PEST MANAGEMENT AND THE AFRICAN FARMER

Edited by

Ole Zethner

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on
Integrated Pest Management in Africa

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The Editor
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PART ONE

INTRODUCTION

Pest Management and the African Farmer: A Conference on Integrated Pest Management

Objectives, Summary and Recommendations

Objectives

- To review pest management practices in various African countries and identify examples of successful approaches and promising opportunities for supporting implementation among farmers.
- To examine socio-economic, institutional and policy constraints which impede improved integrated pest management (IPM) practices among the farmers, and develop recommendations for overcoming them.
- To examine opportunities for increasing private sector involvement in the development and implementation of IPM among farmers in Africa.

Preamble

A Conference on Integrated Pest Management and the African Farmer was held at the International Centre of Insect Physiology and Ecology (ICIPE) in Nairobi, Kenya, from 22- 26 May, 1989. The participants were mainly farmers, extension personnel and agricultural researchers from all over Africa, but also included representatives from donor agencies and the agro-chemical industry. For the first time in Africa, farmers' interests dominated in a discussion on pest management.

The farmer manages all aspects of crop production and is therefore a great integrator. Integrated Pest Management (IPM) itself is only one part of global integrated crop production or integrated resource management.

The Conference opened a dialogue among farmers, extension specialists and scientists with the aim of reaping the great potential of African agriculture on a sustained basis. IPM is suitable as the theme for such an opening because it is critical to all tropical agriculture and we are on the threshold of some major breakthroughs. Although the conference realized that pests include many other organisms, concern was concentrated on insects.

Four distinct themes were discussed in depth:

- Pests as a constraint in crop and livestock production;
- Extension systems as mechanisms for technology transfer;
- The role of IPM specialists and social scientists in generating technologies for the farming community in Africa; and
- International cooperation and IPM in Africa.

CONCLUSIONS

The conference reached the following conclusions:

1. Pests are seen by farmers as a major constraint to crop and livestock production in Africa.

2. IPM offers the best sustainable solutions to reduce this constraint, but must always be adjusted to the varying agro-economic and sociological conditions found in the continent.

3. IPM is an approach, not a technology; therefore a new and different strategy towards extension is needed. In-

stead of the passive transfer of an information package, a partnership is needed, with new roles for farmers, extension personnel, scientists and the agro-chemical industry. It is necessary to change existing attitudes in order to make full use of the new ideas for increasing agricultural productivity.

4. The use of IPM could encourage more young people to stay on the land and could reverse rural-urban drift.

5. The vital role of the extension services in technology transfer is recognized. The contribution of these services could be enhanced by further training in IPM concepts and communication skills. Better working environments and better support services would help to attract and retain high calibre people.

6. The need is recognized for farmers to take an active part in the evaluation of extension services and in the evolution of the technology to be applied.

7. Researchers must respond to the farmers and their needs in formulating research plans. There is need for clear policy guidelines.

8. Researchers must be encouraged to create a better understanding of the ecological, social, and economic environment so that technology can be adapted to fit into farming activities.

9. It is noted that communication among farmers should be enhanced.

10. The agro-chemical industry is to be encouraged to cooperate with national institutions in the formulation and execution of research activities. Greater financial support from industry for research focusing on the small-scale farmer should be given. Such research must take place in the African environment.

11. The conference recognizes the continuing need for international cooperation in the development of African agriculture. The shifting emphasis from excessive use of chemicals to an IPM approach by donor agencies is welcomed. Such shifts should be accompanied by

longer-term commitments, follow-up activities, and recognition of the need to build up local capacities rather than the mere transfer of foreign technology.

12. Because pests are not limited by national boundaries, donor agencies should be encouraged to facilitate inter-country cooperative projects involving the donor and several recipient countries.

RECOMMENDATIONS

The following recommendations were made by the Conference participants:

General Recommendations:

- There is need for follow-up meetings at the regional level and these should include policy makers, in addition to farmers, extension specialists and scientists. These follow-up meetings should be closely oriented to specific crop or livestock production systems.
- It is necessary to have clear policy guidelines on research, extension and the distribution, marketing, and pricing of farm products.
- Communication between farmers, scientists, extension workers and policy makers should be improved. In this respect, farmers must be the prime movers in all the planning and decision making.

Recommendations to African Governments:

- There is need for legislation regulating pesticide registration, use and safety mechanisms, as well as seeds and plant parts certification in germplasm exchange between countries. This legislation must be enforced.
- Human resource development in the area of appropriate training should be given priority. This should include farmers, extension workers and scientists.
- There is a need for the creation of favourable working environments, including adequate support services.

Recommendations to the farmers:

- The setting up of farmers' organizations should be encouraged in order to facilitate continuous contact and exchange of ideas between farmers themselves, and also with the extension services, researchers and policy makers.

Recommendations to the ICIPE:

- ICIPE should be encouraged to extend the operation of the African Regional Pest Management R&D Network (PESTNET) to include plant diseases, weeds and other pests. PESTNET should also be expanded to include other countries and regions in Africa.

Opening Statement

Thomas R. Odhiambo

Barely a quarter of a century ago, Africa was self-sufficient in food staples, and it was almost inconceivable that Africa would become the centre of global concern about its food and nutritional security in the 1980's. Indeed, the colonial powers, then moving out of Africa, had long considered Africa as their bread-basket and the principle supplier of agricultural raw materials for their metropolitan industrial base.

The declining economies of Africa in the mid-1970's; the cataclysmic drought during the period 1982-1985; followed by the just-ended devastating locust plague which started in 1986; and the overwhelming debt crisis that has burdened African economies this decade; have all conspired to paint a totally different picture of Africa's agricultural performance, since agriculture remains the major source of economic activity in Africa.

The most dramatic demonstration of this changed perception was Africa's Priority Programme for Economic Recovery, 1986-1990 (APPER), which was adopted by the Assembly of Heads of State and Government of the Organization of African Unity (OAU) at its 21st Ordinary Session held in Addis Ababa in July 1985. This priority programme characterized agriculture as the most important sector in the economy of Africa, in terms of providing food and employment, and as a major source of foreign currency income. It was estimated that the full implementation of APPER would demand the mobilization of US $128.1 billion, of which $82.5 billion would be derived from African domestic resources, while the rest would come from the international donor community. Later that year, a Special Session of the United Nations General Assembly, convened in New York, adopted APPER; and a consensus was reached as to the framework of cooperation and shared responsibility required to uplift Africa out of its increasing drift towards endemic poverty. This expected solidarity and partnership with the international donor community, highlighted by the Special Session, has not materialized - and Africa should derive important lessons from this seeming international unconcern.

The issues confronting Africa are that Africa can indeed feed itself, and that it could even regain its capacity to become a significant food exporter; that agriculture continues to be a major, if not the dominant, sector of the economic life of most African countries; and that the primary responsibility for food and nutritional security remains with African governments. Furthermore, it is clear that Africa faces a three-pronged challenge to the predominant position it held before independence, as an exporter of food and raw materials. African countries have been the fastest growing source of demand over the last two decades for North American and Australian agricultural exports, especially food grains. South Asia and South-East Asia are growing competitors in food exports, including rice, cassava and palm oil; and the European Economic Community is an increasingly restricted destination for Africa's traditional agricultural exports.

These issues and challenges require that Africa begin to design new solutions to regain its agricultural competitiveness. A beginning needs to be made by examining and restructuring our farmer-scientist relationship. This step can be greatly assisted by our deeper understanding that the African farmer's traditional knowledge base in agricultural practice - including facets of pest management - is based on continual experimentation and experience gained over millenia, and stretching over diverse ecologies and circumstances. There can be no end-point to the farmer's experimentation and gathering of experience; it is not only the scientist who undertakes experimentation, nor is he the only one who can relate to experience. Consequently, in terms of developing efficacious agricultural practices, appropriate to a particular agroecology and cultural experience, the scientist and the farmer should be partners, both working on a common research agenda and a common programme of technology development.

We are going to witness an attempt during this Conference to initiate an interactive dialogue between the farmer, the extension specialist, the policy-maker, and the scientist. Realization of the enormous potential of African agriculture depends on a productive outcome of such a dialogue, which should be going on all over Africa on a sustained basis. We have chosen to open this dialogue on the theme of Integrated Pest Management, since it is critical to all tropical agriculture and we are on the threshold of some major breakthroughs in this difficult field. We hope that other expert groups will initiate similar dialogues in other problem-areas of agriculture.

CHAIRMAN'S KEYNOTE ADDRESS:

Agricultural Challenges in Contemporary Africa

Moctar Toure

Allow me, at the very outset, to express my sincere appreciation for the opportunity that you have given me to be with you, this morning. I feel deeply honoured. The complex issues that this conference will deliberate upon provide me with a rather unique example of the creative and non-conformist thinking that must be used to alleviate if not eradicate, daunting problems that plague rural African agriculture in particular, and African agriculture in general.

Conferences like this one are sometimes caricatured as the gatherings of individuals, who in their inability to solve any problem, jointly decide that nothing can be done. Happily, such a definition does not apply to our meeting. This forum has brought around the table, the multiple protagonists working in the fields of agricultural development: farmers, extension agents, researchers, policy makers, economists, financiers, private entrepreneurs, and industrialists. They will communicate with each other and through that dialogue arrive at a concerted programme of action to deal effectively with a major and clearly defined problem. The establishment of logical linkages among these various actors in agricultural development is a basic objective of this meeting. In that context, I wish to extend my warmest congratulations to our co-sponsors, the international Centre of Insect Physiology and Ecology and the World Bank.Their judicious far-sightedness has brought all of us together in this forum. The central topic for our meeting is integrated pest management within the context of both traditional and modern farming systems in tropical Africa. It is a subject with several dimensions - bio-ecological, socio-economic, institutional - and policy based specialists like yourselves must assess and take into consideration all these factors and their linkages when formulating your strategies to alleviate problems created by pests in the rural environment. This will no doubt require serious adjustments in, and maybe a breakaway from, our way of thinking and conducting research and extension. Within this general framework, I visualize three key goals for this forum to achieve.

First, a broad review of current pest management practices in the various African regions and scrutiny of examples of successful approaches and promising opportunities for supporting their implementation among farmers. Your analysis and judgement will enable us to assess the extent and magnitude of the problems where food, cash crops and livestock products are concerned.

Second, the socio-economic, institutional, and policy constraints that impede the spread and adoption of improved management methods in the farming world must be identified, and recommendations made on ways to overcome them. At the same time, we must clearly delineate the proper place and role of extension and research systems in resolving the farmers problems, particularly in resource-poor communities.

Third, we need to explore ways of fostering private sector involvement in the development and implementation of improved integrated pest management among farmers in Africa. In doing so, we should hold a broad discussion and arrive at a consensus on the cooperation that must exist in this specific field among all protagonists at the national, trans-national and international levels.

So far I have not really touched on the substance of the subject of this conference. It is a task I am going to leave to others better qualified than myself. Instead I wish to share with you some of my thoughts on the current scenario as a general perspective for our discussions here.

Underlying the specific problems that we will be discussing is the fundamental challenge Africa faces in attempting to achieve sustainable agricultural development- sustainable in the sense used by the World Commission on Environment and Development: "development that will enable mankind to meet the needs of today without compromising the ability of future generations to meet their own needs."

At the moment, Africa is dealing with a series of setbacks in its economic, socio-economic and demographic balances. For instance, the human map of the Sahel region changed more radically between 1960 and 1985 than during centuries of its previous history. The population as a whole has doubled and the urban population has increased five fold. For Africa, key problems within the overall challenge of agricultural development, then, are its food security and the rehabilitation and conservation of its agro-ecological systems.

The persistence of the present wide gap between food requirements and food production is no longer acceptable, inasmuch as world-wide food security including that of Africa, certainly cannot be guarantied permanently by a small group of countries that have been traditionally in food surplus and therefore suppliers of food aid. According to FAO projections, Africa's grain deficit is likely to increase from 6 million metric tons in 1975 to 24 million in 1990 and 44 million in the year 2000. That will mean a decline in food self- sufficiency rates from 85% in 1975 to 70% in 1990, and to 61% by the year 2000.

Two considerations argue against a policy of heavy dependence on food imports. On the one hand, there is the cost of the enormous quantities that would have to be imported and the scale of political risk involved. On the other, there are the economic constraints and the ecological concerns which today are leading a majority of traditional surplus countries to reduce the area kept under food crops and subsidize producers who let land lie fallow.

Africa's food security therefore must necessarily rest on what I regard as two essential and mutually complementary policies. First, to achieve a level of domestic food production high enough to preserve the region from the turbulence of external physical, or political, shocks. Second, to raise household (and therefore, national) incomes to levels that will cover contingency food imports should these become necessary.

The question that then arises is whether African agriculture can provide the basis for sustainable development and if so, how. The answer can be summed up in two words: improved productivity. That will not only strengthen resistance to climatic hazards and natural disasters, but will also create remunerative employment in the countryside in agriculture proper, and also in related activities upstream and downstream.

Let us look first at the productivity of the land. It cannot be denied that some particular constraints explain, at least partially, Africa's poor record in this regard. Trypanosomiasis, for instance, affects 10 million km^2 in 36 countries, or one third of the total land area of the continent and half of its inhabited area. Further, vast areas subject to river blindness will remain unusable until the present eradication campaigns are succesfully completed. Besides, the fragility of the natural recource base is demonstrated by the predominance of low-fertility soils in the eco-system that are being exploited beyond their production capacity.

How can we fully develop the potential of this economically utilizable land that is available to Africa's farmers? In my view, there are three parts to the answer: namely the development of appropriate technologies, the strengthening or promotion of institutions supporting rural development, and the restoration of an economic environment conducive to agricultural production.

Technological progress, surely a major focus for our discussions here, is very clearly the essential pre-condition for agricultural development in Africa. Of course, the availability of technology is the outcome of research. Without underestimating the qualitative and quantitative efforts that have been made in agricultural research in various parts of the continent, one may very well ask whether research projects have been designed, and their results utilized, in a manner that has always kept their real objective in focus. That is: improved agricultural production techniques as perceived by the farmers themselves. Past experience seems to indicate that the architects of new technological packages have often failed to take account of realities in the field and the real needs of their intended beneficiaries. Consequently, extension agents have not been able to pass on technical innovations despite their having been tested on research stations and demonstration plots. The reason is that these new production techniques do not address the farmers' own basic concerns. For instance, it would be difficult to convince a subsistence farmer to accept a costly technical package on the grounds that it will guarantee him maximum profit when his primary concern is to minimize risks rather than to maximize the profits.

So, the message to our scientists is a clear one: the approach to be taken in technological development should be guided by the desire to satisfy a specific group of clients who have themselves expressed clearly defined needs."Farmers first and last"; this is the surest way to steer agricultural research toward innovations that provide solutions to real, discrete problems, and therefore have the best chance of being adopted.

As to the productivity of labour, it is readily understandable that there will be no viable and sustainable agriculture in Africa unless there are farms giving to those who work the land a standard of living commensurate with their aspirations. It is the pursuit of such aspirations, and the income levels that go with them, that forces large numbers of people to desert the countryside. The increased income obtained from a given volume of individual or family labour will be commensurate with the remuneration per unit work. Hence, the importance of production techniques that depend on tools and equipment which enhance the value of labour power.

This problem of income and rural employment indicates that sustainable development in African agriculture cannot be achieved simply by improving the physical environment. A series of other measures that are a matter of development policy choices must be instituted at various levels - national, regional, international.

At the national level, measures focused on institutional support are important. These measures should facilitate a closer integration of research extension with the rural beneficiary communities as active participants. They should also encourage local communities to set up groups capable not only of formulating their own development needs clearly in terms of self-help programmes, but also of assuming a significant proportion of programmes designed to improve their local living conditions. They should, for instance, be able to obtain supplies of necessary inputs, arrange working capital and loans, organize marketing of their output through reliable institutions, and avoid being victimized by pricing policies unfavourable to agricultural production. In like manner, tenant-farmers and share-croppers should be able to count on institutional support that guarantees their occupancy of land on terms satisfactory to all parties concerned. It is the responsibility of national authorities to define environmental conservation strategies that set standards for the rational use of natural resources within each ecological zone found in a particular country, and to provide adequate training that will enable officials not only to devise the necessary policies, programmes and projects, but also to carry them out successfully.

Finally, Africa cannot fully realize its potential for viable and sustainable development in agriculture, and for food self-sufficiency, unless adequate resources are made available to the agriculture sector.

At the 21st Annual Assembly of the Organization of African Unity, the participating Heads of State and Government entered into a collective commitment to devote more resources to agriculture by earmarking 20-25% of capital spending to this sector, which is currently assigned less than 10% in in many cases. It will be up to each country to turn its decision into reality - a fundamental one if the continent is to revive its agriculture. The structural adjustment programmes that will be inevitable in many countries should be carefully designed to ensure that national food security and small farm incomes are not sacrificed in the process.

Sustainable agricultural development will also sometimes require actions that extend beyond national boundaries. In practice, it is frequently difficult, if not impossible, for one country to formulate an agricultural development strategy without taking into account the socio-economic realities of its neighbours. The migratory herding of livestock is one good example. In such instances, regional cooperation becomes an essential component in the quest for sustainable agricultural development.

However, domestic resource transfers to the agricultural sector alone, will not go very far towards accomplishment of the agricultural and food production targets that are needed to improve Africa's food situation. If, as the FAO recommends, agricultural production is to increase by 4% annually over the next ten years, the volume of external aid will also have to grow on a scale commensurate with that of the problem to be resolved, especially in view of the chronic indebtedness that is an increasingly serious handicap to the continent of Africa.

The need for international solidarity and cooperation among African countries in their drive for sustainable agricultural development has become particularly urgent. What is needed is not merely financial cooperation, but also cooperation in the realm of ideas, transfers of know-how and a dialogue that will ultimately lead to equitable rules and practices in commercial transactions and intellectual and cultural exchanges.

However, be that as it may, it is up to the Africans themselves to take charge of their economic destiny. Today it is apparent that if long-term solutions are to be found to environmental and productivity problems, they must be African solutions, articulated and implemented by Africans, in the specific biological, technical, socio-economic and political circumstances of their own nations.

PART TWO

INSECT PESTS AS A CONSTRAINT

IN

CROP AND LIVESTOCK PRODUCTION

Pest Problems in Subsistence Farming in Africa

Silpa Odak

I am Mrs. Silpa Odak, a small scale farmer having 6 acres of land. On my farm, I have developed 3 acres of land and grow maize, sorghum, cowpea, beans, groundnuts and banana.

Agriculture is the main occupation of the majority of people in Kenya and over 70% of the population derive their livelihood from agriculture.

There are various categories of farming based on landsize, namely:

- Large scale farming
- Medium scale farming
- Small scale farming

Of these, the small scale farming bracket has the largest number of farmers. Therefore, attention should be paid to the improvement of their farming conditions. As a small scale farmer, growing a variety of crops, my pest problems vary from crop to crop and from year to year. Pest problems also sometimes increase when the rainfall is less.

The main pests noticed in my area are as follows:

- **On Maize and Sorghum:**

  - Army worms are a disaster when the rains have failed. You can hardly salvage any of your crops and you may be forced to replant. Sometimes the government supplies these chemicals but these can cover only spot areas.

- Stemborers on maize and sorghum are also a problem on the farm. If they attack, especially when the crops are young, they kill the plants or the plants become unproductive. I normally use chemicals as a control measure. But the majority of the farmers do not know these chemicals. Further, the chemicals are expensive and not always available. Recently, the ICIPE project taught me how to reduce stemborers by growing resistant maize and sorghum lines, intercropping and disposing of crop stover. It works well, so this teaching should be extended to other farmers.

- Striga weed is a big problem on maize and sorghum. It attacks the crop and once it has attacked, the crop will not produce anything. It is spreading at an alarming rate and is becoming a big threat.

- On maize, there is a disease which has become a common occurrence and is attacking frequently. It is maize streak. Although we uproot the affected plants, that does not work as a control measure as it still persists and we see a lot of it in our fields.

- Another problem comes at storage time. Weevils and beetles attack crops in storage. Many small scale farmers loose a lot of crops in storage and sometimes the weevils come from the fields. They cause serious losses and also lower the market value of the crops.

- **On Groundnuts**

  - What most farmers have noticed is the groundnut rosette. It attacks the groundnuts and they become yellow and do not grow. Such plants cannot produce anything and have to be uprooted.

- **On Beans and Cowpea**

  - When bean seed is bought in the market, there is a tendency for the beans to dry when they are still young; and when uprooted, the roots are swollen and insect larvae are found.

  - Pod borers and pod bugs are also noticed on the pods. These pests destroy the pods and reduce the crop yields. Flower thrips are also found and they also reduce grain yield.(ICIPE provided me with a type of cowpea that is more resistant, therefore less attacked by these pests).

- Beans and cowpea are also attacked in storage by storage pests.

- **Bananas**
    - Bananas tend to fall a lot after the plantation is established for sometime. This is due to banana weevil which lives in the corm of the banana and so leads to the falling of bananas.

Knowledge as a weapon against pests

There is need to educate the small scale farmers as many of us lack the knowledge that can be used as a weapon against pests.

Control of these pests and other pests should also be within the reach of small scale farmers since they lack resources and are not open to credit facilities. This is why the teaching I received in the IPM project of ICIPE has helped a lot.

My experiences as a participating farmer in the ICIPE project

When the ICIPE approached farmers and wanted to know about their pest problems, some people thought they were out to take their land and were therefore not very cooperative. But, they now realize that the ICIPE was out to help them contain their pest problems.

I have benefitted in the ICIPE project in several ways:

- I have learnt new ways of growing crops.
- I have learnt how to deal with insect pests in various ways:
    - ploughing and planting early
    - planting resistant crops
    - intercropping
    - disposal of crop residue

I have increased my yield as a result of the new measures that I have adopted. I have also taught some of my neighbours who have expressed an interest in also learning these new practices.

Are Pests a Problem for Small Scale Macadamia Farmers in Malawi?

A.J. Mponda and W. R. G. Banda

Macadamia are a relatively new crop in Malawi. It was first introduced into the country in the late 1930's but no commercial interest arose until the late 1960's when new clones were introduced by the Shirehighland Tea Estates.

There are basically two species of this crop that have commercial interest: the "smooth shelled" also known as *Macadamia integrifolia*, and the "rough shelled" also known as the *Macademia tetraphylla*.

The crop has developed into a powerful industry and a lot of smallholder farmers are a part of this success. The development of the industry into such magnitude, has of course not been without problems. There are many problems, starting from the production techniques which include agronomy as well as entomology; problems related to clonal adaptations; nutrition problems; and water management problems.

Each of these problems is important, but the main objective of this discussion is the pest problem as it relates to the small scale Macadamia farmers.

INSECT PESTS OF MACADAMIA.

There are a lot of macadamia pests that have caused damage to the plants at one point or another, but the two most important ones, that are presently causing a lot of damage are the macadamia nut borer (*Cyptophlebia batrachopa*) and the stink bug (*Nezara viridula*). Both the insects can cause up to 80% damage if proper control measures are not followed.

The nut borer causes damage by physically boring into the nut, when the shell is still tender, and will normally lay its eggs on the developing nuts.

The stink bug sucks the juices from the nut and in the process injects a substance that affects the developing nut. The affected area is usually abnormal and will always be rejected at the factory as an undesirable nut.

There are many more insects that affect macadamia nuts, but these two are most important. When we are dealing with such insects we have to think also of the secondary problems that the insects bring.

USE OF CHEMICALS TO CONTROL INSECTS

Many techniques have been used widely in other places in trying to control insect populations. But presently, the most commonly used method in Malawi is the use of agricultural chemicals. As you might be aware, chemicals are dangerous; that is why they kill. Many problems arise, especially for the small macadamia farmer in terms of chemical use.

From the experience of small macadamia growers in Malawi, chemicals are sometimes very expensive to buy. The smallness of the farmer's field makes it difficult for the farmer to produce nuts at a profit. The value of the product obtained may sometimes be just equal to that of the chemical input, so that small farmers who use these expensive chemicals, usually do not break even. Probably, if the chemicals were sold in small, affordable units, this problem would be solved.

Some chemicals that have been used are so toxic, that an education programme on how to use them is required, but is sometimes not available. Farmers need to know how to dilute as well as how to dispose of the containers without posing a health hazard to themselves and their families. These problems that arise due to the use of chemicals are really very big and proper education needs to be done before farmers wipe themselves out.

Most of the smallholder farmers in Malawi use ground water for drinking and other domestic use. Some chemicals have a long life and in the process of going underground, the chemical or its residues are carried along and may poison ground water reserves which people use. Thus, the use of chemicals has also brought about environmental pollution. Furthermore, beneficial insects die along with the target insects. This is not good because it may bring about a chain of reactions of other problems.

Apart from being expensive, applicators are sometimes not used for the purpose they are intended for. Trees can grow up to 7 metres high and most small farmers have just the knapsack which is meant for small crops like tobacco. Smallholder farmers cannot afford the motorized sprayers; as a result they use the knapsack sprayers which in this context are not desirable. The farmer is just throwing his money away by using a sprayer that can not effectively cover the whole tree.

The other problem that farmers face is in the calibration of the chemical. Some chemical companies do not give the farmer instructions on the use of the chemical, and as a result, some farmers over-dilute the chemical which is not desirable because the chemical does not kill the pest. Some will tend to under-dilute, which again is not desirable because the chemical is wasted and may also be a health hazard if no proper equipment and protection gear is being used.

RESISTANCE OF INSECTS.

The two commonly used chemicals in the macadamia industry in Malawi are Ripcord and Fenitrothion. The Ripcord or cypemethrin is a broad spectrum chemical that will effectively kill both the nut borer and the stink bug. But of late there has been speculation that the chemical is no longer effective because the insects have gained resistance. This therefore brings a lot of problems to farmer in that he is wasting money on a product that does not effectively do its job, as well as on labour. These resources cannot be played around with if the farmer wants to realize good profit margins.

SUMMARY

Addressing the matter in question: yes, pests are a real problem in Malawi, because they are a major constraint to increased macadamia production. The farmers' profit margin, after the crop is sold, is reduced because of expensive chemicals that are available in large quantities.

Of course, other farmers do not use the chemicals and depend solely on the forces of nature; they also get at least something out of their crop. If insects were reduced to below economic threshold, farmers would get better returns.

Farmers also need to learn how to monitor pest populations before any chemicals can be used.

Pest Problems in Small Scale Livestock Farming in Dar es Salaam, Tanzania

Jasmin Ngallo

My name is Jasmin Ngallo from Tanzania. I am a smallscale farmer and livestock keeper. I keep hybrid dairy cattle of Friesian, Ayrshire and Jersey types. I have 5.5 acres of land in the Dar es Salaam region. I have 17 adult cattle, nine calves, one bull, 60 goats, 500 broilers and 230 layers. I got credit facilities from the Cooperative Rural Development Bank through the auspices of the World Food Programme.

I have managed to grow bananas from the manure that I get from the animals. I use the bananas both as food for the cattle and for my family as bananas are a staple food in Tanzania. For the cattle I also grow Elephant and Setaris grasses as well as vegetables. The manure that I use has enabled the plants to flourish very well. Therefore, from dairy cattle, a small-scale farmer can be completely self-sufficient and produce a surplus harvest. There are many more benefits of dairy farming than I have explained and I think that every one of you knows them. What is needed for you to succeed fully, is to follow modern technology.

I started livestock farming in 1981.

I get technical advice and medical treatment for my livestock from the nearest veterinary centre and from the Tanzania Livestock Research Organization.

PEST PROBLEMS IN LIVESTOCK

The major pests that I see in my livestock are also seen by other livestock farmers. They are:

- Ticks
- Tsetse flies
- Biting flies

An important calendar activity for cattle keeping is taking your cattle to a cattle dip at least once a week. I use a spray pump and the chemical Toxaphene and Bacdip in spraying. I concentrate more on the internal parts e.g. inside of the ears, under the belly and the base of the tail. The main aim is to kill the ticks. Ticks have many hazards including:

- blood sucking
- disturbance
- wounds at attachment sites

Cattle get East Coast Fever (ECF) disease and the animal dies if not treated early enough.

My cattle are also injected with Samorin every three months to prevent sleeping sickness (trypanosomiasis) which is transmitted by tsetse flies.

Other problems are biting flies and house flies. We use pye-grease and insecticide to protect the animals. The biting flies are very disturbing as they cause wounds and hence make the animals distressed. The animals do not feed well and they kick a lot and it is a task milking them. We ensure that the livestock barns are always clean by having them cleaned everyday. We also apply insecticide after the cleaning as we were advised by experts. We also undertake sanitation of the surrounding areas.

Pesticide problems

The dipping chemicals used change from time to time. Today you can get Toxaphene 75% and when it is out of stock you can buy Bacdip. Frequent changes of chemicals is not good. This can result in ten-legged ticks becoming resistant. You directly spray the ticks but they do not die. When an animal gets ECF, it becomes very expensive to treat. Twenty-four mls of the drug Terit, enough for one animal, costs over Tanzania shillings 1,500/=. Other problems are inavailability of the spray pump, and its spare parts when there is a breakdown. Infestation of my cattle comes from up-country cattle which come to Dar es Salaam for slaughter.

Sleeping sickness (trypanosomiasis)

A few animals get trypanosomiasis despite following technical advice and three-monthly Samorin prophylaxis. Although I cut down the bush on my farm, there is a problem of tsetse from the bush of surrounding farms.

CONCLUSION

We are really grateful to the experts who give us good technical advice on how to deal with pests. Without the knowledge of how to handle pests, it would have been difficult to succeed as a livestock farmer. Livestock farming is very profitable in Dar es Salaam.

Without the help of experts, death of cattle from pests would result in a severe shortage of milk for infants whose mothers work away from home.

Knowledge and control of pests can help many small-scale farmers in different parts of the world to sustain their lives. Most people in Africa are small-scale farmers and if their lives can be made more comfortable by the control of pests, it would be a big step forward that will help mankind.

I give special thanks to all those who participated in this conference which has greatly motivated and educated a small-scale farmer like me.

I believe that experts like you will continue to co-operate with the small-scale farmers to free them from the bad economic climate which affects many African countries.

Pest Management and the African Farmer in Botswana

B. P. J. Masire

Botswana has an area of 583,000 square kilometres, but a population of only about one million people. The land lies at 900-1000 metres above sea level, with a rainfall of 400-500 mm per year which falls between October and April, though it can be unreliable and erratic. Some 80% of the population is connected with agriculture and the livestock industry is particularly important in earning foreign exchange. The Department of Animal Health therefore plays a vital role, and reaches the farmers through a Livestock Advisory Centre in each district.

LIVESTOCK PESTS

Ticks, flies, mange mites, lice and biting flies (including tsetse) all present problems. The direct effects of ticks reduce productivity and include persistent disturbance, loss of blood, toxicosis, hide damage and abcess formation leading to loss of teat function when it occurs on the udder. In the latter case, this usually means the culling of breeding animals. In addition, ticks transmit several important diseases to livestock, and others to dogs, poultry and man. Ticks are controlled by the use of dip tanks and sprays to apply acaricides, an operation involving additional labour, building and acaricide costs.

Other ectoparasites cause similar effects (but no disease transmission) and are controllable by the use of acaricides when the facilities are available. The government of Botswana has provided dip tanks at strategic points, and these are supplemented with others constructed by groups of farmers at their own expense. Biting flies are only a problem during the rainy season.

Tsetse flies are restricted to the north-west and transmit African animal trypanosomiasis, which can be treated with trypanocidal drugs. The government embarked on widespread aerial spraying in 1982 and tsetse are now confined to small pockets, particularly in game reserves.

Farmers are served by the Department of Agriculture Field Services, operating in six regions, each of which is staffed by specialist officers in various disciplines. One advantage of installing cattle dips is that the adjacent handling facilities can also be used to muster cattle for vaccinating them against other diseases or dosing them against internal parasites. The Smallstock Unit assists farmers to form sheep and goat management groups, and advises them on treatment of parasites by means of a standard management programme.

CROP PESTS

The major crops suffer an overall loss of 20-30% from all categories of pests. The main crops are sorghum, maize, cotton, millet, vegetables and fruit. The pests which attack them are classified either as migratory (quelea birds, locusts) or resident (insects, weeds, rodents, storage pests, diseases). The former may be sporadic, but their effects can be devastating if not controlled. Government policy is to provide full survey and control, since no farmer can cope with these on his own.

Resident pests are less serious due to the dry conditions, but fungal diseases are potentially important if seed is not treated. The most serious pests are stalkborers, bollworms, aphids, datura weeds, rodents and storage pests. The government will survey these pests but control, if decided upon, is carried out by the farmer himself under the supervision and advice of the extension staff, and when pesticides are needed, they can be bought by the farmer at a subsidized price.

IPM as a system is most welcome and looks very promising for resolving farmers' pest problems without seriously and adversely affecting the environment. But it calls for major requirements in order to succeed. First, trained personnel are required for implementation; second, a strong infrastructure is needed and setups to apply recommended solutions under variable African conditions. These requirements are often lacking in Botswana due to manpower development problems, lack of training at all levels, and the complexity of crop production and protection problems. These are complicated by erratic rains, primitive cultivation practices and the fact that up to now, crop farming is less attractive to farmers than is livestock farming.

Botswana is a member of many international organizations such as FAO, OAU, International Locust Control Organization for Central and Southern Africa, SADCC, and SARCCUS (Southern African Regional Commission for the Conservation and Utilization of Soil). Through these organizations, many technical inputs are utilized.

We feel that IPM can only function effectively, and achieve promising results in increasing crop production as an ultimate goal, if international efforts can be pooled and all possible steps are taken to avoid repetition and overlap. Each ecological condition or zone in Africa should be treated separately, and even minor variations within each zone should be considered. Another asset which can be explored, assessed and improved on is the wealth of experience and knowledge, accumulated by traditional farmers through many generations, on the integration of traditional pest control methods. A good example is the method whereby farmers grow crops that are not damaged by birds but become attractive to them in order to feed on their insects. Those cereals damaged by birds can be effectively protected by a network of scarers who use primitive methods to carry out persistent efforts during the last 5 weeks, when the crop is susceptible to bird attack. A promising IPM policy can emerge if these and other methods can be studied and improved in consultation with the farmers.

SUMMARY OF DISCUSSION:

Pests as a Constraint to Crop and Livestock Production

The previous four papers were presented under the first programme theme, by subsistence and commercial farmers of crops and livestock. Various insect pests and their control strategies were described. These formed the basis for a general discussion, the highlights of which are as follows:

Insect pests were identified as one of the most serious problems of the many problems of the African farmer which require attention. It was agreed that a solution to most of the insect problems should be found through the IPM approach within the broader framework of integrated crop production. The major constraints affecting the implementation of IPM approaches were identified as:

- The present lack of efficient and appropriate IPM packages. Such packages should contain knowledge which can easily be transferred to farmers and which is based on locally available inputs.

- Inefficient information retrieval and communication systems among farmers, extension workers and researchers.

- Institutional constraints such as unavailability of inputs and credit facilities; inadequate infrastructure for distribution, marketing and pricing of farm products; and the inability of most farmers to manage their finances properly, thus denying them control of their own destiny.

- The small farmer is risk-conscious in achieving yield stability through the practice of intercropping. However, the small scale farmer is unable to appreciate the benefits to be derived through appropriate pest control as he cannot assess losses. The commercial farmer is motivated by higher profit margins and is therefore receptive to all measures which will increase earnings. Thus he is prepared to practise pest management to varying degrees.

- Knowledge of small-scale farmers' behaviour and perception of pest management, dictated by cultural traditions and economic conditions, is inadequate. Therefore, adoption of new pest management approaches at the required level of farmers' confidence, cannot be realized at present.

Successful implementation of IPM approaches through the use of improved intercropping techniques, resistant cultivars and rational chemical use reported at this Conference gave hope for increasing productivity by the small-scale farmers.

In Africa, farming systems are very diversified. Small-scale subsistence farming is more complex than commercial farming and thus requires different approaches to IPM. Small scale subsistence farming may require more sophisticated pest management strategies, which include those directed to stored product pests, in order to achieve food security at the village level.

PART THREE

EXTENSION SYSTEMS
AS A MECHANISM
FOR TECHNOLOGY TRANSFER

Is Extension Service Relevant to Subsistence Farming?

G.S.T. Magadzire

INTRODUCTION TO AGRICULTURE IN ZIMBABWE

Certain thoughts came into my mind on receipt of my invitation to deliver a paper on the topic: "Is the extension service relevant to subsistence farming?" My thoughts and interpretation of the intent of the organizers of this Conference who were inviting me, included two main possibilities:

- that the organizers might have been exposed to certain experiences with regard to extension work and subsistence farming which in their view were not satisfactory, positive or productive. In other words, they may have their own reservations on the issue under discussion which therefore might have precipitated doubts on the relevance of extension work with subsistence farmers. On the other hand,
- the organizers might have deliberately proposed this topic (which sounds rather provocative) in order to enervate a lively discussion and therefore get the best out of the participants.

Limitations placed on me by time and space have compelled me to believe that the latter rather than the former, is the motive for giving me the proposed topic. However, it must be noted that I am not an academic or an "expatriate expert" in agriculture. I am an agronomist by training and a simple farmer deeply involved in the production of food to feed the teeming thousands of our people.

Consequently, my approach to the issue will be to look at it from the point of view of a farmer. But before I go any further, let me share some thoughts with you on the overall scenario of Zimbabwean agriculture.

There are three main farming communities, namely:

- The Commercial Farmers Union (CFU), representing the large scale commercial sector;
- The Zimbabwe National Farmers Union (ZNFU), representing the small-scale African farmers; and
- The National Farmers Association of Zimbabwe (NFAZ), a body comprised of subsistence communal rural area farmers of the African majority, who are the least developed in terms of agriculture.

The CFU is the best developed, financed and equipped in terms of professional staff, services to members, contribution to and management of agricultural research, as well as flow of information for management purposes. Beyond these immediate benefits of membership in the CFU, commercial farmers are able to draw upon numerous sources of support in Zimbabwe's sophisticated and integrated agro-industrial, banking, transport, input and marketing infrastructure.

The last few years (since independence in 1980) have brought Zimbabwe's agricultural community face-to-face with the realities and uncertainties that confront the farming industry. Production costs have shown constant increases and a series of crippling droughts have adversely affected production. In the face of these hostile and adverse factors, farmers in Zimbabwe have demonstrated their fortitude and ability to overcome with a reasonable degree of success, even the most unfavourable seasons. It is well that this is so as farming forms the very basis of Zimbabwe's economy; thus the country's well-being is inextricably linked with the performance of agriculture.

The 1987/88 season was a successful one. Exports of agricultural products from all the three farming sectors earned the country Z$ 1.2 billion (about US$ 6,000 million) in foreign exchange - a substantial boost to the economy.

The continued success of Zimbabwe's agriculture is due to a combination of factors not least of which is the very high calibre of farmers. But I believe that a significant part in our success has been played by the enlightened policies followed by Government in the provision of support and encouragement of the most positive nature.

That the excellence of Zimbabwe's agriculture is internationally recognized has been reinforced by the award to Zimbabwe's President, His Excellency R.G. Mugabe, of the Africa Prize for Leadership for the Sustainable End of Hunger. This award, as you may be aware, represents a singular honour to all those involved in agriculture in Zimbabwe.

Extension Service and the Subsistence Farmer

My perception of agricultural extension work is in terms of its role in the dissemination of scientific information through communication, teaching, and demonstration. It is a learning process for both the farmer and the extension worker through feedback where the more difficult problems experienced at the field level are referred to specialists and researchers, depending on their complexity. Agricultural extension work is ideally a consultative process during which new technology, be it new seed varieties, new methods of tillage or conservation, plant cultural practices, or whatever, is passed on to the farmer for adoption, adaptation, and subsequent use.

Agricultural extension should instil changes in attitude or methods of doing things as a result of proven experiences and research either locally or within the region. Changes introduced should be consistent with the farmer's own development and change must not be abrupt, but should be gradual so that it can be sustained and the practices can be reviewed backwards and forwards for consolidation. As an agent of change, the extension service should be evolutionary rather than revolutionary - bearing in mind the fact that change involves people's attitudes, beliefs, practices and entrenched ideas. "Old habits die hard and it is not easy to teach an old dog new tricks", they say.

Extension Service in Zimbabwe

The extension service that is provided in Zimbabwe is implemented on a day-to-day basis by the Agricultural Extension Services (Agritex for short) under the umbrella of the Ministry of Lands, Agriculture and Rural Resettlement - an important ministry of the Government of Zimbabwe. Agritex operates at all levels and is very widespread on the ground. The presence of grassroots level extension workers enables day to day contact with the communal and resettlement farmers. In terms of numbers, however, there are not enough extension workers to enable the Department to operate at the desired level of intensity.

The current average ratio of extension workers to farmers is 1:800. Due to this high ratio, the strategy has been to disseminate agricultural extension technology to groups of farmers. Because Agritex is aware of the weakness of the group approach through which farmers problems tend to be generalized, the extension worker is required to build into his programme, individual farm visits for a more personal service.

The group approach is based on the not-so-accurate assumption that requirements of the individual farmer are similar to group requirements. For instance, it is interpreted that the pieces of land members of the group farm, are small and likely to be subjected to pests and disease problems or conservation requirements. The ideal situation would be an intensive combination of group and individual extension, but the available resources do not permit this level of intensity.

The immediate requirement of farmers from extension services is training that will allow them to share the farming community's optimism and hope for the future. Farmers need to be sufficiently trained and equipped to exploit their environment and increase the productivity of their resources.

Extension staff, researchers, and the farmers' efforts must be to transform agriculture commensurate with population growth. Agriculture has the capacity and the potential to avert the present crisis of unemployment if logical and rational plans take precedence over emotions.

With an effective and goal- or target-centred extension service, agriculture can set the wheels of commerce and industry systematically in motion and thus increase our ability to exploit our untapped human and natural resources. Such a goal-oriented production pattern will create a buoyant, strong, and stable agricultural base which will meet local needs for food self-sufficiency, and foreign currency needs through production for export markets.

The farmer and extension service require, in my view, a completely revolutionary perspective in their plans, approaches, goals, judgement, dedication, determination and commitment, for the national good. The farmer and extension staff are interlinked for their mutual benefit. It must be so.

In my view, the partnership should not create a teacher and listener forum, but committed participants, prepared to venture together into a less known but imagined future. Success in agriculture cannot and should not, be viewed in myopic terms. The gestation period for success is long, hence only a few, out of thousands, finish the race.

Rightly, you should sell ideas, and not decisions. Notwithstanding this assertion, however, you should also be able to evaluate your performance through the farmers' results. Management, whether temporal or scientific, is the KEY word that opens the doors to successful agricultural production. This commodity, management, is in very short supply in African agriculture, and therefore needs particular attention in our training programmes. Training in management needs to be broad and should include financial management, farm records, prudent purchasing of inputs, and wise marketing taking advantage of the market forces that might prevail from time to time. Management training should be such that it elevates the farmer to a position where he may fairly accurately and intelligently determine opportunities. Needless to say, the propensity of agriculture to respond to good management is real.

The farmer requires regular and reliable contact with extension services at all times. There is no good reason why extension services should be "slowed down" during the dry season, as that season is equally important for the farmers in terms of preparing for the next season.

- Farmers require a knowledgeable contact. An extension worker must have the confidence to advise them; as well as to introduce new ideas through a consultative process.

- The extension worker should have access to extension materials and messages which must be produced in a timely and in a contextual manner relative to the season. This access must include teaching and demonstration materials. Farmers are receptive to demonstrations and use of audio-visual materials and it has been noted that mobile cinemas enhance their enthusiasm. Although there are limitations to the use of videos etc., mobile training units should be introduced in the rural areas. Mobile training units should be modified so that they can carry both video and 35 mm films.

- The extension worker must be able to demonstrate to the farmer in the farmer's own environment, taking into account resources that are readily available.

An assessment of the extension service in relation to the farmers' requirements will reveal the following:

- Productivity of farmers either in a downward or upward trend.

- Extension methods that require modification, adaptation, or adoption; or total cancellation of a particular application.
- Perception of farmers with regard to extension work in general or with particular reference to specific issues.
- Availability of data for use in future formulation of government policies *vis-a-vis* strategies.
- Availability of information on weaknesses and strengths of the extension service in general.

PROBLEMS NOTWITHSTANDING EXTENSION SERVICE

In spite of the fact that there have been a fair amount of positive results, overall farming activities by African farmers tend to be in the decline for the following reasons:

- Abandonment of farming as an enterprise by the educated sons and daughters, which leaves the "old people" at home with little capacity to produce.
- Lack of labour for farm operations, or lack of capacity to compete for the little labour that may be available due to lack of working capital.
- Lack of suitable and reliable machinery and equipment. African farmers' farms have characteristically become the dumping ground for obsolete machinery.
- Lack of infrastructural development conducive to production in the rural areas. Despite the high production potential, the development of infrastructure has lagged far behind to the extent that one is tempted to conclude that he is not supposed to be productive, anyway.
- Difficulties in securing inputs and the marketing of products from the rural areas to urban centres.

MODUS OPERANDI

The extension service has long recognized the need for field trials and demonstrations on the farmer's field. A comprehensive network of such trials and demonstrations have to be established in all farming areas. These trials and demonstrations allow for better crop husbandry and management of field operations such as weed control, pest control, fertilizer application, harvesting and preparation of grain for the market. The importance of demonstrations is that when farmers have grasped the technology, the adoption process becomes even faster. A unified approach to demonstrations is recommended so that farmers cannot be confused.

PRACTICAL ADVICE

Farmers call on the extension worker for a wide range of technical advice. As there are many products on the market that have the same, or nearly the same, function, the extension worker should advise the farmer as to what product to buy based on its proven technical performance rather than on the basis of a brand name or company label. While it is appreciated that farmers identify their choices through company labels, they should always be given technical assessment of the product of their choice by the extension service. It is important to note that although the extension service makes recommendations as to what the farmers should follow, the extension service should also translate these recommendations in terms of resources that are available.

EXPECTATIONS OF THE EXTENSION SERVICE

While recognizing that farmers do face constraints in production, there are basic responses that the extension service expects from farmers. They expect farmers to:

- attend as many meetings as they can;
- present their problems so that they can be subjected to discussion;
- take the initiative of inviting the extension worker to the field whenever there is a problem and not wait for him/her to pass by. Otherwise, the extension worker may not be aware of the problem;

- complain whenever they feel that their extension worker is not giving them good service. Such complaints can always be channelled through the respective Provincial or District Agricultural Extension Officer;
- give feedback on some of the technology that the extension service may be promoting so that such technology may be subjected to further scrutiny; and above all, to
- be in partnership with the extension service, for this partnership should be a sustainable one.

Farmers make decisions that are mainly targeted to risk avoidance. Any enterprises that expose the farmer to risk should be avoided as these are likely to increase the farmer's resistance to receiving information in future. Agricultural extension should therefore be undertaken by constantly liaising with the farmer and getting him to articulate his problems to which solutions must be found.

"Give the farmer the chance to lead the way, then the advice you give will be worthwhile; lead the farmer, then you find yourself alone."

The extension service is aware that farmers do experience problems in the process of production. However, for success to be achieved, both parties should work as a team. In the event that they work independently, failure will result. The extension service is like a tide which the farmers should take at the right time, for success.

Let me quickly add that in my considered opinion there is no doubt that the extension service has contributed immeasurably to the success of agriculture wherever it has been practiced and reasonable measures adopted. There can be no hard and fast rules as to the application of the service. The nature of the service to be rendered should be dictated by the available resources.

In conclusion, extension has a critical role to play in transforming our agricultural production scenario and performance through participatory training in the broadest sense of the word. It needs to excel in training the farmers and demonstrating possibilities to them.

Our **key objectives** are a stable base for food self sufficiency commensurate with our population growth, diversification into exportable crops which earn foreign currency for the country, and the creation of an imaginative and responsible African farmer. We believe this can be achieved by active participation of extension, industry, and commerce; and with collaboration between public and private sectors. The potential for success in this approach is immense and staggering!!

Interaction Between Farmers, Extension Service, and Research in the Protection of Cocoa in Cote d'Ivoire - Experiences from Divo-Nord-Yaokro[1]

Christophe Douka

The major insect pests of cocoa in Côte d'Ivoire are capsids and nicids (*Hemiptera Heteroptera: Miridae)* and the stemborer *Earias sp. (Lepidoptera: Noctuidae).* Without control, these pests cause an average loss of some 30% of cocoa production. Chemical control, most often with carbamate, is the only means of control available at present, and no potential biological agent is known. Anti-mirid treatments are carried out in December-January and in July-August and treatments against *Earias* in September-January and in April. Alternate treatments with different insecticides is advised in order to avoid building up resistance in the pest populations.

The major diseases are brown and yellow rot. Prevention is attempted by using various cultural methods such as removing all sources of infection, on the trees and on the ground, throughout the year. In addition, some farmers use chemical control with cupriferous compounds. In the very humid zones brown rot is almost impossible to control.

The Research Institute for Coffee and Cocoa (IRCC) and the Society for Technical Assistance to the Modernization of Agriculture in Côte d'Ivoire (SATMACI) work closely together, informing farmers through media and through Cooperative Farmers Training Groups (GVC). Farmers are doing the actual control themselves, which is rather difficult as cocoa is grown in diversified cropping systems, and not in extensive culture. An effort through

[1] This is a summary of the paper presented.

the Cooperatives may lead to increased productivity. The best growers or groups receive incentives at various administrative levels.

Except for the most humid zones, the control systems used work rather well. The declining price of cocoa, however does not stimulate the growers to continue cultivation of cocoa, and substitutes for cocoa in the world also have a negative effect. Greater cooperation between African governments and with other developing countries, with regard to commercialization and diversification of produce, is advocated.

Extension Systems and Technology Transfer

W.W. Wapakala

INTRODUCTION

The last two decades have witnessed rapid population growth and urbanization in Sub-Saharan Africa. This has happened at a time when the food and agriculture situation in these countries is deteriorating. The net effect has been that population growth has outstripped food production, leading to food shortages which can only be alleviated by food grain imports. These imports were being made at the same time that there was a sharp rise in the price of fossil oil; this meant that these countries used considerable amounts of their foreign exchange earnings on grain imports and oil, thus draining resources needed to finance economic development.

While some of these food shortages could reasonably be attributed to normal vagaries of weather, e.g. the periodic droughts that have hit the region, there are indications that in some of these countries, besides pricing and marketing policies having a negative effect on agricultural production, governments have not allocated sufficient resources to agriculture, despite the importance attached to the sector in the overall strategy for economic development. Improved agricultural production is of great significance, particularly among the smallholder farmers who make up the majority of the rural population. Until recently, the required increased production in agriculture, especially food production, in the developing countries was obtained by bringing more land under cultivation. The rapid increases in population have accelerated the rate of bringing new land under cultivation to the extent that in many countries nearly all good land has been put under cultivation and there is, therefore, no more land to exploit for the purpose of increasing farm production. Any further increases in agricultural production will have to come from the use of improved farm technologies. The "green revolution" that S.E. Asia and Latin America witnessed (it bypassed Africa) was based on new technology and rapid growth in fertilizer use, increased commercialization of agriculture and a rapidly growing highly trained manpower. The technology system that made these rapid increases in food production possible included agricultural research and technically efficient extension service. In Africa where the agricultural sector is central to growth, technological change has to play an immediate major role. Indeed, the Lagos Plan of Action for Economic Development of Africa (OAU, 1981) has underscored the importance of technological development and utilization in the transformation of agriculture in Africa.

Problems of Technology Development in Africa

New agricultural technologies are the aggregate products of agricultural research, while the contribution of extension institutions is the information which is added to the new technology to create a message comprehensible to the farmer. This additional message contains information on credit, marketing outlets, prices and availability of inputs etc. These play an important role in the farmers' decisions to adopt or not to adopt the new technology. Although both research and extension systems consume inputs and produce outputs, the output of research cannot be separated from the contribution made by the extension services. It is for this reason that technology development, transfer and utilization are a part of a mutually reinforcing continuum. When technology reaches the farmer, at which time its economic and social efficiency can be measured, the work of the two institutions is complementary. National agricultural research systems in Africa are at different levels of development. However, they have similar problems limiting their contribution to agricultural improvement. These problems include:

- Lack of continuity in research programmes. The implementaton of research programmes is adversely affected by rapid staff turnover.

- Lack of mechanisms for establishing priorities in research; consequently the research programmes carried out may not be relevant to the farmers' problems.

- Lack of trained manpower. In a number of African countries, most of the research personnel are still expatriates.

- Governments do not allocate adequate financial resources for research.

- Lack of incentives and poor recruitment policies.

- Commodity and disciplinary research on station does not receive feedback from the field.

In order to develop a farmer-orientation in the research system, the linkage between research and extension should be articulated. In order to improve and strengthen their national agricultural research systems, a number of African countries have sought assistance from ISNAR. Strengthened NARS are a prerequisite for accelerated development of technology for improved agricultural production.

Extension Systems and Technology Transfer

The principle mission of the extension services is to decrease the cost of information and access to new technology. The decrease in cost may be achieved through the following processes:

- **Shorten the time of dissemination of new ideas and technologies.** Thus extension services should:

    - serve as a conduit between research and the farmer;
    - disseminate new ideas, information on new inputs, improved production systems; and
    - provide relevant information on credit, prices, etc.

  A longer time lapse in access to new technology represents a cost to the farmer and society in the form of lost potential income.

- **Shorten the time needed to make decisions**. Extension services should show that the new technology is less risky and may be more profitable than one already in use.

- **Clarify technical details.** Technical details should be made simpler by the extension staff. This is a form of public technical assistance and represents a large cost reduction for the farmer.

- **Train farmers.** Training of farmers and junior technical support staff is the responsibility of extension services in most African countries.

For the extension services to be able to carry out these activities, their workers must have three elements:

- access to new technologies relevant to the farmers needs,

- adequate understanding of these technologies, and

- ability to communicate effectively with the farmers.

The three elements needed for an effective extension system point to the importance of extension and research systems interacting closely in order to have a discernible effect on agricultural production.

African extension systems, like their counterpart research systems, have **weaknesses** which make them ineffective in transforming technology. Some of these include:

- **Small numbers of extension workers**. Extension worker/farmer ratios of 1:1000 and over are common. With poor roads and limited transport facilities, most of the farmers are not accessible.

- **Inadequately trained extension staff**. Trained personnel are the major resources of successful technology transfer organizations.

- **Lack of a strong positive interaction between research and extension investments**, such as exists elsewhere in the world. Instead, greater investment in extension has meant that extension has substituted for research (Evenson, 1986).

- **Uncritical dissemination of research findings** without first testing them, resulting from the poor linkage between research and extension. This has had a negative effect on farmers willingness to adopt new technologies. Like the research workers, extension staff have poor knowledge of indigenous knowledge systems, despite the fact that they are in continuous contact with rural communities.

EXTENSION SYSTEMS AND IPM TECHNOLOGIES.

The "green revolution" involved widespread and rapid adoption of high yielding varieties of wheat and rice, high levels of nitrogenous fertilizers and improved supplies of irrigation water. The use of these yield-increasing inputs explains the phenomenal growth in agriculture in Asia and Latin America particularly in the 1970's. It is, however, now evident that further increases in production cannot be realized by use of the inputs that sustained the green revolution, despite the fact that there are substantial opportunities to increase agricultural productivity in the third world countries through increased yields, reduced costs and improved management of pests.

Pests constitute one significant constraint to increased agricultural production in the tropics. Higher yields and increased cropping intensity may lead to increased crop losses from pests; hence it was necessary to use pesticides to sustain high yields in the "green revolution" era. The high cost of these pesticides became a major threat to the economic production of many crops and effects of these agro-chemicals on human health and the environment soon became a concern of environmentalists. Furthermore, increased use of what was being regarded as effective pesticides, led to incidences of pesticide resistance, resulting in pest resurgence. Under these circumstances, increased agricultural production could not be sustained and the established agro-chemical methods of insect pest control had to be re-examined. It was in this re-examination that the integrated pest management (IPM) programmes emerged.

IPM DEFINED

IPM has been defined differently by different people. However, for the purpose of this discussion, I have adopted the definition by Bottrell (1979). Bottrell has defined IPM as "the selection, integration, and implementation of pest control based on predicted economic, ecological and sociological consequences." IPM, therefore, has the objective of developing improved, ecologically oriented pest management systems that optimize, on a long-term basis, costs and benefits of crop protection with the aim being to retain greater profits for the farmer.

COMPONENTS OF IPM

The IPM techniques that do not involve the use of agro-chemicals and are effective against insect pests, include: cultural practices, resistant crop varieties and biological control. All these control techniques have been known for many years. Recent promising alternatives to chemical pesticides include insect attractant chemicals (pheromones), insect disease agents and insect growth regulators. In this discussion, only cultural practices will be reviewed. In looking at the components of IPM technologies, one question we wish to answer is: "What are the constraints in adopting the given IPM technology on a wide scale among African farmers?"

Cultural practices

Cultural practices are one of the oldest modes of pest control. These practices involve modifying field management so that an environment is less favourable for pest invasion, reproduction, survival and dispersal, and in so doing reducing pest populations. Some of these practices include:

- crop rotation
- choice of crop
- manipulation of planting time
- intercropping or mixed cropping and
- farm sanitation

Recent rapid population growth resulting in excessive land fragmentation has made it difficult to practise crop rotation among small scale farmers. Monoculture and high input farming systems have also led to the abandonment of cultural control practices among African farmers.

Cultural control methods have a major draw-back in that these are usually preventive measures that must be applied before the pest attacks. The extension workers cannot advise the farmers in advance of the pest situation; on the other hand, farmers are accustomed to chemical control methods where pesticides are applied to control pest invasions when these have occurred. Both the research scientists and extension staff have, in the past, campaigned against intercropping and it was not until recently, that they discovered that intra- and inter- cropping and rotation of crops as practised by the small scale farmer had their value.

Planting and harvesting times

In this method, the period of crop development is altered to allow young plants to become established to a tolerant stage before the attack occurs, and to mature the crop before a pest is abundant. This is only possible if there is adequate information on the biology and ecology of the pest. Technology systems in many African countries have not yet collected and published information that can be easily made available to farmers for their use in understanding the biology and ecology of the pests; and even if this information were available, it is unlikely that the junior frontline staff could effectively use it to advise the farmers.

Rotations

These involve host- and non-host crops of the insect pests in an area. They are only effective against species having a limited host-plant range and dispersiveness. This practice has fallen out of practice as a result of ever diminishing land size. With small plots, rotations may only be effective in reducing pest incidence if neighbouring farmers adopt similar practices.

Sanitation and farm hygiene help to eradicate harmful weed hosts, and remove crop residues and shelters which may harbour insects.

Host-plant resistance

The benefits from host-plant resistance have been obvious in plant disease control. Unfortunately, entomologists have not made as much progress as have plant pathologists.

From a farmer's standpoint, pest resistant cultivars would be the most effective, easiest and economical means of controlling insect pests. The availability of food crops resistant to a variety of insect pests would be of great importance to the small-scale farmer, because in these crops the profit margin is generally small and the use of agro-chemicals reduces the profit margin further.

Thus, if research services could develop pest resistant cultivars, they would be utilized by farmers. In this connection, it is assumed that there would be a national seed quality service to ensure that farmers use good quality seed.

Biocontrol

Classical biological control, involving the introduction of exotic parasites and predators and the breeding and release of these and endemic species, has been most successful on islands and with perennials. It has not been very successful on long established annual crops. While there are many institutions investigating the potential of biological control measures, most of the research has not yet reached the economic evaluation stage and it is doubtful whether the production and dissemination of parasites and predators will be profitable in the near future (perhaps with the exception of *Trichogramma spp.*). Biological control programmes can only be implemented effectively by trained plant protection staff, and these are in short supply in most African countries.

Insecticide use

Insecticides are widely available and used by farmers for control of insect pests. In most cases, however, the high costs of the pesticides ensure that farmers use only little on their crops. In this regard, it is important that farmers are trained to apply the correct insecticide, in the right amounts, at the right time. Crops should be monitored regularly and the farmer should be ready to spray whenever pests (particularly eggs or small larvae) threaten to exceed the level of population or damage at which the application of insecticide will be profitable (economic threshold). The problem here is how to calculate the economic threshold level, as this will depend on: crop potential, pest damage potential, cost of treatment, and the market value of the crop. Research should be undertaken to determine these parameters for a given situation and extension staff trained in the methodologies of determining the levels. Extension staff should then assist the farmers to appreciate and undertake their own field monitoring.

CONCLUDING REMARKS

IPM technologies are "management intensive", that is they require more information and skills for successful adoption than the earlier inputs that ushered in the "green revolution". Kahlon (1984) has termed these technologies "second generation inputs".

A number of factors would appear to limit the adoption of IPM technologies in African agriculture:

- While the "green revolution" technologies could be spread from farmer to farmer, information flows from farmer to farmer (Gerhart, 1975 and Byerlee and Longmire, 1986) for second generation inputs are expected to be much slower and less effective, since a much greater range and complexity of information and skills are needed (Byerlee, 1987).

- Rapid population growth has led to excessive fragmentation of land. Thus, small scale farmers have plots which are too small to allow a farmer to try a new technology on his own. IPM must therefore be practised by farmers operating together as a group. For this to succeed, the first step would be to initiate programmes of cooperation among the farmers tilling adjacent fields. This would enable the farmers to replace a pesticide - based pest control system with IPM. This would apply when the selected strategies of IPM include: synchronous planting of varieties of the same maturation; group fallowing and ploughing under of stubble after harvest; group pesticide purchase and group pest monitoring and calculating of damage thresholds to decide when pesticides are economical.

- IPM will not come about easily. It must be realized that it is not simple, not inexpensive and will not give the astonishingly rapid and seemingly complete kills insecticides do. The planning and successful implementation of IPM will have to contend with the commercial pressures of the agro-chemical industry and the lack of appropriate education in the farming community. Equally important is the fact that research has not been able to highlight the losses caused to crops by insects. The estimate given of 30% does not seem to have been based on experimental results or if it is, the basis has been research at experimental stations where the ecologies and pest complexes are often atypical of those found in the farmers' fields.

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CILSS Training Project for Personnel Involved in Crop Protection††

Sanou Moussa

Activities of the Crop Protection Training Department (DFPV), located in Niamey, Niger, contribute to one of the primary objectives of the Permanent Interstate Committee against Drought in the Sahel (CILSS): that is, agricultural self-sufficiency. Thus, since 1982, the DFPV has been in charge of implementing this objective, by the increased protection of crops and agricultural products against pests, diseases, and noxious weeds, using methods which can readily be incorporated into traditional farming practices.

Training courses are variable in length, and are designed for persons in middle to high positions, who will be able to apply and utilize the training immediately. The training course for Technicians in Crop Protection (TPV) is the longest, lasting two years, and may be taken by those having achieved the level of Technical Agent in Agriculture. Shorter courses (4 months) are aimed at the more highly trained, particularly crop protection instructors at schools of agriculture, who can disseminate the information to the various participating states, and who can train high-level technicians to assist and educate the local farmers more efficiently. Short courses of 3 weeks are organized by member states to address specific problems (i.e. locusts, borers) or to counter an organizational problem (i.e phytosanitary control). Training courses generally do not directly involve local peasant farmers, but do so indirectly through the mediation of trained personnel.

As regards dissemination of information on plant protection, this is done by the same categories of personnel, who are in contact with the research workers in the Sahel.

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††This is a summary of the paper presented. Full text to be published in *Insect Science and Its Applications* 10(6):1989.

Occasional Country Paper from Zambia†

J.M. Chintu

This paper describes aspects of the Extension Service, which in Zambia is based on a commodity approach.

Problems in cash crops (e.g. cotton, tobacco) are fairly well handled. Control of pests in subsistence crops (e.g. maize, sorghum) is grossly unsatisfactory due to poor distribution of insecticides to rural depots and lack of control packages suitable for small scale farmers. Food storage technology is inadequate and post-harvest losses tend to be higher than pre-harvest losses. Control of livestock pests (e.g. tsestefly, ticks) causes a severe problem particularly in border areas and near game reserves.

The Extension Service is well staffed and the personnel well trained. Although the approach is more or less top-down, the T&V system and a cooperative extension methodology are slowly gaining ground through the cooperative movement. Much closer contacts between agricultural workers and researchers on the one side and small scale farmers on the other, is needed, as 98% of Zambia's farming families consist of small-scale traditional and commercial farmers, who produce most of the country's food.

The main constraints to increased food production are emigration of young, productive persons from rural areas into urban centres, and the rising prices of agricultural inputs. These constraints also hamper extension workers' attempts to convert traditional farmers into commercial farmers.

† This is a summary of the paper presented.

Panel Discussion:

Extension systems in Africa

PANEL:

Mr. W. W Wapakala, Kenya
Dr. A. Diack Makhtar, Senegal
Ms. A. Onyango, Kenya
Mr. J. M Chintu, Zambia
Mrs. N.A. Kawani, Somalia
Mr. Lucas Ngode, Kenya,
Ms. R.A. Mohamed, Tanzania

During the discussion, the following points were high-lighted.

- Importance of well trained, confident and motivated extension workers.
- Farmers loose confidence if the extension worker does not .know his/her subject well, and cannot transmit the message properly. Interaction between extension worker and researcher is a pre-condition for good extension.
- Extension workers must have a good pedagogical knowledge in order to extend their message to farmers. It is not sufficient that extension workers have technical credibility. They must also be able to create an atmosphere of trust between themselves and the farmers.

- Need for evaluation of extension services and extension workers. Evaluations should be based on farmers' adoption rates of information and recommendations supplied.

- Need for government support. Increases in payment or other incentives should be given to extension workers and researchers, based on their performance. Government agencies should support development of IMP packages for communication via radio and TV, and give financial support for field days, and encourage the use of schools, market places etc. for extension purposes.

- Need for on-farm research. In many African countries extension services are very weak or even lacking. An on-farm research approach by researchers would allow them to get into direct contact with farmers, and thereby promote more relevant research.

- Need for legislation on imports of plants and the use of pesticides. Many countries have such laws, but only a few have Plant Quarantine Stations licenced by the OAU. Previous spread of major pests into Africa (ex. cassava mealy bug, larger grain borer) are examples of lack of preventive efforts.

It is important that governments and chemical companies follow the FAO Code of Conduct with regard to the sale and use of pesticides.

SUMMARY OF DISCUSSION:

Extension Systems as Mechanisms for Technology Transfer

The second day was devoted to the theme: Extension Systems as Mechanisms for Technology Transfer. The preceding five lead papers and the panel discussion provided the background for a general discussion.

The consensus was that extension services were essential for the introduction of new technologies in African agriculture, but are ineffective in most cases.

Reasons given for this ineffectiveness include:

- Lack of appropriate technologies that take the resource base of the farmer into consideration. Extension messages from researchers are often diluted during transfer.
- Inadequate training of farmers, extension workers and researchers, particularly in IPM approaches.
- Lack of proper linkages among farmers, extension workers and researchers. An IPM approach not only requires closer collaboration among these groups, but also between farmers themselves.
- Insufficient feedback from farmers and extension workers to guide researchers in policy formulation and determination of research priorities.
- Inadequate mechanisms for evaluating the performance of extension services.
- Professional rivalry between research and extension establishments within Ministries of Agriculture.

The need for improving this situation for the benefit of the farmer was emphasized and the following suggestions were made:

- Farmers, extension workers and researchers must work together as a team in an atmosphere of mutual trust and respect, with each partner having an input in the operations at every level. On-farm demonstrations, group discussions and informal visits should have priority. Such approaches would enhance the credibility and trustworthiness of the IPM message and increase confidence among the collaborators.

- Training systems need to be improved, particularly in the areas of IPM, communication skills and dissemination of information. It was generally agreed that schools, religious organizations, farmers' training centres, cooperative movements and market places could serve as useful focal points.

- Reward systems by way of prices for farm products and remuneration for extension workers and researchers, need to be improved to provide incentives for grêater productivity. This can be achieved through progressive institutional policies on pricing, distribution and marketing of farm products and competitiveness in personal emoluments for extension and research workers.

- It was felt desirable for farmers to be involved in the evaluation of extension services and research.

- Technologies developed should be packaged in a simplified form ready for transfer to farmers. This implies close cooperation between farmers, extension and research workers to avoid dilution of the technologies during transfer.

- Concern was expressed on the need for legislation on pesticides and on germplasm exchange between countries. Better legislation ensuring proper distribution, marketing and use of pesticides, and excluding those pesticides which are found to be undesirable in the developed world, should be enforced. The need for legislation to monitor the influence of pesticides on the environment and for certification of seeds and other plant materials in transit between countries, was emphasized.

PART FOUR

THE ROLE OF IPM SPECIALISTS AND SOCIAL SCIENTISTS IN GENERATING TECHNOLOGIES FOR THE FARMING COMMUNITY

Sudanese Experience in Integrated Pest Management of Cotton[††]

Asim A. Abdelrahman

As a background to an IMP project, this paper describes pesticide treatment of cotton in Sudan Gezira, starting in 1945/46. Until the end of the 1950's, one treatment per season was sufficient to control the only important pest, the jassid, *Empoasca lybica,* but the number of treatments increased during the 1960's (from 3 to 5) and has since the early 1970's been 6-9.

The continuous use of pesticides has resulted in changes of the pest complex, ultimately creating "hyper" pests such as the whitefly (*Bemisia tabaci*), cotton bollworm (*Heliothis armigera*) and aphids (*Aphis gossypii*). The increase in number of applications of pesticide is coupled with the rising costs of pest control and a stagnant yield. The stickiness problem created by the honey dew of whitefly and aphids increased with the rising number of sprays. The exclusive use of chemical control not only failed to improve the quality or quantity of the yield, but put a great strain on the national economy as well.

The Sudan therefore requested the FAO to initiate an IPM project, starting in 1979, with financial support from the Netherlands. During the past two years support has also been given by the World Bank. The IPM approach has given very valuable results during the last two seasons when large (more than 100 acres) plots in the Gezira and Rahad Schemes were left unsprayed with the objective of investigating the potential of the

[††] This is a summary of the paper presented. Full text to be published in *Insect Science and Its Applications* 10(6):1989.

natural enemies in the absence of pesticides, and to compare findings with population trends of pest and beneficial organisms in the fields subjected to conventional chemical control.

The first significant finding was that *Benisia tabaci* and *Aphis gossypii* can be managed at desirable levels by their indigenous natural enemies, and that their outbreaks are attributed to the decimation of these natural enemies by chemical treatment. Populations of beneficial arthropods were consistently much lower in the fields which received regular pesticide applications.

The result of the large scale experiments indicate that *Empoasca lybica* is the only really damaging pest ("key pest") in the Gezira because of the absence of natural enemies to regulate its population. Control of *E. lybica* in the 1940's and 1950's resulted in the creation of *Heliothis armigera* as a major pest. This situation necessitated early season applications of pesticides to suppress *H. armigera*, which further reduced the role of the natural enemies of *B. tabaci* and *A. gossypii* Both have developed into major pests of regular occurrence.

Cotton farmers in Gezira are now faced with a complex of very serious pests. In order to solve this problem, we will have to make drastic changes in pest control strategies and to adopt an IMP approach as soon as possible. The biological control of *H. armigera* is considered as first priority in order to avoid the early season application of pesticides. *Trichogramma pretiosum* was introduced from the U.S.A. and released in the Rahad Scheme in 1988/89. The preliminary results are very promising.

Cultural and biological control of *E. lybica* will be attempted in order to further reduce pesticide applications. The control of this pest by the use of "milder" pesticides is also included in the programme.

The presently used threshold levels for all major pests are very low, and are under revision through properly conducted large scale experiments.

Protection of Cotton in Madagascar†

S.M.Velombola

Experimental cotton cultivation using Egyptian and American varieties, started around 1900 in Madagascar. In the 1950's cotton was grown in dry, and irrigated zones of the country. From the beginning, pests appeared to be very important factors limiting production. Until the mid-1970's, pest problems were solved with the use of chlorinated hydrocarbons including monophos-DDT. After the occurrence of resistance in *Earias sp.* those insecticides were replaced with pyrethroids. Around 1980, all cotton growing zones were invaded with *Spodoptera littoralis* probably due to the earlier over-use of insecticides.

This development caused researchers, extension workers, cotton growers, the textile industries and representatives of the international pesticide companies to form an organization HASY.MA(Cotton of Madagascar) to plan and support execution of research programmes, purchase inputs, establish credit schemes, and sell cotton fibre and seed to textile mills and oil factories.

A number of studies have been undertaken on possible replacement of the currently used organo-mercury seed dressing, population dynamics of insect pests, and developing tests of insecticides before approval for sale.

The five participating groups have joint meetings, in the beginning, in the middle and after the cotton campaign. Thus, the cultivation is followed closely during all stages, enabling HESY.MA to make recommendations for future improvements and research efforts. Specific efforts are made to involve the political authorities of each cotton-growing area in field evaluations.

† This is a summary of the paper presented.

PANEL DISCUSSION:

IPM in Cotton Production

Panel:

Dr. A. A. Abdelrahman, Sudan
Dr. B. Sechser, Ciba-Geigy, Switzerland
Mr.S. M. Velombola, Madagascar
Dr. Agi Kiss, World Bank
Dr. B. Sognigbe, Togo

During the discussion, the following were highlighted:

- **Agricultural practices**

  Good agricultural practices were emphasized:
  - Caution on excessive use of fertilizer which promotes outbreaks of sucking pests.
  - Coordination of control measures so that they take place simultaneously in the same area.
  - Harvesting in time.
  - Shift from one type of cotton to another to reduce pests.

- **Importance of economic thresholds.**

  - Adequate sampling techniques must be developed and used. Big farms may hire professional consultants; small farmers must be trained to identify and quantify pests themselves.

- **Reduced yields in un-sprayed experiments in Sudan.**

  Yields were reduced by 20%, but loss was compensated by saving on pesticide costs and through increased quality of cotton lint due to less stickiness. Participating farmers were compensated in cases of economic loss, in agreement with the farmer's union.

- **Selective pesticides.**

  Selective pesticides, which do not support the build-up of other pests, have shown promising results in CIBA-GEIGY trials.

- **Biocontrol.**

  - There are now only 30 natural enemies of *Heliothis* in Gezira as compared to more than 100 before the insecticide treatment started.

  - Baculovirus (NVP) is to be tested in Sudan against *Heliothis*.

  - Virus mixed with weak dose of pyrethroid has given interesting results in Togo.

  - Various strains of *Bacillus thuringiensis* are being tested in Egypt.

- **Collaboration between countries.**

  Efforts at collaboration between cotton protection researchers is being supported by the World Bank (e.g. the visit of a specialist from Togo to the Zimbabwe Cotton Research Institute).

ICIPE's Philosophy and Approach to Developing Appropriate IPM Technology for Traditional Crop Production in Tropical Africa

G.W. Oloo

One of the crucial problems that plague tropical Africa today is acute food shortage against a background of rapidly increasing population and scarce resources both at the family and national level. Among the major contributory factors to the worsening food situation are poor crop yields and high losses in farm stores of important staple grains, such as maize, sorghum, millet, cowpeas and beans, due to crop pests. For example, it was found on a study in Nigeria, that up to 75% of the potential grain yield of maize was lost due to the maize stalk borer (*Busseola fusca)* (Usua, 1968); and a 56% grain yield loss on sorghum due to the spotted stalk borer (*Chilo partellus*) has been recorded in East Africa (Starkes, 1969). Furthermore, an estimated average of about a 10% post-harvest loss in storage due to pests alone has been reported in Africa (Leakey and Wills, 1977).

These reports clearly indicate that pest management must form a vital part of the food production process, both in the field and in farm storage, since the needs of the human society are in direct conflict with those of the crop pests for the limited food resources produced by man. The pest problem becomes even more critical in the farming environment of the resource-poor traditional farmer in tropical Africa, who although endowed with an enormous wealth of experience in near-zero input crop and livestock production, is faced with a wide range of constraints.

This presentation aims to identify some of the major challenges that the crop protection experts will need to address in formulating and implementing their pest management programmes, and to highlight the hidden advantages of integrated pest management (IPM) strategies in responding to the pressing problems of traditional farmers in tropical Africa. In this endeavour, the magic solution ultimately lies with the farmers themselves who have experienced the problems over generations, sometimes without knowing the cause, and who must be in the front-line and key partners in the fight against crop pests. It is therefore hoped this forum will provide us all with the opportunity to review and discuss together the major pest problems of important food staples with a view to working out solutions to them. In order to do this, we need to have a look at some of the challenges facing pest management experts in developing appropriate pest management technologies for the African farmer.

CHALLENGES FOR IPM IN THE TRADITIONAL FARMING SYSTEMS AS PERCEIVED BY PEST MANAGEMENT EXPERTS

The following limitations and constraints are considered by pest management experts to pose a great challenge for the development and implementation of IPM programmes under subsistence crop production in Africa.

Land size and tenure

In general, subsistence farmers have small pieces of land of less than 3 hectares at their disposal for both crop and livestock production. In most communities, land tenure is such that land size progressively decreases as family size increases, since family members commonly have a right to share the land. In the past, shifting cultivation was a means of solving soil fertility problems, but with increased pressure on the land, the same land is cultivated repeatedly and its fertility status deteriorates rapidly. In such cases, IPM programmes will have to be very efficient to achieve maximum output from a unit area of land.

Lack of capital

Traditional farmers are, as a rule, resource-poor and depend largely on their small pieces of land and labour from their own families. This makes it quite difficult to recommend new innovations for improved crop and animal production. For example, in situations where a farmer has to hire ox plough for land preparation or till the land manually with a hoe or 'jembe', advocating early planting as a cultural practice for pest management might not work. Even such simple technological packages as use of resistant crop varieties may not be fully adopted by all farmers for lack of funds to purchase improved seed every season. In effect, the situation requires the development of "zero input" IPM technologies, with respect to the farmer and the contribution of basic inputs, such as seed, ox plough and "seed funds" by government institutions or charity organizations to launch the farmer into an era of improved crop and livestock production.

Poor scientific knowledge base

For some of the major crop pests, basic knowledge of their biology and ecology is scant. Furthermore, newly introduced pests have, in recent years, caught the National programmes and the farmer in tropical Africa unaware, and have caused devastating damage to some staple food crops. The larger grain borer and cassava green spider mites are examples of pests which pose a serious threat to maize and cassava production, respectively. The situation is further complicated by the poor knowledge base of the majority of subsistence farmers. Hence, an IPM package will have to be simple and easy to implement in cases where the farmer's active participation is necessary.

Agro-ecosystem complexity

The diversity in pest complexes under mixed cropping requires sophisticated systems-analysis to fully understand the complex interactions between the physical environment, the host plant, the pest and its natural enemies in the ecosystem. The complexity is further enhanced by lack of uniformity in carrying out farm operations. For example, in any one season, it is common to find crops of different age groups and varieties in neighbouring farms. A long-term IPM technology will have to take these interactions into account against the background of an ever changing environment.

PROPOSED STRATEGIES FOR IPM UNDER TRADITIONAL FARMING SYSTEMS

It is clear from the foregoing discussion that it will be necessary to re-examine the fundamental concept of IPM and adopt completely new strategies in developing IPM technology that suits the unique situtation of the traditional subsistence farmer. Ultimately, the pest management technology developed should be technically effective, environmentally safe, cost-effective and simple enough for the farmer to adopt and implement. ICIPE's philosophy advocates starting from the farmer's own knowledge base and his existing technology for crop and livestock production. It is from there that we can develop and introduce improved technologies based on scientific enquiry and research.

In principle, the following broad programme of action is advocated in developing IPM technology for crop protection:

- Identify the major pests and quantify losses caused by them in a given agro-ecosystem.
- Study the biology, behaviour and population dynamics of the pests in detail to understand the salient features that may be exploited for pest management.
- Establish the role of local natural enemies and develop mass-rearing (or mass-culture for disease agents on insects) and release (or inoculation) technology for promising biocontrol agents (from local and exotic sources) to be used in biocontrol programmes.
- Study and develop other suitable components of IPM such as intercropping and other cultural practices, plant resistance, etc.
- Integrate the components into an appropriate IPM technology and test for compatibility and effectiveness under different ecological conditions.
- Develop a simple protocol for monitoring the impact of IPM technology in the field to allow for modification, when necessary, under a changing environment and resource base and with new scientific knowledge.

The ICIPE-based African Regional Pest Management Research and Development Network (PESTNET), recently established to foster a joint approach to tackling regional and national pest problems in Africa, aims to meet the challenge for IPM development and achieve an impact by integrating the following IPM components for crop pests developed and tested at the ICIPE:

1. **Improved intercropping methods for pest management.** Intercropping has the following merits for the resource-poor farmer:
   - It is a traditional farming practice and the farmer should not find it difficult to adopt improved tech-

niques and cropping patterns based on scientific research.

- It reduces crop damage by certain pests without the need of a farmer's intervention using pesticides.
- When cereals are intercropped with legumes, nitrogen fixation by the latter ensures balanced and efficient utilization of soil nutrients leading to maximum output per unit area of land. This compensating effect on soil fertility is particularly ideal in situations where a farmer cannot afford fertilizer application.
- Weed control may be achieved through the smothering effect of creeping legumes in the intercrop when planted at the right time.
- Moisture conservation may be accomplished in a similar way in semi-arid agricultural regions (such as the Machakos district in Eastern Kenya).
- Efficient utilization of solar energy can by achieved, provided the planting pattern is properly designed.
- Intercropping is flexible and can accommodate special crop varieties for cash and protein sources to meet family needs.
- Because of some of the above factors, crop yield is usually much better than when the same crop (cereal) is planted as monocrop. For example, in PESTNET field trials at Katumani, Machakos, in Eastern Kenya, intercropping an early maturing maize variety (Katumani composite) with cowpea (ICV2) under marginal rainfall conditions, increased maize yield 4.5 times over that of maize in a monocrop. However, intercropping hybrid maize (H5211) with beans (Mwatimania) at Murinduku, Embu, in Eastern Kenya resulted in yield increases of maize of only 1.5 times under marginal to medium rainfall conditions. The trials were conducted during the 1988 long rainy season. In the latter locality, pesticide application is recommended to farmers as a routine operation for borer control every season.

ICIPE has come up with an optimal intercropping technology for borer management on maize and sorghum using cowpea as the intercrop. This technology is now being tested in different ecological zones.

2. **Plant Resistance to crop pests.** This component has the following advantages:

    - It is easy to adopt by the farmer, provided the food quality (taste, colour, aroma, etc.) is comparable to that of the farmer's traditional crop variety. Once a resistant variety is developed, the farmer only needs to buy the improved seed and plant it in place of the traditional variety.
    - It ensures long-term pest control, unless new pest strains appear, leading to a breakdown of resistance
    - It is compatible with other IPM components.
    - It requires minimum financial input from the farmer, except for the high-yielding varieties that may need a high level of management (e.g. fertilizer, herbicide and pesticide application).
    - It is potentially cost-effective, especially when the breeding programme incorporates resistance to pests and diseases into ecologically adapted and high-yielding varieties.

ICIPE's Crop Pest Research Programme has developed two maize and two sorghum cultivars that show good resistance to stem borers and will be incorporated in the national breeding programmes as soon as the multi-locational testing is completed. Meanwhile, joint pilot trials, involving a crop pest research programme and the farming community at Oyugis, Western Kenya, are in progress.

3. **Biological Control.** Merits of the biocontrol component are the following:

    - Requires minimal farmer's input and active participation.
    - Provides a longer-term and sustainable check on rapid pest population build-up.
    - Is compatible with other IPM components, except chemical control with broad spectrum industrial pesticides.
    - Is target specific (especially parasitoids) and environmentally safe.
    - Is cost-effective on a long-term basis.

ICIPE's biological control team of scientists have identified at least 3 promising parasitoids (including the egg parasitoid, *Trichogramma*) and 2 promising disease agents (including a protozoan *Nosema*) which are being tested for pest control on maize and sorghum.

4. Traditional Pest Control Methods

Traditional farmers have, over generations, applied plant products with pesticidal activity for pest control. These products have the following advantages over industrial chemicals:

- The materials are obtained from local plants.
- They are relatively safe.
- The materials include wood ash and smoke which are by-products of the firewood that farmers use for cooking.
- Other plants such as the neem tree and *Tephrosia* can easily be grown by the farmer.
- If the products were to be processed, they would be used as substitutes for industrial pesticides in situations where chemical control is necessary.

In conclusion, the strategy for IPM development should be to start with intercropping which has already been shown to have the potential to solve the multi-faceted and complex problems of the subsistence farmer. Other IPM components that are feasible and practical under the farmer's unique situation could then be introduced. These include using the right seed showing resistance to pests and with reasonable yield potential, in the intercrop, and incorporating biocontrol agents into the system, to check erratic pest population build-up on a long-term basis. However, should the pest population go beyond an accepted damage threshold, then natural plant products from local sources or even selected industrial pesticides could be applied.

The Role of Social Science in Generating Technologies for the Farming Community in Africa††

K.K. Prah and A.P. Pala-Okeyo

This paper is based on experiences obtained during a joint enterprise between the Social-Science Interface Research Unit, of the Crop Pests Research Programme, and the Livestock Tick Research Programme at ICIPE. Topics bearing on technology design and development are emphasized.

The resource-poor farmer as conceptualized within ICIPE and reinforced by research experience, is by definition a person who operates a diversified system of production in which food security concerns and cash income intakes are crucial.

The family/household provides most of the labour required in production in African farming communities.

For this reason, their labour investment into the adoption of novel activities or technological innovation and their assessment of the value of such innovations requiring changes in their normative practice, is appraised primarily in terms of the returns they would get for the additional labour input.

It is noteworthy that much of the so-called family labour is, in fact, female labour. It is therefore arguable that the perception of the women of technological inputs and innovations as profitable, is crucial for the successful adoption and social acceptance of novel technology.

†† This is a summaryof the paper presented. Full text to be published in *Insect Science and Its Applications* 10(6):1989.

Although agricultural land is in increasingly short supply, it would appear that the crucial limiting factor in production is not a shortage of land *per se*, since a good number of households do not fully exploit all the agricultural land at their disposal. Labour, and/or cash income to secure additional labour, appears to be the most important constraint to production. This tends to suggest that for future technological interventions in agricultural systems of the rural poor, consideration will have to be given to inputs which optimize the use of family/household labour.

The escalating population growth suggests that focus on women's health and incomes could significantly and qualitatively improve the prospects for the adoption of new and improved technology in areas such as pest and vector control.

Farmers' Strategies of Insect Pest and Disease Management in Small Scale Production Systems in Mgeta, Tanzania††

R.A. Mohamed and J.M. Teri

Insect pests and plant diseases are among the main factors limiting bean production in Tanzania. A survey of methods of pest and disease management in small scale bean production systems was carried out in Mgeta Division.

The results revealed that small scale farmers are well informed of the major insect pests limiting bean production. The farmers know the type of damage caused by most insect species and the time of their occurrence. Although farmers are not aware of the pathogens affecting their crops, they can distinguish damage caused by insects from those due to diseases. Farmers are also aware that diseases are associated with environmental factors which influence disease development.

Farmers use both deliberate practices and incidental practices to manage insect pests and diseases.

The most frequently used deliberate practice is avoidance. Choice of growing season and date of planting are observed closely as a means of avoiding diseases. Although beans are cultivated in both growing seasons (September to December, and February to May), the first season is the best for growing beans. Rains are not very heavy, but reliable, and well distributed, and the season does not end up with low temperatures and high humidity which favour

†† This is a summary of the paper presented. Full text to be published in *Insect Science and Its Applications* 10(6):1989.

development of fungal diseases. Planting commences as soon as the rains start because early planted crops suffer less from pests. Farmers do not use purchased inputs in the form of fertilizer and pesticides. Larger insects are killed mechanically.

Incidental control takes place in the form of a number of cultural practices. Intercropping with maize, potatoes, cowpeas, pigeon peas, cassava or sorghum is normal and reduces the risk of crop failure. Terracing, where crop residues and weeds are buried under soil, reduces the amount of initial inoculum of certain pathogens. Farmers use a mixture of seeds of different cultivars deliberately, some high yielding and early maturing; and some late maturing, thus ensuring the farmer of food early in the season and beans as a cash crop later. Such variety mixtures appear to provide a buffer against pests and diseases.

A breeding strategy should be developed of variety mixtures instead of pure line varieties as the productivity of pure varieties in most cases is associated with the use of purchased inputs such as fertilizers and pesticides which are beyond the reach of small scale farmers. Variety mixtures have a greater efficiency in utilizing environmental resources, and are less affected by pests and diseases, and thus give higher yields than pure varieties.

Biological Control of Sugar Cane Pests in Mauritius: A Case Study[††]

S. Facknath

There are 43 identified insect pests of sugarcane in Mauritius, of which several are important enough to warrant control measures. However, insecticides are not used for this purpose. All the insect pests of sugarcane are controlled biologically. This includes traditional biological control using parasites or predators, as well as more recent biology-based methods like the use of resistant cane varieties, sex pheromones, etc.

Mauritius has the distinction of being the first country on record to have successfully introduced a natural enemy, namely the Minah bird, specifically to combat a pest - the Red Locust *Nomadacis septemfasciata,* in 1792.

Very few of the insect pests in Mauritius are indigenous; most of them are exotic, having been accidentally introduced into the country, one way or the other. Some of the important ones include:

Spotted stem borer	*Chilo sacchariphagus*
Armoured scale	*Aulacaspis tegalensis*
White grub	*Clemora smithi*
White grub	*Heteronychus licas*
Soft scale	*Pulvinaria iceiyi*
Armyworm	*Leucania loreyi*
Pink borer	*Sesamia calamistis*

[††] Summary of the paper presented. Full text to be published in *Insect Science and Its Applications* 10(6):1989.

The introduction of various natural enemies from different parts of the world has been made over the years with different degrees of success. In all, there are presently a total of 102 species of parasites and predators controlling the 43 species of sugarcane insect pests.

With sugarcane spread out over most of the island and representing 90% of all cultivated land, close vigilance over the important pest populations and swift counter measures as appropriate is required. This task is being performed efficiently and successfully by the Mauritius Sugar Cane Industry Research Institute.

Weeds as a Constraint to Food Production in Africa

A.S. Adegoroye, O.A. Akinyemiju, and F. Bewaji

INTRODUCTION

The dimension of the food problem of mankind can be described as: age-long, gigantic, deep, hydra-headed, chronic, fearsome, war provoking, time- and resource- consuming. Yet this problem has remained unsolved. Although significant improvements have been made in the technologies of crop production and handling which have resulted in higher yields per unit area of land, better produce acceptability, improved produce distribution, improved produce quality and higher revenues, the world's net food production *per capita* has remained largely unchanged. This is because the dramatic man-made improvement of one area of the world is instantly nullified by similar drastic but horrific man and natural disaster-made food shortages in another area. Perhaps it is nature's way of maintaining an equilibrium. The irony of the whole situation is that the areas of the world with the longest growing season backed by adequate sunshine, temperature and rainfall and the largest number of crop species (including food crops) per unit area of land, are the food deficit areas.

Using the criteria established by the International Food Policy Research Institute, all of Africa except South Africa has a food deficit. Two-thirds of these countries with food deficit, have, in addition, low incomes and are thus unable to import food without constraint.

The food problems of Africa are, largely, man-made and are due to bad planning or no planning at all; poor implementation of policy, unsustained acquisition of improved technologies and the resultant perpetual condemnation of the populace to the traditional, grinding, human labour consuming, inefficient peasant farming, which thrives on simple inherited skills.

One of the explanations given for large scale family sizes in traditional African societies is that they provide cheap labour for crop production. The activity-labour distribution of cultivated crops in Africa shows that weeding accounts for between 30-50% of the total labour requirement, depending on the crop and the level of technology acquired for producing the crop. It is difficult to imagine how African countries can achieve economic, industrial, and educational development if the majority of its populace is engaged in the provision of back-breaking labour for food production activities such as weeding.

This paper reviews the effects of weed as a constraint in food production in Africa. It evaluates weed management approaches, the various constraints militating against the adoption of improved technology for weed control, and suggests strategies for effective and sustainable weed management.

DEFINITION

A weed is a plant growing where it is neither wanted nor intentionally planted. Therefore, weeds include non-crop plants, wild species of domesticated plants and even crop plants growing out of place (e.g. cowpea in a maize plot) and those above the carrying capacity of the land. They are notorious for their nuisance value in various human activities and in particular for the losses they cause in crop yield as a result of competition.

Weeds have influenced human social actions more than other crop pests. Family sizes have, in many traditional African societies, been increased to cope with weeding activities; the undesirables in our societies are referred to as "weeds" that must be removed; names of local recalcitrants are given to new weeds. For example, in Nigeria in 1965, an introduced weed species *Chromolina odorata* that was difficult to control was named "Akintola Taku" (Yoruba, meaning Akintola is pig-headed) after Chief S.L. Akintola the deputy leader of the Action Group (AG) Party who upstaged the more loved leader Chief Obafemi Awolowo and refused to relinquish power even after he was voted out of power by the electorate.

THE MAGNITUDE OF WEED PROBLEMS

Weeds are important components of our agricultural system, and are subject to the evolutionary influences that affect crops and animals. Weeds thrive best in environments disturbed by man. They may be regarded as having evolved from the wild plants. As man selected his crops, he gradually eliminated the natural diversity among plants through growing a few or only one species at a time. Weeds have evolved certain characteristics that distinguish them from crops. The most obvious, according to Akobundu (1987) is that weeds are not artificially propagated, while crops almost always need help from humans for successful propagation. Weeds, therefore, characteristically have:

- Their germination requirements fulfilled in many environments.
- Discontinuous germination and great longevity of seeds.
- Rapid growth through vegetative phase to flowering.
- Continuous seed production for as long as growing conditions permit.
- The quality of being self-compatible but are not completely self-pollinated.
- Very high seed output in favourable environmental conditions.
- Adaptations for short and long distance dispersal.
- If perennials, vigorous vegetative reproduction or regeneration from fragments as a rule.
- The ability to compete interspecifically by special means (rosette, choking growth, allelo-chemicals etc) (Baker, 1974; Akobundu, 1987).

Probably, no single weed species possesses all the characteristics enumerated above. Some of the weeds that appear to have combined many of these characteristics are *Ageratum conyzoides, Cynodon dactylon, Cyperus esculentus, Cyperus rotundus, Imperata cylindrica,* and *Pennisetum clandestinum* (Akobundu, 1987).

It is estimated that some 1800 weed species cause problems in crop production, and about 300 of these weed species are responsible for serious economic losses in cultivated crops throughout the world. African farmers spend more time weeding than in any other farming activity. The implication is that control of diseases and other pests is seriously neglected and hence yield losses result. The labour distribution for selected crops in selected countries in Africa is shown in Table 1. The drudgery associated with weed control is related to hand weeding, which is the weed control method of the majority of farmers in the less developed countries. Consequently weeds limit the area of land that can be cultivated by an individual farmer. Weed infestation and reinfestation are heavy and rapid, allowing no breathing space for the farmer. The subsistence nature of tropical farming can be largely ascribed to the presence of weeds and the absence of improved methods of controlling them.

Table 1. Labour used for selected food crops in Africa (man-days/ha crop).

Crop	Country	Land Preparation/ Planting	Weeding	Harvesting	Total	Weeding as % Total Labour
Maize	Ethiopia	21	39	12	72	54
	Ghana	54	43	16	113	38
	Malawi	26	57	36	119	48
	Nigeria	33	30	20	83	36
	Zambia	38	65	33	136	48
	Burkina Faso	25	42	11	78	54
Sorghum	Nigeria	28	25	15	68	37
Groundnut	Senegal	28	63	35	126	50
Cassava	Nigeria	68	45	70	183	20
White Yam	Cameroon	159	120	125	404	30
	Nigeria	195	70	70	325	22

Source: Akobundu, 1987.

LOSSES CAUSED BY WEEDS

Losses caused by weeds can be direct or indirect.

Reduction in crop yield by interfering with crop growth is a direct loss. This interference includes competition with crops for nutrients, light, and water. It also includes the introduction, into the soil, of chemicals that may adversely affect the growth of crop plants (allelopathy).

There is no crop production whose quality cannot be reduced by weeds. The presence of weed seeds such as those of *Rottboellia cochinchinenses* in maize or rice and *Solanum nigrum* in cowpea or soybean reduces the market value of each of these crops. The presence of weeds can also reduce the quality of forages, make them unpalatable, or even poisonous, to livestock. Livestock products such as milk, may be reduced in quality even to unmarketable levels due to the presence of onion or garlic. Other direct losses caused by weeds include interference with harvest operations, thus increasing harvest cost; and blockage of waterways and the reduction in water flow in irrigation channels (e.g. the invasion Nigeria's coastal waters by water hyacinth). The losses have been enormous, involving millions of dollars: damage to transportation and fishing vehicles, disturbance of means of livelihood, cut-off from home and work, political and financial scandals etc. In seed technology, noxious weeds are objectionable and with concentrations of weeds higher than 0.02% certain seeds would not be certified.

In terms of indirect losses, weeds limit farm size and often serve as alternative hosts for many plant diseases and pests. Our studies on quality changes of a neglected citrus plantation at Ife, Nigeria, showed that an unweeded mature citrus plantation would, over time, produce light weight fruits with puffed juice sacs; reduced juiciness; reduced ascorbic acid, sugar content, and total soluble solids (TSS), both on fruit weight and volume basis; and reduced rind (texture) strength.

Table 2 shows the extent of yield reduction caused by uncontrolled weed growth in selected crops in Africa. While yield losses directly attributed to weeds are only about 5% in the developed countries, the range is 20 -100% in the less developed countries. The difference in yield losses between the developed and less developed countries results from the fact that a well developed weed control package has been practiced in the advanced countries.

WEED CONTROL IN INTEGRATED WEED MANAGEMENT

In crop production, all populations and agronomic inputs inter-relate in a complex form. For example, the applications of large doses of fertilizers to increase yields leads to more weeds and may produce more vegetative, lodging-prone and poor-storing crops. Irrigation produces different types and densities of weeds (Akinyemiju, *et al.*, 1989). Weeds attract insects and may serve as hosts for other pests. Thus, problems cannot be viewed in isolation, but can be addressed through an integrated pest management approach which seeks to preserve environmental quality while striving to provide sustained food supply for man.

Table 2. Losses caused by uncontrolled weed growth in selected crops in Africa. (Source: Akobundu, 1987)

Crop	Country	Yield Reduction (%)
Cereals		
Maize	Ghana	55
	Kenya	34
	Nigeria	40
Rice		
Dryland	The Gambia	100
	Ghana	84
	Liberia	63
	Nigeria	90
	Senegal	48
	Burkina Faso	62
Lowland (transplanted)	Liberia	48
	Nigeria	54
	Senegal	28
Lowland (direct seeded)	Ghana	28
	Nigeria	60
Grain Legumes		
Cowpea	Ghana	67
	Nigeria	65
Groundnut	Ghana	54
Soybeans	Ghana	53
	Nigeria	60
	Zambia	40
Pigeonpea	Nigeria	53
Fibre and Tuber Crops		
Sunflower	Many countries	52
Root and Tuber Crops		
Cassava	Nigeria	65
Sweet potato	Nigeria	91
Yam (*Diascorea* sp.)	Ivory Coast	91
	Nigeria	73

Various management strategies have been used for weed control and these include: preventive, cultural, biological, chemical, and integrated weed control methods.

Preventive control: Preventive control of weeds involves sanitation measures that are taken by farmers and government to restrict the movement of weeds from areas of infestation to clean sites. Prevention may check introduction of new weeds but does not combat native weeds whose growth is tied to that of the cultivated crop as a natural ecological certainty.

Cultural Control: Cultural control of weeds in crops involves all crop husbandry practices that can be used to minimize weed infestation. These include hand weeding, tillage, mulching, burning, flooding, and crop rotation. Cultural control methods have been the most popular, and sometimes the only methods known to peasant farmers in the tropics for controlling weeds. Hand weeding particularly requires much labour and is a problem in times of an unreliable and inadequate supply of labour.

Biological Control: Biological control methods require the control of suppression of weeds by the action of one or more organisms, through natural means or by manipulation of the weed, organism or environment. This includes the control of weeds with vertebrates, and invertebrates, and the use of microorganisms such as plant pathogens. Other areas with potential for biocontrol of weeds are exploitation of crop canopy, density and the allelopathic effects of both weeds and crops on weeds. The main advantage of classical biological control in comparison with other weed control methods is that it provides perpetual, relatively low-cost control with a minimum of detrimental side effects.

A major problem in the use of other organisms for the control of weeds is host specificity. The potential of the control agent moving over to the crop after eliminating the weeds is a real threat in the use of biocontrol agents for weed control.

Chemical Control: The use of herbicides is the most common and versatile management strategy for controlling nuisance weed populations world-wide. Herbicides offer longer lasting control; they are generally easier, faster and frequently less expensive than mechanical methods; their use involves minimal labour and equipment, and provides flexibility and predictability. Chemical weed control has been used successfully for most of the crops grown in the tropics including legumes, cereals, tubers, *Solanaceae* and the permanent crops. In recent years, the use of chemicals for weed control has gained popularity with herbicide-producing companies active in many parts of Africa. However the economic recession in these countries has resulted in 500-2000%

increase in the price of commonly used herbicides, taking them out of the reach of the average farmer.

Integrated Weed Control: The integrated weed control management system economically combines aspects of two or more weed control methods at low input levels to keep weed competition in a given cropping system below an economic threshold. Integrated weed control is one of the best options for weed control in the tropics. In order for integrated weed management to fit into an IPM programme it needs to be integrated into an overall programme for all pests in the cropping system. Manual weed control is laborious, unattractive, and, in some crops such as hydromorphic rice, ineffective. In yams and other very sensitive crops, herbicides used at rates which are safe for the crop, fail to provide effective season-long control. In all these crops, integrated control involving chemicals to minimize early weed competition, and hand-weeding to control late germinating weeds is necessary. Aspects of integrated weed management applicable to crop production in the humid and sub-humid tropics are:

No-tillage technique: The "no tillage technique" is a crop production practice whereby crops are planted directly into a chemically killed sod with a minimum of soil disturbance. The success of this method depends to a large extent on integrating the use of a pre-plant herbicide for dessicating the existing vegetation, a pre-emergence herbicide selective on the crop, and an organic mulch from the dead vegetation which protects the soil surface from erosion and smothers weed seeds.

Stale seedbed: 'Stale seedbed' is an integration of a conventional tillage practice with application of herbicides for pre-plant control of weeds which are either resistant to pre-emergence herbicides, or cannot be economically controlled by other methods.

Intercropping: A good intercropping system requires a combination of optimum crop spacing and population levels with early and well-timed weed control which will be effective until the crops develop canopy to minimize further weed competition.

EVALUATION OF THE VARIOUS APPROACHES TO WEED MANAGEMENT

Various efforts have been made to evaluate different weed control techniques in the tropics. Ogboru (1978) reported on weed control in a hoe farming system. He stressed that the hoe is the most widely used cultivating tool for seedbed preparation and post emergence weed control but it is slow and costly. At Samaru, Nigeria, a single weeding requires 300 to 500 man-hours/ha (Ogboru,1978). In a study to examine the profitability of three weed control methods: hand weeding, bloom spraying and knapsack spraying, on the production of maize both in the early and late seasons in Nigeria. Akinyemiju and Alimi (1989) found that although yields obtained from the three weed control methods were higher than the yields from unweeded plots, yields from the three methods were not significantly different from each other in either of two seasons. Weed control cost expressed as percentage of the total production cost, averaged 19, 22, and 28 in both seasons for boom spraying, knapsack spraying and handweeding respectively.

Methods of tillage appear not to have as much effect on weed-induced yield reductions as compared with applications of herbicide in conjunction with the tillage method. Akinyemiju and Echendu (1987) showed that yields and weed control in plots sprayed with metobromuron plus metolachlor were higher than plots sprayed with alachlor, cyanazine or metolachlor, irrespective of the method of tillage. The poorest yield was obtained from plots sprayed with cyanazine.

ECOLOGICAL-ENVIRONMENTAL -BIOLOGICAL-CONSIDERATIONS

The choice of any weed control method should be based on sound environmental and ecological considerations. Some of the drawbacks of the conventional tillage system, for example, stem from the disturbance of the ecosystem *viz-a-viz* the compaction of the soil and exposure to wind and water erosion. Thus, the conservational/minimum/zero/no-tillage weed control is becoming more widely used. In this system, crops are sown into undisturbed soil after weeds have been eliminated with herbicides.

Zero-tillage results in minimum disturbance of the soil; it controls erosion, and increases soil organic matter and earthworm activities.

The use of biological agents to control weeds requires host specificity of the bio-control agents. This is to guard against a disequilibrium of the system which could result from the widespread attack of the bio-control agents on non-target organisms in the environment after the weeds have been controlled.

With respect to chemical weed control, there is concern about the persistence of the chemicals in the environment and the effect on non-target organisms. Although consideration should be given to herbicides that will cause minimum disturbance in the environment, for a herbicide to be effective it must be able to suppress weed infestation at least beyond the critical period of growth of the crop. Most of the recommended herbicides disappear readily from the tropical African soil due to photo-decomposition, biodegradation by micro organisms, chemical volatility and leaching. Our experience in Nigeria shows that this occurs within 12 weeks (Usoroh, 1976, Akinyemiju *et al.*, 1986). The choice of herbicides should depend on the effectiveness with specific populations and environmental conditions. Herbicide residue accumulation will not be a problem where users adhere to proper application methods, formulation, rates of application and distribution, avoiding drift from target area, and rotation of herbicides.

The effective weed control strategy for Africa and other developing countries is Integrated Weed Management. With it there is little or no disturbance to the ecosystem. It fits readily into the traditional technology of crop production and is more economical and less prone to residue accumulation than chemical control. Cultural and agronomic practices such as bush clearing and burning, planting and transplanting, fertilizer application, seeding rates, tillage and soil management, residue management and timing of operations will have to be studied, to determine their combined effects on weed control and improved crop productivity. Research should also be carried out with a view to developing herbicides that provide broad spectrum protection for different crops and integrate herbicide use into complex intercropping farming systems such as the 4-crop cassava+maize+tomato+okra system. The intercropping of drip spot irrigation into integrated weed management might be a way to achieve absolute water conservation and weed control.

CONSTRAINTS TO WEED MANAGEMENT

Weeds will continue to be a constraint to food production as long as weed management strategies are themselves plagued by several constraints to weed management. These constraints are found in the general problems of agricultural development in Africa as well as in the specific constraints of herbicide use. These constraints are as follows:

General constraints

- **Disorientation of the economy by colonial masters, post-independent allies, and host governments.**
  For example, the "lifting" policy of Britain, with respect to our pre-independence agricultural produce, emphasized and promoted non-food "cash" crops such as coffee and cocoa for use in their home industries, and was detrimental to the cultivation of food crops.
  Similarly, the "dumping" policy of friendly developed nations which sell food crops in Africa at prices lower than obtained in their own country, makes the local cultivation of those crops unprofitable.
  Lastly, many governments in Africa especially those that have other means of obtaining foreign exchange (e.g. oil, minerals etc.), prefer to import food rather than spend the foreign exchange on building infrastructure. Where foreign exchange is not spent on buying food , it is spent on attributes of modernity (which they cannot maintain and sustain) and industries (for which they have no local raw materials). Most of Africa is better endowed for agricultural development than for any other economic advance, and than any of our food-donating friendly developed nations.

- **Food generosity of friendly developed nations.**
  Like "dumping" described above, food donations sap the vitality of agriculture, and dull the political will to develop agriculture by keeping prices at levels that destroy the incentive of indigenous farmers.

- **Political instability and unstable government policies.**
  Instability disallows planning and has been a major constraint to agricultural development in many African countries.

- **Lack of subsidies or discriminatory subsidy policies.**
  The subsidy policy of many governments, where such policies exist, favours fertilizers, insecticides and sometimes fungicides, leaving out herbicides.

- **Need for research and the development of new varieties.**
  The pressures of disease, insects and weeds on crops are so intense in the tropics that new varieties remain useful only half as long as they do in the temperate zone. Hence, research must be sustained to develop new crop varieties. However, there are three threats facing crop research in most African countries:

- There is genuine lack of funds for its sustenance.
- There are those in government who believe that research is esoteric and irrelevant to solving immediate problems.
- There are those who, having been impressed by the advances of the previous years, have come to believe that there is a surplus of useful knowledge and that all that remains is to deliver the new varieties and cultural practices to the farmers - i.e an advocation of a shift in financial support from research to extension services.

- **Poor post-harvest handling and storage technology.**
  Most African countries do not have efficient post-harvest technology for many of their crops. Produce is therefore sold cheaply soon after harvest, depriving farmers of prime revenue for their produce. This results in their inability to aquire technology inputs, such as herbicides for improved productivity.

- **Low income, small farm holdings, and land tenures.**
  As a result of low income, farm production is labour-intensive rather than capital intensive. Expansion of farm land is difficult under labour-intensive technology. African land tenure systems often discourage expansion, and farmers remain perpetually caught in the poverty cob-web.

- **Institutional support.**
  Most banks in Africa are commercial and are reluctant to lend money for high risk agro-business where: the returns come in trickles requiring long term repayment plans; and farmers have little collateral.

- **Rural infrastructure.**
  In most African countries, farm lands are not easily accessible by vehicles; electricity is non-existent; and pipeborne water is not available (even though dams that provide cities with such water, are located in these rural areas).

- **Unreliable statistics.**
  Agricultural data is often unreliable due to factors such as poor education, fraud or simply lapses in sampling procedures.

- **Integrity of those trusted with project execution.**
  Even when planning data are acceptable, fraudulent implementation of projects by those entrusted with their execution

has produced some projects that exist only on paper (e.g. vanishing fish ponds, shrinking farm lands and dry bore-holes!).

Specific constraints

- **Education.**
  The literacy percentage in many African countries is under 20%. In the rural areas, it is lower than 1%. Many rural dwellers are not able to appreciate the magnitude of the problem, and are incapable of reading and following instructions in activities such as formulation and application of chemicals. Stereotypes also exist about the use of inputs such as chemicals in crop production. For example, one hears the Yoruba of Nigeria say: "Fertilizer is not good for yam production". This observation is not totally wrong as heavy applications of nitrogenous fertilizer reduce storability of yams.

- **Cost of input .**
  Rural dwellers are generally poor, but their poverty becomes perpetual when inputs needed to improve their productivity and hence their revenue, are sold at prices beyond their reach. For example in Nigeria, gramozone which sold for N6.00 per litre (N24 per gallon) in 1985, now sells for N100 per litre (N400 per gallon).

- **Availability of agricultural inputs.**
  In spite of the cost, inputs such as knapsack sprayers, herbicides etc. needed to control weeds, are not readily available.

- **Shortage of professional/technical experts.**
  Weed scientists are hard to come by in most African countries, thus limiting the research needed for development of effective prescriptions. And an inadequate number of technical experts reduces effective supervision of prescriptions available.

- **Improper input application.**
  Even when the technology of herbicide use has been adopted, the success of the technology has been marred in many situations, by improper application due to:

  - applying too much or too little
  - improper calibration of equipment
  - absence of proper equipment
  - applying at the wrong time

- **Problem weeds.**
  Some weeds are difficult to eradicate. Some may be resistant to the properly applied herbicide, while others develop resistance with time due to the continuous use of the herbicide.

- **Persistence of chemicals and residue effects.**
  Adoption of chemical treatments is often slow due to fears about the effects of chemical residues in the environment. Once adopted, many complain that the chemical did not last long enough.

CONCLUSIONS AND RECOMMENDATIONS

In order to solve the problem of weeds as a constraint to food production in Africa, the constraints which plague agriculture itself, and economic development in general, must be removed. It is true that Africa has deficits not only in caloric intake but also in protein, essential amino acids, mineral and vitamin intake resulting in various forms of malnutrition. These food problems of Africa will have to be solved by Africa herself.

- The "Father Christmas" approach of the Western nations is not the solution. It has to stop. The potential for solving the problem exists in Africa and is enormous.

- Using a perspective planning based on reliable data, governments must restructure their economies to agro-based ones and evolve sound and realistic policies for sustained agricultural production.

- New lands must be opened and put into crop cultivation. While most of the developed food-donating temperate zones of the world have almost exhausted their potentially arable land, only about 25% of Africa's land has been exploited. Africa is in many ways better endowed for agriculture than these nations. Here for example, climate makes it possible to grow two or three crops a year.

- Research in agriculture must be well funded and its orientation multi-faceted. Most of the cultivated crops in Africa have not yet approached their potential yield. Researchers must continue to seek and develop new varieties using land races. The advantage of land races lies in their genetic diversity which gives the traditional farmer a measure of security. The problems of chemical persistence and problem weeds can only be combatted through research.

- Agro-forestry should be adopted by medium scale farmers to control weeds and soil erosion and to provide the financial benefits of intercropping.

- Government should provide institutional support either by policy, or by physical establishment of institutions for the provision of rural bank credit facilities. The much talked-about efficiency of small scale farmers is only within the framework of static technology based on tried, fool-proof farming systems. Acquisition and sustained use of new improved technologies demand that farmers expand their land or form cooperatives in order to enjoy those facilities in the absence of government-backed loan schemes.

- For increased productivity, farmers should form cooperatives for easy dissemination of information and the acquisition and use of improved technologies.

- Provision of rural infrastructure is a government venture and must be done to reduce rural-urban migration.

- Education of the rural populace is a must. To be able to read and understand instruction; to remove stereotypes; be aware of improved technology and to appreciate the magnitude of weed problems; will hasten adoption of new technologies.

- Establishment of agro-service centres to ensure availability of inputs at fair prices.

- Provision of storage facilities for surpluses which could otherwise discourage production the following season.

- Training of professionals and technical experts to cope with research needs, advise on management methods, and monitor herbicide use on farms.

- Establishment of quality control units to monitor quality and residue effects of chemicals used in integrated weed management.

- Promotion of Integrated Weed Management as the most economic, efficient, easily adopted weed management method for sustainable increase in crop production.

- Improve the integrity and commitment to duty of workers through incentives and by the teaching of ethics espoused in national ideologies and religion.

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Occasional Paper

Experiences of Pest Problems and Management at Mbarali Rice Farms Limited (MRF), Southern Tanzania†

M.N. Mtui, A.J. Nguma, and F.M. Nguma

Mbarali Rice Farms Ltd., established in 1975/76, is the best designed irrigated scheme and the largest irrigated rice and integrated state farm in Tanzania. During the first decade of its existence, the Farms produced an average yield of more than 7 tons paddy per ha. Since then, the yield has dropped drastically, in some years to less than 4 tons.

This paper describes briefly the various problems which have caused the decrease in yields. The problems include wild rice and other weeds, human bilharzia, animal fascioliasis, birds, insects, plant diseases, ageing capital equipment and machinery, inadequate irrigation water, water losses, and occasional shortage of labour.

Several species of wild rice have been the major agronomic enemy, as they have proven difficult and expensive to control, and have aggravated human bilharzia and thus affected labour availability during critical times. The problem of wild rice poses a real threat to the Farms and could result in a complete cessation of rice production at Mbarali.

An Agronomy and Research Unit has been established to examine ways of increasing yields and reducing costs, following an IPM approach, including cultural methods (harrowing, roguing, crop rotation, fallow, wet control and transplanting) and chemical methods directed against weeds and birds.

Mbarali Farms represents a fruitful area for research, development and testing of integrated control management in commercial integrated farming systems.

† This is a summary of the paper presented.

New Developments in Pesticides for IPM in Africa, with Special Reference to Cotton Pests[††]

B. Sechser

There is a large knowledge base available worldwide for growing many crops according to the principles of integrated pest management (IPM). CIBA-GEIGY is active in much IPM related research. Several biological control projects are being carried out at present and include studies of *Trichogramma minutum* against the spruce budworm in Canada; *Encarsia sp.* against glasshouse white-flies in Spain; the fungus *Beauveria brongniartii* against cockchafers in fruit gardens and forests of Switzerland and Italy; and the protozoan, *Nosema* preparations against the African desert locust. In cotton, CIBA-GEIGY is concentrating on testing pesticides for the selectivity of beneficial arthropods under practical field conditions.

Some of the most important pests in cotton, rice and vegetables are monitored regularly for the occurrence of resistance, and strategies are being developed to overcome it. A computer model has been developed for American cotton, which is now under practical evaluation and which should allow for appropriate treatment decisions based on plant phenology and regular pest scouting.

General recommendations are given as to the implementation of IPM programmes in cotton, which are based on methodologically sound monitoring of cotton arthropods, establishment of economic thresholds, use of selective compounds or the selective use of broad spectrum pesticides, rotation of pesticides of different chemical classes to avoid the build-up of resistance, and a strengthened search for biological control alternatives such as more potent strains of *Bacillus thuringiensis*.

[††] This is a summary of the paper presented. Full text to be published in *Insect Science and Its Applications* 10(6):1989.

The Contribution of Pesticides to the Development and Implementation of Suitable IPM Strategies for the African Farmer

Robert D. Schwehr

Integrated pest management (IPM) is based not only on thorough knowledge of the biology of the pest complex in a particular agro-ecosystem, but also on a complete understanding of crop development and environmental conditions. Key components of a successfully implemented IPM system include the use of cultural practices designed to reduce or eliminate suitable habitats for pest development, introduction of pest-resistant cultivars, and application of appropriate biological and chemical control measures. This paper will explore what IPM is, where it is used, how it is implemented, and the role chemical control plays in successful implementation of IPM programmes.

A sound argument may be made in support of the implementation of an IPM programme for virtually any food or fiber crop on which pesticides are used to control insects, nematodes, or mites. The single most important factor to bear in mind is that no one control method is one-hundred percent effective. The basis of any successful IPM programme is to use any of a variety of control methods, including host plant resistance, cultural practices, biological agents, and chemical insecticides, in a timely manner to prevent the target pest from causing economic injury to the crop. The objective is to produce a crop offering the maximum possible return to the grower, either in the form of foodstuffs, feeds or cash.

In order to understand how IPM programmes can be successfully implemented and maintained, it is important to define what IPM is. The National Academy of Sciences (1969) defined IPM as a concept of pest control in which all control techniques are evaluated and consolidated into a unified programme to manage pest populations so that economic injury is prevented and any detrimental effects to the environment are minimized. Concern for the possible over-reliance on chemical control agents galvanized researchers in the 1960's to redefine the scope of control agents available or needed for better overall crop protection. Following the above definition, IPM consists of the use of a variety of methods to contain pest populations at or below economically damaging levels. Any IPM programme must take cognizance of the fact that foliar and soil pests are a very natural part of the ecosystem and can be tolerated at certain levels without a significant loss of crop value.

Cultural and mechanical measures include the proper selection of seed, and the cultivar chosen must be well-suited to local environmental conditions. Timely cultivation to eliminate competing plant species contributes to the overall vigor of the crop. Irrigation, if required and available, should be made to avoid leaving the crop under moisture stress for extended periods of time. Nutrients should be applied as required by local conditions, taking into account soil fertility levels on a regular basis. Sanitation practices are also important. Plowdown of crop residues following harvest eliminates potential breeding or overwintering sites for several key pest species. The use of plant varieties tolerant of or resistant to pest attack is frequently an important line of defense in many cotton growing areas (University of California, 1984).

Biological control measures involve optimizing the presence of naturally-occurring organisms which assist in keeping pest populations at sub-economic levels, either through mass release of parasitoids or predators, application of biological insecticides, or the use of "soft" chemical insecticides which have little or no impact on natural enemies. The application of toxins such as *Bacillus thuringiensis* or mass release of the egg parasitoid *Trichogramma pretiosum*, to control populations of the *Heliothis* bollworm, are excellent examples of the use of biological agents to manage key economic pests of cotton.

IPM programmes have been implemented worldwide in nearly every cropping system. European fruit producers follow well-defined economic threshold guidelines to minimize reliance on any single chemical control method. Cotton cultivars maturing early reduce the need for late-season applications of insecticides to control the pink bollworm *Pectinophora gossypiella*, the boll weevil *Anthonomus grandis*, and the tobacco budworm *Heliothis virescens* in many areas of the United States. *Trichogramma* releases are common during peak population periods of *virescens* in in Colombia. IPM programmes, in many countries, have been implemented in conjunction with insecticide resistance management programmes to assist in preventing or delaying the onset of resistance to chemical insecticides. It must be emphasized that a successful IPM programme is designed according to local conditions; no one programme can be expected to be suitable for a particular crop worldwide.

How does IPM work? A thorough understanding of all occurrences in the field is required in order to make valid decisions regarding the use of external control methods. Fields must be scouted on a regular basis to monitor the presence and density of both pest and beneficial arthropod populations. The knowledge that crops can tolerate low levels of pest infestation is central to the effective implementation of IPM programmes. However, pest levels do rise to levels that exceed the economic threshold, or the level at which the cost of control is less than or equal to the economic crop loss caused by the infestation. Economic crop loss, or the economic injury level, can be described as "the level below which damage is tolerable and above which specific interventions are needed to prevent a pest outbreak and to avert significant crop injury" (Metcalf and Luckmann, 1975).

Chemical insecticides are an important component of any IPM system. The impetus of any pest management programme should be the judicious use of selective pesticides which allow survival of beneficial insects or other regulating factors and do not pose a significant hazard to the environment.

Pesticide applications should be timed for the most susceptible stage of the pest species. First and second instar bollworm larvae are more susceptible to most insecticides than are later instars. Applications timed for the early instar larvae may reduce pesticide requirements considerably. Cotton fields should be scouted for pest species on a regular basis. Economic injury levels should be established for each pest species. This enables the decision maker to determine the need for a pesticide application based on actual population levels, and avoids insecticide applications made on a calendar spray basis.

Pesticide dosage rates generally reflect the degree of control observed in the field. Control of 100% of the pest population is unnecessary and in most cases economically and environmentally unjustified. Dosage rates approaching 100% control place extremely high selection pressure on the pest and are likely to cause rapid development of resistant strains. Beneficial arthropods may also be reduced or eliminated with high dosage rates. Pesticide dosage rates should be targeted at reducing pest populations to sub-economic injury levels.

Why are beneficials important and why should they be preserved? Not only do they greatly assist in keeping pest populations below economic injury levels, but they also reduce the reliance on chemical insecticides. The method of insecticide application and the mode of entry of a particular insecticide can have a significant impact on the toxicity to nontarget species. Several soil pesticides have systemic activity in plants which allows phytophagous pests to be controlled without any adverse effect on beneficial populations. The use of a residual soil-applied pesticide often reduces the need for later applications of broad spectrum foliar insecticides. Foliar applied pesticides are generally either contact toxicants, stomach toxicants, or a combination of both. The contact toxicants are usually less selective than the stomach toxicants, as spray droplets impact on both target and nontarget species. Stomach toxicants require ingestion and primarily affect phytophagous insects. Therefore, the use of stomach toxicants can often help preserve beneficial arthropod species.

Why do we use IPM? Frequently, reliance on a single control method to suppress pest populations has been shortsighted. Although no single factor determines pest abundance, the effect of one factor may have a profoundly undesirable impact on another. The use of a broad spectrum insecticide can severely reduce or eliminate beneficial arthropod populations, causing a dramatic resurgence of pest populations later in the season. Repeated use of a single insecticide or single chemical class of insecticides can hasten development of insecticide resistance. IPM represents a long-term solution to pest pressures, one that attempts to balance the economic considerations of the farmer with the natural cycle of plant-pest-natural enemy interactions.

Reference has been made to the importance of IPM programmes in delaying or preventing the onset of resistance. IPM programmes require the judicious use of chemical insecticides. New classes of insecticides are not being discovered and introduced as they were in the past. Thus we are faced with preserving the useful life of insecticides at hand today. This challenge serves as the basis of numerous insecticide resistance management programmes being implemented around the world. A current situation is exemplified by the efforts to preserve the useful life of the synthetic pyrethroid insecticides used to control the *Heliothis* bollworm in cotton. Management strategies have been developed in Australia, Zimbabwe, Egypt, and the United States, and are in the formative stages in numerous other countries around the world, including Colombia and Brazil. Under the auspices of GIFAP, the consortium made up of basic agro-chemical manufacturers, the Insecticide Resistance Action Committee (IRAC), and the Fungicide Resistance Action Committee (FRAC), are formulating and recommending guidelines for proper use of insecticides and fungicides to manage resistance. A key component of these guidelines is the development of appropriate monitoring techniques to correctly determine resistant gene levels in a given insect population.

What is on the horizon? Pesticide manufacturers are currently investing significant sums for the exploration of alternate pest control techniques. Included among these are development of biological insecticides and continued work on host plant resistance. The search for new chemical insecticides is focusing more and more on specific pest problems, as the understanding of host/pest interaction increases. A key facet of this search is the evaluation of these new molecules on beneficial arthropods, and concurrent or resultant effects on the complete agroecosystem.

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SUMMARY OF DISCUSSION:

The Role of IPM Specialists and Social Scientists in Generating Technologies for the Farming Community in Africa

Highlights of the discussion following the presentation of nine papers on the topic, The Role of IPM Specialists and Social Scientists in Generating Technologies for the Farming Community in Africa were:

- Discussion of IPM in cotton illustrated the need for determining economic thresholds for effective implementation of pest control.

- Based on examples from cotton and sugarcane, it was obvious that biocontrol agents should have an increased role in IPM.

- There is need for regional coordination of pest control activities for specific crops.

- Farmers require training in identification of pests, control options and aspects of utilization of farm products for successful transfer of IPM technology packages. Furthermore, it was emphasized that education in the proper use of pesticides is important. Agro-chemical companies should be encouraged to take an active part in such training.

- Much concern was expressed with regard to pesticides sold in Africa. Written information supplied by local technical company agents was often faulty and labelling of products incomplete. The salesmen's bonus system should be abolished to counter excessive sales pressure. Companies show too little interest in the problems and risks confronting small-scale farmers. Delegates called for the development of selective pesticides.

- The need for improving cultural practices such as timely weeding and harvesting to prevent pest outbreaks was emphasized. The conference pointed out that IPM also includes pests other than insects, such as weeds, plant diseases, vertebrate pests and other organisms.

- The role of social science in developing IPM technology was illustrated with examples from ICIPE. These suggested that closer cooperation between social, biological and technical scientists in Africa would be beneficial.

PART FIVE

INTERNATIONAL COOPERATION AND IPM

International Cooperation and IPM in Africa - An Overview

Montague Yudelman

A good part of my career has been with organizations involved in international cooperation and agricultural development. More recently, I have been working with environmental organizations. Consequently, I suppose I can be described as having been a member of the development community over the past 40 years, a period when changing social, political and economic circumstances have led to substantial modification in our thinking about agricultural development, including pest control.

In the early 1950s, when I spent a brief period at FAO, our main concern was to overcome the Malthusian specter - we **knew** that the global population of 2.5 billion would reach 5 billion by around 1988 (as it has). But we weren't sure how food supply could be increased to meet the needs of this vast population. However, the post-war development of low cost means of manufacturing ammonia and nitrogenous fertilizers as well as synthetic, organic pesticides (especially DDT) seemed to offer one way of increasing the food supply rapidly enough to meet the challenges of population growth. This view was also reflected in my report as a young consultant on the World Bank's first agricultural mission (in 1956). Similarly, this is the way I saw it when I was at the Rockefeller Foundation in the early days of the "green revolution".

There is no doubt in my mind that the availability of low-cost synthetic organic pesticides had a major impact on the concept and implementation of the "green revolution". These chemicals provided an important mode of pest control for the new high yielding varieties of wheat, rice, maize and other food grains. I might add that our early faith in the chemical approach was enhanced by the seemingly spectacular results achieved against pests that affected human health and comfort. For example, the widespread use of DDT led to the apparent elimination of public health scourges such as the malaria mosquito. This certainly seemed to confirm our belief that we were in the golden era of chemically inspired pest control. There were some warnings. A 1970 Report on African Agricultural Research Capabilities organized by the U.S. National Academy of Sciences (on which I served), did draw attention to the importance of designing and implementing regulatory procedures for the use of chemicals deemed to be essential to the control of target pests and pathogens potentially harmful to man and the environment.

Nonetheless, when I moved to the World Bank as Director of Agriculture, I continued to be a firm supporter of the use of agrochemicals to increase output. I shared Norm Borlaug's oft stated view that the benefits of using chemicals to increase food supplies and combat hunger far outweighed whatever seemingly negligible costs might arise. During my tenure, the Bank made many loans for agriculture inputs, loans supporting rural credit programmes so that farmers - including small farmers - could purchase fertilizers and pesticides. This applied to many parts of the world including Africa. In this region, though, where pesticide use is low, most of the loans for inputs were made for the production of high unit value crops, especially cotton, cocoa, tea, and coffee and selected horticultural products. This experience differs markedly from that in Asia where pesticides were widely used on food crops.

In the late 1960s and early 70s, two things happened that led the development community to reconsider the role of agro-chemicals and pest control. The first was the rising concern about the harmful effects of the use and abuse of some pesticides. The publication of Rachel Carson's *Silent Spring* was a bellwether event in rousing public concern; there were a spate of studies and publications that documented the excessive use and harmful effects of pesticides; studies in the Philippines and Central America left little doubt about the high costs to the environment from the abuse of pesticides. The environmental movement succeeded in making members of the development community look at alternatives to excessive dependence on chemicals and encouraged greater efforts on what we now call IPM, i.e. a greater reliance on non-chemical methods of pest management.

A second reason for supporting IPM stemmed from the donor community's adoption of a strategy to help the rural poor. The thrust in this strategy was to raise the productivity of small farmers and at the same time to reduce the use of purchased inputs. Such a strategy lent itself to the adoption of IPM with its reduced dependence on purchased pesticides. Also, more recently, the pressure to correct the budgetary difficulties confronting many governments is leading to a reconsideration of the role of subsidies, including the very high subsidies on pesticides.

The removal of the subsidies is raising costs to farmers and this in turn is adding to the desirability of lessening the use of chemical inputs and of IPM.

The de-emphasizing of chemicals has led the international community including such bodies as the CGIAR, on which I served, to rethink its approach. Donors are now investing much more than hitherto in research on ways and means of reducing the use of pesticides in programmes of IPM. In many respects, ICIPE, with its support from 23 donors is part of this trend. In the last decade, there have also been other internationally supported cooperative ventures promoting IPM in Africa. Many of these have been organized by FAO working with bilateral and multilateral donors. Perhaps one of the most interesting illustrations of international cooperation is the strategy that has evolved for the classical, biological control of cassava green mites. As undoubtedly you are aware, the great strength of biological control is that its effects are relatively rapid and persist in a stable way once successfully implemented. Also, biological control has the advantage that it is an appropriate technology for the control of economically important pests of a crop like cassava in a place like Africa. It requires neither special skills nor purchased inputs by poor farmers. Part of this cooperative programme involves pursuing a control strategy based on biologically sound principles derived from the integration of basic and applied research components. The international involvement in this phase of the programme illustrates the extent of cooperation. The programme is managed by IITA in Ibadan, Nigeria. However, much of this research on cassava green mites is being undertaken in collaboration with other institutions and agencies. These include the CIAT in Colombia, the Commonwealth Agricultural Bureau Institute of Biological Control in London, the University of California (for simulation modelling), EMBRAPA in Brazil, the University of Sao Paolo in Brazil, the University of Leiden in the Netherlands and last but not least, ICIPE.

A further reflection of the international cooperation in this programme supporting a shift in emphasis in pest management, is that the project is financed by many donors including IFAD and the Swiss government. I am sure that there are many other opportunities for cooperative efforts to promote IPM in Africa. The leadership for these efforts will undoubtedly come from FAO, the World Bank and bilateral donors.

The Role of FAO in IPM in Africa††

G.G.M. Schulten

FAO's role in integrated pest management (IPM) in Africa has many components. Broadly speaking, it is the promotion of IPM in member countries, done within the context of strengthening plant protection in general and under the guidance of the FAO/UNEP Panel of Experts on Integrated Pest Control.

Activity areas undertaken by FAO which have links with IPM, include:

- **Awareness, Creation and Promotion of IPM**
  Organizes meetings, seminars, workshops, etc. to discuss and present results obtained in field projects; participates in meetings organized by other organizations; prepares publications on IPM in general, or on specific components of IPM, and on results obtained in field projects; and prepares teaching and training materials on improved plant protection and IPM.

- **Infrastructure**
  Sets up or strengthens plant protection services or plant research institutes to make them functional, giving due consideration to regulatory functions; gives training in improved plant protection at all levels within the framework of the field programme.

- **Development**
  Develops appropriate pest control measures in line with the IPM strategy.

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†† This is a summary of the paper presented. Full text to be published in *Insect Science and Its Applications* 10(6):1989.

- **Implementation**
  Conducts field projects to strengthen capabilities in plant protection at the national level; conducts IPM implementation projects; conducts plant production/protection projects.

- **Policy Development**
  Convenes regular meetings of statutory bodies (various panel meetings); convenes meetings or expert consultations on special topics; advises member countries on strategies to increase capabilities in plant protection.

- **Coordination**
  Convenes donor meetings; coordinates donor activities and inputs; conducts regional or global activities on specific topics such as quarantine, pesticide residues, etc.

IPM is today recognized worldwide as the most desirable pest control strategy. Unfortunately, IPM is interpreted in many different ways, leading to confusing, overly-great expectations, and disappointment. On the other hand, IPM and responsible pest control seem to have become synonymous which is, broadly speaking, correct and laudable.

IPM has to be considered within the context of the plant protection activities in a country in general. Plant protection services have an important role to play in creating optimal conditions for the development and introduction of IPM, particularly in regulating pesticide use.

IPM is location-specific. Therefore, capabilities in plant protection need to be developed and strengthened at the national level. Countries need to have realistic plans on how this capability should be developed, giving particular attention to the availability of funds for personnel and their functioning. IPM should also be considered within the context of plant production.

There are, however, situations where most or all activities can be directed to the pest control aspect - for example, in cases of over-use of pesticides. In other situations, however, IPM often is only one component of the overall activity of increasing agricultural production.

There is a need to demonstrate that IPM is a reliable and economic alternative to an over-reliance on pesticides. Unfortunately, this can most convincingly be demonstrated in cases where there is already an overuse of pesticides. In such situations, the effectiveness of the IPM strategy can be proven quantitatively by a reduction in pesticide use, a reduction of costs to the farmer and government, increased yields, etc. The results of such projects are easily understood by non-plant-protection experts. Therefore, such projects, besides being of direct benefit to the farmers, contribute much to creating an awareness of IPM among politicians, administrators and the general public.

It is, of course, preferable to develop and implement an appropriate IPM strategy before overuse of pesticides occurs. Results of such activities are, however, often difficult to quantify, especially with respect to food crops. In cases where IPM strategy is developed as an alternative to planned wider-scale use of pesticides, such activities are identifiable as IPM, and quantifiable IPM outputs can still be obtained. Governments and donors should, however, realize that the development and implementation of an IPM strategy takes time.

The development and introduction of IPM in industrial crops in Africa has considerable potential to demonstrate how IPM works. However, the interest of donors in such activities is very limited.

Confusion may arise when IPM is discussed in relation to the small farmer. In this context, IPM is often seen as the most appropriate way to increase yields, food availability and farmers incomes. Too much emphasis on IPM, however, may easily lead to a neglect of introducing other appropriate agronomic practices which could also lead to substantial yield increases.

The World Bank's Support for IPM in Africa

Agi Kiss

This Conference on integrated pest management (IPM) represents an important element in the evolution of the World Bank's approach to crop protection and pest management, which has gone from virtually unrestricted support for chemical control, to a phasing out of certain chemical pesticides based on environmental pollution and health hazards, to recognition of the economic and environmental significance of non-chemical control methods and IPM technology, and finally to focusing on economic, institutional and other factors which may either prevent farmers from adopting IPM methods or encourage and assist them to do so.

This paper reviews this evolution and then suggests where we are going and how farmers such as those attending this Conference, are helping us get there.

Lending for agricultural development first became a major element in the World Bank's operations in the 1960's. At that time, the Bank, along with most of the rest of the international community, was swept up in the promise of the "green revolution". Everyone was united to meet the challenge of feeding the world by developing and disseminating new high-yielding plant varieties and the "technological packages" of irrigation and fertilizers which these varieties needed, to realize their enormous potential. Researchers worked to perfect the technical packages; extension services were strengthened to bring these packages to the farmers and demonstrate the yields which could be achieved; governments subsidized the inputs to encourage farmers to use them; and the international donors provided financial and technical support all along the way. It quickly became clear that the new varieties were often very susceptible to pests and diseases, particularly as they were grown in larger and larger monocultures. But this did not really cause much concern because science had already provided the answer in the form of effective and inexpensive pesticides that could control them. So the pesticides were simply added to the packages.

The first real challenge to this approach to pest management came in the late 1960's and early 1970's, as part of a growing environmental movement, with the realization that pesticides were beginning to accumulate in the environment - in water, soils, in animals and even in humans. Soon after the Stockholm Conference in 1972, the World Bank hired its first Environmental Advisor. Over the years, the Environment Office has grown substantially larger; it has become more sophisticated with experience and with the addition of specialists representing a wide range of disciplines; and has become increasingly integrated into World Bank operations. The same evolution can be seen in the Bank's approach to pesticides and pest management.

Because of the concerns surrounding the environmental impacts of pesticide overuse and misuse, it was the Environment Office which first took the initiative to focus the World Bank's attention on this issue. The Bank's policies in this area gradually developed and were finally formalized as part of a comprehensive set of environmental guidelines, which were closely modelled on United States legislation. The main concern at this time was to discourage the use of DDT and other organo-chlorines which had been shown to be very persistent in the environment and to accumulate in the food chain. This was a useful start but it did not really address either the special issues of pesticide use in developing countries or the broader problem of reliance on chemical pesticides as the primary or sole method of pest control. In addition, the World Bank had no in-house expertise to implement training of operational staff to follow these guidelines.

The beginning of a more comprehensive approach came in 1985, with the promulgation of the "Guidelines for the Selection and Use of Pesticides in Bank-Financed Projects and Their Procurement when Financed by the Bank", also known as Operations Policy Note (OPN) 11.01. OPN 11.01 was widely distributed both inside and outside the Bank. Unlike the earlier guidelines, it discussed the problems of pesticide resistance and pest resurgence arising from over-use and mis-use of pesticides and identified IPM as the only effective long-term approach to pest management. It also gave better guidance on selection and use of pesticides based on their toxicity and potential hazards to untrained or poorly equipped users.

I was fortunate to be involved with the development and implementation of these guidelines and in the learning process which has followed. There have been a number of important lessons which we have learned and are still learning. First, we have learned that improved pest and pesticide management cannot be accomplished from the World Bank's Environment Division.

Pesticides first came to widespread attention as an environmental issue, but pest management is both an agricultural and economic issue. It does not consist simply of selecting the right pesticides to apply when pest problems develop, or even of knowing when and how they should be applied. Rather, it means designing a crop production system in such a way as to try to prevent the development of major pest problems. Pest management must be treated as a fundamental element of agricultural production, to be addressed right from the beginning, just like water supply or land preparation.

With this as our goal, we are focusing on raising awareness and educating agricultural operations staff through training seminars and by working together on developing and appraising projects. At the same time, we are trying to provide the tools they need, including assistance in developing IPM programmes for particular situations and advising them about specific non-chemical or reduced-chemical methods which have been shown to be effective for specific pest problems.

A second important lesson is that a project-by-project approach is not enough. Most of the agricultural development and production in member countries goes on without direct Bank assistance. Therefore, we have been broadening our approach to provide support for improved pesticide management and development and spread of IPM through support for research, extension and training programmes as well as addressing policy issues at the sectoral level.

Both of these lessons - the need to operationalize and the need to diversify support, are reflected in the new revision of the World Bank's pest management and pesticide guidelines which were developed with the assistance of an external advisory panel, and which should be finalized and released by the end of the summer.

Finally, a third and very important lesson we have learned is that our best resource for developing our own ideas and for supporting and promoting IPM is the researchers, extension workers and farmers, who are in the trenches, developing the technology, evaluating it, and putting it into practice. Meetings such as this one serve to generate an essential and exciting exchange of ideas and information, not only on the technical aspects of entomology, phytopathology and weed science, but also on equally important and perhaps more elusive aspects such as institutions, human resources and incentives.

I hope that the practical follow-up of this workshop will be the translation of the many new ideas and insights we have had, into new initiatives in the field.

Dutch Bilateral Cooperation in IPM in Africa

A. van Huis

INTRODUCTION

Dutch development cooperation is mainly executed and financed by the Directorate-General for International Cooperation (DGIS) of the Ministry of Foreign Affairs. The most important partner institutes for pest management research are the Wageningen Agricultural University; the Research Institute for Plant Protection, Wageningen; and the Royal Tropical Institute, Amsterdam. The Organization of Dutch Volunteers (SNV) is also involved in the execution of some projects. Crop protection and vector control projects are often carried out through the CGIAR institutes and the United Nations agencies, FAO and WHO. Development cooperation in Africa focuses mainly on two regions, the Sahel and Southern Africa, and on Egypt, Kenya, Sudan and Tanzania. Approximately two thirds of the pest management projects are directed towards research, while one third is concerned with extension and training. The primary aim of Dutch policy is that all activities contribute to a structural and lasting reduction of poverty suffered by whole countries and by population groups. Agricultural development should focus on the achievement of self-reliance in sustainable food production. The policy also states that care should be taken to see that these activities do not harm the environment or exhaust energy supplies. Technology should be appropriate to the region, energy-saving and environmentally as sound as possible.

IPM AND DEVELOPMENT COOPERATION

Pesticides have long been considered to be the remedy for the control of most insect pests. For small farmers in the tropics, however the use of chemical pesticides is impractical and inappropriate. IPM, which can be achieved by locally available technology, seems the most appropriate strategy because (van Huis and Meerman, 1988):

- many agro-ecosystems in Africa have not yet experienced intensive chemical control, so full use can still be made of natural occurring mortality factors;
- in small-farm agriculture, produce is often destined for home consumption, so quality demands are lower and consequently levels of pest tolerance higher; and
- in humid areas, the continuous development of pests creates opportunities for optimal use of biotic regulating mechanisms.

However, there are a number of constraints to development and implementation of IPM programmes:

- Lack of IMP technology and insufficient research capacity to develop strategies;
- Inadequate functioning of extension services; low level of training of extension workers; and consequently poor training of farmers;
- Over-reliance on the effectiveness of pesticides, leading to loss of traditional non-chemical control strategies developed by farmers over centuries, as was demonstrated in Nigeria by Atteh (1984). The reasons for this include:
    - **Psychological factors.**
      There is a psychological impact of insecticide use on the farmers: dead insects and the termination of plant injury are visible in a few days. Plant injury is too easily assumed to be the same as yield loss, complicating rational control of the pest.
    - **Cultural factors.**
      As surveys of farmer's attitudes have shown, many farmers have accepted insecticides as an irreplace-

able part of modern crop production. They believe that treating crops with insecticides is progressive, modern, effective and necessary (Kenmore *et al.*, 1987).

- **Policy factors.**
  To accelerate food production, some governments have tried to help farmers by supplying seeds, fertilizers, and insecticides. In many cases, subsidized or free pesticides, often obtained with bilateral aid funds, have led to overuse, and consequently a resurgence of particular insect pests. Furthermore, farmers have developed the attitude that controlling pest outbreaks is not their business but that of the government (Zelazny *et al.*, 1985). Chemical control policies therefore, are extremely important as they can nullify all IPM efforts.

From the foregoing, it can be seen that major constraints to the establishment of alternatives for chemical pest control are:

- over-reliance on chemical pest control
- lack of IPM techniques, and
- deficiencies in the transfer of IPM technology.

Consequently, emphasis should be given to developing appropriate IPM-strategies and to their effective implementation with full integration of extension and training in the strategy. Therefore, research, extension and training in IPM are important activities of Dutch development cooperation.

HISTORY

Before the introduction of synthetic pesticides in 1945, the Netherlands was involved in IPM research in the tropics. This work was carried out mainly in Indonesia with mechanical, cultural, biological and varietal control (Eveleens, 1976). The findings of these ecologically oriented studies are still relevant for current crop protection problems in Indonesia. Dutch participation in entomological research in Africa began in Ivory Coast at the end of the 1950s. Studies were undertaken on population dynamics and natural enemies of *Scolytidae* in coffee. Subsequently, Dutch plant protection scientists have been working in bilateral and multilateral assistance programmes, mainly ecological field research on components of integrated pest management.

RESEARCH

Half of the Netherlands funds for research and technology in development cooperation are earmarked for agricultural research. This includes a contribution to the Consultative Group on International Agricultural Research (CGIAR) and the so-called non-associated institutions, such as ICIPE, ICRAF and IIMA. The programme concentrates on the development of new methods and techniques which can be used to solve structural problems in developing countries. Emphasis is also placed on strengthening the research capacity of developing countries by arranging for activities to be implemented at institutional levels. Wherever possible, a tripartite arrangement is made involving Dutch and international research organizations and institutes in developing countries themselves.

In this way, the universities of Leiden and Amsterdam are cooperating with the International Institute of Tropical Agriculture in Ibadan, Nigeria in ecological research in support of the "Africa-wide Biological Control Programme of Cassava Pests". Factors determining the successful biological control of the cassava mealybug by the parasitoid *Epidinocarsis lopezi* are being analyzed, and suitable natural enemies for the cassava green mite are being selected using selection criteria developed. The Netherlands is also a funding member of the Africa-wide Biological Control Programme and contributes one million US$ per year.

Another project financed by Dutch development cooperation is the FAO integrated pest management project in cotton and rotational food crops in the Sudan. By limiting the number of insecticide applications in commercial cotton fields, the incidence of the white fly *Bemisia tabaci* can be considerably reduced because of the action of indigenous natural enemies is enhanced. This project has technical support from the Department of Entomology of the Wageningen Agricultural University.

In medical and veterinary entomology, the Netherlands have made funds available for improvement of trapping technologies and for the development of trapping strategies to control the tsetse fly in Kenya and Zambia and the malaria mosquito in Tanzania. Tick research is carried out in Zimbabwe by the University of Zimbabwe in collaboration with the Faculty of Veterinary Science, Utrecht, the Netherlands.

TRAINING AND EXTENSION

Training and extension in Africa should be an integrated part of IPM programmes. The approach should be adjusted to the specific needs of the farmer in his physical, socio-economic and agro-ecological environment (van Huis and Meerman, 1988). Bilateral donors may assist in this process by contributing to institutional strengthening of research and training organizations, and agricultural extension services.

The Netherlands is an important donor to the FAO Inter-Country Programme for Integrated Pest control in Rice, in South and South-East Asia. This project aims to demonstrate IPM techniques to farmers and to train them in their use. In the Philippines and Indonesia, IPM methods have been demonstrated to be more profitable than current practices based on intensive pesticide use, because IPM substantially reduces the cost of chemical control. In 1986, the presidents of both countries declared IPM the national pest control strategy for rice. India, Malaysia and Sri Lanka have also taken this decision.

Since 1972, the International Agricultural Centre, Wageningen has organized a three-month course in plant protection each year. More than 350 participants from 74 countries have been trained, including 95 participants from 19 countries in Africa. As a result of an evaluation in 1988, the course will be made more IPM oriented, integrating the disciplines of entomology, phytopathology, virology, nematology and weed science.

The Wageningen Agricultural University has recently introduced a two-year international crop protection course, leading to an M.Sc. degree. The course covers the principles of crop protection and concentrates on developing appropriate crop protection measures to improve yields. In the second year, participants from developing countries specialize in one crop protection discipline by carrying out a research project relevant to a particular pest problem in their own country.

Although for some time to come, higher level training will continue to be conducted in developed countries, training should preferably be carried out in the agro-ecological and socio-economic environments of the participants' home country. Pest management problems in Africa need solutions developed in Africa by Africans. Therefore, regional training centres or activities in the tropics, such as ARPPIS and DFPV, need the full support of the international community (van Huis *et al.*, 1987).

The Netherlands gives financial support to the African Regional Postgraduate Programme in Insect Science (ARPPIS). This is a collaborative venture between the International Centre of Insect Physiology and Ecology (ICIPE) and a number of African Universities. Students register for the Ph.D. degree with one of the participating universities and carry out their research work under the supervision of ICIPE scientists.

With financial and technical support from the Netherlands, the Permanent Interstate Committee for Drought Control in the Sahel (CILSS) has established a Crop Protection Training Department (DFPV) at the Agrhymet centre in Niamey, Niger. Training is open to all Sahelian countries and member states of CILSS. Since its establishment in 1982, about 80 crop protection technicians have been trained in two-year programmes. In 1986, a four-month course was started for crop protection teachers in agricultural schools and higher level field technicians (van Huis *et al.*, 1987; van de Klashorst and Sagnia, 1989). Each year, short training courses on specific topics in pest management are also organized. DFPV is also responsible for diffusion of IPM information and documentation throughout the Sahel. The Wageningen Agricultural University provides technical back-up for the project.

INFORMATION AND DOCUMENTATION

The Department of Entomology of the Wageningen Agricultural University, commissioned by the Ministry of Housing, Physical Planning and Environment, has conducted a feasibility study on needs and constraints of information and documentation on IPM in the tropics (van der Weel and van Huis, 1989). One major constraint to the development and implementation of IPM is the lack of appropriate information in developing countries. National documentation services are poorly equipped and specific information on IPM is difficult and costly to obtain. Non-conventional IPM literature is not generally available and therefore, the establishment of a database on such literature should be considered.

In a worldwide survey on activities and needs for IPM documentation and information, most organizations indicated the need for establishing a network for IPM in the tropics. Activities of such a network and a coordinating IPM information and documentation centre should comprise: literature searches, exchange of literature (in particular, non-conventional), publications of bibliographies on material relevant to IPM, document delivery, query-answering service, editing of a newsletter, and liaison function (bringing IPM workers into contact with one another).

The Department of Entomology of the Wageningen Agricultural University has made a worldwide inventory of IPM training and extension materials for tropical food crops. The results will be published shortly in a catalogue. The inventory comprises hand-books, field manuals, slide sets, posters, films and videos as well as lists of newsletters, periodicals, research centres and international information centres. The study was made possible by financial contributions from the Netherlands Ministry of Housing, Physical Planning and Environment, the Technical Centre for Agricultural and Rural Cooperation (CTA) and the Netherlands Directorate General for International Cooperation.

STRENGTHENING CROP PROTECTION SERVICES

Since 1983, the Netherlands has been assisting the Zanzibar Government to strengthen its Crop Protection Division. This Division has a responsibility for research through which studies are carried out at the plant, cropping and farming system level. The Division is also responsible for training of extension personnel. The Wageningen Agricultural University is providing technical support for this project.

A request to the Netherlands for funding of an FAO project to strengthen the Plant Protection Service in Chad is currently being considered.

SPECIAL PROGRAMMES

Onchocerciasis control programme:

The World Bank in cooperation with WHO, FAO and UNDP, is directly involved in the Onchocerciasis Control Programme (OCP) in West Africa. The programme assures the control of *Simulium spp.* in rivers of 11 countries in the Volta River basin. The Netherlands has contributed approximately 10% of the total budget of US$ 150 million for the period 1974-1991.

Regional tsetse control programme, Southern Africa

Through the European Community, the Netherlands is supporting a regional tsetse control programme, currently in its first phase, in Zimbabwe, Zambia, Malawi and Mozambique.

Locust and grasshopper control

Since 1986, the Netherlands has contributed between US$ 2.5 and 5 million annually in emergency funds for the chemical control of grasshoppers and locusts in Africa. The Emergency Centre for Locust Operations of FAO is the coordinating body for Dutch activities.

The Netherlands also contributes to the development of remote sensing techniques at FAO for the forecasting of desert locust outbreaks. Consideration is currently being given to financing an inventory of natural enemies of grasshoppers and locusts in the geographical distribution area of the desert locust, in order to develop a microbial control agent. The Netherlands have also financed the joint publications by PRIFAS and DFPV of five extension booklets in the French language on the recognition, monitoring and control of locusts and grasshoppers. Eight thousand copies of the books have been distributed free of charge to all Sahelian countries.

Pesticides and the environment

In developed countries, the negative environmental effects of intensive pesticide use are increasingly being felt. Environmental costs can become very high and therefore are an important political item. The recent downfall of the Dutch government was caused by a difference in opinion on how to finance a national environmental programme. Newsweek of 15 May 1989, called this phenomenon Europe's new epidemic: "green fever". How can developing countries, however, reconcile the environmental debt of tomorrow with the financial debt of today? The Netherlands Minister for Development Cooperation, addressing a Seminar on Development and Environment in Amsterdam in March 1989, stated that for developing countries, alternative routes to development should be sought which will not repeat the mistakes made by the industrialized countries in the 1960s and 1970s. Therefore, it is to be expected that in policies concerning development cooperation, environmental concerns will be of major importance.

Environmental impact of chemicals: locust control

Since 1987, large areas of Africa have been treated with pesticides to control the desert locust *Schistocerca gregaria*. In 1988 alone, approximately 14.5 million hectares were treated in Africa and the Arabian Peninsula. During the rainy season of 1989, an FAO pilot project called "LOCUSTOX" is planned for the Senegal River Delta to make a preliminary assessment of the environmental impact of desert locust control. The institutions involved are the Plant Protection Department of Senegal, Wageningen Agricultural University, Overseas Development Natural Resources Institute (ODNRI), Denver Wildlife Research Centre and FAO. The studies will concentrate on the effects on aquatic invertebrates, fish, birds, and terrestrial arthropods.

Pesticides in the Sahelian environment (PENSAH)

The Permanent Interstate Committee for Drought Control in the Sahel (CILSS) has formulated a project to strengthen national capabilities in ecotoxicological monitoring. Its objectives are:

- to strengthen national plant protection services, in pesticide legislation and the safe and effective use of pesticides
- to increase awareness of the side-effects of pesticides; and
- to evaluate the ecological effects of pesticide applications.

The project will assist in the implementation of the FAO International Code of Conduct in the Distribution and Use of Pesticides.

Creation of an information and training component at the CILSS Crop Protection Training Department (DFPV) in Niger has been proposed. Short, specialized courses will be organized for Directors of Plant Protection Services, officers responsible for the legislation of pesticides, national trainers in ecotoxicology, and the heads of phytosanitary bases.

An ecotoxicological research component will evaluate the effects of pesticide applications on the Sahelian environment. Legislation on phytosanitary products is based on ecotoxicological data which are collected from standardized experiments on certain species of animals and plants. Unfortunately up until now these species, except for some fish, represent the ecosystems of temperate zones. For example, termites and ants of great ecological importance in the Sahel have not been tested where climatic conditions are very different from those in temperate zones. Ecotoxicological data on phytosanitary products needs to be obtained for the specific conditions of the Sahel.

CONCLUSIONS

The Netherlands Directorate General for Development Cooperation is engaged in a number of crop protection and vector control projects in developing countries executed by international organizations such as FAO, WHO, CILSS, and CGIAR institutes. This approach assures proper donor coordination. In general, these projects are provided with technical cooperation and back-up from relevant institutions in the Netherlands.

IPM is considered to be the most appropriate pest control strategy for sustainable food crop production for small farmers in Africa. Constraints to developing and implementing IPM programmes relate to insufficient capacity at the research and extension level and widespread confidence in chemical control. Therefore, the main objective of Dutch development cooperation in crop protection is to strengthen appropriate national and regional capabilities in IPM development and implementation. Experience has shown that lasting and structural results can only be obtained when the donor is committed to a long-term involvement. Bilateral donors have less constraints to pledging themselves for periods longer than the three-year period usual for United Nations agencies.

The control emergency campaigns (1986 to 1988) against locusts and grasshoppers have required about US$ 240 million from bilateral donors. Environmental costs of such campaigns, which at present have not been taken into account, should be assessed in the future. Efforts should also concentrate on the development of more structural solutions to the migratory pest problems. Therefore, development and application of alternative control technologies, establishment of effective monitoring systems, and training of personnel, should be pursued,

The overall objective of Dutch development cooperation in crop protection is to support countries in Africa to develop and sustain their capability to control pests and to reduce crop losses, taking fully into account environmental considerations.

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Experiences of Networking in Africa: PESTNET, A Case Study†

E.O. Omolo

PESTNET stands for African regional "Pest Management Research and Development Network" for integrated control of major pests of crops and livestock. It is one of a number of agricultural networks in Africa.

PESTNET is community-based and, at the same time oriented towards pest management, an important factor of the community production systems. The clients of PESTNET (farmers, extension officers, scientists and opinion leaders) are all involved in the development of pest management technology in interactive research and development at the community level. PESTNET strives for the total integration of pest management into national agricultural and livestock production systems. It is hosted and coordinated by ICIPE and is at present active in Kenya, Zambia, Somalia and Rwanda.

IPM for agricultural crops

After several years of inter-active research and development, ICIPE has developed non-pesticidal management of certain crop borers of maize, sorghum and cowpeas for use by resource-poor farmers, with the view to increasing food productivity in tropical Africa. Four components have been identified as potential candidates for wider use: cultural practices (mainly intercropping), plant resistance to insect attacks, biological control and behavioural manipulation of borers.

† This is a summary of the paper presented.

Intercroppings of cereals with cotton and legumes were found to be less infested by insect pests and weeds, and showed combined yields which were at least comparable with those of monocultures. Intercropping is now being tested by PESTNET in several countries. Other cultural measures include: plant density, time of planting, choice of seeds, and field sanitation. Application of such measures varies according to agro-ecological and climatic conditions in different countries.

Resistant varieties, also being tested by PESTNET, decrease further damage by stemborers, and thereby stabilize yields.

Biological control agents, such as disease-causing bacteria and protozoa, parasitoids and pheromones, are ready to be tested in farmers' fields. If proved effective, such agents will be included in the IPM packets developed by ICIPE and spread by PESTNET which also supports investigation of traditional ways of propagating disease-causing agents at the farm level.

Natural plant products for pest control as repellents or feeding inhibitors, are being explored by PESTNET. PESTNET is involved in reducing losses caused by post-harvest pests, transferred from fields to storage.

IPM for livestock, ticks, and tsetse

ICIPE and collaborators are developing integrated pest management packages for the control of ticks and the tsetse fly, which can be grouped into four categories: vaccine development, animal husbandry practices, natural resistance, and manipulation of pests.

Development of vaccines against ticks has reached an advanced stage at ICIPE. The impact of mixed husbandry on the rate of tick-transmitted disease, spread from one particular stock to another, is being investigated and as is the variability of resistance between different stocks. Resistance to ticks can be induced through vaccination using different parts of the tick. The mechanism of trypanotolerance is under study in order to learn whether such tolerance could be transferred eventually to livestock through vaccination. None of those categories of control have, however, reached the stage where they can be spread through PESTNET.

Blue-coloured traps, combined with samples of cow urine, have proved extremely attractive to tsetse flies, and are included in

PESTNET packages for control of livestock pests now being tested in pilot schemes by farmers in collaboration with ICIPE scientists and national programme extension officers/scientists in several countries.

Lessons learnt from the field are useful in re-designing new experiments for further testing and confirmation in collaboration with farmers. Since most resource-poor farmers have a mixed farming system of both crops and animals, the most appropriate IPM strategy should incorporate components for the control of crop pests, livestock ticks and tsetse. For an IPM to be sustainable, a whole location or a Division should take part in the programme. Otherwise, insect pests from surrounding areas would re-infest the clean fields or animals.

Resource-poor farmers are not supposed to remain resource-poor forever. Once they have taken off, they should be encouraged to maintain that level and become resourceful, thereby increasing their living standard.

Summary of Discussion:

International Cooperation and IPM in Africa

Five papers were presented and formed the basis for discussion on international cooperation and IPM in Africa.

It was agreed that international cooperation was a necessary ingredient for IPM to succeed in Africa at the present time. Experiences from several IPM projects in the tropics, highlighted the reasons for their varying degrees of success. Those that were successful included the following factors:

- Long-term commitment by donors and the proposal of realistic goals within a given time frame.
- Existence of strong plant protection institutions in recipient countries.
- Strong governmental support.
- Direct involvement of farmers in project implementation.
- Benefits by way of savings and increased productivity which were visible to the farmers.
- Harmonious working relations between all project staff.
- Effective training provided through consultancies, fellowships, visits and participation in related projects elsewhere.
- Availability of relevant data.

PART SIX

CONCLUSION

Visions for IPM in Africa

Thomas R. Odhiambo

The central challenge of scientific research in Africa is how it can help to mobilize and build up the home-grown human capacities in the continent so as to make common-sensible personal, family, and national development decisions on a sustained basis. Such a policy standpoint requires that there be a vigorous and continuing interaction between the research community, the policy-makers, the implementors of policies, and the users of the research results. This interactive relationship is nowhere evident in Africa - not in any of the major sectors of the economic life of this continent, such as mining and manufacturing, and is only seen in a few areas of agriculture, such as the tree crop industries of tea, coffee, cocoa and oil palm. We need to deliberately bring these four groups of actors together for the economic well-being of the continent. They must all be brought together to a common feeding trough in order to develop a common agenda and to act out a common future.

African agriculture, now at a difficult crossroad, not sure which path to follow in preparation for the even more problematic and severely competitive twenty-first century, must be able to do at least three things in a superlatively productive manner.

First, it must be able to regain its capacity to provide the food and nutrition that the continent's people have traditionally expected up until two decades ago. Until then, the sombre biblical-scale hunger and famine were known in Asia, the Middle East, and even in Europe, while Africa only periodically experienced famine after long periods of drought followed by locust plagues of biblical proportions. But even then, the highly developed post-harvest technology and village-level food security systems in most of Africa, assured that an organized domestic food aid system would come to the rescue of the affected communities.

Second, African agriculture must regain its capacity to provide a challenging and worthwhile way of life. An agrarian environment should not only be farmed; it should also be worked, perceived, known and lived. In short, we are looking at farming as a way of life, rather than merely a source of employment. It is this holistic approach to farming that may begin to attract the youthful and the literate community back to the land rather than mere exhortation to stop the drift to the urban centres.

Third, African agriculture is likely to provide the simplest and quickest entry point for modern scientific methodology to transform African societies by building upon the existing traditional agricultural knowledge base. Science grows by building on already tested and accepted knowledge: this accumulation of small steps in the growth of science goes on all the time, throughout the world. It is only rarely, and usually without warning except in hind-sight, that startling and epoch-making discoveries are made that revolutionalize conventional scientific thinking and technological development. These have included, in the last century, the discovery of the units of inheritance, the gene, and how these are characterized in biochemical terms and the discovery of antibiotics. In similar fashion, the traditional knowledge base grows and develops through the accumulation of new experiences and the tested results of experimentation and repeated observation. It is evolutionary in character; but it is nonetheless solidly based - even though it does not necessarily grow through the analytical methodology of science. The challenge for the African agricultural scientist is to be able to understand and rationalize this vast traditional knowledge base so as to have a systemic foundation on which to build a truly African-oriented science-based agricultural practice. To ignore the African traditional knowledge base is unscientific and wasteful of past intellectual energy. Thus, the farmer-scientist relationship we are seeking in this Conference on "Pest Management and the African Farmer" must be future-oriented, but at the same time firmly based on a rationalized accumulated traditional knowledge base.

Pest Management Innovations

What the farmer is seeking in Africa at this time - and probably for a long time to come - is assurance that he will harvest year after year, without interruption or failure, a reasonable yield of his crop, whether plant or animal, and that he will live on it and be able to make a reasonable profit on selling his surplus yield. He is not interested *per se* in crop breeding, or soil chemistry, or pest management, or any of the specialized areas of research so dear to the specialist. It has been said that the farmer is "the great integrator": it is in his best interest to integrate all the technological knowledge and experiences he has acquired over the years from neighbours, scientists or others, to achieve the goal he has set himself. Thus, if the reduction of losses due to insects can make a significant impact in his overall performance, he will certainly want to know about it and test it fully to his satisfaction.

Caution is a quality that every farmer exercises; but he is by no means the only one who exercises this quality. Even though innovation is the life-blood of industrial development, innovators normally have a hard time selling their innovative ideas, since new ideas are perceived as a threat to the existing technology or as an attack on the *status quo*. As stated so succinctly by an industrial watcher only recently:

"Big corporations are always reluctant to hand power to men with novel ideas, especially if they cost a lot of money. They feel more comfortable with people who "understand business", who play by the rules. Ideas are all very well, but they involve risk" (Davis, 1989).

Thus, the innovator must persist with the demonstration of his faith in the workability and profitability of his innovation. It is said that the founder of McDonald's fast food chain, the late Ray Krock, had a sign behind his desk which read:

"Nothing in the world can take the place of persistence. Talent will not: nothing is more common than unsuccessful men with talent. Genius will not: unrewarded genius is almost a proverb. Education will not: the world is full of educated derelicts. Persistence and determination alone are omnipotent" (Davis, 1989).

The need to keep in mind, that innovations brought to the attention of the farmer will only be accepted after clear and repeated demonstration that the new technology or idea is superior to the conventional practice, tells us at least three things. First, it is prudent to bring the farmer into the researcher's world at the time of formulating a scientific research and technology development (R&D) agenda, so that he can take a personal stake in the goal to be achieved by the R&D activity. Second, the extension specialist needs to be a participant in both the R&D agenda setting and agenda implementation, so that he can deliberately bridge the perceived gap between the scientist's intellectual vision and the farmer's social vision. And, third, the policy-maker needs to make it his business to create the political space which will allow all the three partners in R&D - the farmer, the scientist, and the extension specialist - to have an identical goal, because they have adopted an identical R&D agenda.

That agenda will only be implementable if the three parties use and understand a common language. That does not necessarily mean that the African farmer must become a scientist in the classical sense, although we should not rule out this possibility; or that the extension specialist must be a researcher although we should not brush this possibility aside. What is essential is that the importance of the scientific information being conveyed for the technological innovation being demonstrated, is being fully realized. There is a widespread mistaken idea that print-based information is the only type of information that is important, and that anyone who is not conversant with the technology of its acquisition is illiterate and beyond rehabilitation. But Africans are highly literate in oral and traditional knowledge, in which most modern scientists are illiterate. Both sides need to develop an accommodation so as to provide an environment for interactive communication and productive partnership.

THE FARMER'S IPM SCIENCE

We already know that in tropical Africa, a key element in agricultural production is its interaction with insect life. The pressure of insect pestilence on crops and animals in tropical Africa is more intense than anywhere else in the world. Fully 20-30% of our harvests are lost in the field, and another 10-20% are lost in storage through the predation of insects as pests in themselves or as vectors of plant and animal diseases. We therefore need to recognize the crucial importance of insect pests in tropical agriculture. What the farmer needs, to drastically reduce these losses,are pest management technologies that are technologically effective, long-term and sustainable in nature, simple in application, and cheap in cost.

Pest management technologies with these characteristics are not in general use anywhere in the tropics, where the largest pest problems exist. There are, however, two classes of component technologies that can form the foundation of a new integrated pest management IPM system in tropical Africa. These are (a) intercropping, a traditional technology which on a closer and scientific look, has revealed its efficacy in reducing pest pressure under certain cropping patterns; and (b) the development of crop or animal resistance or tolerance to specific pests or insect vectors or tropical diseases. We know that of 31,000 accessions of the world sorghum germplasm repositing at ICRISAT in India, about 150 accessions have degrees of resistance to the sorghum shootfly, stem-borers, the sorghum midge, and headbugs (Rao and Reddy, 1989). These resistant cultivars were collected from traditional varieties of domesticated sorghum collected from many countries - Ethiopia, Sudan, Cameroon, Nigeria, India, etc. It is the farmer who discovered, bred , and nursed along these resistant cultivars; but the scientific plant-breeder is now using these resistant lines to transfer the resistance characteristics to other more desirable or designed sorghum varieties.

Plant breeding is a practice that the African farmer understands well. It is conceivable, therefore, that he will achieve a rapid understanding of the goal of modern genetic engineering just as well. However, he may not necessarily grasp the techniques for gene transfer itself, whether through the use of a micro-shotgun, or the use of a microscope-directed laser, or the utilization of a disarmed Ti plasmid from *Agrobacterium tumefaciens*. Any of these techniques can be employed to transfer a desired gene from an isolated cell into a plant cell, and then regenerate the transformed cell into a whole fertile plant able to reproduce the new characteristics brought in by the implanted gene (Cowen, 1988). The ability of the farmer to be familiar with such techniques is not important. What is important is that, in employing genetic engineering, which will soon be as common as classical plant breeding techniques but much quicker and easier to control, we will be able, for example, to transfer a particular resistance-conferring gene to a selected plant against specific pests without environmental hazards. What the farmer will need to acquire is the seed. Africa must therefore enter the molecular biology and biotechnology field with foresight and enthusiasm.

Equally, we must get involved in fundamental research into biological control with a deliberate view to developing a pest management technology which will be congruent with our knowledge of pest biology, and which will match the farmer's quest for efficacy, sustainability, simplicity and cost-effectiveness in their IPM. A basic fact of the present status of biological control research is that we cannot predict if a natural insect enemy of a pest, when introduced into the general environment of the pest, will get established and reduce the pestilence successfully. We have only a few guidelines to give us some hope; and we have to adopt a trial-and-error approach to the selection of an appropriate insect parasite (Greathead, 1989). We have an excellent chance in the tropics to discover the principles governing this phenomenon, so essential for adopting biological control as a regular component of IPM.

THE VISION FOR IPM IN AFRICAN FARMING

The event that has taken place at Duduville, Nairobi, this week has a profound lesson for us all. This tripartite forum of farmers, scientists and extension specialists has demonstrated powerfully that this forum is a vital element in the development, adoption, and implementation of IPM whose time has come.

It is therefore recommended, as the single most important act of this week's conference, that an interactive **Farmers' Forum for Integrated Pest Management (FFIPM)** be established and sustained over the years

- to promote the farmer-scientist-extension specialist partnership;
- to foster the practice of formulating and implementing a common and agreed R&D agenda for IPM development; and
- to implement IPM packages for crop and animal production and post-harvest technology that recognize that losses due to pests are an important factor in overall agricultural performance in Africa.

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Closing Remarks

Moctar Toure

In his Closing Remarks, the Chairman expressed his appreciation for having been given the opportunity to chair a Conference where so many competent persons from many different groups of people were able to share ideas on how to tackle pest management problems. In particular, he thanked the participating farmers for the quality of their contributions, which confirmed his pride in the quality of human resources in Africa. He expressed the conviction that no real obstacles to progress exist when people have the same level of conception of problems, no matter the clothing they wear.

The Chairman reminded the Conference that we need to respect the laws of nature, not only locally, but also internationally, because environmental problems have no frontiers. African problems are everyone's problems.

He reminded the Conference that we must expand on what we have learned during this programme, and try to translate the ideas expressed in the recommendations into something concrete at the regional, national, local and individual levels.

The Chairman expressed thanks to the organizers of the Conference, The World Bank; and the ICIPE, whose Director, Professor Thomas R. Odhiambo, had guided and encouraged the participants before and throughout the Conference.

APPENDIX

APPENDIX

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The rate of self-sufficiency in food production in Africa is declining rapidly. In 1975, Africa produced 85% of the food it consumed; by the year 2000, it is predicted that it will produce only 61%. Almost all basic crops are grown by small scale, resource poor farmers, faced with devastating losses caused by pests. One way to increase productivity is to reduce those losses; integrated pest management (IPM) on a sustainable basis is the best method for reducing crop losses.

Sponsored by The World Bank and the International Centre of Insect Physiology and Ecology (ICIPE), a conference on integrated pest management: *Pest Management and the African Farmer*, was held in Nairobi in May 1989. The participants were farmers, agricultural extension service and research personnel, and representatives from the agro-chemical industry and donor agencies. The objectives were to review pest management practices, to examine socio-economic, institutional and policy constraints, and to examine opportunities for increasing private sector involvement in the development and implementation of integrated pest management among farmers in Africa.

Issues addressed were wide:

"It is noteworthy that much of the so-called family labour is, in fact, female labour...the perception of the women of technological inputs and innovations is crucial for the successful adoption and social acceptance of novel technology."

"The partnership between the extension service and the farmer should not create a teacher and listener forum but committed participants, prepared to venture together into a less known but imagined future."

"The shifting emphasis from excessive use of chemicals to an IPM approach by donor agencies is welcomed. Such shifts should be accompanied by longer-term commitments, follow-up activities and recognition of the need to build up local capacities rather than the mere transfer of foreign technology."

"Greater financial support from the agro-chemical industry should be given to research focusing on the small scale farmer. Such research must take place in the African environment."

This Proceedings of the Conference has been published in order to convey to a wider forum that losses caused by pests can be reduced provided African governments, national institutions, international agencies, and industry take action to remove existing constraints and promote IPM.

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