge base of Agricultural Extension Agents (AEAs) and farmers, adapted and updated training materials would be published and distributed. This activity would require close collaboration among researchers, extension officers and farmers.

Recommendations

To enhance the nutritional well-being of people, raise the income levels of poor vegetable farmers in the forest-savannah transition zone, efforts should be made to improve methods of vegetable production through rainwater harvesting techniques, promotion of organic farming practices, dissemination of new technologies to improve storage, processing and marketing of vegetables. Effective dissemination of appropriate technology to farmers would not only increase yields but also contribute to preservation of quality of the environment and the health of both producers and consumers.

A strategy to disseminate information and technology to farmers to improve vegetable production should be preceded with a training programme for extension officers. The training programme would enable extension officers become technically competent to effectively communicate and convey innovations to different categories of farmers and encourage them to adopt and adapt new technologies for their own benefits. Appropriate training is necessary because if the extension officer is not sufficiently ahead of the farmer in understanding the principles behind the new technologies to improve soil fertility, store and process vegetables for the market, he will not achieve the respect and credibility required to influence farmers who are risk averse to adopt the technologies being disseminated. Other strategies may include:

Firstly, vegetable production must increase to remedy the present inadequate availability in the urban markets during the dry season. To achieve this objective, technologies for management of rainwater should be promoted. If rainwater is harvested during the rainy season, and it is used in the dry season to bridge the rainfall gap, the problem posed by water shortage for dry season vegetable production would be reduced.

Secondly, vegetable production must be achieved on less land, using less water and less of agro-chemicals (i.e., chemical fertilizers) that have negative effect on land and underground water resources. Thirdly, while researchers must develop improved varieties and advanced technologies adapted to the diverse agro-ecological and socio-economic conditions, extension officers must develop effective strategies to disseminate research information and technology to farmers.

Lastly, the Internet is increasingly becoming an important source of research information for extension officers and farmers. It provides a much wider range of practical advice and experiences on techniques, methods and materials. For the benefit of farmers, extension officers should be strengthened to access data and information from the Internet.

Conclusion

Effective dissemination of research information and technology to poor farmers is crucial for food security and poverty alleviation in Ghana. For this, basic knowledge about new technologies and acquisition of skills for effective dissemination of information is require of the extension service. However, in spite of the significant research activities that have been

carried out to improve soil fertility and promote sustainable farming systems, farmers lack information and technology and adoption of innovations in the rural areas has been disappointing. The difficulty, however, is getting relevant information and effective channels to disseminate technologies to farmers who need them to improve methods and processes in agriculture.

Unless research information is made available to farmers, funds put into research would be wasted. Vegetable farmers need information, knowledge and technology to improve soil fertility, methods of production, control pests, storage, processing and marketing. While technology development is the responsibility of the research institutions and the Universities, technical information required by farmers must come from the extension service with support from research. In order to facilitate dissemination of appropriate technology, short practical and user-friendly manuals/guidelines for vegetable production would be produced and circulated to extension officers in training farmers and to guide farmers.

NRSP 7992 Technology dissemination to improve vegetable Production in the forest-savanna transition zone, Ghana: with Special reference to the maintenance of soil fertility

K. Nsiah-Gyabaah
Sunyani Polytechnic
P.O. Box 206
Sunyani, Brong Ahafo Region
Ghana
Email: spolytec@ghana.com