Directors' Forum for ICIPE's Strategic Framework for the 1990s and the R & D linkages with National Programmes

PROCEEDINGS

The International Centre of Insect Physiology and Ecology

DUDUVILLE, NAIROBI
3rd–6th September 1991

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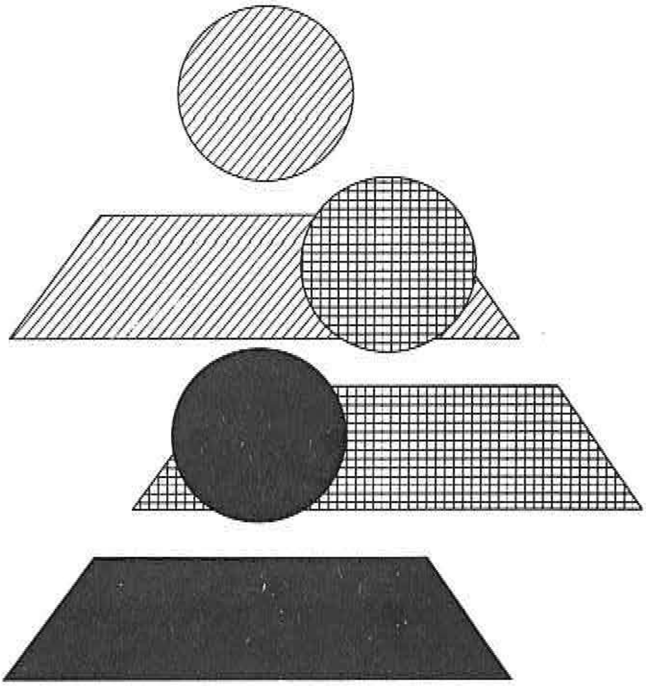

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LENNARD OKOLA

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Why Directors' Forum?

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Twenty-one years ago the International Centre of Insect Physiology and Ecology (ICIPE) was established in Nairobi, Kenya, by a group of scientists who felt concerned that poisonous and expensive chemical pesticides were being extensively used in the tropics as the principal means of controlling insect pests. It was an African initiative which soon attracted widespread support from the international scientific community as an innovative experiment in scientific institution-building in the Third World. The new Centre was given a unique two-part mandate by its founders: firstly, to undertake mission-oriented basic research in insect science leading to a better understanding of the biodiversity of the tropical insect world and, progressively, to the development of low-cost integrated pest management technologies that are environmentally sensitive and appropriate for resource-poor rural communities; and, secondly, to enhance, within the Centre's area of competence, the scientific capacities of the developing countries through advanced training programmes and interactive collaboration with national R&D systems.

For the first time in Africa, a new initiative was being undertaken to shift attention deliberately away from the traditional pest control philosophy that relied almost exclusively on pesticides, with their proven harmful effects on the environment as well as on the unsuspecting users. Again, for the first time African scientists were making a bold move to use science to solve some of their continent's development problems, setting their own agenda and priorities, but drawing on the available resources of the international community. During the early stages of the Centre's life those resources were mainly intellectual, but it soon became apparent that considerable material support was required in institution-building even at a modest level, and that donor support was essential. Thus, from the very beginning the ICIPE was also an experiment in international cooperation, bringing together scientists, science policy-makers, and other interested parties from both the Third World and the industrialised countries.

After two decades, ICIPE's mandate remains as valid and relevant today as it was in 1970. Insect pests are still a major constraint to food security and health in tropical developing countries, and the environment is still a major concern as a key factor in ecologically sustainable development.

Yet in the same period there has been remarkable progress in some areas of agricultural research and development, the most dramatic example perhaps being the so-called "green revolution" which made available high yielding varieties of certain staple food crops, through the work of some of the pioneer international agricultural research centres. In the case of the ICIPE, a formidable body of fundamental knowledge on the biology, physiology, biochemistry and ecology of selected target pests has been built up, making it possible to begin to develop and to apply low-cost pest control technologies that are scientifically and economically viable, and at the same time, environment-friendly.

However, the success of the international centres such as the ICIPE ultimately depends on the extent to which they are able to interact and cooperate with the national programmes, through which they can reach the end-users and beneficiaries of their research results: the farmers. The ICIPE considers this partnership critical to successful execution of its mandate. This special meeting has been convened to bring together a cross-section of the top leadership of the National Programmes in Africa to discuss ICIPE's strategic framework and its vision for the next ten years. It is designed to give forum participants, who will be drawn not only from Africa but also from other tropical regions of the world, a chance to discuss freely ICIPE's proposed research and capacity-building agenda for the 1990s as well as its plans to R&D linkages with the national programmes, and to recommend ways of making that agenda and those plans even more relevant, more effective and more responsive to the needs of the target beneficiaries. The forum for dialogue thus established is expected to lay down the groundwork for a truly interactive and dynamic partnership that is based on understanding of one another's role and priorities in our common efforts to manage pests and improve the quality of life of the farmers.

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Welcome Address

THOMAS R. ODHIAMBO

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Welcome Address

THOMAS R. ODHIAMBO
Director, The International Centre of Insect Physiology and Ecology (ICIPE), P. O. Box 30772, Nairobi, Kenya

On behalf of the ICIPE Governing Council and Management, and the entire ICIPE community of scientists, technical and administrative staff, visiting scientists, postgraduate scholars, and scientific collaborators throughout Africa, Latin America, the Middle East, Asia, and the industrialised world, I wish to welcome all the participants from the tropical world, the representatives of regional and international institutions, and the donor community to this uniquely important meeting being held at Duduville, in Nairobi this week.

It is probably the very first time that an international scientific research and technological development (R&D) centre has put on the table its vision and long-term strategic plan for scrutiny and debate by the seniormost experts and policy-makers from its main constituency — the national research, development, and education systems. The ICIPE has grown and matured into an advanced research and training institution in its 21 years since inception, on an agenda which was debated and approved by a wide-ranging international Planning Forum that met in Nairobi in October 1969, just a few months before the ICIPE was formally established in April 1970.

The goal of the Directors' Forum this week is to consider ICIPE's vision and strategic framework for the next 10–15 years, and to see whether it concurs with their own national and regional perspectives in at least three areas. First, is ICIPE's perspective of regional and international priorities consistent with the Forum's own perception? Second, is ICIPE's R&D goal of developing long-term and effective insect pest management technologies which are also economically and environmentally sustainable feasible? And, third, ICIPE's principal concentration in terms of scientific cooperation will be with national research, extension, and university systems — without operationally decreasing its elaborate R&D interfacing with advanced research laboratories throughout the world. Does the Forum concur with this strategic focus?

We are fortunate that these key issues — and the panoramic view that the Directors' Forum will take of ICIPE's strategic framework in tropical insect pest management for the 1990s — will be debated under the eagle eye of the Forum's Chairman, Honourable Anna Abdalla, M. P., and Tanzania's Minister of Agriculture, Livestock, and Cooperatives.

My final task is a very pleasant one indeed. It is to request the Honourable Minister for Research, Science and Technology in Kenya's Cabinet, Honourable George Muhoho, M. P., to introduce our Chief Guest for the Opening Ceremony for the Directors' Forum, His Excellency the Vice-President and Minister for Finance, Professor George Saitoti. Minister Muhoho is a man of many parts — a former theologian and ambassador, an experienced international communication expert, and now a budding wine-grower and an accomplished politician.

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Opening Address

H.E. The Vice-President and Minister for Finance
HON. PROF. GEORGE SAITOTI, E.G.H., M.P.

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Opening Address

H.E. The Vice-President and Minister for Finance
HON. PROF. GEORGE SAITOTI, E.G.H., M.P.

Forum Chairperson, Honourable Anna Abdalla
Your Excellencies
Directors of National Programmes
Ladies and Gentlemen,

It is indeed a great pleasure for me to address this gathering and participate in the first ever Forum of National Directors organised by the ICIPE. At the outset, I am very happy to convey a very warm welcome to Kenya to all the participants of this Forum from H.E. President Daniel arap Moi, who has always championed the themes of this Forum — the welfare of the people through food security, relevant research and local capacity-building.

We are all aware that within a short period of its coming into existence as an inter-governmental agency, ICIPE has played a critical role in Africa in promoting collaborative research of a very high quality.

It is against this background that I welcome this meeting of Directors of National Programmes in agriculture, livestock, health, forestry and others dealing with national research and development programmes. ICIPE's linkages with national programmes are very important and I am sure that a Forum of this nature will not only provide a valuable feedback to ICIPE but will also ensure that the National Directors have an opportunity to discuss ICIPE's overall strategies in the context of their own needs in the control of insect pests for increasing food production and for improving rural health.

Ladies and Gentlemen, this is not an occasion for me to dwell at length on Africa's food production and health problems. As experts in the field you are well aware that we in Africa have still a long way to go in terms of application of modern science and technology to our food and livestock production systems. Despite the fact that 65% of Africa's economically active population are in the agricultural sector, per capita food production is declining, ecological disasters are lurking everywhere and public health systems have come under severe stress.

On top of these developments, Africa has also become a net importer of food, with food imports increasing at an alarmingly high rate of about 5% every year, of the past 30 years. Although there are striking regional variations in these trends, it cannot be denied that twenty years ago, the growth rate in agricultural production was about 2.4% a year in Africa, while the population growth averaged around 2.6%. By the late eighties the growth rate in agricultural production had fallen to 1.3% while population was growing at 3.1%, due notably to a decline in death rates.

I am aware that there are several reasons behind this lacklustre performance of African agriculture, including a series of external shocks, particularly for the commodity exporting countries. In addition to experiencing a continuous decline in terms of trade, the continent has also to face the problem of servicing massive debts, a problem made more acute due to decline in real transfer of resources from the developed world to the continent and wide fluctuations in the currency markets.

Consequently most Governments in the continent have found it extremely difficult to establish an enabling environment in which science and technology can have their desired impact in increasing the productivity of our agricultural and livestock systems. Of late, however, in a number of countries policy reforms of a fundamental nature are being designed and implemented, which are bound to create the necessary conditions for a dramatic take-off of the agricultural sector to an era of higher productivity and growth.

Ladies and Gentlemen, in this essential task of increasing productivity in Africa's agricultural and livestock systems, the application of science and technology have a critical, if not a fundamental role. Pioneering institutions such as the ICIPE have already accomplished a lot within a short period of time. In fact this gives me confidence that with your active support, understanding and collaboration, we can all make this institution the pride of Africa, in ushering an era of technological development.

On many occasions, we have noticed that international research institutions tend to treat national programmes simply as recipients of technologies which have been developed elsewhere, without properly assessing their relevance, appropriateness or acceptability. When this happens the results may not be commensurate with the resources spent on the development of such technological packages. Therefore, a true partnership between international research centres and national research and development agencies would go a long way towards eliminating these difficulties. I do hope that this Forum will serve as a model which will be the forerunner of many others to come, not only in agriculture but also in other areas of scientific research.

As far as Kenya is concerned, ICIPE's partnership with several national programmes in technology design and development has already led to some notable successes. In Oyugis and Kendu Bay Divisions of South Nyanza district, ICIPE scientists have worked very closely with national extension service staff in a pilot project using integrated pest control methodologies. Not only have grain yields increased by as much as 81% in some instances, but also there has been a demonstrable improvement in the standard of living of farmers in the pilot project. We do hope that donor support will be available to expand this collaborative project and also to extend it to other parts of Kenya.

I can also refer to another example of fruitful partnership between ICIPE and Kenya Government in Kajiado. In this project, an ICIPE tsetse control pilot project at Nguruman, using a specially designed and baited trap, has suppressed the population of this disease vector by as much as 90% within the 100 square kilometre experimental area. Hence ICIPE's community-based approach has been singularly successful and the local livestock farmers in the area have regained large tracts of valuable grazing land for their cattle, with consequent improvement in productivity. I understand that this tsetse control strategy has also been tested successfully in the Kagera River Basin regions of Tanzania, Uganda, Rwanda and Burundi, where tsetse continues to be a major constraint in increasing productivity.

Again we should note that in a highly specialised area of capacity-building for scientific endeavour, ICIPE has achieved remarkable success within the entire continent. The African Regional Postgraduate Programme in Insect Science (ARPPIS), has now a total of 18 participating African universities, and by the end of 1990, almost 50 Ph.D. scholars had successfully passed through this programme. It is important to note that most of the ARPPIS graduates have so far stayed within Africa, teaching in universities or working with national or international research institutions. If this success is maintained, Africa can have within a few years, a critical mass of her own scientists in one very important area of science, trained in Africa and African problems, and to the highest level of scientific excellence. I understand that plans are being developed to consolidate ICIPE's training and human capacity-building programmes, through the establishment of an ICIPE Graduate School which will award its own Ph.D. degrees while still remaining very much part of the ARPPIS network and through the establishment of four sub-regional centres for awarding an M.Sc. degree in insect science. These are developments in the right direction and Kenya Government is following them with great interest; I do hope that this Forum will facilitate and speed up ICIPE consolidation exercise.

Madam Chairperson, let me now touch upon a critical issue for the success of all such collaborative efforts between ICIPE and national Governments.

We are all aware that Africa is facing very severe resource constraints, even as it is moving ahead in meeting the aspirations of its people. The requirements are indeed much too much compared to the meagre resources that most Governments can command. At the same time, we have to ensure that enough financial resources are allocated to the development of science and technology. It is well known that investments in research and technology development, particularly in agriculture and disease control have a very high rate of return, sometimes exceeding 40%. This compares very favourably with many of competing demands for allocation of our limited financial resources. I am, therefore, confident that Governments will give adequate support to such high priority investments in the future well-being of our people. Even after mobilising enough domestic resources, we will still need the financial support of the international donor community as the requirements are indeed very high. Here we need to be very careful and ensure that such resources are used most effectively and in accordance with clearly established and mutually agreed priorities. We must also appreciate the fact that the flow of resources to Africa will be affected due to the developments in Europe and the competing demands that have emerged for such resources. Although we have been told repeatedly that Africa will not be marginalised and that there will be no decline in the flow of real resources to the continent, we need to be vigilant and realistic and take steps that will ensure our continued access to such resources.

I am, therefore, happy to note that representatives of the international donor community are also attending this Forum which will indeed give them an opportunity to interact with the directors of national programmes and see for themselves the effectiveness with which their support has been utilised. Partnership with donors is just as important as partnership between research centres and national programmes, and with the international scientific community.

Finally, I would like to wish you all a very pleasant stay in Kenya and very fruitful and productive discussions. I do hope that deliberations in this Forum will lead to collaborative efforts in different parts of Africa, with the ICIPE scientists and technicians working side by side with their counterparts from national programmes, learning from one another and helping Africa to feed itself and become self-reliant.

I am sure that you will also come up with a number of action-oriented recommendations to strengthen the links between ICIPE and national programmes on the one hand and identify the critical elements of the broad developmental strategy for the ICIPE in the nineties, on the other. With these remarks, it is now my pleasure, Madam Chairperson, to declare this first National Directors' Forum officially open.

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Opening Statement

FORUM CHAIRMAN, HONOURABLE ANNA ABDALLA

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Opening Statement

FORUM CHAIRMAN, HONOURABLE ANNA ABDALLA
Minister for Agriculture, Livestock and Cooperatives
Republic of Tanzania

It gives me great pleasure to welcome you to this Inaugural Session of Directors' Forum for ICIPE's Strategic Framework for the 1990s and R&D Linkages with National Programmes. I consider it a great privilege to have this opportunity to participate in this unique forum. It is unique because for the first time since the inception of the international agricultural research system and related centres, an international centre has seen it fit and desirable to consult the national research organisations and to invite them to comment and make suggestions on its proposed strategic framework. I would like to take this opportunity to congratulate the ICIPE management for its farsightedness in conceiving this idea and for its courage to go ahead and organise this forum. I suppose I do not have to justify the use of epithet "farsightedness": The forum will provide an excellent opportunity to representatives of different institutions from Africa and other third world countries to examine critically ICIPE's strategic framework and to contribute towards shaping it, hopefully, into something better, something more effective. My use of the second epithet "courage" was quite deliberate, for what if this forum were to conclude that the proposed ICIPE's agenda for research, training and collaboration is totally out of tune with your aspirations? However, having read the Strategic Framework myself, I am sure that that is unlikely to happen. Nevertheless, we must admire ICIPE's courage to expose itself so openly to comment from outside. This is a reflection of not only of high maturity of the institution but also the positive outlook of its leadership which has undoubtedly made ICIPE a great success story in Africa and a model of how to nurture and manage scientific enterprises in the continent.

I do not wish to say much more. We have a challenging task ahead but a very good programme. I do hope that every one here will feel at ease and contribute freely to the discussions. As a presiding Chairman of this inaugural session it is now my pleasure to invite the Director of the ICIPE, Professor Thomas R. Odhiambo to give us the Keynote Address on "ICIPE's R&D Partnership with National Programmes in Meeting Pest Management Challenges in Africa."

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ICIPE's R&D Partnership with National Programmes in Meeting Pest Management Challenges in the Tropics

THOMAS R. ODHIAMBO

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ICIPE's R&D Partnership with National Programmes in Meeting Pest Management Challenges in the Tropics

THOMAS R. ODHIAMBO
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P. O. Box 30772, Nairobi, Kenya

Twenty-one years ago, the International Centre of Insect Physiology and Ecology (ICIPE) began its institutional life with a real-life adventure — a journey into the unfamiliar world of scientific discovery and technological development (R&D) in tropical pest management. It was an "unfamiliar territory" because the long-term mission of this new advanced research institute, located *in situ* within the tropics itself, was to serve the priority interests of the resource-poor rural community, which were generally overlooked by the scientific world. And it was an "adventure" because the public worldwide was beginning to sound an outcry against the widespread overuse and abuse of insecticides, while the scientific community was trying to go back to the drawing-board to design a completely new approach to insect pest management.

The founding fathers of the ICIPE took a bold step. Instead of mounting a fire-brigade operation to test already available technologies on the shelf, an approach much favoured for solving technology-oriented problems in the developing regions, the ICIPE pioneers took a long-term view. They decided that the major tropical insect problems are so manifestly difficult that applied research alone might not resolve these issues, and that prudence dictated running the R&D first by slow, careful, painstaking mission-oriented fundamental research. In the words of the very first page of the ICIPE brochure published in March 1970, one month before the ICIPE was legally established in Nairobi, Kenya:[1]

> "The central aim of the ICIPE will be to carry out research of high quality in certain fields of insect physiology and ecology ... The research contemplated will be of a fundamental nature; but the topics chosen are such as may well yield results which could transform current methods of insect control. Traditional techniques to control harmful insects with pesticides have met with a number of problems: most of the pesticides developed so far have been too broad in their action, proving toxic to other insects and other living things besides the target pest species; many of the pesticides, particularly the chlorinated hydrocarbons such as DDT, persist in the environment, thus progressively polluting it to a dangerous degree; and many insects have shown a remarkable ability to develop resistance to these pesticides. An aim of the Centre will be to find agents and methods which are highly selective in their effect, that do not lead to the pollution of the environment, and to which the pest species do not become resistant."

This boldness is now beginning to pay off, and in a handsome manner. Let us take one illustrative example — the control of tsetse.

Tsetse, the fly vectors of "sleeping sickness" in man and "nagana" in livestock, two tropical diseases which are devastating in terms of human morbidity and livestock losses, have been confined, since at least the last 10 million years, to Africa. Except that in a recent report, two species of tsetse *(Glossina fuscipes fuscipes* and *Glossina morsitans submorsitans*), were caught in south-western Saudi Arabia, close to the north-western border of Yemen — and at least 1000 km north of the northernmost apparent distribution limit of tsetse in Ethiopia and The Sudan.[2] It is estimated that approximately one-third of Africa south of the Sahara is not open to livestock production because of the risk of livestock trypanosomiasis. Further, the fear of human sleeping sickness is still stalking parts of Africa. For instance, the sleeping sickness epidemic which devastated the inhabitants living along the shores of Lake Victoria in 1899 to 1901 is a famous event in the annals of tropical medicine, as it launched the first systematic effort to find out the cause and epidemiology of this disease, from which one-third of the lake-shore population perished. Since then, there have been at least four such epidemics in eastern Uganda — in 1939–1945, in 1960–1971, in 1976–1980, and in 1985–1989.[3] Such outbreaks have led to depopulation of the affected regions, and out-migration of people. And, in terms, of livestock production, it has resulted in most of coastal West Africa being devoid of animal production, except where trypanotolerant breeds have existed and where, therefore, concomitantly tsetse challenge is relatively low.

Since 1901, an enormous effort has been mounted to undertake R&D towards trypanosomiasis epidemiology, anti-trypanosomiasis drug development and testing, tsetse vector biology and control, and campaigns — both national and regional — to contain and then eliminate this scourge. What have we to show for this effort so far? A recent conclusion is that — very little indeed:[4]

"There have been, admittedly, some minor control successes, such as in the northern part of the Republic of South Africa, in Zululand, as well as in other parts of the tsetse range. But Zululand, and these other areas, are in fact located in ecological zones marginal to the prime distribution areas of tsetse. Why have we been so spectacularly unsuccessful in tsetse control? Why has this endeavour failed in spite of a governmental commitment throughout most of Africa to tsetse vector control, a commitment which has been more consistent than for any other pest control programme in Africa — far surpassing that for the control of locusts, armyworm and other migrant pests, stored product insects, crop borers or even major introduced pests?"

The answer seems to be that the tsetse control campaigns relied almost completely on a militaristic, scorched-earth strategy to tsetse control.

Such a strategy has taken the form of drastically altering the tsetse environment — through deforestation and bush clearing, and through the suppression of forest undergrowth by spraying arboricides or burning. Or it has assumed the spectre of eliminating all sources of tsetse bloodmeal provided by wildlife — which has led to the denudation of parts of Africa of its rich ungulate fauna (such as Zululand, parts of Central Africa, and West Africa). Or it has assumed, since the early 1950s, of blanket spraying of synthetic insecticides, either from the ground or from the air, even though there are no specific insecticides tailored to the selective requirements of tsetse control.[4] None of these tactics have worked for long, and a final solution to the tsetse problem — and ultimately the control of trypanosomiasis — has remained elusive. Even in those cases, such as the on-going tsetse insecticidal control campaign by air and the use of insecticide-impregnated targets which is aimed at eliminating tsetse from an area of 320,000 square km common to Mozambique, Malawi, Zambia, and Zimbabwe, the experience is that "a residual population of flies often survives and may increase to pre-control densities in relatively short periods of time."[5] Thus, a long-term strategy for tsetse control is called for — and the ICIPE initiated in 1974 a mission-oriented R&D to seek a completely new approach to sustainable tsetse control.

The ICIPE decided to adopt a knowledge-rich control strategy which would attempt "to have a comprehensive understanding of individual tsetse species and their holistic world — as it sees and communicates with its own tsetse community, as it interacts with and gathers intelligence on its animal and human hosts, as it employs its biological potentials to manage its life in an often hostile environment, and as it gets sick from the many pathogens that prey on it."[4] The first ten years of this mission-oriented R&D saw the accumulation of a considerable knowledge base on the reproductive biology of the tsetse, especially that of a major vector species in eastern and southern Africa, *Glossina pallidipes,* as well as its physiological ecology, ecological behaviour, chemical ecology, and communication system, both acoustic and chemical. The seminal discovery, however, made by a young mammalogist turned insect ecologist, Mary Owaga, was the finding that buffalo urine contains chemical compounds that were highly attractive to *G. pallidipes*, more potent than anything previously known.[6,7] Almost with a rapid-fire sequence of discoveries at the ICIPE, the kairomones responsible for the potent attractancy were characterised by Hassanali and his co-workers;[8] the relation between each of the chemicals involved was worked out by Saini through sensory-physiological techniques;[9] it was realised that the attractant factor is actually a blend of several closely related kairomones;[10] and that there was a natural slow-release mechanism which operates to release the attractant from the kairomone precursors in the buffalo urine over a period of several weeks. We now know from the work of Okech and Hassanali that these phenolic tsetse attractants arise from the microbial breakdown (by, for example, the bacterium *Aerococcus viridens*) of precursors, which have now been identified as a mixture of glucuronates and sulphates in the urine.[11]

This knowledge has been put to extremely productive use by the ICIPE, to design and develop a community-based sustainable control technology of *G. pallidipes* in trypanosomiasis-endemic areas. The basic component is a tsetse trap technology, based on a visually-attractive biconical trap to which has now been added the urine-sourced attractant. This innovative technology has been found to be extremely effective in tsetse population suppression, to less than 1% the original fly population, within weeks of setting two such traps in each square km of a tsetse-infested area; and the incidence of trypanosomiasis among resident cattle is then eliminated.[12,13] Already, the technology has been tested in Nguruman, in south-western Rift Valley of Kenya, and in the regionally important Kagera Basin, which is shared by four countries (Burundi, Rwanda, Tanzania, and Uganda). This basic bivalent tsetse trap is the beginning of the development of a tsetse supertrap, to which can be added other components of control, to take care of the 1% tsetse that do not enter the trap, and other technical characteristics that will make it equally attractive to other species of tsetse.

Whatever the case, this mission-oriented R&D dedicated effort, which is now in its 17th year, has clearly demonstrated long-term dividends in several quarters. It has provided a basic trap technology that is extremely efficacious; it is abysmally cheap (less than US$ 5 per square km); it uses no synthetic insecticides whatsoever (since the trapped tsetse are simply killed in minutes by high solar temperatures); it is sustainable. These are qualities that the resource-poor rural communities can live with; and they fit into the new environmentally-conscious development paradigm.

Nonetheless, with all these new dividend-giving potentials, the ICIPE original adventure takes on a new texture. It is this: that the ICIPE in bringing in an airborne special corps of problem-solving R&D specialists, and parachuting it to quell a raging pest problem, is not a sufficient basis for long-term management of tropical pest problems. This technical assistance paradigm is simply unacceptable in terms of the increasing size of the pest problems of Africa and other tropical regions of the world — witness the recurring crises of malaria, locusts, armyworm, tick-borne diseases, and a host of serious tropical pests and arthropod-transmitted diseases of plants, livestock, and man.

The dilemma we face is that, whereas much of the world's bioresources are located in the tropical and subtropical lands, the world's poorer people are mostly found there. Yet, their poverty goes beyond mere physical possessions:[14]

> "Their poverty is not of physical resources but of knowing how to use them. Developing countries could shift comparative advantage in their favor by educating their citizens to help them understand their biotechnological potentials".

HUMAN CAPITAL

The ICIPE adventure train is, therefore, riding on a twin-track. While locomoting along to lay a rock-steady foundation for knowledge-rich innovative technologies for sustainable tropical pest management, it is simultaneously nipping smartly along to build a highly competent scientific leadership at the national level to work synergistically with the ICIPE scientific community in problem-solving. It is this partnership that is at the core of the ICIPE's goal to serve its primary constituency — the resource-poor rural community.

The rationale for insisting on capacity-building in Africa at the scientific leadership level is quite clear, as a recent World Bank study graphically demonstrates:[15]

> "Overall technical assistance to sub-Saharan Africa increased by 50 percent between 1984 and 1987 and is currently estimated at over $4 billion a year. Some 100,000 expatriates are at work across the region, a greater number than at independence. Nevertheless, it has become increasingly evident that not nearly enough local skills and institutions are being systematically built, technologies are not being transferred effectively, and lasting indigenous capacities are not being developed. Donor efforts and commitments to capacity-building need to be better focused and coordinated. At the same time, the commitment of African governments to those same capacity-building goals — as well as to a willingness to utilise local policy analysis and management skills — must also be reaffirmed."

The mandate of the ICIPE in this area is quite explicit. It is to "provide advanced training in research methods for doctoral candidates and postdoctoral fellows, as well as young practitioners in insect science and technology" for all those in the world particularly committed to tropical insect science and its application to pest management goals; and to "promote the growth of the scientific community in the tropics and especially Africa, both by its activities and its special relationships with universities, research institutions, specialised agencies, and Academies of Science."[1]

The ICIPE has translated this mandate into three separate programme activities. First, it has initiated, from the very first day of the Centre's functional activation, the appointment of young Postdoctoral Research Fellows, on a competitive basis, from round the world on a range of disciplines which have come to constitute the field of "insect science". These include insect ecology, behaviour, population biology, sensory physiology, natural products chemistry, molecular sciences, immunology, epidemiology, parasitology, insect-host relations, biomathematics, agronomy, plant and animal pathology, genetics, social sciences, etc. The young postdoctorals are vital agents of new scientific ideas, and are prospective collaborators when they complete their 2–4 years of intense research experience at the ICIPE.

Second, the ICIPE manages a small, but vigorous R&D management training network, which started 6 years ago as the Financial and Administrative Management of Research Projects in Eastern and Southern Africa (FAMESA); and is destined to expand into Central and West Africa next year. In this period, FAMESA has developed a whole package of case studies on R&D management under African conditions; and has designed, prepared, validated, and then implemented several training manuals, including those on R&D Institute-Constituency Relationship; R&D Strategic and Project Planning and Budgeting; R&D Institute Facilities and Materials Management; and R&D Project Planning, Monitoring and Evaluation. A Manual of Science, Technology, and Management Information Systems is in an advanced state of development. The validation of each Manual is rapidly followed by a series of national workshops in order to deliver the principal messages of enhanced R&D management within the socio-economic context of Africa, on a broad front, with insect science being only a small component of the R&D concerns. Because of this wide-ranging purview, the ICIPE has negotiated with the African Academy of Sciences, already engaged in other capacity-building projects (such as forestry research, soil and water management research, and research on the education of women and girls), for the Academy to take over the coordinating role of FAMESA as from the beginning of 1992.

Third, the ICIPE is the executing agency of a consortium of 18 African universities and the ICIPE, that are jointly sponsoring a postgraduate training programme in insect science. The African Regional Postgraduate Programme in Insect Science (ARPPIS), initiated in March 1983, has now trained 86 Ph.D. graduates from more than 15 African countries. This programme is unique: it is a partnership between an advanced centre of research (the ICIPE) and several African universities, which jointly plan the academic programme and monitor its quality on a regular basis, with all the training — including a 6-month period of taught courses — being undertaken at the ICIPE over a three-year programme after the masters degree. The successful candidates are granted the Ph.D. degree of any of the ARPPIS participating universities. The graduates are highly motivated; and all are still working in Africa, in national research systems, at the university, and in regional and international scientific institutions located in the continent.

It is, therefore, not surprising that at two recent planning conferences convened in Bellagio, Italy (in June 1991) and at Juja, Kenya (in August 1991), specifically to consider new ways of enhancing the performance and extent of ARPPIS, four important decisions were reached. It was recommended that four sub-regional centres for a two-year Masters Degree Programme in Insect Science be established at the University of Ghana, at Legon (for West Africa); at Dschang University Centre, in Cameroon (for French-speaking Africa); at the University of Zimbabwe, in Harare (for Southern Africa); and that a fourth sub-regional centre be identified to serve Eastern and North-Eastern Africa. Secondly, it was recommended that the existing ARPPIS Ph.D. programme at the ICIPE "be consolidated and enriched by the addition of a degree-awarding programme at the ICIPE within the ARPPIS network, noting that ARPPIS students will have the option of having the Ph.D. awarded by their registering university or by the ICIPE Graduate School." Thirdly, it was recommended that the Association of African Universities review, after a suitable interval, the "academically autonomous ICIPE Graduate School as a model of involving recognised Centres of Excellence concentrating on Ph.D. training" as a contribution to capacity-building in Africa in other R&D priority areas. And, fourthly, that a policy meeting of donors be convened early next year to explore the proposal to establish a Consortium of Donors for the purposes of strengthening and further developing the ARPPIS network and its new and crucial component parts.

These three capacity-building projects, taken in conjunction with the vitally important R&D advances that ICIPE's core programmes were making, enabled the ICIPE to enter into an interactive networking in 1986 with a number of national R&D systems and development institutions. Essentially, the Pest Management Research and Development Network (PESTNET) acts as a contextual framework for interactive R&D information generation, for the development and field testing of pest management technologies, for information exchange, and for updating technologies and experience. The network is already active in 18 countries, and is now focusing on intensifying its networking in West and North Africa.

As the ICIPE train of exploration and adventure roars into its twenty-first year, what are the singular accomplishments that we can immediately state have been written into its history? There are at least four watershed accomplishments:

- **First**, we have demonstrated many times, through 118 external donor-led reviews that the ICIPE has repeatedly undergone, that the Centre is a first-class centre of research, of high-level training, and of information dissemination.

- **Second,** the ICIPE has demonstrated an unfailing commitment to working closely and in partnership with the national research, extension, and education systems for achieving a common goal. In this respect, the Centre has clearly shown its long-term goal of assisting the national systems in creating and nurturing its R&D community so as to meet the long-term national development goals.

- **Third,** the ICIPE has succeeded in demonstrating the feasibility of developing knowledge-rich sustainable pest management technologies that can respond to the resource poverty of the rural communities living in the tropics, while at the same time being community-operated.

- **Fourth,** the ICIPE has demonstrated that a centre of research excellence can be created *in situ* within a developing region largely under the impetus of developing region scientists. Clearly, the ICIPE has met the concerns that many international development agencies, such as the World Bank, United Nations Development Programme, and the African Development Bank have expressed about the widespread failure of African institutions:[15]

> "Of primary concern is a pervasive lack of the basic elements of successful institutions [in Africa]: educated and trained human resources, sound management systems and strategies, and favorable policy environments and incentives structures..."

These four singular achievements have now placed the ICIPE on a solid foundation for moving forward to the next strategic phase of its development, and of a new vision. A new dream — a new adventure — is essential because, otherwise, institutional rigidity and obsolescence may well set in, as Page Smith forewarns:[16]

> "The laws of institutional life are that all institutions, large and small alike, and the large ones more rapidly than the small, tend first to defensiveness and rigidity, then to decadence ... Bureaucratic obtuseness stifles all real creativity. Huge institutions become muscle-bound, slower to respond to stimuli than the dinosaur..."

The main reason for convening the Directors' Forum for ICIPE's Strategic Framework for the 1990s and its linkages with the National Programmes is to allow the ICIPE and its national partners in the developing world (in Africa, South America, and South-East Asia) to dream one single dream jointly for the current decade and beyond.

VISION FOR THE NEXT 10–15 YEARS

As the twentieth century comes to an end, the ICIPE will have consolidated its scientific position as the premier R&D institute in insect science and its technological application in the tropical world. This four-part leadership will be based on the following crucial areas:

- **First**, the capacity to undertake a holistic, information-rich approach to development issues in ICIPE's mandated fields of concern. The latter will range all the way from basic, fundamental, mission-oriented research, to pest management technology design and development, to technology validation and pilot-scale field testing, and to widespread dissemination of these innovative technologies through the national research and extension systems right up to the rural households;

- **Second**, the comprehensive purview required to thoroughly understand the major insect targets, all the way from population ecology and host-insect relationships, to cellular and molecular bases of these associations, and to the manipulation of the resulting pest management technologies and the factors that integrate to assure the sustainability of such technologies;

- **Third**, the existence of a dynamic family of R&D institutions composed of at least five elements: (a) the ICIPE headquarters establishment, concentrating on cellular and molecular biosciences, biotechnology, and behavioural sciences; (b) ICIPE managed, sponsored, or other field research stations located in key agro-ecological zones in Kenya (representing similar ecologies elsewhere in the tropics) that concentrate on population studies, host-insect relations, social science interface research, and technology design and development; (c) collaborating institutions in Africa, South-East Asia, and Latin America and the Caribbean through a consolidated pan-tropical PESTNET, concerned primarily with interactive technology development and validation for their specific agro-ecologies, and their pilot-scale demonstration under these circumstances; and (d) a network of high-level education and training institutions in tropical insect science (under ARPPIS) which includes the degree-awarding ICIPE Graduate School;

- **Fourth**, the consolidation of a worldwide ICIPE "invisible college", consisting of active insect scientists who have graduated from the ARPPIS network; former Postdoctoral Research Fellows, Research Associates, Professorial Fellows, and Visiting Scientists; and other R&D cooperators.

From this leadership platform, the ICIPE will have the opportunity to venture into new areas of R&D, including the beneficial uses of insects, such as in pollination and nutrition, and long-distance insect migrants. Such venturesome R&D will be undertaken while maintaining ICIPE's modest size and cost-effectiveness.

The greatest management challenge will be in the field of marketing the ICIPE to governments, the donor community, the private sector, and private philanthropy. The measures of success for the ICIPE are clear to us: **the** indicators must include measures of **scientific impact** (through the number and quality of peer-reviewed research publications, international citation of ICIPE's R&D, and patents granted); tools, devices, approaches, and systems that ICIPE's **technology generation** have brought to life to manage major tropical pests; the extent to which ICIPE's **technologies are adopted** by ICIPE's prime constituency in the tropics; and **the number of graduate students who elect to have their degrees awarded by the ICIPE Graduate School,** and the marketability of such graduates in the tropics. If the ICIPE meets these success yardsticks, and assuming that it is still true that the social rate of return for scientific research still exceeds the private rate of return,[17] then ICIPE would have justified a continued and substantial investment in its R&D effort over the next 10–15 years.

This optimism, we earnestly hope, is not misplaced. Fifteen years after the founding of the ICIPE in April 1970, one of the key pioneers of the ICIPE, Victor Rabinowitch, had this to say in reviewing the ICIPE institutional experiment:[18]

> "...ICIPE is truly an international success story and continues to be so. Its scientists come from all over the world, publish extensively in international journals, attend and address international conferences, organise international seminars and symposia, and conduct training programs for insect scientists and administrators world-wide. To those who were skeptical that an international research institute of world standard could be created and thrive in Africa, I can only say ICIPE has proven them wrong. We have survived growing pains and occasional problem of vitamin deficiency (funds, in our case) to become stronger and more vital than before. If lessons are to be drawn from this experience, they are that strength and vitality relate to a clear sense of purpose, a dynamic leadership, an enthusiastic and capable staff, and the recognition worldwide that important contributions are being made."

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The Scope of Tropical Insect Pest Problems and Priorities in Integrated Pest Management Research and Development: The Indian Example

A.K. RAHEJA

6

The Scope of Tropical Insect Pest Problems and Priorities in Integrated Pest Management Research and Development: The Indian Example

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INTRODUCTION

Exciting changes in agriculture are taking place in the tropical countries of the world. Food production has been increased by introduction of modern technology, the use of high yielding varieties and optimisation of agricultural inputs such as chemical fertilisers and pesticides. Associated with these changes are, however, the problems of sustainability and environment quality. Sustainable agriculture has been defined by the Technical Advisory Committee (TAC) of Consultative Group in Agricultural Research as one that "involves the successful management of resources for agriculture to satisfy changing human needs while maintaining or enhancing the quality of environment and conserving natural resources". The challenge of sustainable agriculture is not new but our predicament is its huge dimensions. To maintain adequate food production without degrading the natural resources requires an effort colossal both in its magnitude and complexity. According to the 1987 Report of the World Commission on Environment and Development, this presents "a greater challenge to world's food systems than they may ever face again."

While tremendous advances have been made in the last 3–4 decades in agricultural research, the breadth of change is disappointing and still a large number of farmers do not appear to be affected by the new technology. "Resource limitation" is said to be responsible for much lack of progress as small farmers are unable to extract the high yielding potential of new varieties. This is specially true in case of plant protection which is an essential component of any crop improvement effort. Efficacy of resource use will be the name of the game in agricultural development in future. The great majority of farmers in the tropics will continue to have access to only a limited rural infrastructure. The development of appropriate Integrated Pest Management (IPM) packages must, therefore, be our first priority.

In India, crop losses due to all pests range from 10–30% per year depending on the crop and the environment. Annual crop loss due to pests in India is estimated at Rs.60–70 billion (U.S.$ 3.0–3.5 billion). Of this, losses from weeds are 33%, from diseases 26%, from insects and rodents 26% and birds, nematodes etc., account for the rest. More than 70% of pesticides used in India are insecticides, 12–15% fungicides and about 4–5% are weedicides.

CURRENT TRENDS IN CROP PEST CONTROL IN INDIA

Pest control in India is still largely dependent on the use of synthetic chemicals. In most instances, spray schedules are based on calenders with little consideration of real necessity and little regard to various detrimental side effects. This has resulted in degradation of the environment, while our pest problems seem greater than ever. At first, we experienced minor hints of trouble, but these have rapidly become alarming. There are more and more reports of resistance of pests to pesticides, the number of pest outbreaks have increased and many inocuous insect species have attained the status of serious pests in recent years.

There has been a steep growth in pesticide usage in the country and the estimated demand for pesticide has risen to 82,000 metric tonnes (technical grade) in 1991. Cotton and paddy account for almost 70% of the total pesticide

Table 1. Pesticides market share (%) in relation to total cropped area and pest outbreaks recorded

Crop	Pesticide share (%)	Cropped area share (%)	Major pests outbreaks
Cotton	51.6	5	Whitefly, *Heliothis*, spider mite
Paddy	17.2	24	Brown plant hopper, gall midge, armyworm
Fruits and vegetables	13.2	3	Spider mite, mango hopper
Plantation	7.8	2	
Cereals, millets, oilseeds and pulses	6.7	58	Shoot fly (sorghum) *Heliothis* (pulses)
Sugarcane	2.3	2	
Others	1.2	6	

Note: Modified from *Farmer's Journal* (1988).

Table 2. Statewise pesticides consumption and pest outbreaks

State	Pesticide consumption (million rupees)	% to total outbreaks	Pests outbreaks
Andhra Pradesh	1865.0	33.6	Whitefly, *Heliothis*, BPH gall midge, spider mite
Karnataka	899.7	16.2	Spider mite, groundnut leaf miner
Gujarat	842.7	15.2	Spider mite
Punjab	633.9	11.4	Spider mite
Maharashtra	285.2	5.1	Whitefly
Others	1029.9	18.5	

Note: Pesticide consumption figures are based on information compiled by Srivastava and Patel (1988).

consumption (Table 1). The data on spatial distribution of pesticides consumption in agriculture for the year 1984–85 are presented in Table 2. It is interesting to note that 33.6% of the total consumption of pesticides in India is concentrated only in Andhra Pradesh. The two whitefly epidemics consecutively during 1983–84 and 1984–85 and the havoc brought by American boll-worm, *Heliothis armigera* on cotton crop in recent years in Guntur and Prakasham districts of Andhra Pradesh are, therefore, not mere coincidences but indications of self-defeating features of injudicious use of broad-spectrum pesticides. The information contained in Tables 1 and 2 clearly indicates that insect outbreaks have been maximum in the areas or crops where pesticide consumption is maximum. The indiscriminate use of pesticides at least in cotton and paddy is of such magnitude that a re-appraisal is necessary.

Contributions by Indian scientists on the components of IPM system are well documented. Biological control of pests, the development of resistant crop varieties, the manipulation of cultural practices to reduce pest incidence, and the use of botanicals, such as neem are practices well-known in Indian agriculture. Additionally, crop diversity, intercropping, and the fact that most agricultural holdings are relatively small and intensively managed are all factors that favour the implementation of IPM at the farm level. Indian scientists and extensionists are all aware of the problems that can result from overuse of pesticides, and the concept of economic threshold for pesticides use is well-organised in the research community. In spite of these factors favouring IPM implementation, pesticides use continues to increase.

STATE OF IPM IN INDIA

National Policy

The Government of India and the Indian Council of Agricultural Research (ICAR) are fully committed to the promotion of the IPM concept. The "development of Integrated Pest Management practices to optimise plant protection" has been included under the "Priorities and Thrust Areas" for the Eighth Plan (1990–95) of the Department of Agricultural Research and Education of the Ministry of Agriculture, Government of India.

The Government is also fully seized of the need for an effective and pragmatic National Pesticide Policy. Various steps have been taken in this direction and specific expert committees have been formed to advise the government on the various aspects of pesticide usage in the country.

Research

India has a large and excellent infrastructure including well-trained scientific manpower. Research support for plant protection (emphasis on IPM) is provided by the Indian Council of Agricultural Research (ICAR) through its various research institutions and All India Coordinated Research Projects and the 26 State Agricultural Universities (SAU).

Plant protection research is an in-built component of crop improvement research and its various disciplines are incorporated in the Crop Research Institutes as well as in the All India Coordinated Crop Improvements Projects of the Indian Council of Agricultural Research. An integrated strategy for the management of major pests and diseases has been possible by, (i) breeding new varieties with built-in resistance, (ii) modifying agronomical practices to evade or reduce pest incidence, (iii) recommending safe and efficient methods of pest control through pest surveys and monitoring, and (iv) biological control of pests with the help of their natural enemies like parasites, predators and pathogens. However, there are certain special areas concerning pests and diseases or beneficial insects where the ICAR has implemented separate All India Coordinated Research Projects. These Coordinated Research Projects are:

(i) Biological control of crop pests and weeds
(ii) Nematode pests of crop pests
(iii) Rodent pests
(iv) White grub
(v) Seed-borne diseases
(vi) Economic ornithology
(vii) Honey bee research and training
(viii) Vet bovine diseases
(ix) Agricultural acarology
(x) Apple scab disease
(xi) Pesticide residues

In addition, a National Centre for Integrated Pest Management has been recently established in Faridabad with the aim of evolving environmentally sound pest management strategies for pest and disease problems in major crops.

Easily adaptable and economically viable integrated pest management strategies have been developed for the control of major pests in rice, cotton, pulses, sugarcane, etc. Large success in biological control of crop pests has been in the conservation of biologically useful organisms through either selective use of pesticides or their avoidance. Control of *Pyrilla* and top borer of sugarcane, mealy-bug of coffee, lepidopterous pests affecting cotton, tobacco, coconut, sugarcane, etc. are a few examples where success has been achieved through the release of biocontrol agents. A major achievement has been the development of mass rearing technology for biotic agents such as *Trichogramma* spp., *Chrsoperla* spp. and nuclear polyhedrosis viruses (NPV) of *Heliothis* and *Spodoptera*. Spectacular success has been achieved in biological control of two aquatic weeds, viz., the water hyacinth *Eichhornia crassipes* and the water fern, *Sylvania molesta*.

The major thrust in the next five years of the VIII Plan of the country from 1990–95 will continue to be on promotion of IPM concept in all major crops. This will include emphasis on:

(i) biological control of insect and plant pathogens, specially mass multiplication and development of appropriate systems for dissemination of biological control agents; and use of novel methods such as insect growth regulators, pheromones and kairomones, etc.;

(ii) survey, surveillance and monitoring in order to develop medium- and long-term pest forecasting and forewarning systems;

(iii) a national support system for screening of germplasm against major pest and disease problems;

(iv) application of biotechnology for pest and disease management including development of efficient quarantine techniques for exchange of disease and pest free germplasm;

(v) research on pesticides with particular emphasis on compounds of botanical origin;

(vi) monitoring the development of pest resistance to pesticides (IPM); and

(vii) establishment of a centre for bio-systematics of agriculturally important organisms.

Extension

Agriculture is a state subject in India and extension *per se* is the responsibility of the state governments. However, the appropriate IPM technologies developed by ICAR/SAUs are validated through "First line extension programmes", e.g. Operational Research Projects, Lab-to-Land programmes, etc. The technology thus validated is then taken up for further extension by the concerned departments of agriculture/horticulture of the state governments.

Role of Government and Private Sector in Promotion of IPM

Pilot projects on IPM were initiated by the government in the V Plan (1975–80) in a modest way. Pest surveillance activities which were first started in 1980 soon after India became a signatory to FAO-Intercountry IPC Rice programmes have now been extended to all the major crops.

In addition, the Government of India, Ministry of Agriculture has established 25 centrally funded IPM centres in the country under the Directorate of Plant Protection, Quarantine and Storage to provide critical inputs needed for implementation of IPM programmes and to act as catalysts and model stations. These centres have been mandated to educate and create mass awareness of IPM among state extension functionaries and farmers through training and demonstrations. As these IPM centres can cover only about 5% of the total area under crops, it has been proposed that apart from 25 IPM centres operated by the Central Government, 228 IPM centres approximately one for every two districts, should be established by the State Government in the next five years of the VIII Plan. Fifty per cent of the cost of these centres would be borne by the Central Government. It is envisaged that there would be about 550 such centres in the country by the year 2000.

At present the Central Government is giving about Rs.580 million as subsidy for distribution of pesticides under various crop schemes. In order to promote IPM, it has been proposed that this expenditure should be reduced substantially and the saving diverted to IPM schemes.

A few private commercial insectaries in the country are now successfully producing biotic agents for growers, especially in southern India. A number of sugar factories are mass rearing egg parasites and distributing to these farmers for control of sugarcane borers. Also there are some socially conscious voluntary organisations promoting in general better agriculture and IPM. Overall, however, the role of private sector in popularising the adoption of IPM is very small.

IPM PROGRAMMES: TWO CASE STUDIES

Rice IPM

Rice is now cropped continuously in the southern, central and coastal areas of the country. Increased irrigation facilities coupled with high density planting and increased application of inorganic fertilisers have accentuated pest problems. Disease epidemics of bacterial blight, tungro virus and blast, increase in the incidence and damage by stem borer, gall midge, brown plant hopper, and weeds such as *Echinochloa* have emerged as major challenges. The use of pesticides became inevitable for control of rice pests and today the rice crop's share of the total pesticide use in agriculture is about 17%. This intensive usage of pesticide has had serious ecological consequences resulting for instance, in the emergence of minor pests as major pests such as leaf folder, whitebacked plant hopper and green leaf-hopper; development of biotypes of brown plant hopper and resurgence of BPH.

The Indian Council of Agricultural Research launched an Operational Research Project on rice IPM at six locations in the mid-seventies. Packages of IPM practices for different regions of the country have been developed by ICAR and SAUs. The main feature of the IPM packages has been strategic use of host resistance, i.e., use of resistant varieties, modified cultural practices such as raising community rice nursery, prophylactic treatment through seedling root dip etc., proper planting, spacing, conservation of bio-control agents, pest surveillance and monitoring of economic threshold levels of pests and need-based application of selective pesticides. These packages of technology were translated into action by large-scale field demonstrations, training of state extension functionaries and farmers.

IPM efforts in rice have paid rich dividends in the form of bringing about a change in the perception and attitude of extension workers. It has also been clearly demonstrated that IPM approach can yield greater economic returns, besides other benefits to the ecosystem (Table 3).

Table 3. Cost-benefit ratio of adopting rice IPM

Particulars	Units	IPM	Non-IPM	Net gains *
National demonstration data (1989)				
Yield obtained	Kg/ha	2300	2000	300 (Rs.600)
No. of pesticide applications	Nos.	1	3	2 Nos. less
Cost of PP input	Rs	100	300	200
Cost of cultivation	Rs	2000	2500	500

*Net gain (IPM over non-IPM) = Rs. 1100/ha.

Particulars	Units	IPM	Non-IPM	Net gains *
Tamil Nadu (1989)				
Yield obtained	Kg/ha	6750	6250	500
Cost of cultivation	Rs	4600	5000	500
Total receipts	Rs	13,500	12,500	1000
Cost benefit ratio	–	1.0:3.0	1.0:2.5	–

*Net gain (IPM over non-IPM) = Rs. 1500/ha.

Cotton IPM

The magnitude of insect pest problem in the cotton agro-ecosystem has forced the farmers to depend heavily on insecticides. Cotton consumes over 50% of insecticides used annually in the country. Indiscriminate use of insecticides, however, instead of increasing the productivity, has resulted in the following undesirable ecological changes:

(a) development of resistance in pest population, especially *Heliothis*.
(b) induced resurgence of insect pests, e.g. whitefly.
(c) destruction of natural enemies.
(d) contamination of food chain and environment.
(e) loss of ecological security.

Hence, adoption of an alternate technology which is ecologically viable and economically feasible has become imperative in the cotton growing areas of the country.

Research results have shown that the dependence on insecticides can be considerably reduced by adoption of the integrated pest management approach which includes cultural and mechanical manipulation, biological control by timely release of parasites and predators, the nuclear polyhedrosis virus and the judicious use of insecticides.

The benefits of IPM have been also conclusively demonstrated in the farmers' fields through Operational IPM project in some of the more progressive cotton growing states, especially Tamil Nadu. These results show that IPM system for suppression of insects can maintain the high productivity of cotton varieties and hybrids, increase the abundance of the natural enemies and reduce the cost of insecticides (Figure 1).

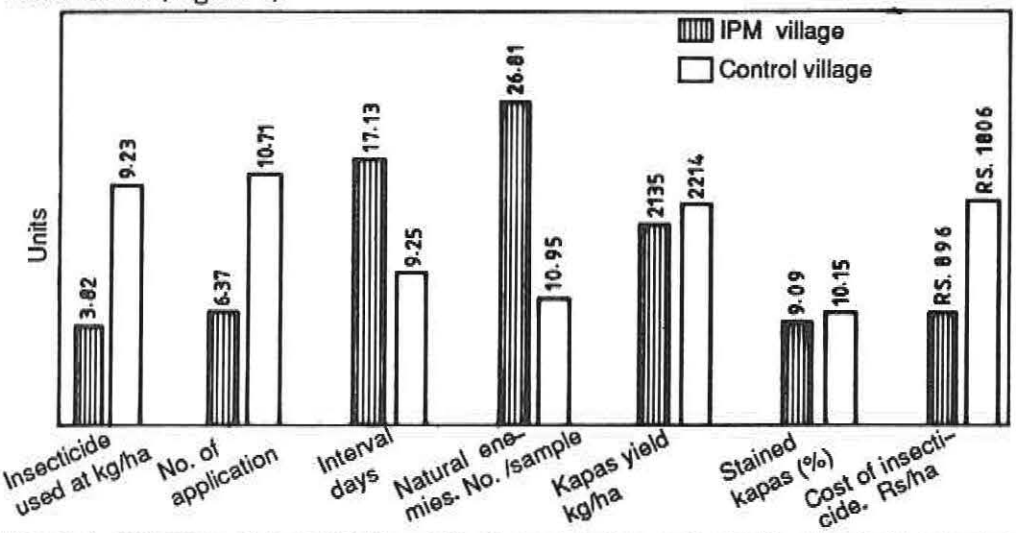

Figure 1. Utilisation of insecticides, yield of seed cotton and activity of natural enemies in IPM village. Source: ICAR 1989.

The recent cotton disasters (whitefly 1983 & 84; *Heliothis* 1987 & 88) in Andhra Pradesh and other states of the country and the resultant socio-economic problems have attracted a lot of public attention. For IPM these disasters have come as a blessing in disguise. The cotton growers and the extension workers in these states are now much more conscious of the problems associated with excessive use of insecticides and are more willing to accept the IPM approach. The surveillance activities by both state and federal agencies have been strengthened and the number of sprays have been reduced from as many as 20 to 3–6 applications in most cases. There is greater vigilance against the sale of spurious chemicals. Apart from this, the pesticide industry itself has become concerned with the misuse of chemicals and the increasing incidence of pesticide resistance, especially in *Heliothis*. These companies have set up their own communication and extension programmes and are working with the government agencies in conducting demonstration trials for the benefit of the farmers.

CRITICAL RESEARCH NEEDS

The knowledge and information required to implement IPM strategies will have to be generated by basic research by carefully examining the factors affecting population regulation in various agro-ecological zones. Investigations are needed in population ecology, systematics, behaviour, physiology, and biochemistry. The maintenance of a broad basic research effort can only yield suggestions for novel approaches to the challenge of rational pest management.

The emphasis in future research needs to be shifted from crop-based research to pest-oriented research. This view has been further reinforced by the recent outbreaks of polyphagous pests like *Heliothis* and whitefly which attack a number of different hosts.

Host Selection and Feeding Behaviour

There is an urgent need to identify and understand the role of visual, chemical, mechanical and biological signals involved in different steps of an insect's selection behaviour. Nutrition ecology is another area requiring attention. The role of chemicals mediating the feeding behaviour is not fully understood and little is known about their action threshold in crops. We must broaden and refine our basic knowledge of plant-insect relations. Host selection has been studied in only a few economically important insects. There is perhaps no example in which all the behaviour cues involved in host selection have been identified. Also, there is very little information available on the manner in which multiple sensor cues reinforce each other and are integrated by the insect's central nervous system. This presents both a challenge and opportunity to basic scientists for solving entomological problems of agricultural importance.

Breeding for Resistance

The green revolution of the seventies was a classical example of breakthrough in wheat production because of the breeding of disease resistant varieties.

Breeding for resistant varieties has also been adopted with certain amount of success in other crops such as paddy, sorghum, pulses, etc. Breeding of high yield varieties with in-built pest and disease resistance is one of the top priority areas of research in the next plan. Special emphasis should be given to biotechnological approach to exploit somaclonal variation and genetic engineering to evolve new multiple resistant varieties.

While there is no question about the importance of resistance breeding in preventing insect and disease damage, this approach must be tempered by heavy doses of caution. Breeding for high yields and other desirable traits has fostered a widespread trend towards large-scale monocultures. Intensive cultivation of high yielding varieties over contiguous areas has facilitated the pests of hitherto minor importance to acquire a status of major pests, for example whitefly in cotton and gall midge on paddy and sorghum. While the traditional agro-ecosystem was genetically diverse, there is now a danger of genetic erosion due to depletion of the gene base of many crop plants. There is also the problem of the evolution of biotypes which break the resistance. It is also unlikely that most severe pests of our crops such as *Heliothis* will be adequately controlled by plant resistance only.

Biological Control

The need for improving and expanding the use of biotic control agents is well recognised. Technology for their mass propagation, harvesting, packaging, storage, distribution and release or application is now viewed as high priority.

The management of natural enemies (predators, parasites, pathogens) and selected beneficial organisms (antagonists, competitors and allelopaths, etc.) and their products to reduce pest population and their effects is one of the most important components of our pest management strategy. The emphasis, therefore, is to develop pest management systems that enhance the survival and effectiveness of biological control agents by selective and minimal use of chemical pesticides.

Two aspects of biological control research that require attention are systematics and genetic improvement of biotic agents (through biotype selection, conventional crosses and genetic engineering) to enhance key attributes such as pesticide resistance and climatic tolerance. Research must also be continued on the biology, ecology and behaviour of biotic agents for using them more effectively in pest control.

Proper identification and quarantine facilities are vital to the continued success of biological control programme. Slight mistakes in identification or escape of exotic insects from quarantine can lead to disastrous results. There is a tendency to emphasise technology at the expense of the classical biological control approach. A balance between innovative technology and proven methods of biological control is essential for advancement of this field.

Considerable success in the country has been achieved in the use of microbials for the control of insect pests. Among the microbial pathogens, the baculoviruses especially nuclear polyhedrosis and granulosis viruses are the most promising. The spore forming bacteria, *Bacillus thuringiensis*, and *Bacillus popilliae* and also some species of entomogenous fungi have also been utilised with varied degree of success. Microbial insecticides are considered as possible safe and effective replacement for chemical insecticides. However, compared to chemicals, these are poorly understood, little used and insufficiently supported.

Technology for mass production of pathogens such as NPV of *Heliothis* and *Spodoptera* has been developed but needs much refinement. There is also the need for development and optimisation of application techniques to place the microbials at their most favourable infection sites. The critical research needs would also include identification of new potential candidate micro-organisms and their development into microbial pesticides; use of classical or molecular genetics to produce novel pesticides or enhance the effectiveness of those already in use; development of improved methods for characterising and identifying biotypes; consistent availability of easily produced, effective, quality assured preparation and maintenance of field infectivity of natural and artificially dispersed microbials. The most important aspect in the success of microbial control is the development of an overall strategy that includes the use of microbials both as insecticides and in pest management programmes.

The development of computer-based decision-making technology bringing together climatological, microclimate, economic and biological data that will allow decision-making for maximising the usefulness and effectiveness of biotic agents is very essential.

Insect Growth Regulators and Behaviour Modifying Chemicals

A number of natural and synthetic hormonal chemicals are known. These include insect hormones, hormone analogues, and a diversity of synthetic compounds that mimic the action of insect hormones and/or interfere with hormonal regulated process of insects. These compounds cause diverse disruptive effects on insect development, moulting, metamorphosis, and reproduction when they are either applied directly to the insect or added to insect's diet or medium in extremely small quantities. Some of the synthetic compounds, particularly few more active juvenile hormones, and chitin inhibitors have been commercially formulated. The challenge lies in translating the disruptive effects of these compounds into effective pest management tools.

Insect pheromones and kairomones offer great promise in pest management. While pheromones can be employed in survey, monitoring, trapping and mating disruption of insects, kairomones can be used to increase the efficacy of parasitoids and predators. Research effort in future would have to be directed to evaluation of physical, chemical and biological factors influencing pheromonal catches for development of high efficiency pheromonal traps and formulations. An essential requirement is the development of statistical modelling of pheromonal catches in relation to field populations and its application to pest forecasting.

Biotechnology

Biotechnology will play a major role in developing new approaches to pest control. Our research should aim at using the modern tools of biotechnology to increase the efficiency of the established microbial agents by enhancing their virulence, increasing/decreasing their host range and modifying their tolerance to the environment. The development of genetically engineered microbial pesticides offers exciting possibilities for the future. Another exciting area of research is the development of transgenic crop plants with insect resistant genes from *Bacillus thuringiensis.*

Insect Systematics

This has been a neglected area of research in the country. In-fact, taxonomists as a group appear to be becoming extinct and very little support is being given to maintenance and curating of taxonomy collections/museums in ICAR Institutes and Agricultural Universities. Research activity in insect systematics should not only be encouraged but also adequately supported. The development of comprehensive bio-systematic data base must be given top priority.

Pesticides

Management of pesticide use is an integral part of IPM. Our priority should be to refine our pesticide application recommendations so as to reduce their use to the absolute minimum. Research must also be intensified on other pesticide related problems such as residues, resistance, etc. The challenge to the industry lies in developing novel molecules and products that are less injurious to the environment, and more active against pests and, of course, are also not more expensive to use. Basic research into developing biodegradable pesticides by better understanding of the biochemical processes in the intoxication and detoxication process could be initiated by some of the high-tech research laboratories. Similarly, such research could also examine the degradation of pesticides by micro-organisms. Very little attention has been given to pesticide application techniques in the past and this deficiency must be corrected. Most spray application methods conventionally used though quite effective are wasteful and inefficient. Much of the pesticide is not deposited on the target resulting in contamination of the non-target areas, thus increasing the incompatibility of the chemicals with other methods of control.

Insecticide resistance management

In India, in the last few years, the outbreaks of *Heliothis* in Andhra Pradesh, Tamil Nadu and more recently in Punjab and Haryana have caused great alarm. A very high degree of resistance to pyrethroids has been found in *Heliothis* populations in all the major cotton growing areas of the country. In addition resistance has also been reported in *Heliothis* on pigeonpea and chickpea.

In order to ensure long-term effectiveness and provide guidelines for judicious use of all classes of insecticides, sound resistance management strategies are needed. This need is of course greatest in crops like cotton, where numerous insecticide applications throughout the season exert significant selection pressure on several arthropod species.

Botanical pesticides

A lot has been recently written about using "neem" and other plant products as pesticides. Neem has also been the subject of many a national and international symposia and seminar. While there is no doubt about the potential of neem derivatives as an important tool in pest management programmes, we are still far away from the stage of their effective utilisation. There is, therefore, an urgent need to critically review the technology and develop inter-institutional and multi-disciplinary approach to solve the problems associated with the use of botanical pesticides. Cheap and simple methods for isolation of pure active compounds such as azadirachtin must be developed. Research is also needed to further elucidate the biological activity of neem compounds and their effect on insect growth and behaviour. Research and development of formulations of neem is being carried out in a number of laboratories in the country and we also now have a few commercial formulations available in India. There is need for standardisation of these formulations in terms of the active ingredient and their bio-efficacy. It would appear that complexity of neem compounds precludes their synthetic production in the near future. Industry, however, can play a major role in development of suitable and stable formulations.

Vigilance Against Introduction of New Pests

This aspect has gained special significance with the introduction of the new liberalised National Seed Policy in India which along with inadequate quarantine facilities and procedures has greatly increased the chances of introduction of new weeds, pathogens and insects into the country. Of course, weeds and pathogens have a greater chance of entry than insects. The arrival in the country of the psyllid pest, *Heteropsylla cubana* now affecting large tracts of *Lucaena* plantations in many states is also a matter of great concern. There is obviously a need for greater vigilance to prevent such occurrence. Some of the insects on which watch is essential include the cotton boll weevil, *Anthonomus grandis*, tomato leaf miner, *Liriomyza* sp. and the Mediterranean fruit fly, *Ceratitis capitata*.

Integrated Pest Management

Volumes have been written about IPM and its relevance to sustained agriculture and environmental quality. However, as pointed out by Dr. E.J. Tait, in most cases, only lip service is paid to IPM by most researchers, academicians and advisory and extension staff, many of whom would also claim to be practicing it. The meaning of the concept of IPM is seldom specified in detail. This is certainly not enough when it comes to planning an IPM system.

Implementation of IPM is only possible if criteria necessary for appropriate decision-making are developed. The utilisation of the concept of "economic threshold" and "economic injury level" still encounter numerous difficulties. A system management approach is essential for an effective IPM strategy. The research must be intensified to understand the interactions between crop, pest, climate, and natural enemies to fine tune our control approach to a particular pest problem in an agro-ecosystem.

The survey and surveillance programmes must be strengthened and research is needed to develop effective methodology for sampling, collection and analysis of such data. Development of forecasting and forewarning systems with corresponding advisory services are pre-requisites for effective implementation of IPM programmes. Here, the role of plant protection advisory services must be emphasised. Trained and specialised extension personnel are needed to undertake monitoring and scouting to provide forecasting and forewarning services and also to ensure timely action. In this respect, establishment of plant clinic centres at district level as has been done in Tamil Nadu is a step in the right direction.

CONCLUDING REMARKS

Pests will continue to be a major constraint and a serious threat to yield stability. Increases in crop yields in India (and many other countries of the tropics) over the past two decades have reached a stage of rapidly diminishing returns. Even varieties that possess high yield potential will be unable to express this trait without pest control. Good pest management can reduce production variability and will be more lasting and even less expensive than the reliance on continuous breeding programmes. This is both an opportunity and a challenge to the ingenuity of the research workers — basic and applied, in the field of entomology and IPM.

Our dilemma today is that while we are fully aware of the potential hazards of the use of chemical pesticides and although there have been significant strides, we are still far away from a truly predictive ecology. We can neither permit this lack of knowledge to serve as a basis for abandonment of use of all chemicals (as advocated by some environmentalists) nor can this become a basis for an approach that ignores environmental insults. Thus, to quote Dr. Donald S. Farner from his introduction to *Pest Control — Strategies for the Future*, there is a critical need for two developments: (i) We must have an effective algebra of decision-making — an apparatus that can produce the best decision in light of an always deficient but always improving body of knowledge of the beneficial and deleterious effects of control practices. It must be an apparatus that works in terms of successive proximations as more knowledge and new options become available. (ii) We must continue to evolve, through research and development, "a much broader spectrum of control strategies to provide additional and optional inputs into the decision-making apparatus."

7

The Practice of Integrated Pest Management Within Resource-Limited Livestock Farming Situations

H.G.B. CHIDZYUKA and J.B. MULILO

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The Practice of Integrated Pest Management Within Resource-Limited Livestock Farming Situations

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INTRODUCTION

The current threat of world famine vindicated by food shortages creates a vivid precedence for the world community awareness to boost food production which is needed to feed the present population and those masses of the year 2000.

According to the Commonwealth Agriculture Bureaux (1979) the situation is that the world population is rising at an alarming rate from 1500 million in 1900 and 4000 million in 1975 to 8000 million in the year 2000. The problem is, how to produce the required food, at the same time preserving the environment and its natural balances. The amount of food resources available are not adequate for meaningful and comfortable living for the majority of the people. Food production inputs in terms of machinery, capital and labour costs have all contributed to this hardship. Other constraints include limited land for the expansion of agriculture and the food losses caused by insects and other pests. But the need to produce more food is still the cardinal condition for human survival.

However, the strategy for increased food production is still dependent on intensification of agriculture both under large-scale mechanisation and small-scale resource-limited farming situations. The mechanised large-scale farming systems, that were thought to produce excess food to feed everyone on the planet, have suffered serious setbacks because of the escalating costs of the technologies. The small-scale farmers are equally at the mercy of the applied science and technology to assist them with cheaper production know-how.

Apart from pests and direct production costs, there are problems of drought and floods that destroy farm produce thereby drastically reducing yields. It is these farming constraints that heavily contribute to food shortages. For example, while drought has reduced harvest in all of the countries bordering the Sahelian zone from Mauritania in the west, to the Sudan and Ethiopia in the east, civil strife continues in a number of countries pointing to the fact that Africa below the Sahara will need substantial increases in food aid.[1] Most important of all are the pests that cause complete damage to crops and livestock through transmission of fatal diseases. For this reason efforts to contain these production constraints are actively being sought through research.

Pest management being one of the most complex problems has received considerable attention in order to save the much needed food stocks. The combined techniques for attempting to control pest problems must heavily rely on the practice of Integrated Pest Management.

THE PRACTICE OF IPM

The term IPM combines Integrated Pest Control (IPC) and Pest Management (PM). The term IPC was originally proposed to describe the integration of biological and chemical control to achieve a Pest Management system.[2,3] However, in 1960s, FAO adopted the term and broadened its definition to emphasise the integration of all compatible tactics into a pest control strategy.[4]

In 1972 the FAO panel of experts defined PM as "an all exclusive term that describes man's continuous efforts to control populations of pest species at levels that are advantageous to his well being." They added "although there has been a widespread tendency to synonymise the terms IPM and PM, they are not synonymous. Pest Management includes all approaches ranging from a single, to the most sophisticated integrated control systems. Thus, PM is a general term which applies to any form of pest population manipulation invoked by man, its objective being to optimise control in terms of realistic overall economic, social and environmental needs of mankind."

Smith (1978) proposed that "Integrated Pest Control is a multi-disciplinary ecological approach to the management of pest populations, which utilises a variety of control tactics compatibly in a single coordinated pest management system.[5] In its operation, IPC is a multi-tactical approach that encourages the fullest use of natural mortality factors complemented when necessary by means of pest management. Also implicit in its definition is the understanding that imposed artificial control measures, notably conventional pesticides, should be used only where economic injury thresholds would otherwise be exceeded. As a corollary to this, IPC is not dependent on any single control procedure or tactic. For each (farming) situation, the strategy is to coordinate the relevant tactics with the natural regulating and limiting elements of the environment."

The following are some illustrations of the practice of IPM in the resource-limited livestock farming situations as guided by the above definitions. IPM is a Pest Management system that, in the context of the associated environment and the population dynamics of the pest species, utilises all suitable techniques and methods in as compatible a manner as possible and maintains pest population at levels below those causing economic injury.

The Practice of IPM in Tick Control in Zambia

The tick has been the most frustrating livestock pest for almost 100 years.[6]

Elsewhere in the world, the practice of tick control using integrated approach has yielded fruitful results as assessed by cost-benefit analysis. A typical case is the control of the Australian cattle tick, *Boophilus microplus*.

The three approaches used to contain the tick problem were chemical control, pasture spelling, and the introduction of cattle that limit the numbers of ticks which survive on them. The first two approaches always depend on good management. Dipping costs are very high and ticks eventually become resistant to chemicals. In many resource-limited farming situations, including in Zambia, pasture spelling cannot be practised because of limited land and land husbandry practices (e.g. communal grazing). Tick resistant cattle may have been available for many years but the idea of using them was only proposed by Munro, an Australian dairy farmer, some 70 years ago who observed that some of his Jersey cows had fewer ticks than others. He attributed this to tick resistant trait which is common among zebu cattle. Another farmer used this idea and produced cross-breeds with a tick resistant trait. This aspect of tick control, complemented with reduced acaricide use illustrates IPM in tick control.

In Zambia the concept of IPM in tick control dates back to Matthysse (1954).[7] He intensively studied different techniques of acaricide application in order to control ticks and tick-borne diseases. However, it soon became apparent that intensive acaricide usage was becoming unaffordable to the resource-limited small-scale farmers. Since then, studies in the tick pest ecology have yielded sufficient information on which to base integrated pest management approach to tick control.[8,9,10,11] It is upon such ecological data on the seasonal abundance of ticks that tick control using reduced amounts of acaricides during the periods of highest tick challenge have been practised and have proved cost-beneficial.[12]

Although host resistance *per se* has not been studied in Zambia, certain cattle within the local breeds have shown tick resistant characteristics. In the continuing studies on the economics of tick control in Zambia, Mulilo (1989 unpub.) observed that among the Ila cattle (sanga), there were almost 50% which carried relatively fewer ticks than the rest.[13] Furthermore, when two separate groups of these cattle (i.e. group one under intensive acaricide treatment and group two without tick control) undergo strategic tick control practice[12] those from group one carry more ticks than those from group two.

In practising IPM, therefore, this means that breed selection of animals which show tick resistant traits and less exposed to intensive acaricide treatment can play a vital role in tick control under resource-limited livestock farming situations.

Similar ideas on the practice of IPM were discussed by Chidzyuka and Mulilo[14] in their paper to the FAO expert consultation on revision of strategies for the control of ticks and tick-borne diseases. As the mandatory tick control practice continues in order to improve livestock health and productivity, it is of great economic importance that control be dependent on seasonal activities, parasitic period, predilection sites, the efficacy of an acaricide and cattle breeds, manipulated in a manner to achieve the desired production goals.

It was a government policy in Zambia to dip cattle weekly until 1985[15] when the practice changed to 26 dippings during the wet season only. To this end Chidzyuka and Mulilo[14] did not just advocate tick resistant cattle production but also recommended that IPM is necessary under resource-limited farming situations. They further proposed that because of the uneconomic use of acaricides, strategic tick control should be practised because it is cost saving. Pour-on formulations of acaricides demand less logistics thus reducing operational costs. Some of these formulations also act against more than one pest. Finally, wherever possible, proven vaccines should be used against ticks and tick-borne diseases.

IPM Practice in Tsetse and Trypanosomiasis Control

Zambia has a total land mass of about 750,000 km^2, one third of which (250,000 km^2) is tsetse infested. Tsetse transmitted animal, particularly bovine trypanosomiasis causes severe limitations to livestock production and productivity.

The magnitude of the pest problem varies according to the occurrence of the vector species. The *fusca* group (*Glossina brevipalpis*) has a low socio-economic impact on communities. The *palpalis* group (*Glossina fuscipes*) has not been studied adequately to reveal its economic significance. This group of flies occurs together with the *morsitans* group (*Glossina morsitans*) which is widespread and covers 99% of the tsetse infested areas. *Glossina pallidipes* (*morsitans* group) is the most economically important species because it transmits trypanosomiasis to both animals and humans.

The tsetse transmitted trypanosomiasis causes heavy mortalities of livestock and has debilitating effects on humans, rendering them economically unproductive. The traditional methods of tsetse control have been game exclusion, bush clearing and large-scale application of insecticides either by aerial or ground sprays. The latter has been very costly in terms of aircraft hiring, and labour costs of ground spraying operations. On the other hand, use of persistent insecticides has been a source of worry because of its potential to contaminate the environment.

Recently (1987), an IPM approach was initiated to control tsetse and trypanosomiasis in a block of an area of 4500 km^2 (known as the Kalomo block) in the Southern part of Zambia (Figure 1) where tsetse flies were initially cleared by sequential aerial spraying of endosulphan. Prior to this operation a holding line of deltamethrin-impregnated targets deployed at 60 per km was erected 20 km away from the block towards the main tsetse fly belt. Furthermore, the fly density, before and after aerial spraying, was monitored by odour-baited (using acetone) F3 traps. Also fly rounds using odour-baited black screens, being carried by two men following each other, were deployed as another technique for tsetse density monitoring.

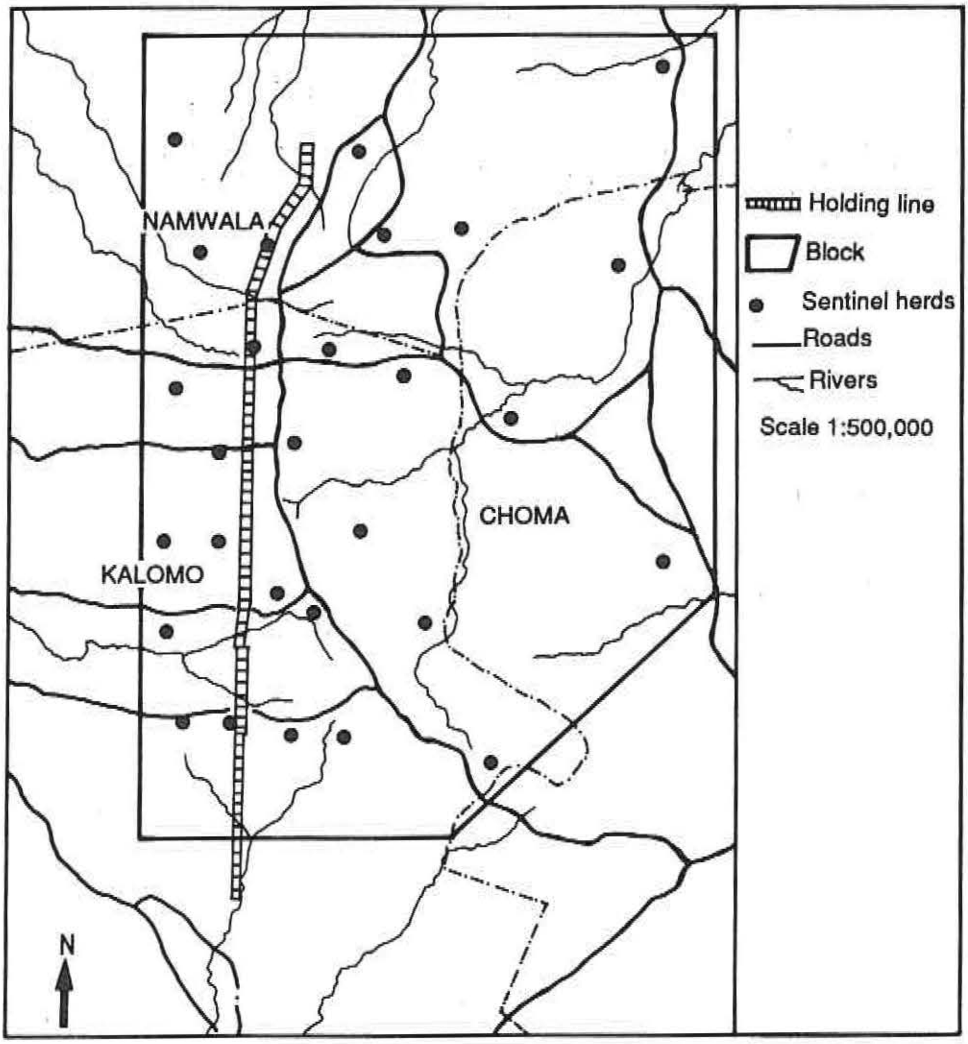

Figure 1. Location of sentinel herds in Kalomo Block.

This operation was necessary due to high land pressure for farming and settlement by small-scale farmers who depend on draught power for their agricultural activities.

Following the successful aerial spraying exercise, which took place in August–October 1987, sentinel herds were established to serve as an indicator of the incidence of bovine trypanosomiasis inside and outside the treated block. Also more herds were treated with deltamethrin pour-on, so as to augment the effect of the target holding line in a continuous effort to reduce tsetse flies invading the cleared area from the main flybelt. The results indicate that since 1987 to-date there has been no evidence of re-invasion except for two cases of trypanosomiasis which are believed to have been in cattle from outside the cleared block (Figure 2). This practice of combined use of available methods and techniques has facilitated to

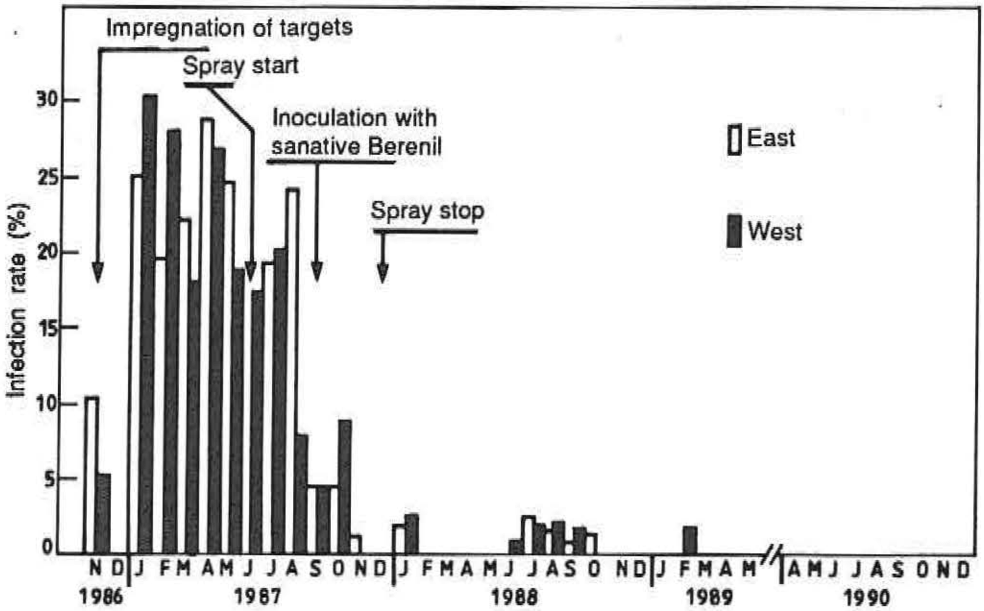

Figure 2. Kalomo Block trypanosomiasis infection rates in sentinel herds east and west of the old holding line.

clear a block of land suited to livestock rearing, thus, enhancing agricultural production in a resource-limited farming situation.

DISCUSSION

The fact that resources are inadequately distributed in the world, the protection of the overall and long-term viability of the environment and its resources is of prime necessity.

In nature the environment functions on the basis of the interdependence of component parts. The proportionate function of each part is of importance to the viability of the whole. Nature, therefore, is managed and controlled through in-built ecological principles and laws which regulate various processes.

In an attempt to make adjustments to the environment in the process of food production, new stresses and strains are created which lead to instability within the introduced farming systems. For example, in their struggle to produce food, the subsistence farmers destroy a lot of natural resources such as trees or even cause soil erosion through over-grazing because of land resource limitations. These subsistence farmers are not necessarily less interested in the conservation of their environment. They are only desperately struggling for survival so that long-term interests are sacrificed for short-term gains.[16]

Thus, in the course of developing resources (i.e. food production) ecological mismanagement has enhanced the development of pests and pest activities by destroying the natural mechanisms of pest control. Naturally existing insects which are provoked to pest status, such as ticks, through increase in livestock populations, can cause heavy losses due to disease epidemics.

In many parts of Africa the tsetse flies abound in their natural habitats surviving strategically at levels consistent with their natural hosts. However, the introduction of livestock in these new land resource-limited farming situations puts the animals at risk of dying from trypanosomiasis which also limits animal production and productivity.

The traditional methods of pest control of ticks and tsetse flies, are very expensive, for example, regular use of acaricides for dipping cattle and extensive chemical aerial sprays. Consequently more satisfactory control methods to contain the pest problem of livestock production must be found and practised. The IPM systems rely on the use of all measures and methods and techniques in an integrated approach to reduce pest populations to levels which neither significantly affect the economic production nor cause serious state of disease as revealed by epidemiological data.

In order for IPM to operate in the manner compatible with the environmental safety, systems analysis should be employed in order to allow for adequate decision-making on pest control approaches.

In the scientific pursuit to understanding the physiology, ecology, habitats and living conditions of the pests, the available knowledge has acted as a pre-requisite for sound assessment of pest status and evaluation of methods for controlling these pests. The IPM is such a "technical product" whose practice is centred on cost-benefit analysis and economic threshold.

CONCLUDING REMARKS

The practice of IPM in the livestock resource-limited farming situations emanates from the fact that new land available for livestock development has ticks, tsetse flies and other potential insect pests. The traditional methods of chemical control of these pests are very costly. The IPM approach is cost-beneficial because it uses limited chemical application strategically and economically, for example, the use of pour-on formulations and pesticide-impregnated target cloths deployed to control tsetse flies. This practice is then complemented by the use of chemotherapeutics. This is in contrast to the costly large-scale chemical application in form of aerial and ground sprays against tsetse which consequently may pollute the environment.

IPM cannot be effectively costed under inadequate livestock management and poor food resources because these constitute the main limiting technical factors which reduce the efficiency of livestock productivity. Therefore, in discussing the practice of IPM in this paper, these aspects have been assumed to be optimal under a given farming situation.

Finally in order to practice IPM effectively three important ingredients are necessary:

(a) the sociology of the farmer should be such that he understands both government policies (efforts) in implementing pest control measures and the technology that is current and economically affordable;

(b) proper understanding of the pest and disease vectors and the interaction between climate, pathogens and livestock; and

(c) applied livestock breeding and genetics that characterise: (i) resistance to pest attack; and (ii) high productivity for power, milk and beef yields.

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Models for High-Level Capacity Development in Africa: The Nigerian Approach to Graduate Training in the Sciences

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Models for High-Level Capacity Development in Africa: The Nigerian Approach to Graduate Training in the Sciences

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INTRODUCTION

Education and manpower development was recognised soon after Nigerian independence in 1960 as the catalyst for social and economic transformation of the country. Along with agriculture, industry and transportation, manpower development was accorded the highest order of national priorities. The Second National Development Plan 1970–74 underscored the pride of place accorded education when it observed that:

> ...Strictly speaking, rates of growth in per capita income are not direct operational targets as they do not constitute an end in themselves. They flow as the end-result of the optimum exploitation of real valuables — growth of knowledge of natural resources, intensity and character of innovation, level of savings, character of investments, quality of manpower, managerial ability and the degree of productivity consciousness.[1]

University education in particular was regarded as the hub and mainspring of all scientific and technological innovations and adaptation which are essential for the industrial and agricultural revolution of the country. The philosophy underlying educational development in the country was harmonised and integrated with the overall objectives and aspirations of the nation, with the result that education was conceived as a tool or instrument of national policy for making

Nigeria a free, just and democratic society, a united strong and self-reliant nation, a great and dynamic economy and a land full of opportunities for all its citizens. Education was regarded as "the greatest investment that the nation can make for the quick development of its economic, political, sociological and human resources."[2]

The Third National Development Plan 1975–80 set the stage for science- and technology-oriented education by a deliberate policy of putting greater emphasis on the study of medicine, pure science and technology. Science/ humanities student enrolment ratio in the universities was fixed at 60:40, and university enrolment in the six universities at that time was to be expanded from 23,000 in 1975 to 53,000 at the end of the Plan period. However, as Table 1 shows, by 1988/89, the number of universities had risen from 13 to 30, and student enrolment had skyrocketed from 68,065 in 1980/81 to 169,914 in 1988/89. Enrolment in science-based disciplines rose from 34,461 in 1980/81 to 90,531 representing an average growth rate of 12% per annum. Table 2 shows that the ratio of enrolment in science-based disciplines to that of arts and humanities marginally improved from 51:49 in 1980/

Table 1. Distribution of total student enrolment in Nigerian universities by discipline (1980/81–1988/89)

Year	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89
Field of Study									
Sciences, including Earth and Mineral Science	9868	12,900	14,192	14,313	17,077	19,917	22,715	24,941	28,235
Medicine and Related Courses	7826	9037	9978	10,469	8988	9353	10,018	10,300	10,546
Pharmacy	–	–	–	–	1811	2043	1995	1994	2174
Engineering and Technology	4979	4986	6768	8282	10,021	11,272	12,654	13,964	14,021
Environmental Studies	2147	3022	3515	3628	4585	4717	5089	5186	5647
Agricultural Studies and Related Courses	3196	3422	3810	6169	7566	8002	9187	9582	13,407
Veterinary Medicine	735	739	763	1030	994	1121	1292	1364	1345
Education (1/2)	5710	7085	7928	10,879	11,878	12,657	13,875	14,674	15,165
SUB-TOTAL	34,461	41,191	46,954	54,770	62,925	69,082	76,825	82,005	90,531
Art & Humanities	10,908	13,610	14,717	16,084	18,029	17,834	21,287	22,378	22,390
Social Sciences	9,233	11,640	13,314	14,444	16,348	17,676	17,874	19,692	20,663
Business and Management Studies	4008	4162	5418	6327	7614	8179	9225	9974	11,106
Education (1/2)	5710	7085	7927	10,878	11,877	12,656	13,874	14,674	15,165
Law	3745	4467	6756	6250	6950	8199	9605	10,034	10,059
SUB-TOTAL	33,604	40,964	48,132	53,983	60,818	64,544	71,895	76,752	79,383
All Disciplines	68,065	82,155	94,086	108,753	123,743	133,626	148,757	158,757	169,914
No. of Universities	13	13	13	15	16	24	24	24	30

Source: Federal Ministry of Budget and Planning, Lagos, Nigeria.

Table 2. Percentage share of student enrolment by discipline in Nigeria (1980/81–1988/89)

Year	1980/81 (%)	1981/82 (%)	1982/83 (%)	1983/84 (%)	1984/85 (%)	1985/86 (%)	1986/87 (%)	1987/88 (%)	1988/89 (%)
Field of Study									
Science, including Earth & Mineral Science	14.5	15.7	15.1	13.2	13.8	14.9	15.3	15.7	16.6
Medicine and Related Courses	11.5	11.0	10.6	9.6	7.3	7.0	6.7	6.5	6.2
Pharmacy	–	–	–	–	1.5	1.5	1.3	1.3	1.3
Engineering and Technology	7.3	6.1	7.2	7.6	8.1	8.4	8.5	8.8	8.3
Environmental Studies	3.2	3.7	3.7	3.3	3.7	3.5	3.4	3.3	3.3
Agriculture and Related Courses	4.7	4.2	4.0	5.7	6.1	6.0	6.2	6.0	7.9
Veterinary Medicine	1.1	0.9	0.8	0.9	0.8	0.8	0.9	0.9	0.8
Education (1/2)	8.4	8.6	8.4	10.0	10.0	9.5	9.3	9.2	8.9
SUB-TOTAL	50.6	50.1	49.9	50.4	50.9	51.7	51.7	51.7	53.3
Arts and Humanities	16.0	16.6	15.6	14.8	14.6	13.3	14.3	14.1	13.2
Social Sciences	13.6	14.2	14.2	13.3	13.2	13.2	12.0	12.4	12.2
Business and Management Studies	5.9	5.1	5.8	5.8	6.2	6.1	6.2	6.3	6.5
Education (1/2)	8.4	8.6	8.4	10.0	9.6	9.5	9.3	9.2	8.9
Law	5.5	5.4	7.2	5.7	5.6	6.4	6.5	6.3	5.9
SUB-TOTAL	49.4	49.9	51.1	49.6	48.3	48.3	48.3	48.3	46.7
All Disciplines	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
% Share Sciences	50.6	50.1	49.9	50.4	50.9	51.7	51.7	51.7	53.3
% Share Arts	49.4	49.9	51.1	49.6	49.1	48.3	48.3	48.3	46.7

Source: Federal Ministry of Budget and Planning, Lagos, Nigeria.

81 to 53:47 in 1988/89. The implication of this phenomenal growth in student enrolment in the sciences in the universities was the unprecedented demand not only for laboratory equipment and facilities but also for university teachers in the sciences.

The development was not confined to the universities alone. It is noteworthy that a parallel, although less spectacular, development was evident in the polytechnics. Total enrolment in all disciplines in the polytechnics increased from 42,381 in 1980/81 to 74,468 in 1989/90, which represents an average growth rate of 6.6% per annum. Science-based disciplines accounted for 45% of the total enrolment. The number of polytechnics increased from 23 in 1980/81 to 27 in 1989/90, thus the demand for teachers with postgraduate qualifications in the sciences was further swelled by the explosion in student enrolment in the polytechnics.

In recognition of the importance of science and technology in the socio-economic transformation of the country, the Federal Government of Nigeria created in

October, 1979 a separate Ministry of Science and Technology, and charged it with four main responsibilities: (a) formulation of national policy on science and technology; (b) promotion of science and technology research; (c) liaison with universities and federal polytechnics; and (d) promotion and administration of technology transfer programmes. As at the time of publication of the First National Rolling Plan 1990–92 there were 25 federal research institutes under the supervision of the Ministry. The high-calibre manpower needs of these institutes further increased the demand for science-based researchers.

Finally, the emerging growth of the private sector in science-based industries together with the indigenisation policy of the Federal Government meant that more and more graduate training in the sciences would be required for private sector development.

In all these scenarios, the pertinent questions to ask are: how has Nigeria coped with the enormous task of training the trainers in the sciences? What strategies did she adopt? The next section of this paper will make an attempt to answer these questions.

MODELS OF GRADUATE CAPACITY DEVELOPMENT

Two models may be identified in Nigeria's quest for graduate training in the sciences: overseas training and indigenous training capacity development. Although the two models are complementary and temporally interfaced, overseas training may be strongly identified with the short-run while the development of indigenous capacity is long-run.

Overseas Training

Soon after independence, four universities were established by the federal government and the three regional governments in 1962/63 in addition to the only premier institution bequeathed by the colonial administration, by taking over the colleges of science and technology which were then located in three regions. From the inception of these new universities, which are now commonly referred to as the older generation universities, there was a marked distinction in the academic programmes of both the old and the new. Whereas the premier colonial institutions concentrated on liberal arts and classics, the new ones were more science and technology oriented. Beginning from a very limited manpower base, it was inevitable that these institutions would have to adopt two complementary strategies for academic staff recruitment. First, was the organisation of a massive recruitment drive that took the executives of these institutions to overseas countries, mostly United Kingdom and the United States, to persuade Nigerian indigenes employed in overseas universities to come home, and to tempt foreign nationals with generous incentives to come to Nigeria to help build the new universities. An inter-university council which had been established in Britain served as the employment exchange and clearing-house for both prospective recruits and the new universities. Sometimes exchange agreements were entered into by a new university and an overseas institution. The second strategy was a massive academic staff development effort. In this strategy, Nigerian indigenes with masters degree or good first degree were recruited as assistant lecturers, and after successfully serving a probationary period, were sent overseas for Ph.D. degree in the relevant field. To ensure that the training met the needs of the university concerned, the overseas university and the field of specialisation had to be approved before the staff could proceed on study or training leave. Sometimes formal and informal contacts were used to place the Nigerian staff in overseas universities.

A current application of this strategy was also taking place in both the federal and regional civil services and parastatals. The adoption of a planning strategy as a framework for socio-economic development of the country implied a great demand for high-level manpower both for sectoral planning and for plan implementation. In all of these, overseas training of staff had to be resorted to.

Indigenous Training Capacity Development

The development of indigenous training capacity started late in the 1960s and early 1970s when the products of previous overseas training began to blossom and the expansion of tertiary educational institutions and research institutes gathered momentum. It is reported that postgraduate studies began informally at the University of Lagos in the 1966/67 academic session, and over 270 students graduated with higher degrees in arts, business administration, education, law, science and medicine between 1968 and 1978. However, the University Senate formally established a postgraduate school on July 22, 1981 to enable postgraduate studies and research grow more rapidly.[3] A similar development was taking place in the other older universities.

Table 3 shows the total enrolment for higher degrees in the sciences in the Nigerian universities by discipline and by sex in 1987/88. As one would expect, enrolment for the pure sciences topped the list with 34.1%, followed by agriculture,

Table 3. Total enrolment for higher degrees by faculty and sex in Nigerian universities (1987/88)

Faculty	Male	Female	Total
Agriculture	576	109	685
Engineering	613	30	643
Environmental Design	577	70	647
Medicine	286	116	402
Pharmacy	35	23	58
Sciences	1059	292	1351
Veterinary Medicine	148	27	175
Total	3294	667	3961
Total all disciplines	8513	2380	10,893

Source: Federal Ministry of Budget and Planning, Lagos, Nigeria

17.3%; environmental design, 16.3%; engineering, 16.2%; medicine, 10.1%; veterinary medicine 4.4% and pharmacy, 1.5%. Enrolment in the sciences accounted for 36.4% of the total enrolment for higher degrees.

The graduate output in the sciences for postgraduate degrees in some selected Nigerian universities by institution by sex in 1988/89 is shown in Table 4. The output of postgraduate students in pure sciences once again topped the list with 32.8% of the total output followed by agriculture 29.5%, engineering 16.5%, medicine 12.6%, environmental design 11.9%, veterinary medicine 1.1%, pharmacy 0.6%. Graduate output in the sciences accounted for only 0.6% of the total graduate output for all disciplines in 1988/89.

Table 4. Graduate output (P/G degree) in the sciences by institution and sex in Nigerian universities (1988/89)

	Universities																		
	Bendel		Ibadan		Ife		Ilorin		Jos		Lagos		Maiduguri		Rivers		Total	Total	Total
Discipline	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M/F
Agriculture	0	0	145	27	19	5	0	0	0	0	0	0	10	1	15	0	189	33	222
Engineering	0	0	7	0	15	4	0	0	0	0	110	1	0	0	7	2	142	7	149
Environmental Design	1	0	0	0	29	7	0	0	35	1	25	4	0	0	5	1	95	13	108
Medicine	0	0	21	14	2	2	1	2	0	0	44	28	0	0	0	0	68	46	114
Pharmacy	0	0	0	0	2	3	0	0	0	0	0	0	0	0	0	0	2	3	5
Sciences	0	0	65	20	36	8	18	7	34	10	61	23	0	0	11	4	225	72	297
Veterinary Medicine	0	0	8	2	0	0	0	0	0	0	0	0	0	0	0	0	8	2	10
Grand Total	1	0	246	63	103	29	22	9	69	11	240	56	10	1	38	7	729	176	905

Source: Federal Ministry of Budget and Planning, Lagos, Nigeria.

The primary responsibility for postgraduate studies remains with each department of the university. The Postgraduate School Board of Studies lays down minimum standards and regulations to ensure that high quality is maintained throughout the university. A system of external examinership whereby renowned professors outside the university are appointed to moderate or veto examination questions and students answer scripts is an important feature of the postgraduate programme designed to ensure inter-university comparability of programmes and to maintain high academic standards. All external examiners are expected to write a report on each examination moderated. To teach on the postgraduate programme, a lecturer must hold the Ph.D. degree in the relevant field or must have thorough research and publication, attained the status of not less than a senior lecturer grade. To prevent stale and stereotyped programmes and insularity of staff, there are ample opportunities for visiting professorship, learned conferences and seminars both within and outside the country, study leave, sabbatical leave and leave of absence. These opportunities are provided to enable members of staff update themselves and breathe in some fresh air.

The structure of the graduate programme across the country is virtually the same. Some universities have two masters degree programmes, the master of science (M.Sc.) and the master of philosophy (M.Phil.), together with the doctor of philosophy (Ph.D.) programme. The M.Sc. degree programme lasts 12 calender months and is generally by course work and a research project in an area of specialisation chosen by the student. The courses are made up of both compulsory and elective courses. The student's choice of courses is made in consultation with his project supervisor. The M.Phil. and Ph.D. programmes consist of course work and research. One important feature of the postgraduate programmes is the presentation of seminar papers; at least one in the student's area of specialisation and another, on the student's project in the case of M.Sc. programme, or on the student's research proposal in the case of the M.Phil./Ph.D. programmes. Members of staff and postgraduate students are usually invited to the seminars. These seminars provide ample opportunities to expose graduate students to the world of academics in general where sound scientific procedure is esteemed as an object of virtue in itself.

SUMMARY AND CONCLUSION

The major problem of graduate training in Nigeria is rightly identified by Fourth National Development Plan 1981–85, when it remarked:

> "A weakness of the academic planning of universities is the absence of adequate postgraduate facilities to produce within a reasonable time frame a large number of academic staff required. Under the Fourth Plan, steps will be taken to develop and strengthen postgraduate facilities especially in the older universities."[4]

The economic crisis of the late 1980s has further exacerbated the problem. There will be no abatement to the problem until the universities are adequately funded.[5]

Another problem of graduate training is the lack of coordination and cooperation in research activities especially in the applied sciences. Graduate training is enriched by the research activities of the department concerned. At present research is individually organised. Collaboration in research is virtually non-existent. It would be desirable if every science faculty has a research unit attached to it as a basis for intra-faculty and inter-university cooperation.

Unless urgent and drastic measures are taken to "... develop again first-rate university programmes that can produce the highly skilled professionals who can undertake basic and applied research",[6] through adequate funding and aggressive staff development activities, the objective of achieving high-level capacity development in Africa will remain largely unrealised.

REFERENCES

1. Federal Republic of Nigeria, *Second National Development Plan 1970–1974*, p. 34.

2. Federal Republic of Nigeria, *National Policy on Education*, (Revised), p. 8.

3. University of Lagos, *Postgraduate Prospectus 1987–1989*, p. 9.

4. Federal Republic of Nigeria, *Fourth National Development Plan 1981–1985*, p. 28.

5. This and other related issues were highlighted and discussed in "West Africa, Changing the Future", Educational Special, 19–25 August 1991 and The World Bank, *The African Capacity Building Initiative*, Washington, 1991, especially the section on Crisis in Higher Education.

6. The World Bank, *The African Capacity Building Initiative*, p. 11.

Discussion of a Paper Entitled: "Models for High-Level Capacity Development in Africa: The Nigerian Approach to Graduate Training in the Sciences

Presented by SIYANBOLA TOMORI
Discussant: SHIBRU TEDLA
Addis Ababa University

Mr. Chairman
Distinguished Participants

Professor Tomori has addressed high-level capacity development in Africa as viewed from the Nigerian experience.

From his presentation, it is apparent that serious input has been put into the National Planning in order to arrive at the present stage of high-level manpower development in Nigeria. The emphasis given to building national capability in science and technology is reflected by the gradually increasing student enrolment in tertiary education favouring science and technology. The creation of a Ministry of S&T is part of the process of enhancement for achieving the desired goals.

The models identified in capability-building are two, and these are traditional ones:

- Sending candidates abroad for training
- Training of candidates in national institutes

At this juncture I would like to briefly highlight the basic differences of the two traditional models.

In being educated abroad, one gets better exposure to the international setting of education. However, the research programme that one will carry out is likely to be irrelevant to the candidate's country of origin.

In local training programmes, the research is likely to be relevant to the situation within the country. One major drawback is the high risk of intellectual inbreeding.

Let me try to augment Prof. Tomori's presentation of capability-building using my limited experience as a dean of a young school of graduate studies at Addis Ababa University for six years. This experience may have been equally true for others in this room since we share many situations in common. Perhaps a brief background to the history of tertiary education in Ethiopia is essential for the appreciation of the situation.

The need to develop high-level capacity was appreciated because of the manpower required to run a "modern" bureaucracy in the turn of this century. This felt need was more intense after the Italian invasion in the early 1940s. Tertiary education institutions were established in the first half of the 1950s. At the same time young Ethiopians were being sent for further education abroad, mainly to Europe and N. America.

The political upheaval in 1974 resulted in many drawbacks for the process of high-level capacity-building in tertiary educational institutions. Among the major causes of these drawbacks were:

- the expatriate academic staff left the country for good reasons
- Many of the young Ethiopians who were sent for training abroad preferred to stay out — again for good reasons
- The traditional sources of fellowships and scholarships dried up because of political reasons
- Many senior staff — nationals — who at that time were on sabbatical leave, or on other missions abroad failed to return.

This obviously resulted in a crisis. In order to teach at the tertiary level institutions — one needs Ph.D. holders or at least MA/M.Sc. holders — but such people were not easily available. This capacity had to be developed somehow.

In order to man the ever expanding undergraduate programmes, the establishment of graduate programme, where the needed manpower need be trained, was found to be necessary.

How can an institution establish graduate programmes when it does not even have high enough manpower to manage its undergraduate programmes? This was a vicious circle; it had to be broken somehow. So the concept of "junior academic staff-cum-student" was envisaged and a model for capability-building was formulated.

First a school of graduate studies had to be established. It was envisaged to train sponsored candidates only. (A sponsored candidate receives his/her full salary during the duration of training. Research funds are provided by the university). The candidates were all part-time students — working half-time and studying half-time. All programmes were to have a very strong research component. The thesis problem had to be relevant to the sponsoring institution. The advantages of such a setting were that:

- There were many young academic staff members who provided lots of help to the over burdened senior staff in managing undergraduate programmes
- The brain drain was minimised
- The chances of carrying out research beyond the call of the degree programmes was enhanced if not guaranteed
- The research was very relevant to the country; it provided information for planning as well as for the enrichment of relevant teaching materials.

The possible disadvantages include:

- The quality of coursework is compromised because of the limited manpower enrolled in graduate teaching
- There is a high possibility for intellectual in-breeding.

This model was revised when the Ph.D. programme were envisaged. Ph.D. programmes model is what is now referred to as the "Sandwich" programme.

A prerequisite for the establishment of such a programme is collaboration with universities abroad; in this case in N. America and Europe. This model has two steps in phases.

In phase one the registration for a degree programme is done abroad. The coursework, the acquisition of skills, literature, etc. is all done in the collaborating university abroad. The research is carried out locally. All the necessary equipment and supplies need be obtained at the in-country institute. The write-up of the thesis is carried out in the collaborating university abroad; the degree is also granted by the same.

In phase two, the registration is done in the in-country institute. The course work, most of the skill, literature, etc. is acquired abroad. The research is carried out locally; so is also the write-up of the thesis. The degree is granted by the home institute.

Both types require having two advisors for each candidate, one in the home institution and the other in the collaborating institute abroad. This implied substantive support from outside, for purchase of equipment and supplies, travel cost, maintenance cost of candidates abroad, etc. This was graciously and amply provided by SAREC of Sweden and CIDA of Canada.

Finally, when a certain level of capability-building is achieved, more and more of the components will be managed locally — however, close contact should always be maintained with universities, and other institutions of higher learning abroad.

Using the said modes of operation are we going in the right direction? Are we on the right track? Perhaps what we have aimed to-date were on the basics, in that case we were perhaps in the right track and in the right direction. When we plan to specialise, where should the emphasis be? I believe the emphasis should be in reducing, controlling or eradication of local and regional problems such as disease and hunger.

For such mission-oriented activities, we need to pool resources regionally — we have more or less the same problems in the regions, albeit with varied intensities. We must look for the solution of problems we share in common in a coordinated manner. That is where regional affiliation and collaboration come to the scene. Specific examples of problems shared in common are tropical diseases of man and his domestic animals, pests that substantially reduce agricultural production. It is for solving such problems that we need to pool our resources and utilise them effectively.

Even on individual level the need to solve these problems must be clear. For example, a graduate student can express his/her intellectual potential as a behavioural biologist either by studying the mating sounds of a frog species or by studying the feeding behaviour of a mosquito — a malarial vector. For now we need to make a choice in favour of the latter. Incidentally, people outside the region are taking less and less interest in our perennial problems; and all will be left to us to manage.

Repeated self examination is an essential component for defining a mission.

ICIPE appears to have adopted this modality of operation from its inception — the intellectual forces behind such a positive thinking need to be congratulated. This is exemplified in:

- Its approach to pest management — opting on approaches despite the presence of already existing, albeit less desirable, technologies
- Its defined mission-oriented graduate programme, ARPPIS
- Its networking strategies in many areas, information, etc.

We must all be convinced that there is no shortcut in life — apparent shortcuts have grave shortfalls. Hence, however frustrating, we must seek amicable solutions to all our problems and in the process build our capability for handling future problems.

Irrespective of the situation, there should always be an open door policy to development — there should be easy flow of information and ideas.

What Prof. Tomori has addressed and that I augmented till now is formal educational modes of operation. Perhaps equally important, if not more so are the conscious efforts that each one of us need make to enable our fellow citizens — especially the younger members of society — to express their full potentials. This is not done in a classroom setting alone. Such processes and interactions should be positive enough to build confidence which will eventually and inevitably lead towards invisible academia — or invisible colleges. This has aptly been presented by Professor Odhiambo.

Individuals can achieve very little by themselves. The product of a collegiate is more than the same of its components. Human mind performs best amidst such interactions.

What I have narrated up to now is what is expected from individuals. What should individuals expect? Let me present an unorthodox setting which may foster capability-building.

I must admit that I am not a religious person but I do appreciate the need for a model — call it a diety, or a hero — one must have models for cultivating one's moral and intellectual aspirations. We must be able to give appropriate recognition to those who have contributed most and best to the development of science and technology in Africa. The least we could do is recognise this essential, albeit fragile, asset — it must be nourished and cultivated.

9

The Case of Tick and Tsetse Control in Ethiopia: Tailoring Extension Service to Pest Management, Research and Development

FESEHA GEBREAB

9

The Case of Tick and Tsetse Control in Ethiopia: Tailoring Extension Service to Pest Management, Research and Development

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INTRODUCTION

With 27 million cattle, 23 million sheep, 18 million goats, 7 million equines and one million camels, Ethiopia is reputed for possessing the largest livestock population in Africa, a reflection that livestock raising is a deep rooted tradition, an integral part of the farming system in established settlements and the main occupation among the nomadic and semi-nomadic pastoralists. Precise articulation for the framework indicates the presence of two production systems with 92% of the population living in the higher altitude, higher rainfall areas owning some 78% of the cattle, 78% of the sheep, 74% of the equines and 27% of the goats while the nomads are left with the remaining fraction of the resource.[1] A more specific examination of ownership versus herd structure relationship reveals that a typical individually owned sedentary herd is composed of one or two oxen, a cow, one or two immatures, three to five sheep and/or goats, some chickens which provide draught power, milk, meat, breeding of replacements and income from sale of sheep, goats, chickens, old oxen and cows while a typical family owned nomadic herd generally averages about 100 head. The lowland cattle herds contribute considerably to the provision of milk to the local inhabitants, draught animals for the highlands and directly or indirectly to beef production. The great majority of these livestock are of indigenous breeds selected naturally over time for survival and adaptability to the environment. About 13,000 pure and crossbred cattle exist on state farms, Ministry of Agriculture cross breeding ranches, producer cooperatives and are owned by individuals.[2] The fact is, however, that this important resource has not been harnessed, tapped and exploited to a reasonable degree in support of a sustained national economic development. At present off-take rates are estimated at 7% for cattle, 30% for sheep and 36% for goats.[2] Among the major constraints dictating this state of affairs, animal diseases stand at the forefront. Therefore, interventions to reduce mortality, morbidity and improve nutrition have become priorities of the highest order. The measures and strategies to be implemented must, however, be tailored without ignoring or overlooking the traditional systems which have evolved as determinants of minimum risk. From this general background emerges the rationale for the major theme of this paper: Tailoring extension service to the management, research and development of ticks and tsetse fly in Ethiopia. In this context, extension services face a major task in identifying, adopting and adapting technology appropriate to location-specific cattle, diseases, economic conditions in order to make the production system viable.

TICKS, TICK-BORNE DISEASES AND THEIR CONTROL IN ETHIOPIA

Infestation of livestock by tick species is common and widespread in Ethiopia. The knowledge base on the occurrence, distribution and importance of ticks indicates the presence of 48 species of which four are of considerable significance.[3] Tick species incriminated of exerting great influence on cattle breeding are: *Boophilus decoloratus, Amblyomma variegatum, Rhipicephalus evertsi* and *Hyalomma* sp. *A. variegatum* is also the second most abundant tick species in Ethiopia next to *R. pulchellus*. It is found uniformly dispersed in all regions of the country. The distribution of *B. decoloratus* is similar to that of *A. variegatum*, but quite low in abundance.[4] Fortunately *Rhipicephalus appendiculatus*, an important tick vector and the fatal disease East Coast fever it transmits is absent from the Ethiopian territory.[5] In the area of tick-borne diseases a number of fragmented works report the presence of important diseases such as babesiosis in cattle, horses, donkeys and dogs, anaplasmosis in cattle, theileriosis caused by *T. mutans* and *T. annulata* in cattle;[6] foetal cowdriosis in pure and crossbred stock and dermatophilosis in improved cattle. Reports from professionals and observations suggest that the latter two diseases are increasingly becoming serious health constraints in livestock improvement programmes. Cowdriosis (heartwater) is causing losses of crossbred cattle in the central, east and south-western highlands of the country which has considerable potential for dairy development.[6] Dermatophilosis is an acute fungal skin disease and causes extensive economic damage in infected herds. Recent surveys indicate that it is on the rise both in geographic and population dimensions.[7] In general and at this juncture of time tick-borne diseases resulting in clinical cases are encountered rarely and reported losses are minimal. However it should be well underlined that the significance of ticks is far from the debilitating effects of the diseases they transmit. Heavy tick burdens entail blood loss, worry, exert physical damage to hides and skins in indigenous breeds and pose potential hazard to exotic and grade cattle including the loss of udder quarters.

In the few areas where tick control is practised a wide variety of acaricides is available and their selection is a matter of individual choice. The methods of application are mostly hand spraying and hand dressing. A few spray races are available in research stations, training institutions and dairy farms. Diptanks ranging from 50–60 in number are also available in the various parts of the country, but most of them are not in working condition for a variety of reasons.[6] Traditional methods of control such as pasture spelling or grass burning are not employed extensively, and for financial reasons many farmers must resort to hand picking, burning with hot iron, or hand dressing with various forms of local products.[6] Acaricides in general are not made available free of charge and therefore the farmers in the majority of areas can only afford the commercial preparations once or twice a year. Farmers do not use any type of tick control during the rainy season believing that any application would be quickly washed off and wasted, and also believing that there are few ticks present during the onset of the rains, not realising that this is the build-up of the tick population due to increased larval (or nymphal) infestation which only becomes evident to their untrained eyes at the adult stage at the end of the rains in September.[6]

TSETSE, TRYPANOSOMIASIS AND THEIR CONTROL IN ETHIOPIA

Five species of *Glossina* namely *G. morsitans, G. pallidipes, G. fuscipes, G. tachinoides, G. longipennis* are found in the seven administrative regions of Sidamo, Gamugoffa, Keffa, Shoa, Illubabor, Wollega and Gojjam comprising a total area of some 98,025 km^2.[8]

The species of trypanosomes of economic importance to livestock are *Trypanosoma vivax, T. congolense, T. evansi, T. brucei* and *T. equiperdum*.[5] The first two mentioned are the most common. *T. vivax* is ubiquitous, *T. congolense* appears to be restricted to the tsetse infested south-western parts while *T. evansi* occurs predominantly in low-lying south-eastern and eastern parts of Ethiopia.[9] A five-years trypanosomiasis survey (1978–82) in nine of the 14 administrative regions indicated a general average incidence of 8.6% in cattle. The highest being in the regions of Gamugoffa and Wollega.[10] Biting flies play a very significant role in disease transmission in the highland areas in the absence of tsetse although the magnitude and economic significance of the problem still have to be determined.

Advances and recessions is an important feature of the problem. The so-called buffer zone between the densely populated highlands of Ethiopia and the semidesert of northern Kenya and south-eastern Sudan is diminishing as a consequence of ecological changes reflecting in the present distribution of *G. fuscipes, G. tachinoides* and *G. longipennis*.[8]

G. fuscipes infests the Omo valley, upper reaches of the Baro, Gilo and Akobo rivers and the nearest major infestations of *G. fuscipes* are on the head waters of the Nile in Uganda, some 500 km distant. An even greater distance separates *G. tachinoides* infestations of the Abay and its tributaries as well as the Baro, Gilo, Akobo and Beles from the distribution in the Lake Chad basin some 200 km to the west. *G. longipennis* previously reported on the head waters of the rivers Dawa, Genale and Wabeshelle now only survives around the lower Omo. This species is still present in the lower reaches of the Wabe Shebelle and Juba rivers in Somalia some 200 km from the Ethiopian border.[9] Consequently the present distribution of *Glossina* is confined to south-western Ethiopia, and there is no evidence that it still occurs east of the rift valley.[9] The tsetse fly *G. morsitans* has also been reported to be spreading up valleys and over escarpments and establishing itself in hitherto tsetse free valleys. *G. morsitans, G. pallidipes* and *G. fuscipes* have been found on the Giba River north of Metu in Illubabor region, some 60 km east of the Bure escarpment, an area hitherto tsetse free. The advance of *G. morsitans* and *G. tachinoides* has also been noted up the Muger Valley as that of the *G. pallidipes* and possibly *G. fuscipes* up the Omo Valley.[11,9]

It would be logical to assume that *G. morsitans* may be present well above 1600 m elevation in some valleys, particularly in consideration of the widespread incidence of trypanosomiasis outside the tsetse infested areas bordering the Ethiopian highlands which seem unlikely to be caused by mechanical transmission alone.[9]

In the country as a whole the exercise for the survey and control of trypanosomiasis is inadequate. The launching of a comprehensive plan based on an integrated pest management scheme is not yet in sight. At present trypanosomiasis control measures is limited to chemotherapy and chemoprophylaxis. In this regard a total of 9.4 million doses of trypanocides were imported into Ethiopia in the five years of 1978–82, and 8.2 million doses were used by the end of 1982 (1.72 million doses per annum). Of this total 2.72 million doses were used in three regions (Illubabor, Keffa and Wollega). This is equal to a ratio of 1.6 doses per livestock unit per year in three regions.[11]

An in-depth view of the situation reveals that of the 13.5 million head of cattle present in the six tsetse fly infested administrative regions where a quarter million are at high risk of contracting the disease and a further 2.5 million are exposed to medium or low risk,[12] the dosage administered is far from being adequate for conferring protection. As far as tsetse control is concerned no attempt has as yet been made. However an experimental aerial application of insecticide was done in Didessa Valley during mid-seventies but indifferent results were reported.[9]

Preliminary trial has been made at Ketto resettlement project in Wollega administrative region to control tsetse populations using a range of very efficient traps and new odour attractants. In the work three species of flies were caught: *G. pallidipes, G. morsitans,* and *G. fuscipes* using biconical traps, Ngu traps and the new 4 x 4 teletrap. The latter which is a development of Ngu trap with four compartments each having a separate entrance and cone gave a significant increase in the catch over both the baited biconical and Ngu traps.[13]

BRIDGING THE GAP BETWEEN RESEARCH, DEVELOPMENT EXERCISES AND IMPLEMENTATION PROGRAMMES

In establishing the conceptual framework for Ethiopia in regards to damages inflicted by ticks and the control measures to be adopted complete awareness of the following state of affairs is important:

- Previous studies have established that important tick species are found widely distributed in Ethiopia. The four species deserving particular mention are *B. decoloratus, A. variegatum, R. evertsi* and *Hyalomma* sp.

- One of the shortcuts to the improvement of the productivity of livestock in the country is the introduction and propagation of pure and crossbred stock in individual, cooperative and parastatal farm holdings of the country. This trend has enhanced and will continue to do so the importance of the tick problem.

- In the sedentary and nomadic livestock farming systems of the country predominantly based on indigenous cattle, owners are managing to increase their livestock numbers with minimal tick and tick-borne disease control inputs. Under the aforementioned production systems tick-borne diseases resulting in clinical cases are encountered rarely and reported losses are minimal. Furthermore the use of acaricides for tick control is quite limited.

- *Rhipicephalus appendiculatus* and the disease it transmits theileriosis is not a problem.

Nevertheless ticks are a nuisance worth scrupulous study in light of their following behaviour:

- *Blood loss*: All ticks are greedy devourers of blood. It is an established fact that cattle can lose one to two pints of blood per day through the activity of these parasites.[14]

- *Worry*: The resultant exhaustion interferes with production.

- *Loss of udder quarter:* Particularly from infestations by *Amblyomma* and other long mouthed ticks. They also cause damage to the scrotum in males. Observations suggest that this is a serious problem in Ethiopia.

- *The downgrading of hides and skins*: This is caused by the abundant long mouthed tick species which is of paramount importance. A conservative estimate of birr 1 million is lost annually through rejection or downgrading of skins and hides.[6]

- *Anorectic effect*: an important factor in the tick host damage syndrome.[15]

- Important tick-borne diseases such as cowdriosis (heartwater) and dermatophilosis (streptothricosis) are on the upsurge particularly in pure and crossbred stocks threatening livestock improvement programmes in many parts of the country.

In the choice of control measures an understanding and satisfactory grasp of the real status of ticks and tick-borne diseases and the various determinants governing its complex behaviour is essential. Within the realm of this conceptual framework it can be generally established that in Ethiopia as a whole there is an enzootic situation and the status existing between tick disease agents and hosts is at present stable. This is largely attributed to the preponderance of the indigenous breed in the livestock production system of the country with very limited presence of the more susceptible exotic pure and crossbred stock. The few works conducted to elucidate this hypothesis suggest that the cornerstone for an integrated tick management programme in Ethiopia should be basing protection on natural host resistance. The nutrition, concurrent disease and type of animal management should also be given pertinent and due consideration. Two preliminary works have been undertaken to explore the situation in this regard. The findings obtained from the first study indicate boran-freisian crosses to be more susceptible to tick infestation than pure borans.[16] Permethrin-impregnated eartags were also tried for minimising tick infestations on the boran-freisian crosses and significant reduction of tick burden of the shoulder, neck and head region was observed.[16] Contrary to the widely held view a relatively high death rate was encountered in the pure borans due to cowdriosis than the freisian-boran crosses. Most deaths amongst the boran stock apart from their alleged increased susceptibility to cowdriosis was due to cessation of acaricide application as a consequence of power interruption in the spray race.[16] In spite of its many demerits, under such conditions the acaricide-impregnated eartag showed a superior advantage over the conventional ones. In view of the recurrent water shortage imposed by the protracted drought in various parts of the country it would be worthwhile trying slow release devices that have been meticulously shaped and developed to meet the needs of tropical situations, distribution of important tick species on the body of animals, of course in conjunction with resistant hosts.

In the second study involving indigenous breeds such as boran and horro and their crosses with simmental, freisian and jersey the following observations were recorded. Boran-simmental crosses carried seven and six times more ticks than the indigenous horro breed, pure borans had intermediate tick burdens, jersey-horro-simmental crosses seem to tolerate nearly as well as pure *B. indicus* breeds. In the same observation freisian cross either with horro or boran tended to be heavily infested, the simmental-horro cross showed relatively high resistance but the simmental-boran cross very low.[17] The observation on the jersey deserves due consideration in the light of the place it has as a breed of choice in the dairy development scheme of the country.

Present-day knowledge advocates minimising the use of chemical in pest control. This can be best achieved by the strategic or tactical application in combination with non-chemical methods to maintain pest populations at levels below those causing injury. As a matter of fact this is the basis of an integrated pest management programme. In tick management schemes for Ethiopia an integrated control strategy involving natural host resistance is the alternative choice and should form the basis for a sound and feasible extension service input.

The disease trypanosomiasis can be controlled by the use of trypanocidal drugs (both curative and prophylactic), by the resettlement of human or animal populations at risk, by the exploitation of trypanotolerant livestock and by vector control. A point of departure in seeking for the best alternative is understanding that as a general rule a given approach is only valid for a limited region. It is not feasible or sound to look for a unique and radical solution for a country as a whole, a national economy and as a matter for all sub-Saharan Africa. Focusing on an integrated measure that takes into account various factors and is manageable with available means — should be the guiding principle. In line with this, an attempt is made here to outline some of the methods that should form the basis of an extensiön service input in the control of tsetse and trypanosomiasis.

Use of Trypanocidal Drugs

Experiences from Kenya and Tanzania have shown that cattle including those of exotic origin can be maintained with success and for long years in tsetse-infested regions with the systematic use of trypanocidal drugs.[18] The development of drug resistance in trypanosome populations is a problem, but the constraint in this regard is considered to be less important compared to the outcome obtained using the drugs.[18] The specific advantage lies on the nature of the expenditure involved. High infrastructure cost is excluded and basic cost is limited to that of operation only, and in most of the cases governments are not required to provide subsidies.

Use of Trypanotolerant Breeds

This is a situation where certain breeds of cattle, sheep and goats and certain species of wild game survive in *Glossina* infested regions without the use of protective trypanocidal drugs. Trypanotolerant cattle (Ndama) have been transferred from their country of origin (West Africa) to other regions. Its feasibility has been well demonstrated in the Central African Republic, the Congo, Zaire and Rwanda,[18] but the most outstanding problems limiting the implementation are:

- The nucleus herd in the countries of origin is limited in number.
- The initial investment cost is rather high.

Tsetse Eradication Operation Followed by Settlement

The control operation is based on eradicating *Glossina* from a prescribed area by clearing of vegetation on which tsetse depend for shelter, and the destruction of game animals on which they depend for food and application or residual formulations of insecticides either from the ground or air.

Use of Tsetse Traps

An efficient method for the reduction of tsetse populations. Its cost, efficacy and the possibility of its being used by the local population at the village level makes the method much more attractive. Ideally traps should catch as many of the target species as possible with minimal effects on non-target fauna and should also be effective against low density target populations. The traps should be highly efficient so that they can be deployed in relatively low number to reduce construction and deployment costs. They should also be made durable and require little maintenance to cut service costs.

In a country like Ethiopia with severe population pressure on the highlands and where famine is the rule rather than the exception, the tsetse and trypanosomiasis problem should be seen as a problem of land use. The implementation of tsetse eradication scheme involving high cost may be justified in view of the fact that costs of eradicating *Glossina* from an area may be relatively insignificant in the light of the economic advantages gained.[19] However, given the prevailing objective realities in terms of resource allocation in the country, prescribing a high cost venture without external assistance provisions may not be feasible. Therefore the alternative control scheme should be based on packages for the resource-poor farmer. In line with this trypanosomiasis and tsetse control in Ethiopia at least in the short-term should be founded on maintenance of cattle using trypanocidal drugs, community-based odour bait trapping programmes and modifying the environment by settlement and/or development to such an extent that tsetse can no longer survive.

AREAS OF RESEARCH UNDERTAKINGS FOR BASING ON EFFECTIVE EXTENSION SERVICE AS PART OF AN INTEGRATED PEST MANAGEMENT SCHEME

If resource-poor farmers are to receive relevant and realistic assistance and advice on a first-hand and timely basis, farmers and extension staff should be incorporated into the process of helping to determine research priorities, especially because extension is basically a decentralised, provincial or district level affair, and is therefore along with farmers more aware of location-specific realities. Tick control programmes must be tailored to specific places and livestock production systems — and for this purpose a close and effective linkage between research and extension is an essential prerequisite. In this context areas of research undertakings for basing a functional extension service as part of an integrated tick management strategy must be preceded by:

(i) Updating knowledge base on ticks and tick-borne diseases; tick fauna, population dynamics and importance; incidence, severity and case fatality of clinical tick-borne diseases; availability of infection for ticks in association with cattle stocking rate and on the host/age preference of tick species and instars concerned; cattle management systems in use particularly in relation to the determination of size of parasite populations; nutritional status of cattle.

(ii) Study natural resistance of the various main cattle breeds to tick infestation and tick-borne diseases, namely boran, fogara, horro, arsi, barka and horro and their crosses.

(iii) Study of the biology of important tick species including *Amblyomma variegatum, Rhipicephalus bergeoni,* etc. The latter tick species is confounded with *Rhipicephalus appendiculatus.* Its vectorial capability needs to be studied.

(iv) Animal breeding experts in the country recommend the jersey breed as a stock of choice for the development and propagation of the dairy industry. Various workers have indicated its relatively better natural resistance to tick infestation while its status vis-a-vis tick-borne diseases is still unknown. It is also known to succumb in a relatively easy manner to milk fever (hypocalcaemia), a serious problem with the likelihood of becoming an important bottleneck in the livestock management system prominently marked by protracted feed shortage paroxysms. The overall status of the breed needs to be comprehensively examined.

(v) *For the control of tsetse*: Update knowledge base on tsetse and trypanosomiasis with particular reference to advances and recessions. In this particular study it is essential to take into account the species of tsetse present, any natural limiting or enhancing distribution, climatic vegetational and edaphic factors. In short it is important to have a full understanding of the factors responsible for fly movement.

(vi) The sheiko and abigar breeds of Keffa and Gambella regions respectively are known to exist in areas of tsetse challenge. Studying their status in relation to trypanotolerance requires pertinent attention.

(vii) Study cattle management system to minimise fly/cattle contact with particular reference to each locality.

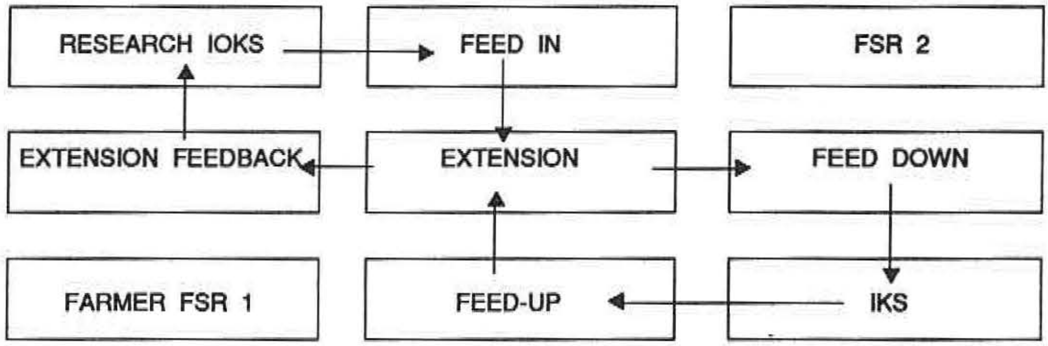
(viii) Implement vector control with regular fly monitoring — using community-based approach. Improve close to perfection various developed traps with pertinent modifications, by identifying and exploiting appropriate visual shapes and colours in combination with host mimicking chemical odours to attract and catch flies.

(ix) Develop efficient and durable traps requiring little maintenance to cut service costs using local materials.

(x) Development of computer simulation models for ticks, tick-borne diseases, tsetse and trypanosomiasis to predict epidemiological patterns and validate control measures.

Summing up, the issue sketched thus far in this paper, scientists need to spend a certain amount of time in direct interaction with resource-poor farmers and farming system situations. Scientist's awareness of indigenous knowledge or farmer-derived knowledge system and understanding of traditional practices should be seen as a prerequisite to decision-making regarding the priorities of research to be conducted (Figure 1).

Figure 1. A Systems Perspective for Extension Service in Comption's View



FSR – Farming Systems Research
IOKS – Institutionally Organised Knowledge System
IKS – Indigenous Knowledge (Farmer-Derived Knowledge System)

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Mechanisms for Implementation of Interactive R&D in Tropical Insect Science and its Application: The Case of Major Forest Pests in the Sudan

HASSAN OSMAN ABDEL NOUR

10

Mechanisms for Implementation of Interactive R&D in Tropical Insect Science and its Application: The Case of Major Forest Pests in the Sudan

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INTRODUCTION

Sudan is a vast country with an area of 2.5 million km^2. It lies between latitude 21° North and 3° North and longitude 21° 54' East and 38° 30' East. It is bounded on the east by the Red Sea and on the other sides by eight African nations — Ethiopia, Kenya, Uganda, Zaire, Central African Republic, Chad, Libya and Egypt. It acceded to independence in 1956. It is administratively divided into 66 provinces which are grouped into nine states.

The most salient geographical feature of the country is the Nile Valley. The Blue Nile originates in the Ethiopian Highlands. The White Nile originates from the Equatorial Lakes. The two rivers and their tributaries unite at Khartoum to form the River Nile which runs north to the Mediterranean Sea.

The soil in about 60% of the country, particularly in the north-east, north, and north-west is predominantly sand. Heavy cracking clay soils form a triangular central easterly plain which makes up some 30% of the country. Red soils of different types are characteristic of the remaining south-western portion.

The rainfall varies from zero in the northern desert to more than 1500 mm in the southern tropical mixed deciduous forests.

The vegetation can be divided into seven principal types which in general follow the isohyets and form consecutive series from north to south: 1. Desert; 2. Acacia desert scrub; 3. Acacia short grass scrub; 4. Acacia tall grass scrub; 5. Broad-leaved woodland and forests; 6. Forest (Gallery forest, Bowl or Depression forest, and Cloud forest); 7. Swamps and grassland (permanent swamps, seasonally inundated land, grassland, mountain meadow). The effect of topography on vegetation is limited and confined to mountain massifs, hills, upland country and Nile Valley and its tributaries.

Sudan's total population in 1990 was 26.4 million, of which 25% was urban and the other 75% rural. Nearly 8.7% of the total population resided in the three towns making up the capital (Khartoum, Khartoum North and Omdurman). The total population grew at an average of 2.9% per year.

The economy is predominantly agricultural (including livestock production, forestry and fishing), which altogether contribute to about 40% of the Gross National Product (GNP). The principal exports are primary agricultural products. Cotton is the main export commodity, followed by oil-seeds. Sudan is the world's largest producer of gum arabic.

THE ROLE OF FORESTRY IN THE NATIONAL ECONOMY

The forestry sector contributes some 12% of the Sudanese GNP, beside the indirect benefits it renders in the way of environmental protection, soil

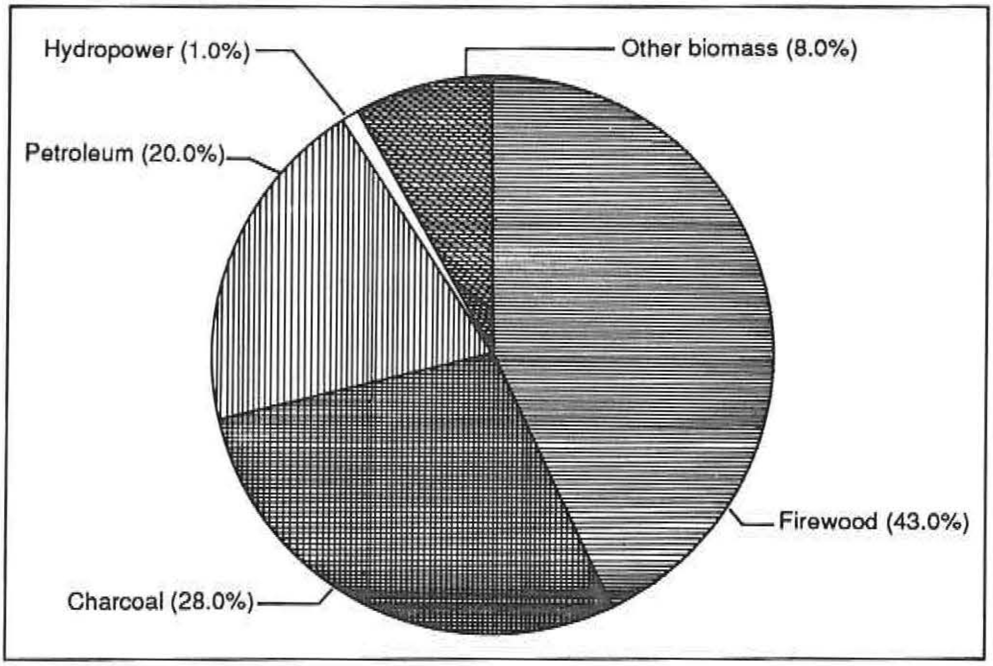

Figure 1. Energy Consumption (1989/90).

amelioration, work opportunities for rural population, etc. Perhaps the most tangible benefit derived by the people of Sudan from their forests is fuelwood (firewood and charcoal).

In 1990 Sudan consumed energy equal to seven million tons of oil equivalent (TOE), 80% of this was in the form of wood, charcoal and other biomass, 20% as petroleum products and 2% as hydropower (Figure 1). The total wood consumption for the period 1983–2000 is shown in Table 1. The annual exports of gum arabic range between 20–40 thousand tons and earn some US$ 50–80 million (Table 2).

Table 1. Estimated consumption of wood products 1983–2000. Production units are in millions of cubic meters roundwood equivalents*

Product	1983	1985	1990	1995	2000
Woodfuel	42.84	45.12	51.18	57.05	63.18
(Fuelwood)	15.79	16.30	17.49	18.28	18.59
(Charcoal)	27.05	28.82	33.69	38.77	44.59
Poles	2.14	2.26	2.56	2.86	3.16
Sawnwood	0.83	0.89	1.07	1.30	1.57
Panel products	0.02	0.02	0.03	0.04	0.05
Paper products	0.11	0.12	0.16	0.21	0.27
Total	45.94	48.41	55.00	61.46	68.23
Domestic supply	45.10	47.60	54.38	60.95	67.75
Forest and woodland (million ha)	94	90	85	79	73
Remaining growing stock	2850	2820	2750	2640	2500
Annual allowable cut	88	87	85	81	78
Population (mill.)	21.59	22.89	26.41	30.46	35.15

*Source: *World Bank Forestry Sector Review* 1986.

Table 2. Sudan exports of gum arabic*

Season	Gum Hashab tons	Gum Talh tons	Total tons	Value in Dollars
1984	29,603	3632	33,235	45,389,076
1985	12,618	14,210	26,828	26,784,204
1986	16,482	2235	18,717	48,727,158
1987	16,099	1645	17,744	78,791,426
1988	16,672	1931	18,603	55,713,290
1989	17,385	1967	19,352	46,786,994
1990	22,960	3952	26,912	54,594,740
1991				

*Source: Gum Arabic Company, Khartoum.

ENVIRONMENTAL PROFILE

Sudan's current environmental problems stem from two main inherent phenomena:

(a) The climatic desert "the Sahara" which existed for millennia and covers 29% of the total area of the country in the north.

(b) A population distribution which is inversely proportional to vegetation cover in such a way that 78% of them inhabit areas with only 33% of the vegetation cover (north), with the remaining 22% of the population inhabiting areas with 67% of the vegetation cover (south).

The inherent phenomena coupled with anthropogenic factors such as high population growth rate, lack of land use policies, national and international economic factors etc., precipitated the following environmental problems:

(a) Desertification, land degradation, siltation, sand encroachment, recurrent drought spells and floods.
(b) Deforestation.
(c) Wildlife depletion.
(d) Excessive use of pesticides.
(e) Diseases related to water provision for irrigation.
(f) Environmental urban crisis.
(g) Marine and coastal pollution.
(h) Industrial pollution and problems of waste disposal.

The most salient environmental events of direct bearing on major pests of forests and forest products include: Desertification, drought and floods.

ENDEMIC PESTS OF FORESTS AND FOREST PRODUCTS IN SUDAN

These include:

Orthoptera

Desert locust (*Schistocerca gregaria*)
Tree locust (*Anacridium* sp.)
Crickets (*Gryllus* sp.)
Mole crickets (*Gryllotalpa* sp.)

Isoptera

Sand termites (*Psammotermes hybostoma*)
Large mound-building termites (*Macrotermes* sp.)
Lesser mound-building/subterranean termites
(*Odontermes* sp.)

Ground-dwelling termites (*Microtermes*)

Hemiptera

Gall-flies, jumping plant lice (Psyllidae)

Coleoptera

Die-back beetles (Buprestidae)
Wood borers (Bostrychidae)
Longicorn beetles (Cerambycidae)
Seed borers (Bruchidae)

The honey bee *Apis mellifera* (Hymenoptera) is not a forest pest but a valuable forest insect.

PEST MANIFESTATION DUE TO ENVIRONMENTAL VARIABLES

Most of the aforementioned endemic pests repeatedly feature in annual/periodic reports of the Forests Administration or those of forestry projects as causes of appreciable damage to seedling stock in nurseries, transplants, trees of various stages, seeds, logs, sawn timber, firewood or wood in use. The degree of damage varies from one year and from one locality to another. Protective/remedial measures are applied with varying degrees of success.

However, some recent environmental events in Sudan seemed to trigger infestation by insect pests to forests and forest products and led to such damage as to cause alarm and call for some drastic measures. The following are examples of events, pests and measures:

Anacridium melanorhodon (Wlk.) (Orthoptera) *Sarie ellail* (Arabic) = Night wanderer

Tree locust

Description, life history and bionomics covered by Schmutterer (1969).[1] It occurs in North-east, Central and West Africa including Cape Verde Islands and Rio de Oro. In the Sudan the species has been recorded mainly from the central, northern and western parts. It is very common in Kordofan and Darfur where it may cause harm to gum trees (*Acacia senegal*), heglig (*Balanites aegyptiaca*), occasionally also to crops such as cotton, fruit-trees (mango, guava, citrus, date palm) and to dura (sorghum) in the milky stage. The species forms scattered swarms which usually fly at night or early in the morning hence the Arabic name. During the day the swarms are observed settled on trees preferably acacias. There is only one generation per annum and breeding takes place during the rainy season. The female lays 1–3 egg-pods containing 150–200 eggs. The incubation period lasts 23–65 days. The dry season is spent in the adult stage. The tree locust occasionally warrants control measures such as spraying Y-BHC, dieldrin or aldrin. Baiting may also be successful under certain circumstances.[1]

Impact on gum arabic production

Hashab trees (*Acacia senegal*) enter a natural dormancy period prior to their being ready for tapping. For trees growing on well-drained sites this takes place towards the end of October. Gum tappers recognise this by the changes which take place in the leaf and bark colours and by the onset of natural leaf-fall. They then start tapping.

If swarms of the tree locust alight on hashab and defoliate it prematurely (before natural leaf-fall), the trees react by resuming their vegetative growth and produce a new generation of leaves. In so doing, they use up their stored nutrient resources which otherwise would have been used to produce gum when tapped. Gum tappers have learnt this by experience and refrain from tapping when swarms of the locust appear.

Sudan rainfall figures since the mid-sixties indicate a general decline.[2,3] Gum production figures tended to follow the same trend.[4,5]

Recent studies cite the tree locust among the major constraints to gum production. Other factors encompass biotic, physical, socio-economic and institutional aspects.[4,5]

Of late the occurrence of the locust swarms is more frequent, swarms are larger and the damage is more severe than in the past. Indications are that the occurrence of the locust is more pronounced during years of above average rainfall.

Control measures

Intervention to control the tree locust is limited to ground and/or aerial chemical spraying by the Plant Protection Department.

Termites (Isoptera)

The influence of termites on tropical forestry has been extensively covered by Harris.[6,7,8,9], Sands[10] and others. Their damage to structural timber and to property is also extensively published.

Harris (1968) listed 38 termite species from 26 genera that were known to occur in the Sudan at the time.[11] These were predominantly of the belt of dry country which stretches across Africa along the southern border of the Sahara. Subsequent collections so far classified indicate that Harris' list is far from being complete.[12]

(a) Termite damage to forest trees in Sudan assumes different degrees of magnitude depending on tree species, age and climatic conditions. Both indigenous and exotic forest trees are subject to termite damage with the latter being more susceptible particularly new transplants and trees at the pole stage. In most cases of termite damage to both indigenous and exotic forest trees, the attack is preceded by factors which weaken the tree emphasising the notion that termites are secondary pests. Of the factors which weaken trees prior to termite attack moisture stress is the most common. This is usually caused by drought, prolonged gaps in rainfall or irregular irrigation. Other factors include fire, other pests such as locusts and deep scars or wounds which expose the heartwood and allow access to rot fungi. The following are examples of large-scale termite damage to elucidate the aforementioned:

(i) Low rainfall in western Sudan for two successive years during the drought spell of the early seventies coupled with neglect of cultural operations, left weakened exotic cypress (*Cupressus lusitanica*) plantations, which were established in the early sixties, (pole stage) on ex-hardwood sites in shallow mountain soil on Jebel Marra, susceptible to attack by subterannean termites.

In Beldong, virtually every tree had been girdled by *Microtermes sudanensis* and *Ancistrotermes crucifer* and tunnelling had progressed into the root-collar zone. In Galol, with even less rainfall, *Odontotermes sudanesis* had girdled the roots and tunnelled similarly.[13] *Eucalyptus*, mainly *E. camaldulensis, E. citriodora* and *E. umbellata* used for replacement for the cypress were also caught by the drought spells of 1984 and 1990 at the pole stage and mass mortality was quite sporadic. The same climatic factors were behind the virtually complete failure of afforestation activities using *Eucalyptus* sp. along the Dinder River by NGOs such as Concern and by the Forests National Corporation (FNC) along the Blue Nile using *Eucalyptus* sp. and even the indigenous mahogany *Khaya senegalensis*.

(ii) The drought spells of the mid-seventies and mid-eighties did not spare indigenous trees or shrubs in many parts of western Sudan. Mature trees of hasha *Acacia senegal*, the source of gum arabic (Table 2), *A. nilotica* along water courses and depressions and *A. mellifera* were stressed by the drought. Termites moved in and gnawed the roots thus loosening their anchorage and winds toppled them over. It was a very common sight for miles on end to encounter these trees upside down, with crowns on the ground and root system up in the air.

(iii) A mobile sawmill erected in Southern Blue Nile in 1981 to produce long planks from mature natural stands of Taraya, *Pterocarpus lucens* had to be closed. The majority of trees felled for the purpose had to be rejected because brown rot and termites (*Macrotermes* and *Amitermes*) have completely hollowed the butt log. It was not conclusively established how the rot set in but it was likely that termites followed the rot.

(b) Termite damage to structural timber, wood products and property is of a magnitude to cause concern and call for intervention. A project to protect buildings through the use of naturally durable and impregnated timber has been undertaken since 1975. Natural durability tests of timber from Sudanese grown tree species have shown that the greater majority of them are either not durable or only moderately so. Only the dry zone mahogany (*Khaya senegalensis*) has endured the test for 15 years.[14]

Control measures

For the control of termite damage to newly transplanted seedlings and trees at the pole stage of both indigenous and exotic forest trees, cultural practices conducive to the raising of a healthy tree are resorted to first. These include weeding, thinning, terrace maintenance, and timely irrigation when applicable. However, as most plantations are rainfed and with the periodic drought spells cultural practices on their own do not always check tree mortality by termites. The application of termicides to the potting mixture in the nursery and during transplanting then becomes a necessity. Of the latter only chlorinated hydrocarbons proved to be highly effective. But these are no longer available in the world markets due to their proven environmental and health hazards.

Dipping and pressure pre-treatments, with chemical preservatives such as creosote oil and CCA have proved effective in protecting perishable timbers. For timber *in situ* injection of a weak dieldrin solution behind and under wooden frames has been successful, but not without considerable resentment over environmental and health hazards.

Sphenoptera (Chalcichora) arenosa Ob. (Buprestidae-Coleoptera) = Die-back Beetle in Sunt (_Acacia nilotica_)

The Blue Nile and its tributaries — the Dinder, Rahad and Atbarawi — originate in the Ethiopian Highlands. The Blue Nile joins the White Nile in Khartoum where they form the River Nile which runs north to the Mediterranean Sea. Of the total annual yield of some 80 billion cubic meters of Nile water, the Blue Nile contributes some 75%. During its flood season June–September, the Blue Nile carries some one billion tons of silt which is a blessing and curse to the Sudan. The former attribute is due to soil fertility while the latter is due to the disruptions to irrigation and hydroelectricity generation.

Through its meandering action between Rosieres and Khartoum (623 km and dropping 73 m) the Blue Nile has cut a channel through deep clay deposits. In so doing it established the unique feature of flood basins. The mechanism involves erosion action on one bank and deposition of sand and silt on the opposite bank of the river bends. Although this process is slow, it is believed to be continuous, cutting off alternating channels and creating a new river course. The cut-off channels are linked to the new river by narrow canals which become shallow due to the continuous deposition of sand and silt.[15] The old river bed is locally known as "*maya*" which means a shallow depression, which may remain flooded for 1–3 months a year. The basin slopes nearest to the river are known as "*gerf* slopes" and the slopes adjoining the clay plains inland are known as "*karab* slopes".

The *gerf* slopes are intensively cropped with citrus, mangos, bananas, sugar-cane and vegetables. The *maya* depressions have been largely constituted as forest reserves. To-date some 210 reserves with a total area of 90,410 feddans (37,972 ha), have been gazetted (Table 3).

Table 3. Riverine forest reserves between Roseries and Khartoum

River	Circle	Reserves	Area (ha)
Blue Nile	Damazine	15	3164
	Singa	15	4061
	Suki	16	4824
	Sennar	57	5490
	Gezira	34	5540
	Khartoum	1	353
Dinder	Dinder	22	8914
Rahad	Hawata	50	5626
Total	–	210	37,972

Source: FNC files.

The riverine reserves are predominantly forested with sunt (*Acacia nilotica*). Other tree species encountered include talh (*A. seyal*), haraz (*A. albida*), dabkar (*Celtis integrefolia*), dom (*Hyphane thebaica*) and sidir (*Ziziphus spinachristi*).

Sunt (*A. nilotica*) is by far the dominant tree species on account of its tolerance of annual inundation for up to three months. The reserves have thus been put under management plans of 30 years rotation since the early thirties, with sunt as the main tree species. Besides its adaptability to the topography of the area, the wood properties of sunt have rendered it to be perhaps the most economically important plantation tree in the Sudan. Several FNC sawmills and hundreds of small private ones working on it produce railway sleepers for Sudan Railways and the Gezira Scheme lines, wood for construction, joinery, tannery and a wide spectrum of small industries. 50% of the commercial firewood for bakeries and brick kilns in Khartoum are derived from branch wood of rotation age trees or from areas managed on short rotation for the purpose (~120,000 cubic m per annum). The net annual revenue to FNC from these sunt reserves approached Ls.60 million (US$ 5 million).

Sunt die-back

In 1936, three-year-old sunt plantations in Sennar area were noted to show a phenomenon of die-back. Subsequently the phenomenon came to be known as the sunt die-back and is caused by a larva of a buprestid beetle, *Sphenoptera (Chalichroa) arenosa* which tunnelled under the bark of the stem or branches and killed all the tree above that point.[16]

By the early 1950s the disease had affected most of the forests between Khartoum and Sennar and is estimated to cause losses of up to 60% in the plantations along the Dinder River. The die-back has since been confined to these areas and was not reported south of Sennar Dam. Its spread south has been cut off by the complete clearing of sunt in that area to provide fuel during the dam construction (1914–25). The forests south of the dam commence 15 km or more south of the dam. The 15 km sunt clearance seemed to have formed a buffer area to the spread of the beetle. However, on the Dinder River which joins the Blue Nile below the dam, the buffer has progressed upstream and is very active far south of Sennar level.[16]

With the buffer area maintained clear of sunt, and a legislative control measure strictly enforced which prohibited the transport of sunt wood upstream the Blue Nile from Sennar and from Dinder, the die-back status quo was maintained, upto 1978 when it appeared in Hedaibat on the west bank and Wad Behaiga on the eastern bank 90 kilometres south of Sennar.[17] Infestation remained sporadic for the following 10 years, until 1989 when it suddenly erupted reaching plague proportions. 14 reserves have been affected with a total area of 1191.5 feddans (500 ha) equivalent to 15% of the sunt area in the reserves being killed off (Table 4).

Table 4. Areas of sunt killed off by die-back beetle in riverine forests along the Blue Nile in 1990 (one feddan = 0.42 ha)

Forest	Bank	Total sunt area feddans	Infested area feddans	% of total sunt area
Dangada	E	168	53.2	31.7
Wad El Ais	E	400	12.1	3.0
Gezair	E	736	112.4	15.3
Dontai	E	452	167.4	37.0
Zumurka	E	652	126.3	19.4
Abu Tiga	E	546	3.3	0.6
Golgani	W	270	67.8	24.1
Hedaibat	W	1110	275.9	24.9
Rumaila	W	411	108.2	26.3
Barankawa	W	410	37.0	9.0
El lakandi	E	402	1.0	0.2
Launi	W	744	130.7	17.6
Siru	W	548	48.9	8.9
Azaza	W	940	47.3	5.0
Total	-	7789	1191.5	15.3

Source: Report by Sayed Yahia I. Bushara to FNC 7.1.1991.

The 1989 die-back eruption in sunt plantations seemed to be somehow correlated with the 1988 Blue Nile flood. The latter was one of the highest on record attaining 13 meters at Ed Deim on the Sudanese/Ethiopian borders. However, the 1988 flood was even more exceptional with regard to the silt load of the water which attained a record high of 200 ppm. Beside the recurrent disruption to hydroelectric generation at Er Roseires Dam, irrigation in the Gezira, and domestic water supply in all Sudanese towns and villages along the river, the 1988 flood drastically modified the terrain in and around the sunt riverine forests. Silt deposition of up to 2 m were not uncommon. The butt logs in most of the sunt forests between Sennar and Damazine were inundated and perhaps lost for good. It was then that the widespread infestation by the sunt die-back beetle and the subsequent mortality on trees at the pole stage to rotation age were observed (Table 4).

Control measures

Control of sunt die-back beetle took the form of silvicultural and legislative measures. The former took the form of maintenance of the 15 km buffer area immediately to the south of Sennar Dam, and the removal of infested trees. The latter prohibited the transport of sunt wood upstream the Blue Nile and from Dinder to the Blue Nile.

Control of the current infestation is taking the drastic form of felling of dead trees and all of those which show signs of infestation in an attempt to create isolation belts. The results are still to be assessed.

MECHANISMS FOR IMPLEMENTATION OF INTERACTIVE RESEARCH

When reviewing the economic impact of the afore-mentioned insect pests, reference was made to various forms of interaction. Factors which trigger off insect build-up to pest status, geographic distribution and multiplicity of hosts are but some of these interactions. Mechanisms for implementation of research to mitigate the impact of these pests would by necessity involve a wide spectrum of disciplines and would therefore be interactive. Again, since economic sectors affected by these pests are integral to the overall economic set-up, then any successes achieved in mitigating their impact are necessarily developmental.

Factors Which Trigger Off Insect Build-Up to Pest Status

Insect build-up into pest status seems to be correlated to some environmental factors particularly fluctuations of rainfall. This is evident in the instance of above average rainfall with tree locusts, drought with termites and high flood and higher silt levels with the sunt die-back.

Geographic Distribution and Host Multiplicity

As was previously mentioned the distribution of the tree locust covers most districts of the Sudan and transcends the boundaries of many neighbouring countries. Its damage tends to span various economic crops such as gum arabic, cereals and fruit trees. Termites at least share the latter parameter.

It is thus evident that effective research to mitigate the impact of these pests would have to involve entomologists, silviculturists, hydrologists, agronomists, horticulturists, meteorologists, and remote sensing specialists, from just as many organisations. Collaborative research is also needed between neighbouring countries in such aspects as watershed management. Collaboration is needed too at the sub-regional, regional and international level in monitoring and exchange of information.

A closer examination of the case study in hand (forest pests of the Sudan) indicates that most ingredients of interactive research are already in place. Most of the institutions concerned are under the umbrella of the Ministry of Agriculture, Natural and Animal Resources. The Forests National Corporation (FNC), the Plant Protection Department (PPD) and the Agricultural Research Corporation (ARC) are all functions of the Ministry of Agriculture, Natural and Animal Resources. The PPD is the government authority entrusted with control of national pests *viz* rats, birds, bugs and locusts. The ARC on the other hand is the authority in charge of agricultural research. The ARC has eleven substations which cover the whole country together with four specialised centres researching food, forestry, fisheries and wildlife. ARCs departments include: Soils, Crop production and physiology, Entomology, Plant diseases, Cotton, Horticulture, Sugarcane, Statistics and Agricultural Economics.

The ARC is pursuing a package of research strategies enacted in February 1989.[18] The objectives of crop protection are to devise ways and means to protect cash and food crops from pests with the aim of maintaining projected productivity in quantity and quality while preserving the environment from pollution and without disrupting the natural balance between pests and their natural enemies.

The specific objectives of the control of insect pests are:

a. Short-term:

Stress shall be on

(i) Integrated control.

This is expected to decrease the dependance on chemical control through the integration of cultural operations, the use of resistant varieties and the promotion of natural enemies of pests together with the rational use of chemical insecticides.

(ii) Determination of the critical economic level for chemical control.

(iii) Study of insecticide resistance.

(iv) Use of high efficacy, high safety and selective insecticides.

(v) Control of chewing and national insect pests.

b. Medium- and long-term:

(i) Develop spray technology.

(ii) Biological studies.

(iii) Selection of naturally resistant crops.

(iv) Integration of biological control into the critical economic level of chemical control.

(v) Enactment of legislation to regulate the trading in pesticides, their handling and use.

Collaborative research on some of the pests in question seemed to have initiated informal linkages between other related organisations. The FNC, PPD, the Gum Arabic Company and the University of Khartoum (U of K) are jointly funding M.Sc. studies on the tree locust. Similar ventures have taken place between University of Khartoum, the National Council for Research and the FNC on termites. There is room and indeed need to involve other relevant disciplines e.g. meteorology in existing activities. Linkages for interactive research on the sunt die-back need to be established between the FNC, Forest Research, Meteorology and Ministry of Irrigation, all within a broad developmental activity. Very little can be achieved in this particular activity without collaboration with Ethiopia.

Avenues supportive to R & D such as scientific gatherings are organised on ad hoc basis. NGOs such as the Sudanese Entomological Society are not particularly active.

CONCLUSIONS

Some form of interactive research in major pests of forests and forest products in the Sudan already exists, through formal and informal linkages. There is a felt need to consolidate existing activities, augment and complement them with relevant disciplines and tap collaborative opportunities at sub-regional, regional and international levels.

RECOMMENDATIONS

- Consolidate existing R & D activities by involving relevant disciplines.
- Seek collaboration with neighbouring countries and at sub-regional, regional and international levels.

- Establish formal and informal linkages at all levels.
- Support information exchange through seminars, networks, newsletters, etc.
- Revitalise Non-Governmental Organisations such as Sudanese Environmental Society, Sudanese Entomological Society, etc.

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Discussion of a Paper Entitled: "Mechanisms for Implementation of Interactive R&D in Tropical Insect Science and its Application: The Case of Major Forest Pests in the Sudan"

Presented by HASSAN OSMAN ABDEL NOUR
Discussant: J. O. ONG'IRO

I wish to discuss this paper on the basis of its strengths and weaknesses in terms of (or in relation to) the mechanisms for implementing interactive research and development in tropical insect science and its application.

The key words in this paper in my opinion are *interactive research and development.*

The first chapters (pp.73–85) deal with the case study of the Sudan in terms of the major forest pests. The author intends to demonstrate how these pests could be contained through interactive R&D. The author rightly points out that effective R&D to mitigate the impact of these pests would have to involve scientists in various disciplines, i.e., entomologists, silviculturists, hydrologists, agronomists, horticulturists, meteorologists and remote sensing specialists. The role of economists should be appreciated also. Collaborative research is also needed between neighbouring countries as well as at sub-regional, regional and international levels. The case study confirms that in the Sudan most of the ingredients of interactive research and development are already in place since most of the institutions concerned are under the umbrella of the Ministry of Agriculture, Natural and Animal Resources.

LESSONS TO BE DRAWN FROM THIS STUDY (POSITIVE ASPECTS)

1. Need for reorganisation of research infrastructure within countries so that interaction among the various scientific disciplines is enhanced. This would be consistent with the knowledge-rich approach Prof. Odhiambo proposed in his keynote address to this forum.

   It is gratifying to note that most African countries are in the process of restructuring their agricultural research systems to be more responsive to the needs of the farmers. Integration of relevant university departments is also important.

2. Need to intensify collaboration between scientists in different countries, i.e., sub-regional collaborative mechanisms for this collaboration already exist in the form of various sub-regional organisations which have been established in West, Central, East, South and Northern Africa.

   However, care should be taken in farming networks revolving around individual scientists with no policy-making mandate.

3. Need to intensify regional collaboration among the developing world through international institutions such as ICIPE and the CGIAR system. It is noteworthy to state here that ICIPE and the CGIAR system can only be utilised effectively by strong national and sub-regional research systems.

NEGATIVE ASPECTS (WEAKNESSES OF THE PAPER)

1. Too much emphasis on the case studies without throwing light on the details of the interactive R&D in the control of the pests. The roles of the various scientific disciplines are not well elucidated in the paper.

2. Modalities for collaboration at sub-regional and regional levels should have been discussed because some have been found to be ineffective. The experience of the Sudan should have brought this to light.

3. The application of interactive R&D in the case study has not come out very clearly; it is subsumed. Scientists are one people who prefer the details to be laid on the table for further analysis.

11

ICIPE's Experience in Interactive R&D: PESTNET as a Model

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11

ICIPE's Experience in Interactive R&D: PESTNET as a Model

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BACKGROUND AND RATIONALE

Insect pests constitute a major obstacle to increased food production in sub-Saharan Africa. The food loss due to insect pests is anything from 25–40% in Africa and the control method is mainly the use of chemical pesticides which has several adverse effects. It has further become apparent that even effective selective use of these conventional control methods rely on thorough understanding of insect physiology and ecology.

It is against this background and need to develop alternative pest control strategies that the International Centre of Insect Physiology and Ecology (ICIPE) at the moment is at the forefront for search for improved pest control methods. Since its inception in 1970, ICIPE has developed components of pest management systems which have been tested and confirmed in the Field Station, farmers' fields and in different agro-ecological zones. Some of these have been successfully tested in pilot schemes under farmers management.

For relevance of application in a wider scale, these achievements are now being validated, refined and made available for application by subsistence farmers in a number of African states. Further testing after modification and adjustment are being conducted by the ICIPE scientists in collaboration with the national institutions through PESTNET in the areas of interactive research collaboration, medium- and short-term training, national and regional methodology workshop as well as the flow and exchange of information.

Why ICIPE?

After several years of mission-oriented research ICIPE developed components of IPM technologies which were tested in the Field Station and later on in different ecological zones representing major agricultural areas in Africa. Through Pest Management Research and Development Network (PESTNET), ICIPE developed a long-term partnership with national pest management R & D programmes to facilitate the validation, demonstration and dissemination of integrated pest management (IPM) technologies in the region.

Therefore, in June 1986, representatives from 12 Eastern and Southern African countries, and other institutions in Africa signed a communique to indicate their willingness to cooperate in the establishment of PESTNET and requested ICIPE to coordinate the network initially, while partners would still exercise their control through the Steering Committee and Annual General Meetings. To begin with, the network conducted studies on crop pests, especially the borers of maize, sorghum and cowpea. This would be followed by work in tsetse and livestock ticks.

Concept

The concept of PESTNET advocates, effective but horizontal partnership interaction between ICIPE, national and international institutions and farmers in the development of integrated control of major pests of crops and livestock with a view to stabilising food and economic security in tropical Africa.

PESTNET Model

Certainly there are a number of networks in the region supported also by other international centres which carry out commodity research, and in most cases, this may lead to a direct conflict, overlapping and duplication. PESTNET is unique in the sense that it is oriented towards pest management which is a factor of commodity production. Besides, it is not a mere network for exchange of information. PESTNET generates scientific information and develops national scientific capacity through training to validate, demonstrate and disseminate the scientific information throughout the network.

PESTNET integrates into and interacts with the national production system. The resident scientific teams are totally integrated into the national research system. They are responsible to the national Directors of Research through the Station Directors with whom they jointly hold the authority to incur expenditure (AIE). There exists a free and friendly but scientific interaction between PESTNET and the national research and extension systems. The resident teams interact with communities, opinion leaders, farmers, policy- and decision-makers.

Community response and attitude is very much affected by the individual's attitude and response. However, in the African context, most decisions are communally made. PESTNET approach has therefore benefited from the interaction with the informal sectors such as the church, women groups, schools and so on. Collective responsibility and decision making has made the work much more practical.

The technologies developed are based on traditional and indigenous knowledge which make them easy to adopt. The IPM technology for control of crop borers is based on intercropping systems and the trapping of tsetse is equally derived from the traditional trapping of wild game. The success of networking depends on sharing the knowledge and cost. The philosophy of sharing ideas, facilities, technologies, methodologies and cost is not new as it is well provided for in African extended family system. This approach happens to be also attractive to the donors.

We believe that the sustainability of the network depends on the level of training the participants have acquired and the ability with which they can manage the available resources and that is why we have the other two networks; ARPPIS (African Regional Postgraduate Programme in Insect Science) and FAMESA (Financial and Administrative Management of Research Programmes in Eastern and Southern Africa).

Staff and Support Facilities

The secretariat staff of the PESTNET is small and it is intended to remain so. The scientific coordinator is the main coordinating officer of the network, reporting in the same way as other special projects of the ICIPE do. He is assisted by an IPM specialist and supported by a secretary, a driver and technicians.

Resident scientists with PESTNET are posted in member countries where they are supported by national counterparts. They form research and development team around them with which they design and diagnose mission-oriented research in their respective countries.

The secretariat has facilities in the form of office space, equipment, computer/ word processor and a vehicle.

Linkages and Mechanisms of Operation

Once the government commitment to participate is ascertained and approval given, the national capability assessed and national priorities are identified, then the operation of PESTNET activities start.

Goals and Objectives

The main goal of the PESTNET is to improve food security of the developing countries in the tropics, especially in Africa by improving the control of insect pests of crops and vectors of human and animal diseases through the development and dissemination of integrated pest management techniques by a network of concerned member countries.

In order to achieve this goal PESTNET has the following objectives:

1. The generation, development and dissemination of technology for the control of designated insects and disease vectors;

2. The establishment of an efficient data handling system;

3. The strengthening of the national scientific leadership and capabilities in insect science of participating countries through education and training in integrated pest management.

INTERACTIVE COLLABORATION WITH THE NATIONAL PROGRAMMES IN TECHNOLOGY DEVELOPMENT

Efforts have been made to strengthen the national agricultural research systems (NARS) in selected activities in the area of insect pest management. These activities are grouped in three areas: interactive technology development, training and exchange of information.

The aim is to develop integrated pest management systems that significantly improve the food supply of member countries who have problems with those pests currently studied in the network.

Scientific information and methodologies which can be adapted for integrated management of pests in four member countries, Kenya, Zambia, Rwanda and Somalia have been generated and a facility for testing and demonstrating these methodologies in different agro-ecological zones within the network has been established.

Research Areas in General

Crop pests research

- Major pests of staple food crops and their natural enemies have been identified;

- Development of insect mass rearing technologies to ensure efficient, reliable and effective screening methodologies;

- Testing crops for pest resistance and for desirable agronomic characteristics in major agricultural areas in member countries;

- Identification of crop combinations and any other cultural practices that may reduce the insect pest populations and minimise their population build-up during the season;

- Investigating the feasibility of biological control agents including parasitoids,

predators and pathogens (bacteria, viruses, fungi, protozoa and nematodes) for the control of crop pests.

Tsetse research

- **Evaluation of odour-baited traps developed by ICIPE and insecticide-impregnated targets originated from Zimbabwe.**

COUNTRIES WITH RESIDENT RESEARCH TEAMS AND THEIR ACTIVITIES

Kenya

- **Survey has been conducted in major agricultural ecological zones to determine major pests affecting maize, sorghum and cowpea yields in Kitale, Embu, Machakos, Kwale and Kilifi;**
- **Testing of intercropping systems as a pest control methodology for maize, sorghum and cowpea in these regions;**
- **Investigation of the feasibility of biological control agents including parasitoids, predators and pathogens in the control of crop pests;**
- **Testing maize, sorghum and cowpea lines for pest resistance and for desirable agronomic characteristics in the major agricultural areas in Kenya and their subsequent use by the national institutions in their breeding programme.**

Zambia

- **Conducting survey studies in the three major zones to establish major pests affecting maize yield and then work out an appropriate control strategy;**
- **Development of mass rearing technique for maize streak virus vector *Cicadulina* spp. and crop borer especially *Chilo partellus* to ensure the efficient and reliable screening procedures for maize streak virus and borer resistance;**
- **Identification of crop combination which would maintain the yield of the anchor crop upto 90% of the pure stand and at the same time keep the insect pest population down and minimise their population build-up during the season.**

Somalia

- **Identification of major pests of staple food crops and their natural enemies (maize, sorghum and cowpea) in both rainfed and irrigated agricultural areas of Somalia;**
- **Use of the (ORSI) or modified index to ensure efficient and effective screening methodologies for identifying source of resistance in maize and sorghum;**

- Development of mass rearing technique for stem borers to ensure efficient screening methodologies for maize, sorghum and cowpea resistance to these pests;
- Development of low cost integrated pest management (IPM) systems for resource-limited farmers in Somalia.

Rwanda

- Collection of local and exotic germplasm of maize, sorghum and beans and screen them for resistance to borer attack;
- Studies involving banana-based cropping systems; banana/maize, banana/beans/maize and banana/sorghum crop combination;
- PESTNET intensified studies in tsetse in Kagera basin where Uganda, Rwanda, Tanzania and Burundi are involved.

Tanzania

- Studies on the distribution of nematodes and their interaction with banana/plantain;
- Evaluation of bananas for resistance/susceptibility to nematode complex;
- In collaboration with Crop Pests Research Programme as well as the national programmes, on the distribution and incidence of banana weevil complex in Tanzania and the effect of banana-based cropping system on banana weevil and nematodes. The information generated will be applicable in Uganda, Rwanda and Burundi as well.

Ethiopia

- PESTNET is involved in a large programme of tsetse control in Ethiopia. Since the area happens to fall on the same river belt which cuts across Sudan, it is proposed that the same project should eventually cover both countries.

NETWORKING WITH INTERNATIONAL RESEARCH CENTRES

The ICIPE has developed linkages with National Agricultural Research Systems (NARS) for IPM research and development activities through the PESTNET, where ICIPE provides the focal point for PESTNET that facilitates collaboration between the scientists of ICIPE, NARS, International Agricultural Research Centres (IARCs) on partnership basis.

The IARCs with which PESTNET has been interacting, particularly in the area of plant resistance to insect pests include, International Centre for Maize and Wheat (CIMMYT); International Centre for Research in Semi-Arid Tropics (ICRISAT); International Institute of Tropical Agriculture (IITA) and International Rice Research Institute (IRRI).

CIMMYT

The collaboration has been in the area of maize resistance to stem borers and has involved exchange of maize genotypes, scientific visits and information exchange. Maize materials, including those that show resistance to the stem borer occurring in North America, have been received at the ICIPE from time to time. These maize materials have been evaluated for resistance to the African stem borers particularly *Chilo partellus*. Also, the major components, mechanism and genetics of borer-resistance in some selected genotypes have been elucidated. Selections from the maize materials from CIMMYT have yielded two derivatives ICZ1-CM, ICZ2-CM which show high levels of resistance to *C. partellus* than the local materials, although they are yellow in colour.

ICRISAT

Collaboration has been in the area of sorghum resistance to stem borers and has involved: evaluation of sorghum lines from ICRISAT for resistance to the pests in East Africa; exchange on scientific visits and participations in workshops on sorghum and millets. Landraces from Kenya national programmes, both ICRISAT in India Headquarters and Eastern African Regional Cereal and Legume Network have also been received and evaluated. The materials from ICRISAT have shown resistance to *C. partellus*.

IITA

The collaboration with IITA has been in the area of cowpea resistance to insect pests and IPM in legume-based cropping systems. The collaboration has involved: (i) evaluation of germplasm and varieties from IITA for resistance to insect pests and for agronomic performance in different ecologies — Kenya; (ii) improvement of selected lines through breeding by the IITA scientist who was based at Mbita Point Field Station (MPFS); (iii) development of legume-based cropping systems by IPM specialist from ICIPE stationed at IITA.

IRRI

The collaboration with IRRI has been in the area of rice insect pests and has involved basing an ICIPE team at IRRI in the Philippines and basing a rice breeder from IRRI at the ICIPE-MPFS. The ICIPE team in Philippines carried out research on rice brown plant hopper *Nilaparvata lugens* and thereafter has taken up the study of rice leaf folders *Cnaphalocrocis medinalis* and *Marasmia patnalis*. The emphasis has been on the resistance in rice to these pests.

The IRRI scientist based at MPFS has focused on screening and improvement of the rainfed rice.

TRAINING AND EDUCATION

The main objective in training is to strengthen national scientific leadership and capabilities in the management of pests, insect research and information exchange. In order to achieve the above, prioritised register of the training needs of all member countries had to be established and a curriculum of courses developed for all levels of training, e.g. higher degree, practitioners and postdoctorals. Attempt was made to conduct and organise regular series of conferences, workshops and seminars to ensure the regular transfer of research, IPM data and the updating of scientists from the member states.

Graduate Level Training for Doctoral/Masters Degree

Training at this level has been aimed at raising the capability of scientific research and leadership of national agricultural personnel. This training has been mostly given under the ARPPIS programme jointly with 19 universities in Africa, though occasionally, it has also been given outside this programme to Africans from other universities. Students from the African countries that have received training under ARPPIS since 1983 at Doctoral or Masters level have gone back to their countries and have been able to upgrade research and development in their own areas of agricultural expertise. Besides ARPPIS, other African nationals from the USA have also received research supervision under Crop Pests Research Programme for Ph.D. and M.Sc. degrees.

Non-Degree Training at Postgraduate and Postdoctoral Level

Scientific staff from Europe, America, China, Japan, and Asia are interested in gaining experience in tropical insect science from Africa in carrying out research on crop pests and their management including plant resistance to pests as Postdoctoral Fellows. These fellowships are available to newly qualified Ph.D. candidates and are awarded worldwide on a highly competitive basis. It is limited to 2 years to allow the candidates to go back to their respective countries and strengthen the national capabilities.

Short-Term Training

Short-term training has been given mainly to practitioners and technologists from Africa and other countries in the tropics on methods of environmentally safe integrated pest management. In addition to these, individual scientists and technologists have also been trained at Mbita Point Field Station and these include personnel from Somalia, Zambia, Mozambique, Uganda, Tanzania, Nigeria, Côte d'Ivoire, Swaziland and Sudan. The supervision has been provided by ICIPE as well as other international research centres.

Research Consultants

These research consultancies include short-term visits by national senior scientists to provide advice to specific research programmes and demonstrate new techniques or research methodology as may be required by those programmes visited.

Research Associate Scheme

Linkage with ICIPE to enable middle-level and senior scientists to spend 3 to 4 months each year as a member of a research group at the ICIPE for a period, once a well-defined project is underway in the scientist's country. These schemes will facilitate the exchange of research ideas and developments. However, scientists like plant breeders do spend 2 years or more as a member of the research programme in ICIPE then go back to their national programmes.

EXCHANGE OF INFORMATION

The network aimed at developing data base that will satisfy the needs of the member for retrieval, collation and dissemination of scientific information. In order to achieve this, PESTNET has established a computerised centre called Pest Management Documentation, Information System and Service (PMDISS) dealing with the documentation and information relating to insect pest and vector management that will serve the information needs of PESTNET and other users in the developing world, especially Africa.

The Centre has developed and consolidated an efficient information exchange and document delivery capacity between the relevant national institutions of the network, a computerised data base though small but is already there together with an extensive collection of literature hard copy with special emphasis on grey literature. The centre collaborates with other known information organisations like FAO, CIBA, etc.

Methodology Workshops

There are two types of methodology workshops, National — where national issues are addressed and Regional — where issues of regional nature are addressed. The participants are drawn from the member country on a national or from the region for a regional workshop. A methodology workshop focuses on a specific topic and the resource persons specialised in the area who are actively involved in similar research areas are invited to give lectures or present papers which are fully discussed. At the end of the workshop, recommendations are made and some of these form the basis for future research plans, studies or form the basis for further workshops.

Publications

Network News is a newsletter that exchanges information and experiences among the Network scientists and institutions. A number of documents are also prepared by the secretariat. These include *PESTNET Profile*, PESTNET brochures, proceedings of PESTNET annual conferences, PESTNET Steering Committee Meetings, reports of PESTNET missions to member countries and proceedings of the methodology workshop, symposia and seminars.

PESTNET Annual Research Conference

PESTNET annual conferences are held once each year. National coordinators and delegates representing member countries participate. The Scientific Coordinator, IPM Specialist and PESTNET Resident Scientists present progress reports highlighting the achievements ready for technology development and plan of work and activities for the following year to be reviewed in-depth. Members of the PESTNET Steering Committee are nominated by the countries and the Annual Conference approves and confirms the membership.

PESTNET Steering Committee

This is the advisory wing of PESTNET, which meets twice in a year. Once the two meet (Steering and Annual) and the other before the PESTNET Annual Conference so that they can report their activities to the Annual Conference. The members review research and development progress and critically evaluate programmes presented, including matters related to institutional building, interactive research, future plans of work and status of budget. Membership is for three years and is renewable.

Conferences, Congresses, Symposia and Seminars

National, regional and international conferences, congresses, symposia and seminars are organised periodically to provide fora for information flow and exchange between secretariat and member countries and also between member countries themselves. Proceedings from these are published and disseminated to the participants through the network systems.

Pest Management Documentation, Information System and Service (PMDISS)

There is a Pest Management Documentation, Information System and Service (PMDISS) to nurture the information and documentation component of PESTNET. PMDISS is an integral part of the ICIPE Library and Documentation Service. The development of an extensive collection of scientific literature on insect pests of agriculture including stored products and allied fields is going on and will continue. This information bank will carry both documentary and non-documentary data including personnel, project and institutional data. It will be integrated and comprehensive in order to serve the tropical developing world, particularly Africa, for effective storage and retrieval of the ever increasing scientific information that is scattered in data banks, periodicals, reports, conference proceedings, patents and grey literature all over Africa.

The major goal of PMDISS is to create a dependable centre of information on pest management for all categories of potential users in research management and field work (researchers, extension personnel and policy-makers) for the tropics especially Africa.

The specific objectives are:

- Establishment of a regional centre of pest management documentation and information service to meet the needs of Africa and other tropical developing areas;
- Development of a computerised retrieval data base with a capacity in documentation, project profiles, list of specialists and institutional profiles; as a nucleus at the ICIPE containing documentary data, forming the nucleus of a regional pest and vector management information network;
- Implementation of selective dissemination of information (SDI);
- Dissemination of the information by effective documentation through indexes, bibliographies, bulletins, information packages, reviews and other current awareness tools; and
- Collaboration and cooperation with other organisations for advancement of information availability using the most effective information handling techniques.

INTERACTIVE TECHNOLOGY DISSEMINATION

The PESTNET has refrained from using the word "outreach" or the phrase "transfer of technology" because these expressions give the impression that we are getting involved in extension services. In fact, we are not and our mandate does not allow it. Similarly the words suggest that there exists a pool of knowledge or information and it is from there that the information is transferred to reach out to others. This new thinking led to the change of name of Outreach and Training Unit (OTU) to Institutional Building and Interactive Research Unit (IBIRU). The new name clearly spells out the role and function of the Unit. However, the fact that our mandate does not allow involvement in extension *per se* being a scientific organisation, there is no reason why PESTNET should not carry out systematically scientific studies on the methodologies of technology dissemination or diffusion.

It is in this connection that ICIPE has preferred to use the phrase "interactive technology dissemination" instead of "technology transfer or extension". In general, extension systems have been a problem in Africa and a large amount of information is lying in the research institutions which have not been disseminated to the farmers or have been inappropriately disseminated and, therefore, were not taken up by the farmers. Therefore, it is time for the agenda to be addressed scientifically. The problems with extension have been identified as management, organisation and training.

Management

Choice of farmers

Extension systems normally work with the selected few progressive farmers who do not need them anyway. The system is so much biased that it has no chance of sustainability. Most of the resource-poor farmers are, therefore, left out. In PESTNET the focus is on the poorest of the resource-poor. The criteria for selection has been carefully tailored to eliminate the so-called progressive farmers. Farmers have to be typical farmers, in other words, they should never be telephone, absentee or part-time farmers. The socio-economic requirement is some land, however small because a farmer cannot be landless. Women have been referred to as landless because the title deed is normally issued in the name of the husband but this does not necessarily mean that she has no land to till.

Participatory management

The present extension systems practice pyramid management style with no feedback. Top-down with no upward flow whatsoever. Under these circumstances, those at the bottom feel left out and do not consider themselves as part of the decision-making and are, therefore, not bound by the decision made. In PESTNET the management is participatory, partnership approach with collective responsibility. Whatever activities are undertaken are planned, budgeted and discussed in detail by the scientists, extension staff, social scientists and the farmers.

Organisation

Programmes are made on daily and weekly basis and appointments are made before farmers are visited. Although it is understood that farming is business but it is also an accepted fact that farmers have their own socio-economic commitments which they have to attend to. So it is important that appointment is made and adjusted according to the farmer's convenience because we are at his/her service.

It is important to observe the extension to farmers ratio since the ratio used by the present T & V method of one extension officer to 50 or 80 was derived from the work done in SE Asia. Contact farmers are identified and contact groups are clustered to make visits easy. The farmers as well as the extension staff have to record farm activities in their farm notebooks so that in three or four years the impact of the project would be determined.

Transport

Extension agents do not need a landrover to reach the farmers. It is not realistic to provide every extension staff with a vehicle. But it is practical to provide them with motorcycles, bicycles and where possible accountable advance could be given to enable them to travel by matatus (Private Vehicle Service) and while in the matatus extend the knowledge and information to the clients.

Training

In the common T & V system, the extension staff are trained more than the farmers. They attend training after every two weeks then they visit the farmers. At the same time in the pyramid system the man who is best qualified is at the top of the pyramid while the front liners who are mostly in contact with farmers are the least trained. Most of the training in PESTNET is done on-farm where scientists, extension officers, subject specialists and farmers interact freely. Training is extended beyond farms to include off-farm institutions like churches, schools, *barazas*, markets, clinics and clubs.

Scientists also learn from the farmers and extension agents are given the opportunity to interact with subject specialists and scientists in front of the farmers. Scientists may be handicapped in communication but being with the farmers and extension in the field, barriers are usually broken.

Interaction

Dynamic interaction between the four partners, scientists, extension, farmer and subject specialist is the order of the day. Interaction is multi-disciplinary and also horizontal. Either in two, three, four or multiple interaction among and between equal partners. The interaction centres do not have to be research stations, farmers training centres, but on-farm and off-farm as has been illustrated by PESTNET in training.

SUSTAINABILITY OF PESTNET

Once the national scientific leadership and capabilities are achieved and partners are equally strong the network would definitely be sustained. As long as PESTNET is integrated into and interacts with the national research systems, sustainability will be assured. The approach has to be community-based and the knowledge or technology being developed has to be based on the indigenous knowledge as this will make acceptability and adoption smooth. Initially ICIPE is coordinating the network and the secretariat is housed at the ICIPE, however, as the partners get stronger, the secretariat shall eventually be coordinated from one of the partners and funding would be obtained through bilateral and multilateral arrangements.

SUSTAINABILITY OF TECHNOLOGY

Once the national capability is fully developed and the technology developed is appropriate all that is needed for sustenance of technology is accessibility to credit that will enable the farmers to acquire the available inputs, labour and low cost equipment. Finally through interaction the project is closely supervised on a day-to-day basis.

FUTURE PROJECTION OF PESTNET

PESTNET is for the time being focusing mainly on Africa for the simple reasons that there is lack of trained manpower in insect science and very little information accumulated on tropical pests particularly of Africa. However, with the new developments, there are plans for ICIPE to move out of Africa and venture into the tropical world of East Asia and Latin America. It is common knowledge that there is indeed a growing pest management concern in SE Asia and Latin America following the implementation of "green revolution" and integration of rural development schemes and projects. There have been many situations where the results of these projects have had deleterious effect on the environment and the social fabric of peasant communities. For example, green revolution meant increased yields, but it also brought with it monoculture, heavy pesticide use which has failed, leaving them with no alternative but to fall back onto the integrated pest management approach. This will change PESTNET from an African regional network to a pantropical network for the development of long term integrated pest management strategies for controlling crop, livestock pests and arthropod vectors of disease.

FURTHER READING

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Criteria for Priority Setting in Funding Third World Agricultural Research and Development in the 1990s: A SAREC Perspective

BO BENGTSSON

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Criteria for Priority Setting in Funding Third World Agricultural Research and Development in the 1990s: A SAREC Perspective

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THE PERSPECTIVE

During the recent past, we have seen a number of major events, such as:

- A break-down of the cold war between the East and West and the current crisis in the Soviet Union;
- The tragic consequences of warfare to both humans, in capital costs and to the local as well as the global environment, exemplified by the Gulf War;
- Increasing problems of environmental degradation and the increasing rate of the spread of HIV/AIDS;
- An accelerating growth of urbanisation in the Third World with a growing number of refugees; and finally
- The overall declining funds in ODA. This is combined with an alarmingly spreading aid fatigue. Partly this is due to egoistic concerns, partly to a lack of visible results to show tax-payers in the North.

To be more precise:

- More than 1 billion people — one-fifth of the world's population — live on less than one dollar a day;
- The interest on debt of the developing countries is now accumulating by 274 million US dollars per day;
- The world's population is increasing by 9000 individuals per hour;
- Net deposits of carbon in the atmosphere grow by 11 metric tons per minute.

These are prominent indicators of human welfare. In general, they are the product of human activity taken without either awareness or concern for the impact on others. Some activities are more pronounced in the industrialised parts of the world, others in the Third World. At any event, they are global concerns. We are all neighbors.

A FUTURE DEVELOPMENT WITH SUSTAINABILITY?

According to the World Bank, the crucial question for the future development is whether national and international policies will permit the potential created by technological progress to be exploited. Sustainable development requires peace. Also, it depends on global conditions and especially on country policies.

The World Bank has made projections for the world economy in the 1990s. If there are no major, adverse shocks and generally good policies, average per capita real incomes in the industrial countries might grow by about 2.5% a year. This could be achieved with an inflation rate of 3–4% and a real interest rate of about 3%. If world trade expands more than 5% a year, per capita income in developing countries might grow by roughly 3% annually. But to what extent have substantial inputs from the South influenced these projections?

Over the past four decades, mainly outsiders, e.g. from the North have advised what to do in the South. During this period, thinking on development has repeatedly shifted. Still, many questions remain unanswered. The Brundtland Commission Report is important because it (a) has put the issue at the political level, and (b) was a consensus document from both the East and West and the North and South.

In principle, the notion of sustainable development is radical. At the same time, it is conservative since it is to work within the traditional framework of economic theory. Sustainability is neither conservation, nor protection. In a dynamic setting, certain components must not be conserved since they may not be necessary. What is necessary? For whom? And within what time perspective? These are critical questions. Some of the problems are researchable; others require decisive political action.

In short, we have to look at how many people can live on the globe and how rich they should be allowed to be in terms of the use of the global, natural resources. Current trends must be re-considered. Some of us have to change our behaviour. How? Do we have the relevant knowledge, the most appropriate methods and adequate scientific tools? Are the policy-makers willing to allocate the necessary financial and human resources?

In the North, we have gradually learnt something about the South. Still, there is much ignorance. Frequently there is an unjustified arrogance that "we in the North" know better than "they". Such a sense of superiority that sometimes is projected to the South is misplaced. Past records in the North of enormous resource consumption, conflict and environmental degradation is not a model for a sustainable, global future.

One paradox is that the North has great surpluses of food, resulting from the inter-related and ecologically unsound agricultural, economic trade and aid policies. Subsidies to small and powerful groups of farmers constitute one of the factors, contributing to this paradox. Nonetheless, why is the taste of a meal of broiler chicken produced in large-scale production and in the name of efficiency in an industrialised country so inferior to that of a "farm chicken" served at a clean, local restaurant in a Third World country?

In the South, the concern is both food quantity and quality. Contract farming is an emerging form of corporate control, also in the Third World. The agribusiness see countries as markets, using sophisticated mass marketing techniques to create a demand. They operate globally. For instance, the General Mills Company introduced recently a new brand for customers of breakfast cereals. In a study by the US Centre for Science in the Public Interest, it was concluded that:

(a) This cereal was the original but sprayed with vitamins; and

(b) The cost for the company was 2% whereas the consumer was charged with 22%!

CONCEPT AND ROLE OF DONORS

Most development thinking in the past has focused on the transfer of finance and technology on terms more or less exclusively decided upon by the North. Collectively, governments give financial support through an extensive organisational set-up inside or outside the United Nations. Contributions are usually given to an approved, regular budget but sometimes as extra-budgetary resources outside the regular budget in order to maximise donor influence. Sometimes both approaches are used. Then, there is bilateral support to individual Third World countries, based upon explicit, political criteria.

Normally, the Ministry of Finance allocates the national development funds in the donor countries through a Ministry of Foreign Affairs or Ministry of Development Cooperation and/or special government development agencies. However, prime responsibility with the technical bodies of the UN rests with the technical ministries, such as Ministry of Agriculture for FAO, Ministry of Health with WHO, etc. This highlights the need for coordination and coherent policy formulation in the respective donor countries.

Looking forward for a period of one or more decades is understandably difficult for democratic governments, accountable at elections at the end of a 3–5-year period. However, we must not forget that great statesmen have been able to keep their eyes firmly on distant horizons. One example from the past is Prime Minister W. Churchill and President T. Roosevelt in the times of cruel war in the early 1940s. Today, the globe is in need of great leadership.

The future agricultural research may increasingly be carried out in the laboratories and test plots of industry, e.g. pluralisation and privatisation of research. Public funds for agricultural research may be reduced which may mean that either some kinds of research will not be done at all, or they will be done in industry. Since industry is looking for profit, this may affect Third World agriculture.

In this century, the North has seldom acknowledged the Third World as donors. However, for most of the Middle Ages, the scientific predominance was exercised by the Arab and Asian world. In Arabised Spain, young people came to study algebra, an Arabian invention. By experience, we all know the importance of zero, an Indian invention from those days. Today, biological diversity is one area where the South is powerful. Major centres of diversity of crop plants are in the Third World. With the tools of biotechnology, these genetic resources are gaining importance to the globe as such. Furthermore, Third World professionals represent some 10% of the 4 million researchers in the world. Developing countries are estimated to contribute about 5% of the globe's scientific production. This talent could be better utilised.

Most assistance has stressed short-term, development projects. The whole "development machine" still seems to be engaged in a frantic exercise to develop project proposals for field implementation. Far too often, efficiency is judged by the speed with which money is spent. Much less attention has been given to science and capacity-building activities. However some attempts have been made by the Swedish Agency for Research Cooperation with Developing Countries (SAREC). It is the smallest of the four Swedish agencies dealing with development assistance. SAREC was set up in 1975 to support research in the Third World. Today, SAREC handles annually 3% of all Swedish total development aid, e.g. some US$ 70 million. This equals one movie admission per Swede per year!

Science in the South is mostly treated as a marginal activity. Instead, priority has usually been given to acute crisis management and concrete field projects. The long-term task of building up and maintaining endogenous research capacity has generally been neglected. The power structure has not realised that science of today will be the technology of tomorrow. But, efforts in science have often been too academic and less problem solving.

Both development and science are about people. In science, individuals are vital. Furthermore, science can only flourish on criticism and toleration of opposing views in a stimulating environment. Above all, it is imperative that research is directed to solve major development problems. Only through such accomplishments, policy-makers can be convinced that science can contribute to development and assist them in their work.

OBJECTIVES OF SAREC SUPPORT

SAREC's primary task is to fund development research in the developing countries. The twin objectives of SAREC's support are to (a) produce research results on development issues of global relevance, and (b) assist in the strengthening and building up of national research capacity in the Third World.

During SAREC's 1st decade (1975–1984), the major share of the budget was allocated to several international research programmes. This support has shown many successes. New knowledge of profound, scientific and developmental importance has been produced. Plentiful examples can be found from ILO, UNRISD, the special programmes (TDR and HRP) of the WHO and the international centres within the Consultative Group on International Agricultural Research (CGIAR).

Nevertheless, we have also learnt that there are weaknesses. For instance, too little participation and influence by Third World scientists in setting research priorities and in the execution of research tasks. Also, the national research systems are often too weak to absorb and utilise the produced results. Among others, this is due to lack of attractive research environments, including scientific equipment and shortage of scientists, particularly in Africa. National systems must be strengthened. At the same time, are the international research programmes willing to accept the need for much closer involvement by — and delegation of power to — the national research systems, making better use of their competence and experiences?

To SAREC, one concept has been given particular emphasis, namely endogenous research capacity. It will enable national scientists and qualified manpower to identify, define and carry out research within the economic, social and cultural context. The strengthening of their own resources is also a pre-requisite for their scientific manpower to participate actively and influence international research activities. In the future, we should speak about partners in both science and development. We must talk about "us" not "we" and "they". We are all vulnerable to global processes. Effective and constructive responses must take the form of participation by all.

SOME CRITERIA FOR FUNDING THIRD WORLD AGRICULTURAL RESEARCH

General

1. SAREC operates within the overall development assistance policy of the Swedish Parliament. Bilaterally, SAREC is concentrating its support to 15 developing countries, the majority of which are African. Here, the objective is to strengthen national research capacity in a long-term perspective. In countries with strong research capacity, the objective is to produce research results in problem areas of relevance to most Third World countries. SAREC spends about 40% of the total budget on international research programmes or institutes. ICIPE is one example.

   As a matter of policy, SAREC's bilateral support has increased from nil to some 35% of the total budget since 1975. Sectorwise, SAREC funds are mainly directed to agriculture and medicine in broad terms, each comprising about one third of the budget. These proportions are largely the result of demands expressed by developing countries — not resulting from specific SAREC priorities.

2. SAREC supports research on relevant problems. There must be political commitment and government contribution. In principal, SAREC does not pay salaries to local scientists. Not only research projects are funded but the overall research environment is considered. SAREC can also offer general core support to institutions.

3. SAREC's bilateral support is based upon initiatives by scientists at national institutions in the Third World. The support is seen in the long-term perspective, though budgets are approved for 2–3 years. It is important to involve the national scientists in the decision-making process so that the research problem is identified in a scientific dialogue with SAREC. The research work is to be conducted by local scientists. They have the overall responsibility. Apart from 1–2 exceptions over 15 years, SAREC does not recruit expatriates on long-term contracts.

4. SAREC promotes research collaboration. The local scientist has to provide the research idea of high priority and a tentative budget. If approved in principle and — if research collaboration is requested — he/she will get SAREC funds to travel and review for himself a number of research departments that may — or may not — be Swedish. If he/she is satisfied with one department, the potential research collaborator, the scientific resources, the staff's willingness to assist on his or her terms, a second step may take place. Then, SAREC may finance the travelling of the prospective collaborator — Swede or non-Swede — to the national scientist's home department. After that, the scientist may jointly decide to elaborate a well-designed research plan. It may include active research at both departments, collaborative research activities, research

training, scientific equipment, documentation, etc. to be provided to the research department in the developing country. This — sometimes time-consuming — work forms the basis for a final SAREC decision.

Research collaboration can take various forms. They can be elaborated between research departments in developing countries and Sweden, between national institutions and international research programmes and between national institutions within developing countries. SAREC is not confined to Swedish research departments.

Well-established, collaborative research arrangements can provide productive and useful scientific linkages to more advanced institutions. These arrangements are only granted if they are requested by the Third World scientist and approved by the responsible authority in the developing country. Some developing countries are much in favour of establishing collaborative research arrangements. Others may be more careful. It is important to stress the need for flexibility from a donor point of view. Generally speaking, our experiences are that:

- the approach avoids the dependence on expatriates on long-term contracts in the South;
- collaborative arrangements are much appreciated by the partners, both in the South and the North;
- they are productive but not without problems.

After a very slow start, collaborative research arrangements have developed gradually. The first one started in the late 1970s. Six years ago, about 40 different research departments were involved. Today, the figure is 127 departments, mainly in Sweden, comprising nearly 200 agreements on research collaboration with a corresponding partner in a Third World country. To be useful and effective, there are certain requirements from the Swedish side: (a) the necessary scientific competence; (b) mutual interest for a long-term collaboration, and (c) insights about the problems of research in a Third World environment.

5. SAREC does not offer individual scholarships for research training for longer stays abroad. Research training is, however, supported within well-defined research projects and as part of a long-term collaborative research arrangement. A model of "sandwiching" is regularly applied.

6. SAREC support to international research programmes is granted on the basis of their production of scientific results. The impact they may have in the Third World, their willingness to involve Third World scientists in governance and priority setting, etc. In my view, the CGIAR, for instance, cannot continue to grow in the future. National agricultural research systems must expand and

take over certain activities. Also, Third World agricultural scientists must be involved in the decision-making process of the CGIAR.

7. To SAREC, it is critical to let Third World scientists advise and influence SAREC's own work, its overall policy, etc. Furthermore, Third World scientists and policy-makers are frequently asked to conduct and participate in independent reviews of our activities.

SOME EXAMPLES OF IMPORTANT PROBLEM AREAS FOR RESEARCH

Based upon our own experience, on-going international and national agricultural research, SAREC has, as a donor, elaborated a more precise view in a policy paper on our support to research on bio-resources and rural development. It is to serve as a survey and guidelines for the 1990s. Now, I can only illustrate with a few highlights.

- As agriculturalists, we have to work on relevant development problems. The goal should be re-oriented towards overall socio-economic development and improved livelihood instead of a fragmented sectoral and disciplinary approach only. There is a need for a vision where agricultural sciences will regard itself — and be regarded by others — as one segment of the integrated science and technology and ethics that deals with concerned people and their environment. Since our research work will have consequences — sometimes anticipated, sometimes not — there is a need for scientific tools for consequential analysis.

- The future agriculture must not only be sustainable but must also use and conserve biological diversity. A key factor for a successful implementation of these two concepts is adequate biological understanding. This has been neglected during the last 4–5 decades. For example:

  — understanding the genetic interactions in plant science communities at the molecular level in order to design varieties with improved insect resistance. Such work is already taking place here at ICIPE.

- There is need for using not only the most modern techniques — such as biotechnology, computer sciences, tissue cultures, etc. but also tapping the local, existing knowledge, up-grading it and modifying it. The blend of technologies —traditional and modern — should include a range of alternative options, recognising both local conditions and different target groups.

  Biotechnology has no unique qualities. But, it will provide us with new tools. They may succeed or fail. The fundamental question is not "what can we do"? but rather "what kind of world do we want and what will nature require of us"?

- The structure of Third World institutions, for instance, in agriculture operate on historical basis in management, being little changed since the colonial days.

The curricula of Third World agricultural universities have not been very much influenced to focus on adequate, national and local food production but also seen in long-term perspective, recognising a sustainable development. ICIPE is a good example of institution building, being developed both as an international centre and from the perspective of African aspirations and the African social context.

- Countries like South Korea has used technological change as a major force to move forward. It wasn't possible, however, to modernise or industrialise without improving agriculture first. Before World War II, any country who wished to improve agriculture had to go alone. Today, there are elements of a global agricultural research system. It is urgent that this system can genuinely collaborate with the national systems.

SOME GENERAL POLICY ISSUES AND DONOR BEHAVIOUR

1. More attention must be given to policy matters both in research and to influence policy-makers, including the donors. One policy issue is to find appropriate values of natural resources in a long-term perspective. Who should assign such values?

2. Science is public good. In the research process there are various changes in the observed values. All scientists must accept social relevance and responsibility in their design of research policies. They must also be active in the dialogue with policy-makers and donors.

3. Donors must act with competent staff and formulate their own policy for support to priority areas by both drawing lessons from their past experiences and monitor on-going scientific and policy discussions in the North and the South.

4. Donors exercise collectively considerable power. They influence on policy, type of investments, values and attitudes to the concept of development. They are also influential using their technological knowledge and expertise, including the scientific field. Scientific training, in addition to providing skill and knowledge, can also be a process of social and intellectual indoctrination. This is relevant to the flourishing field of "experts", consultants to the Third World as well as improper training of Third World country personnel. Such training may too often be on problems in the industrial countries, in these countries, using only Western-type approaches. Instead, there is need for support to M.Sc. and Ph.D. programmes at national Third World universities. In many countries, a national science culture must be developed.

CONCLUSION

Let me conclude with a strong plea. The Medieval Western society invested a lot of its social product in building cathedrals. My vision is that national policy-makers, including donors, will act and now embark upon a process by which the national research capacities of Third World countries will be strengthened during the next decade. This is a great challenge — but quite realistic if we join forces.

Recognising that poverty in the South is the problem, it is important to realise the consequences. Let me illustrate by the words of the late Mahatma Gandhi of India: "Before you initiate any development project, ask yourself whether what you plan to initiate will bring cheer and wipe the tears of the poorest person you have seen in your life. Proceed with your plan only if the answer is yes".

Discussion of a Paper Entitled: "Criteria for Priority Setting in Funding Third World Agricultural Research and Development in the 1990s: A SAREC Perspective"

Presented by BO BENGTSSON
Discussant: JACOB KAMPEN,
Senior Agriculturist, World Bank

Mr. Chairman, Ladies and Gentlemen

We have just listened to an excellent presentation by Professor Bengtsson. Before reacting, permit me a few introductory remarks. I am particularly pleased to participate in this Forum because I feel that:

- Such interaction is essential to the continued relevance of programmes at ICIPE and other International Agricultural Centres;
- Such meetings will contribute to regional collaboration and in doing so make more efficient use of scarce available resources;
- They provide opportunity to focus attention of key decision-makers on resolution of critical weaknesses in the agricultural research systems; and
- This forum will contribute to carrying forward the concepts of IPM which are critical to the development of sustainable, more productive farming systems.

I wish to congratulate ICIPE management with taking this initiative which I am sure will significantly add the strength and relevance of ICIPE-supported programmes.

The organisers have asked me to, jointly with Dr. Omuse, discuss Professor Bengtsson's paper on "Criteria for Priority Setting in Funding Third World Agricultural Research and Development". I would like to divide my discussion into three sections:

(i) A brief review of key points of Professor Bengtsson's paper;

(ii) A few remarks on critical constraints which in my view stand in the way of implementing some of the recommendations;

(iii) A short discussion of two recent World Bank sponsored initiatives in response to concerns about research priorities and limited resources.

In review, I support many of the points Professor Bengtsson makes such as:

- the need for shared concerns, collaborative priority setting and joint action;
- the coming globalisation and privatisation of agricultural research, although Government-funded work will remain important;
- the imperative of directing research at solving major development problems; and
- SAREC's focus on strengthening endogenous research capacity.

Similarly, one cannot argue with the need to:

- reorient agricultural research towards improving overall socio-economic development and livelihood;
- use and conserve biological diversity;
- recognise the location specificity of most research on sustainable systems; and to
- generate new research methodologies addressing the farming system rather than solely the components.

SOME QUESTIONS

Mr. Chairman, Ladies and Gentlemen: permit me at this point to refer to a few statements in ICIPE's draft Vision and Strategic Framework and pose some questions:

(i) The statement on Vision on page 1 refers to the National Agricultural Research Systems (NARS) for the adaptation and dissemination of new technology;

(ii) On page 10, the draft predicts important IPM technologies being ready for testing and adaptation by the National Agricultural Research Systems within the next few years;

(iii) On page 30, it is stated that it is important to reach out to the extension workers, national programme scientists and policy makers;

(iv) On page 37, under Measures of Success, ICIPE's clientele is said to comprise of the national agricultural organisations and the farmers;

(v) And finally, on page 23, it is said that the most frequent reason for research project failure in Africa is the lack of trained national personnel.

It is evident from the first four points that in the end, the capacity of national programmes and the strength of ICIPE's linkages with them **will determine the impact of the Centre's effort.** Has sufficient attention been paid to how these linkages will be formed and nurtured, not only with the universities but also with the national centres and systems? Is there reasonable assurance of continued support and guidance for the young graduate scientist after he or she has joined the NARS?

I also wish to question the lack of trained staff being quoted as the most important current cause of project failure — **not** because I do not see the need for continued manpower training programmes, but because I believe that there is a more important constraint that must now be addressed by the countries involved and by the international community. That constraint has to do with underutilisation of already available resources of facilities and manpower, due primarily to inadequate and undependable recurrent budgets for operating costs of national research systems. To illustrate the critical importance of this issue, let me again focus on some key aspects of Professor Bengtsson's presentation:

(i) When we talk about results of "global relevance", do we not often tend to forget that in the end the improvement that will "wipe the tear" of some poor rural person, man or woman, can only come when a lonely researcher at some far out regional sub-station tailors technology to location-specific needs by joining hands with extension staff, and that can only happen when they both have the means to do the work at hand?

(ii) Or when we recommend that new innovations are to be based in traditional patterns of work and customs, that we need to build on existing knowhow and apply a farming system approach, do we realise sufficiently that this means that local staff in research and extension require the right types of incentives and — again — the vehicles, fuel and allowances to work together and get to their clients in time?

(iii) Given the important resource of biological diversity, are the means in place to get geneticists and researchers off the research stations to remote areas to inventory, describe, collect, and preserve?

(iv) When we stress the long-term framework essential to all research, and we regret the under-utilisation of scientific talent at many national centres, do we sufficiently realise that in addition to offices, laboratories, equipment, and vehicles, above all, operating funds to capitalise on what we have are essential?

(v) When we recommend the development of production systems not based on the Northern model of use of high doses of costly inputs, is it clear that in an environment as diverse as the African continent, we will need a research effort unprecedented in the world's agricultural history?

(vi) We would all agree that only development in agriculture can provide the engine for overall economic recovery in Africa and that agricultural research and extension are to be the spark-plugs to that engine. But have we been able to extend that realisation to the decision makers and politicians to the point that research support does become an overriding priority even at times of national emergencies?

You yourself can fill in the answers. What I am trying to say is **not** that ensuring recurrent operation budgets will resolve all problems on the long road of technology generation and dissemination in Africa. However, without those I believe we cannot even get started.

NEW INITIATIVES

In recognition of the acute shortage of funding and the need to utilise available resources more efficiently, the World Bank, jointly with other donors is currently exploring two new approaches towards strengthening agricultural research in Africa. Both are undertaken in the context of SPAAR, the Special Programme for African Agricultural Research. The SPAAR group decided in Brussels in May 1990 that an agreed research strategy is needed as a basis for consensus building and concerted action on technology development in Africa. The proposed strategy will consider: (i) whether all aspects of research are adequately covered to achieve the targeted 4% agricultural growth for sub-Saharan Africa; (ii) whether the institutional arrangements are optimal; (iii) what will be needed to minimise many of the operational and administrative problems presently apparent in the region; and (iv) how SPAAR can help build an agreed consensus on what to do about it.

The first initiative relates to the decision at the same May 1990 conference that regional strategies and "Frameworks for Action" (FFA) should be developed for the major agroecological zones and/or regional groupings, starting with the Sahel and the Southern African Development Coordination Conference (SADCC) regions and followed by others.

Let me briefly outline what is involved in these FFAs:

They are a package of measures to improve national Agricultural Systems (NARS) in a regional context with a NARS defined as the entire spectrum of agricultural research activities undertaken within a country by a multiplicity of organisations, national, regional and international.

FFAs include:

(i) Defining National Agricultural Research Strategies (**master plans**), coherent with a **regional** research agenda. A master plan presents a long-term vision of agricultural research requirements, coherent with and responsive to priority national agricultural sector policies.

(ii) Identifying priority collaborative **regional** research programmes. Such regional research programmes must be implemented by the NARS, on existing research stations. This is a new concept that goes beyond simple networking! It is based on a common agreement between the NARS on comparative advantage and a distribution of tasks.

(iii) Designing consolidated funding mechanisms to improve research efficiency and donor coordination (**by governments**). Such mechanisms can take many forms, but the main purpose must be the adequate provision of recurrent funds for agreed national plans and regional activities, implemented within a national context.

(iv) Introducing and testing **institutional reforms** to create the **enabling environment for quality research** (such as human resources development and career opportunities for scientists) and strengthened linkages between researchers and their clients. The **main challenge** would remain the required change in "institutional climate and culture" that must make researchers accountable for being responsive to the constraints of their research "clientele" (the resource-limited farmer).

To give an example, at a workshop in Gaberone in November 1990 the SADCC's Southern African Centre for Cooperation in Agricultural Research (SACCAR) and SPAAR launched a joint initiative to strengthen the concerned national agricultural research systems. The overall objective is to boost the regional agricultural growth rate through developing sustainable National Agricultural Research Systems, including Faculties of Agriculture.

The elements of the proposed SACCAR Framework for Action in agricultural research and training would serve to provide the research software and address critical gaps in agricultural research in the region. It will require the cooperation of the SADCC member states and the donor members of SPAAR, in concert with the IARCs and private sector research institutions, to put the following elements in place:

(i) establish a **Research Fund** for each NARS to ensure the adequacy of recurrent funding for the National research master plan and thereby improve the enabling environment;

(ii) develop a capacity for policy analysis within each NARS to assist governments in setting sound market-oriented policies (production, pricing, marketing, processing, utilisation and trade) for the agricultural sector;

(iii) encourage private sector involvement in formulation and implementation of the national/regional research programmes;

(iv) redress the adverse **scientific terms-of-trade** in the region and enhance the quality of the science and technology sector in the region through the establishment of specialised regional technical institutions that will enable African scientists to establish leadership in their field; and through enabling the agricultural faculties to increase their research output;

(v) **intensify** existing farming systems in the arable farming areas, and **diversify** the commodity base through research and development with the goal of increasing and sustaining the agricultural growth rate at about 4% per annum;

(vi) assist the rural poor in ASAL areas through support for wildlife management and other specifically tailored programmes.

The SACCAR Framework for Action (as well as the one for Sahel) was endorsed in principle at meetings in Abidjan in May 1991 and will now be finalised for presentation in November to the SPAAR membership for formal adoption. The FFA is also being presented to the SADCC Council of Ministers to obtain political endorsement. It is envisaged that in the next few years, similar FFAs will become operational for much of sub-Saharan Africa.

The **second initiative** relates to a new approach towards financing of agricultural research. It is based on the realisation that:

(i) Financial support for agricultural research limited to infrastructure development and incremental recurrent costs, which is current practice by the Bank and most other donors, may result in unsustainable research facilities.

(ii) Distinction between capital, non-incremental and incremental operating costs of agricultural research is incorrect — all expenditure for research, whether of an investment or maintenance character, contributes to asset (i.e. improved technology) creation.

(iii) Broad programme support of both research capacity development and research activity leading to monitorable results, with conditionality of acceptable programme planning and review, and borrower financing increasing over time, would contribute to much more productive and sustainable agricultural research systems in Africa's developing countries than has been the case to-date.

(iv) By nature, technology creation is a risky task requiring patience and long-term commitment. Also, efficiency of use of resources already available to existing agricultural research systems in Africa must be rigorously improved. The organisation and programme and resource-use planning that would be required under the newly envisaged approach to World Bank support for consolidated research programme budgeting, is expected to contribute to solving these problems.

The main idea involved in the new approach is **to define a national research programme with monitorable outputs** and to consider all research expenditures **(including incremental and non-incremental operating costs)** as capital costs and, therefore, eligible for Bank/IDA financing. The ultimate goal is to achieve a consolidated programme budget approach among donors and the concerned Government towards financing of the agreed programme. The new approach will be implemented on a pilot basis in specifically selected projects/ countries in the two regions involved in FFA implementation (and possibly others).

Mr. Chairman, Ladies and Gentlemen, in conclusion: I hope that in these comments, I have not wandered too far from the subject of our session. I do believe that the strength and vigour of the national systems, both in research and extension, and the efficiency with which available resources including and especially manpower, are used, are critically important criteria for priority setting in funding agricultural research. In many of the countries of our region, the current state on this issue is not good. Unless we can convince those in decision-making positions to resolve the recurrent funding crisis, many of our efforts at the levels of the international and regional centres and a large part of the inputs into NARS may be in vain with disastrous consequences for development and human welfare on the continent. Until the recurrent operational funding issue is resolved, it should in my view be put up-front in all our vision and strategy documents. Thank you for your attention.

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Interface Between Integrated Pest Management and Industry: The Brazilian Experience

CLAYTON CAMPANHOLA, GERALDO STACHETTI RODRIGUES AND GILBERTO JOSE DE MORAES

13

Interface Between Integrated Pest Management and Industry: The Brazilian Experience

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INTRODUCTION

Brazilian agriculture has been submitted to a radical change in the last three decades. The incorporation of new technologies, involving intensive use of chemical fertilisers, pesticides, improved plant varieties and mechanisation, certainly contributed to put the country in a prominent place in the world agricultural market. The reasons for this pattern of evolution is beyond the scope of this paper. It suffices to say that the dynamics of replacement of traditional by new crops in Brazil indicates the changes in the agrarian pattern and in the circumstantial development policies adopted by the Federal Government. Crops intended for exportation (soybean, citrus), for importation replacement (wheat) and for energy production (sugarcane) were given higher priority.

The temporary and substantial development observed was sustained by a bursting economic build-up, and was based on a series of favourable factors, such as the abundance of natural resources, low cost of energy, fast adoption of new technology by large growers responsible for the production of the new priority crops, availability of funds, fertile lands and expanding markets. However, after the initial phase of success, the negative effects of the development policy adopted raised the awareness of its inconvenience. Deforestation, soil erosion and general pollution were inherited by the whole society as a result of the adoption of a "use-and-discard", non-sustainable, agriculture.[1] When this was realised, all the technologies supporting that approach were questioned. On the other hand, the spread of agriculture over new frontier regions did not result in significant increase in the overall cultivated area in that period (Figure 1), because the newly incorporated areas continuously replaced degraded ones.

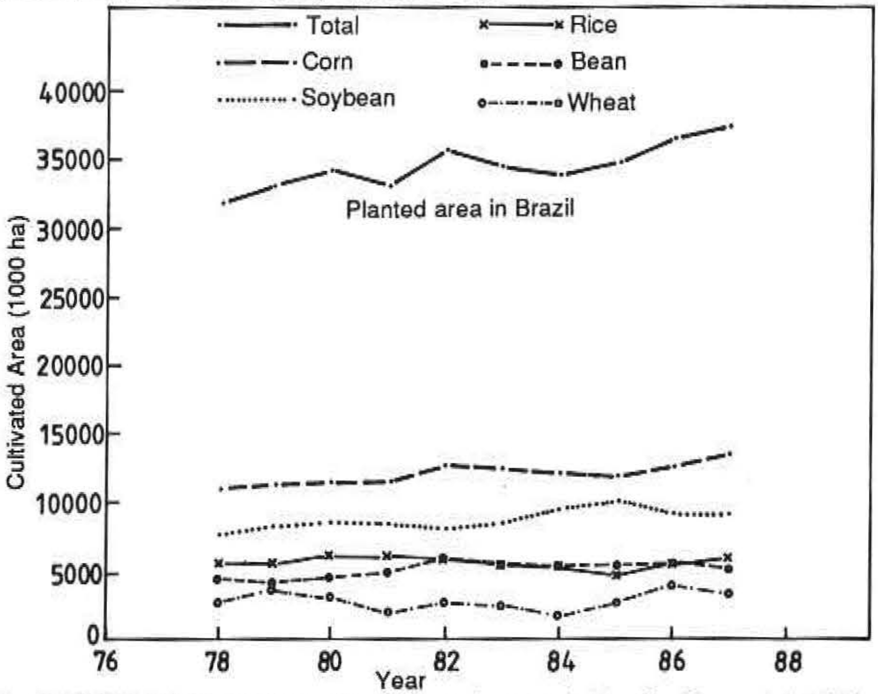

Figure 1. Evolution of the area planted to some grain crops in Brazil. (Source: *Anuário Estatístico do Brasil.* FIBGE, Rio de Janeiro, 1982, 1985, 1989).

This brief historical overview introduces to the nationally perceived necessity for the development of sustainable crop production systems, based on the principles of IPM, and to the role of industries in this new process of modernisation.

TRENDS IN PESTICIDE USAGE AND EFFECT ON YIELD

The use of pesticides rose steadily in the last few decades, peaking in late 1970s (Figure 2). Comparing with 1967, in 1980 there was an increase of about 136% in the apparent use of insecticides, 667% in the use of fungicides and 2460% in the use of herbicides. Very soon, however, a period of crisis occurred in early 1980s, with a consequent reduction in pesticide utilization to approximately half of what it was in the previous decade. Since then a slow and unstable ascent in pesticide use has occurred.

No correlations have been observed between pesticide usage and planted area or yield (Figures 1–3). In other words, more intensive use of pesticides has not necessarily implied higher yields.

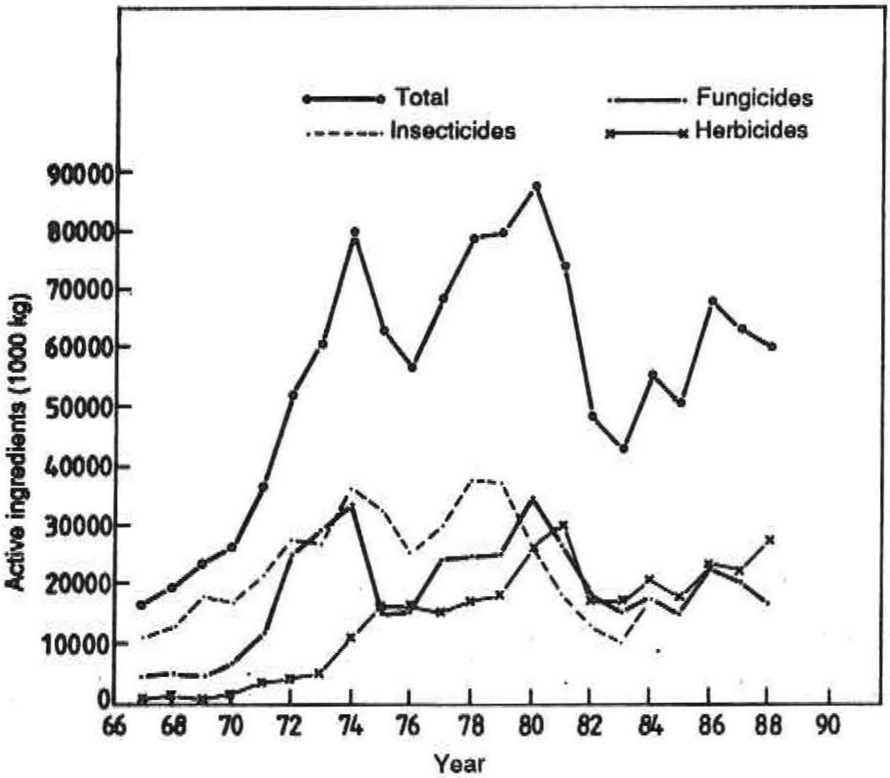

Figure 2. Apparent usage (production and importation) of pesticides in Brazil. (Source: *Anuário Estatístico do Brasil.* FIBGE, Rio de Janeiro, 1978, 1985, 1989).

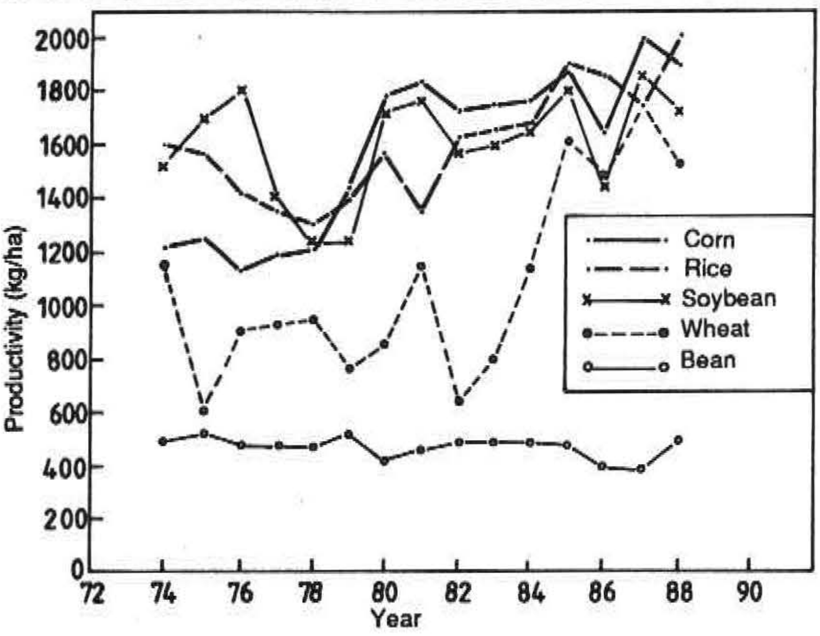

Figure 3. Yield of some grain crops in Brazil. (Source: *Anuário Estatístico do Brasil.* FIBGE, Rio de Janeiro, 1978, 1985, 1989).

What are the possible specific causes for the reduction of pesticide usage per unit area in Brazil? It is not possible to single a reason for that. It is most probably the result of several factors, which may be variable for different regions or crops. It seems that generalised public outcry, influenced by international trends, has played an important role in this situation. The demand for safer, non-contaminated food commodities and less polluted environment ultimately determined a ban in the commercialisation of virtually all chlorinate hydrocarbon pesticides in use in the country, which was done by a portaria of the Ministry of Agriculture and the Ministry of Health published in 1985. The only exceptions were a few chlorinate products for which no effective alternative control measures were promptly available.

A second factor which most probably had an impact in the use of pesticides is related to the role of television in public day-to-day information. Outstanding results achieved with successful IPM strategies broadcasted in specialised TV programmes have led growers to try those programmes in the particular crop concerned, generally resulting in a lower use of chemicals. Not rarely, growers were also induced to reduce the use of chemicals in other crops, expecting similar results.

But a factor that really had an important bearing on the reduced use of pesticides was the shortage of credit funds to agriculture, linked to the end of subsidies. A few years ago, the approval of credit for production projects depended heavily on growers' commitment to use "assurance" pesticide treatments, which constituted a symbol of growers' enlightenment. Pesticides in those cases were subsidised, allowing growers to "have a better chance" to succeed. Today, with no subsidies of this sort, growers realised the real cost of pesticides, which they started to use more judiciously, for economical reasons.

In some of the most important States in terms of agricultural production still another factor was responsible for the drop in pesticide use. That refers to a Federal law, supported by State regulations about the requirement of prescriptions, issued by authorised agronomists, when purchasing pesticides of any sort. This has certainly introduced an additional difficulty in purchasing those products, especially to the small growers.

MAIN IPM PROGRAMMES IN BRAZIL

Cotton

Traditionally, cotton is one of the crops in which large amounts of pesticides are used worldwide. Until recently, up to 40 insecticide applications were done yearly in Brazil against two key pests of this crop, tobacco budworm *Heliothis virescens* (F) and cotton leafworm *Alabama argillacea* Hubner. Increasing production costs and secondary pest outbreaks led to considerable research efforts to develop an IPM programme for this crop. This programme resulted in significant savings for cotton growers, who were able to drastically reduce the frequency of sprayings until the introduction of another serious pest, the boll weevil, *Anthonomus grandis* Boheman in 1983. Although the fast dispersion of *A. grandis* caused great concern, the management strategies introduced such as trap crops, elimination of plant stalks after harvest, scouting for pest levels and appropriate timing of effective pesticide applications have kept the pest under control. The mean number of sprayings now stands at 4 or 5 per season.

Soybean

Commercial soybean cultivation started in Brazil in the early 1950s, exclusively in the south. It is grown today in an area of more than 8 million ha, spread over subtropical and tropical regions, with yield above 1700 kg/ha. The main soybean pests include a few Lepidoptera and some Hemiptera, against which an average of five sprayings are seasonally done. Pest control in this crop represents a considerable expenditure, each spraying corresponding to about 10% of the total production cost.[2]

One of the most destructive soybean pests in Brazil is the caterpillar *Anticarsia gemmatalis* (Hubner), which feeds on the leaves. A nuclear polyhedrosis virus (*Baculovirus anticarsia*) was identified in 1971 as an effective mortality factor of this pest. In 1980/81, *in vivo* production of the virus was initiated by EMBRAPA/ CNPSO (Empresa Brasileira de Pesquisa Agropecuaria/ Centro Nacional de Pesquisa de Soja) for the control of the pest in growers' fields. Concurrently, a technique was developed to allow an adequate formulation of the virus for use by growers. In 1987, about 500,000 ha of soybean were sprayed with the baculovirus for the control of *A. gemmatalis* (Figure 4).[3] This has represented tremendous

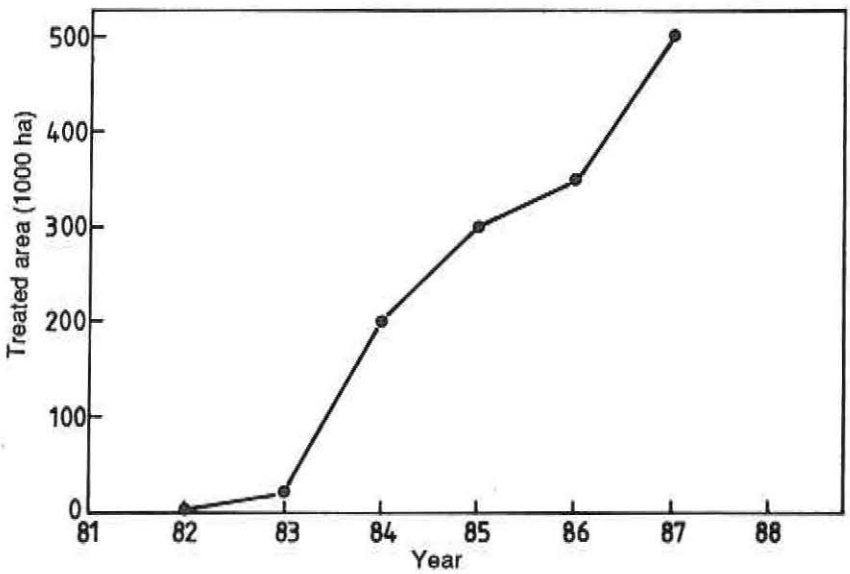

Figure 4. Soybean area treated with *Baculovirus anticarsia* for *Anticarsia gemmatalis* control. (Moscardi, 1991).

savings to growers, who now can use an effective and economic tool to control the pest, and to the country, that has reduced the use of imported pesticides for this purpose.

Wheat

Brazil was ranked among the largest world importers of wheat for many years. The dependence on external suppliers has challenged the government to stimulate the development of appropriate technology for the production of this cereal within the country. Thus, in a few years the crop which was grown only in the south started to be cultivated under low latitudes, with the development of new varieties. To reduce the severity of damage caused by introduced aphid pest species, an IPM programme was initiated in 1978, based mostly on the introduction of effective parasitoids and predators. About 3,800,000 natural enemies were released in a period of 5 years over four different states.[4] As a result of the effort to improve the cropping system, yield of this crop has increased by 90% from 1983 to 1988, despite the reduction in the percentage of farms using pesticides from 100% in 1977 to less than 5% in 1981.

Citrus

Citrus has long been an important crop in Brazil, a country which is now one of the two top producers in the world. There are a few arthropod species which may cause severe damage to this crop under different circumstances. Two of the main pests are the "leprosis" mite, *Brevipalpus phoenicis* (Geijskes) and the citrus rust mite, *Phyllocoptruta oleivora* (Ashmead). Several other insects, mites and fungi may also affect this crop. The determination of economic damage levels for the main mite pests has made it possible to establish an IPM programme which has resulted in a significant reduction of pesticide applications.[5]

IPM AND INDUSTRY

A distinction must be made between industries represented by chemical companies and other industries whose main activities are not related to the production of chemical pesticides.

There are a few examples of serious commitment to IPM in its strict sense by several Brazilian industries, because of economical considerations or because of technical difficulties faced in the use of more conventional pest control methods. As examples we should mention the use of fungus *Metarrhizium anisopliae* and the parasitoid *Apanteles flavipes* Cameron for the control of sugarcane plant hoppers and stem borers *Diatraea* spp., respectively, by sugar industries,[6] resulting in effective and economic control of both pests. Those pests are controlled exclusively by the use of the respective natural enemies over tens of thousands of hectares.

Another example of this kind refers to the production and use of *Trichogramma praetiosum* and *Bacillus thuringiensis* for the control of the tomato fruit borer *Scobipalpuloides absoluta* in thousands of hectares in north-east Brazil by growers and processing industries. The use of both natural enemies was the only effective means of controlling the pest, after heavy losses in several consecutive years, despite the use of a number of chemical pesticides.

Another aspect relates to the industries whose main objective is the production of chemical pesticides. Because they depend on sales to be able to maintain themselves, they have to adapt to the new situation by offering products economically and technically most suited to the new reality. Thus, what are the options those industries have? First, forced by the new regulations, they have to offer products which are more selective, safer to the environment and humans, held in containers which are more easily disposed of, in attendance to new Federal environmental laws. Also, to be more appealing to the public, as far as possible, new pesticides had to have low persistence in the soil, be a natural compound or a natural enemy, that is, a predator, parasitoid or pathogen.

By their characteristics, chemical companies are involved in large-scale productions which require skilled production systems, amenable to patenting. Thus, it seems that any company of this type would be more interested in the production of pathogens, which demand more refined production techniques, probably warranting the patenting of production processes. This is actually what has been observed in Brazil. A serious constraint in the wider involvement of the chemical industries in this aspect is the present absence of an adequate specific legislation concerning registration, production and use of those organisms. Today, the laws applied to chemical pesticides are also applied to those controlling agents. Considerable investments by the industries are expected to occur only after those issues are properly addressed. There is today an effort in this sense, with the recent establishment of an *ad hoc* committee by the Ministry of Agriculture in order to study those aspects. Depending upon the outcome of that study, the Ministry of Health and the Secretariat of Environment will improve the specific issues related to them.

Quite a few organisms have already been experimentally shown as potentially useful in the control of important pest species. Some preliminary studies have indicated the feasibility of widescale production and commercialisation of those organisms. The most outstanding example in Brazil is the wide use of *Baculovirus anticarsia* for the control of *A. gemmatalis* in soybean; regardless of confirmed virus effectiveness, until today it is exclusively produced by the Centro Nacional de Pesquisa de Soja of EMBRAPA, an official institution. Other examples of organisms which have been produced by official institutions in Brazil and widely used by growers but still not commercialised, are viruses for the control of the cassava hornworm, *Erinnyis ello* (L.), and the corn borer *Spodoptera frugiperda* (J.E. Smith).

MODERN STRATEGY OF THE INDUSTRIAL SECTOR

An adequacy to the new IPM era is a matter of necessity by the industrial sector. The new reality in terms of availability of resources and growing public pressure towards the use of less disruptive means of pest control has led the traditional chemical industries to new directions. Most certainly, without losing their characteristics of enterprises and with their experiences in development, quality control and marketing, the big businesses can facilitate the use of techniques, tools and materials which are expected to be used by a wide public. The industries are aware of the need to modernise adopting the IPM concept, and in this sense, the Brazilian National Association of Pesticide Producers has been offering regular courses on matters related to IPM, and has played an important role in the coordination of the last International Plant Protection Congress in Rio de Janeiro, whose central theme was IPM.

Aside from the involvement of the official institutions and the modernisation of traditional chemical enterprises, we have seen that a relatively small but growing number of small industries have started the production of natural enemies for commercialisation of biological control agents, especially pathogens. Growers associations are also playing a role in particular instances, as for example in the case of the production of *Metarrhizium* for plant hopper control in the north-east.

RESEARCH IN OFFICIAL INSTITUTIONS AND THE INDUSTRY

We have assisted recently in Brazil in increasing interaction between the industrial sector and the official research institutions. Without question, an important factor in this sense has been the introduction of new strict requirements governing registration and renewal of registration of pesticides, determined by newly implemented Federal laws. In many cases, that intensification has occurred by initiative of the industries. In other cases, Brazilian official institutions have also tried to intensify the interactions with the private business, understanding that those organisations which depend on public acceptance of their products and technologies, and duly equipped to do so, offer one of the best ways to implement the positive research results. However, interactions have often been hindered, because of some conflicts of interest, as for example in the case of equipments designed to significantly reduce the use of pesticides, or equipments which would compete with similar ones already available in the market. Of course, developing and marketing any product represents a considerable investment and industry will only engage into that if profitable in the first place.

CONCLUDING REMARKS

As an official national research institution it is obviously not our affair what we can do to make the traditional chemical industry adapted to the new reality, but rather what we can do in the interest of growers and the general public, interacting with those organisations, when necessary. We understand that the industrial sector has its own interest as business corporations, but we also realise that the experience of the industrial sector may make widely available in due time the means for new IPM techniques to be significantly implemented nationwide.

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14

The ICIPE Strategic Framework

RHODA A. ODINGO

14

The ICIPE Strategic Framework

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INTRODUCTION

We have learned many truths during the last three days. The Scriptures assure us that "And ye shall know the truth and the truth shall make you free". Can the scientific truths set our people free from poverty? In his keynote address, Prof. Odhiambo said and I quote "The poverty of the people living in the tropics is not of physical resources but of knowing how to use them".

We are here to plan how to generate and share knowledge in order to empower the people to use the resources to improve the quality of their lives in health, nutrition, higher incomes, education, and sustainable environment. Let me quote from the latest edition of the World Bank World Development Report 1991: The Challenges of Development (page 52) where a Chinese philosopher, K'uan-Tzu, 551–479 B.C. is quoted as having said:

> "If you plan for a year, plant a seed. If for ten years, plant a tree. If for a hundred years, teach the people. When you sow a seed once, you will reap a single harvest. When you teach the people, you will reap a hundred harvests."

We hope that the results of our planned research and development will serve the people for many decades to come. Therefore, we must teach the people at the various levels of decision-making.

In his address, Prof. Odhiambo emphasised that ICIPE is committed to working closely in partnership with the national research, development, extension, and education systems as well as with industry, for achieving a common goal. This goal, as far as ICIPE's mandate is concerned, is the generation of knowledge in insect science for developing pest management technologies that are environmentally sustainable for resource-poor communities. You are gathered here to assure us that this goal is driven by the needs of the wide range of our constituency, which together with you, the ICIPE seeks to serve, and that the final outputs or results will be of benefit to you in strengthening your capacity to serve the people at the grassroots, who through their participation in agricultural production are also the producers of wealth for your country.

A draft planning document has been circulated as a starting point. We look forward to a critical examination and discussion of the issues proposed in the document as well as those new ideas you wish to encompass and for which the ICIPE would have a comparative advantage, for those of your countries which are already collaborating with us, as well as those which intend to do so.

In particular, we are seeking your advice on how to assure relevance, to identify the needs, to interface with your own planning process in order to strengthen the partnership between your country and the ICIPE, how to implement the plan, how to finance the selected priorities and last but not least, how to assess the impact and assure continuous feedback. Indeed the presenters of the Papers and the Discussants, as well as your general discussions have laid a very firm foundation for discussing this ICIPE's Strategic Framework for the 1990s.

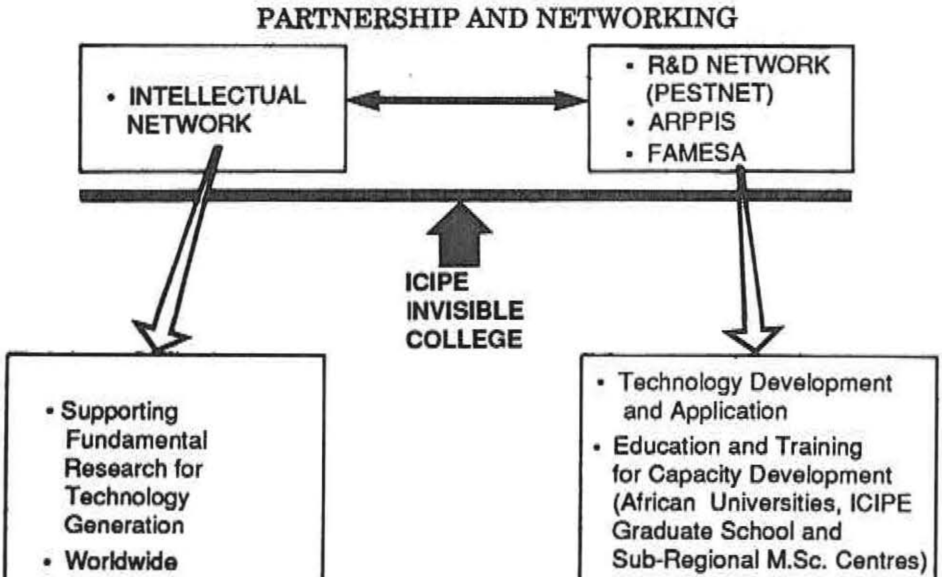

Figure 1. Linkages for R&D in pest management and human resource development.

Prof. Odhiambo spoke about ICIPE's "Invisible College". This is an attempt to show how the BALANCE is achieved. ICIPE has a worldwide intellectual network encompassing advanced research laboratories. This network supports fundamental research for the generation of knowledge for the development of technology. In undertaking mission-oriented fundamental research, the ICIPE has the goal of developing technology and validating it in pilot trials for its applicability.

The knowledge generated feeds into the Research and Development Network (PESTNET) which is a consortium of national research and development, and extension institutions together with the international centres. Ecoregional and locale-specific large-scale trials are undertaken where researchers (biological and social sciences), extensionists and farmers work together.

PESTNET is coordinating the Pest Management Documentation and Information System for the network. The paper on "ICIPE's Experience in Interactive R & D: PESTNET as a Model", presented the details. My mandate is to raise the concerns relating to the planning processes for effective interfacing and networking.

Where national institutions do not have adequate personnel to make the partnership with ICIPE effective in technology development, education and training programmes have been established to strengthen their capacity. The African Regional Postgraduate Programme in Insect Science (ARPPIS) was established in 1983 for this purpose. ARPPIS is a Ph.D. degree programme undertaken by a network of universities in Africa together with the ICIPE. It is now being enhanced to include sub-regional centres offering M.Sc. degree in insect science while the programme at the ICIPE will also have the authority to award the degree itself as the ICIPE Graduate School.

PESTNET and ARPPIS are currently limited to Africa. Other training programmes for practitioners in integrated pest management are offered for the whole of the tropical region. The question is "Should the geographical coverage of these programmes be expanded"?

The suggestion was made that ICIPE set up funds for research grants to assure continued scientific productivity of young scientists completing education and training programme and returning to the national programmes. ARPPIS has a small scheme of this type for its graduates but funding is a major constraint. However, would the Research Associateship scheme described in the document be useful in this regard? You all know that the ICIPE unlike the CGIAR centres has no donor of last resort and must raise all its funds.

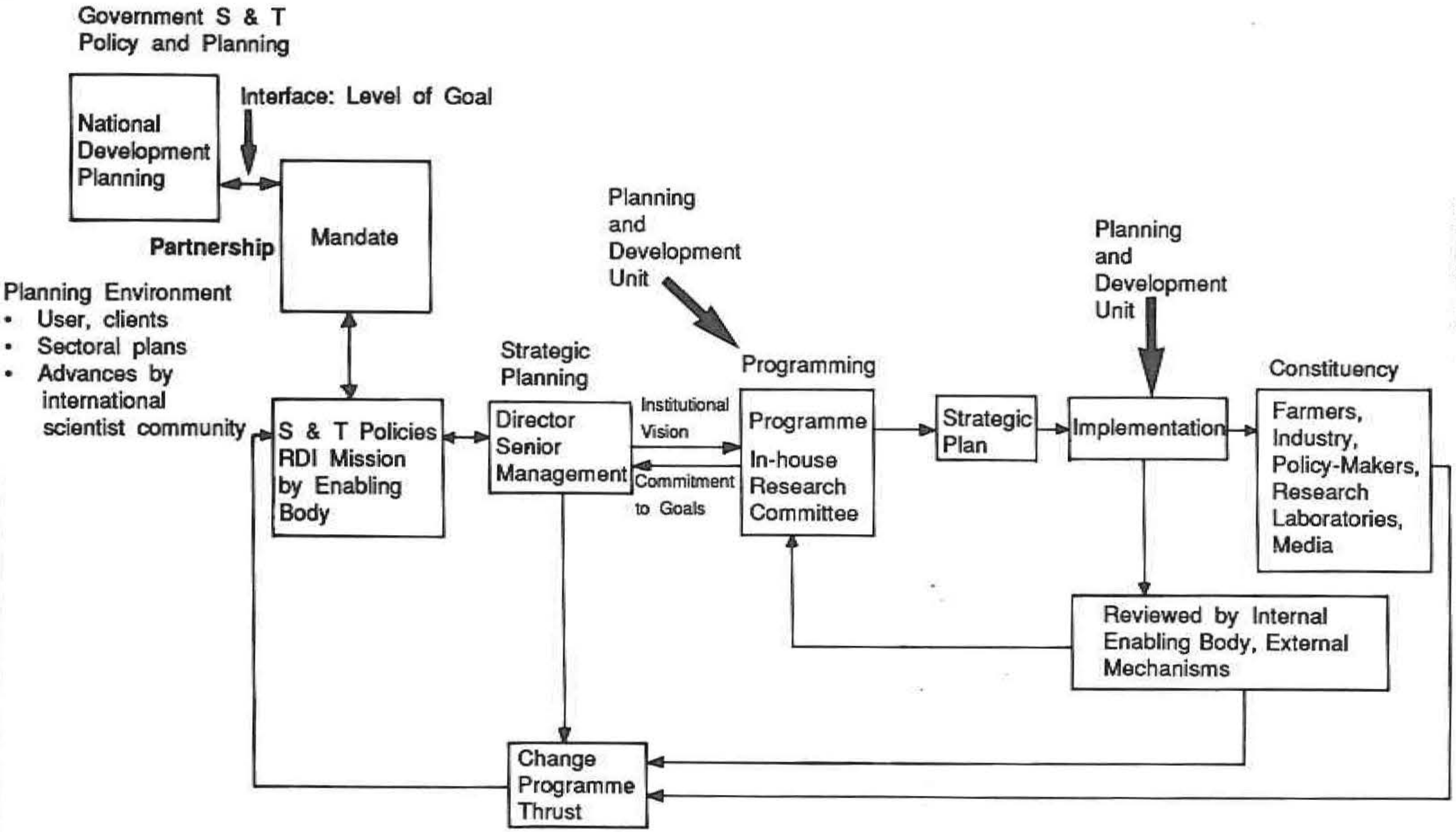

Figure 2. Model of strategic planning process: Levels at which international centres interface with national institutions.

The question of setting priorities has been addressed by all the Papers and the Discussants have emphasised it too. Choices are usually made in the process of strategic planning. A model of strategic planning process is presented in Figure 2 to demonstrate the linkages at various levels of decision-making. The needs of the constituency in the context of the environment should drive the national development plans.

The interfaces of all the linkages are crucial in terms of implementable results and in reaching the intended beneficiaries. The capacities of the "interfaces" must, therefore, be adequate otherwise they must be strengthened. In the partnership, the interfaces must link into the strategic planning process. The identification of causes and effects of the problem, through the constituency leads to the establishment of goals and objectives, leading to the results needed to achieve them and thus the activities that must be undertaken to accomplish the selected priorities.

The model in Figure 2 uses ICIPE as an example of an international centre linking with national institutions in the strategic planning process. I trust that this Forum will discuss ways of making this linkage effective. For example, one participant has already given me a copy of the Draft Science and Technology Plan Options by the Government of Ghana. This Forum in itself is a planning mechanism, so is the Steering Committee of PESTNET; and these promote regional perspectives and the sharing of resources for research and development and for education and training. This way, the ICIPE can link up with several national strategic planning processes to produce a well-coordinated and effective overall plan.

A good plan should facilitate the assessment of results and impact and subsequently lead to the marketing of the results. These research results must reach not only other scientists and the beneficiaries of the technology, but also the policy-makers who influence the allocation of national resources including bilateral aid. An informed policy environment is important for enhancing support for research and development. The ICIPE is coordinating a network in research management, and has produced manuals for use by research institutes and other national institutions.

There is an in-built mechanism of feedback to assess their usefulness. The ICIPE is also experimenting with collaboration with journalists and the media. Above all, the ICIPE established several years ago the journal *Insect Science and its Application*.

FUNDING

Earlier (Interfaces in the Linkages) it was stated that interfaces in all the linkages are crucial in reaching the beneficiaries. Substantial financial and technical resources are, therefore, required to make them effective. These resources are likely to be provided by the governments themselves or through

Funding

Activity	Institution	Projected Annual Cost	Source
1. Fundamental Research for Technology Generation	• ICIPE • Other Advanced Laboratories		Multilateral UN Agencies Governments Private Foundations
2. Technology Development and Application	• PESTNET (National Institutions and ICIPE) • National Research and Extension		UN Agencies Bilateral Private Foundations Governments Industry Patents Licences Contracts
3. Human Resources Development • Postgraduate Education and Training (ARPPIS)	• Participating Universities. • M.Sc. Sub-Regional Centres • ICIPE Graduate School		Governments Bilateral Private Foundations Fees Industry UN Agencies
• Practitioner Courses	• ICIPE • Other Institutions		UN Agencies Govenments Industry

Figure 3. Some sources of funds.

bilateral aid funds. We know that governments and industry will finance research and development if the results are likely to be of benefit to them. This view was confirmed by the Vice-President of the Republic of Kenya in his Opening Address when he referred to the results of ICIPE's research and development being applied by the rural communities in Kenya. I quote him "It is well known that investments in research and technology development, particularly in agriculture and disease control have a very high rate of return, sometimes exceeding 40%. This compares very favourably with many of the competing demands for allocation of our limited financial resources. I am therefore confident that Governments will give adequate support to such high priority investments for the future well-being of our people. Even after mobilising enough domestic resources, we will still need the financial support of the international donor community as the requirements are indeed very high. Here we need to be very careful and ensure that such resources are used most effectively and in accordance with clearly established and mutually agreed priorities". In Figure 3 are listed some sources of funds. Research institutions should try some of these sources of non-governmental funding.

ISSUES FOR DISCUSSION

1. COMPLEMENTARITY IN R&D AND LINKAGES IN RESEARCH PLANNING PROCESSES: **PARTNERSHIP**

   ICIPE:
   - Fundamental Research
   - Technology Development and Validation
   - Pilot Trials

   NATIONAL INSTITUTIONS
   - Research and Development
   - Pilot Trials
   - Technology Diffusion

   NETWORKING
   - PESTNET in Africa
   - Linkages in S. America and S. E. Asia

2. CAPACITY-BUILDING (EDUCATION AND TRAINING)
   - ARPPIS
   - Research Associateships
   - Practitioner Courses

3. MARKETING RESEARCH RESULTS AND INFORMATION
   - Research Management (FAMESA)
   - Linkages with Journalists and Media
   - Scientific Journals
   - Assessment of Impact

4. FINANCING
   (a) Contribution of Governments (Personnel, Facilities, etc.)
   (b) Bilateral Grants
   (c) Others

Figure 4. Issues for discussion.

You are here to discuss ICIPE's strategic statement and to make recommendations both to help the ICIPE in its R &D plans to make them relevant to your own needs for example, as well as to strengthen the partnership which will benefit the national institutions and the people they serve. We have listed some of the issues in Figure 4 and we look forward to your advice in the context of ICIPE's mandate in insect science, its comparative advantage and the future direction it has chosen for itself, vis-a-vis the constituency it has set out to serve. A proper feedback is essential to increase relevance and usefulness of the intended strategies.

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Closing Remarks by the Forum Chairperson

HONOURABLE ANNA ABDALLA

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Closing Remarks by the Forum Chairperson

We have now come to the end of the Forum. I believe I am speaking for every participant here when I say that the Forum has been a great success. I personally feel very enriched indeed and I shall be taking back to Tanzania a number of things I picked during this forum:

1. First, I can now understand one of the reasons why ICIPE has been such a major success in Africa: it has developed a strong tradition in strategic planning. I believe this is critical to ICIPE's success and an important lesson for national systems. For a scientific enterprise to succeed it must have a long-term vision and a strategic plan as well as detailed short-term plan of activities.

2. Second, we saw from Mrs Rhoda Odingo's presentation that ICIPE has built extensive consultation avenues and mechanisms which it uses in the process of developing its plans, both strategic as well as short-term. It consults internationally as well with national systems. Indeed, this Forum represents a consultation mechanism par excellence in that the most senior representatives of national organisations as well as donor representatives have been invited to comment on what is probably a very critical document of the Centre that relates to its vision and strategic framework for the 1990s and beyond. Within the Centre, Mrs Odingo informed us that there is extensive top-bottom and bottom-top consultations. Such consultation tradition is clearly critical for the success of any institution.

3. Third, ICIPE has evolved impressive ways of self-appraisal and measures of productivity at various levels: at the level of the researcher, the Research Programme and Unit, as well as at level of the institution. The willingness to give an account of yourself at all levels is clearly important. How many of our institutions at the national level blissfully exist from year to year without ever instituting quality control processes, without ever being asked to explain what they have been doing or how they have been spending scarce national resources?

We in national politics may be ahead in this regard! Every five years we have to stand up before our electorate and justify ourselves and our actions. If we fail to do so, we lose our seats! Scientists and scientific institutions must similarly be made accountable to their constituency and, in this regard, we can learn a lot from ICIPE.

4. The fourth thing that has impressed me about ICIPE's strategic document is the setting up of measures of success. Clearly this is important for a research institute. The productivity of a research institute needs to be measured against certain clearly defined indicators. ICIPE has spelled this out in its proposed strategic framework. I believe national institutions need to do the same.

Well, these are some of the things that I wanted to make special mention. I now want to say a few things about this Forum. First, I want to commend and congratulate the ICIPE management for conceiving this very innovative idea. My hope is that it has sown the seed of a dynamic, new tradition in consultation between ICIPE and national organisations. I also hope that it will be a model for other institutions. I want to thank everybody who have made it a success. My special thanks go to ICIPE's management, and especially to Professor Thomas R. Odhiambo, for inviting me to chair this Forum. I want to thank members of the working group and its chairman Dr. D.M. Wanchinga for their impressive distillation of the discussions that took place during the two days in the form of the draft recommendations. The working group had to sacrifice their lunch hours to do their job, but I hasten to add that they did not have to sacrifice their lunches! I want to thank all staff of ICIPE who were involved in one way or another in the organisation of this Forum. Lastly, I want to thank one and every participant for their incisive contributions in the form of discussion or papers. I have no doubt that this Forum, collectively, has made a significant contribution toward enriching ICIPE's document on its Vision and Strategic Framework for the 1990s.

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Recommendations

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Recommendations

PREAMBLE

The current global concerns on conservation of the environment and promotion of biodiversity require that pest management should rely on selective, environment-friendly technologies. The Forum has clearly established the commonality of pest problems in the tropics and, therefore, the need for closer interaction and wider consultation among NARS, the donors, and IARCs, including the ICIPE. ICIPE's vision for the decade of the 90s should reflect the current changing scenario of global economic and political events. These events require that new resources be tapped and the available resources be utilised most effectively and judiciously.

The Forum, in principle, endorses the ICIPE's "Vision and Strategic Framework for the 1990s" as laid out in the draft statement.

RECOMMENDATIONS

For ICIPE

- The ICIPE should intensify research on plant-derived pest control agents, biotechnology, biological control and behaviour-modifying materials along with other pest management components.

- For indexing biodiversity, the ICIPE and the national programmes should undertake the documentation of indicator species of insect pests and natural enemies through appropriate taxonomic and ecological studies. Such efforts will help in understanding how species interact in an ecosystem.

- Because of the availability of limited options for vector management, as opposed to crop pest management, greater collaborative efforts should be made to identify and integrate appropriate vector management components.

- The ICIPE's initiative in capacity-building of national scientists has been highly successful. Therefore, ICIPE should continue to pursue this goal with greater vigour in response to the needs for critical mass required at national and regional levels for tackling existing and future pest problems. Likewise, the ICIPE provides an intellectually stimulating environment for research at the postgraduate and the postdoctoral levels. These programmes should be strengthened further.

- The Forum commends ICIPE on its postgraduate training initiatives and recommends continued consultations on the proposal for the establishment of the Graduate School.

- While it is important to consolidate the ICIPE's efforts on current target pests, the dynamic nature of pests and hosts, and shifts in pest status, production systems and the environment, require a flexible approach in dealing with pest problems at national or regional levels.

- ICIPE should continue to devise mechanisms for sensitising and forging close collaborative links on a regular basis with policy-makers on agricultural research programmes.

- Because of a clear need for taxonomic services within NARS in the region, ICIPE should play a facilitating role in providing these services.

- The ICIPE has developed an impressive network of partnerships with a broad profile of its constituents at regional and international levels. This network needs to include new emerging groupings at regional and sub-regional levels.

For NARS

The NARS should have a strong and operative institutional capacity to enable them to implement their own programmes and to benefit from ICIPE's R&D efforts. Given the limited resources available, the national programmes should be sensitised on the need to develop mechanisms for effective R & D collaboration and technology transfer.

- Complexity of pest problems in an agroecosystem requires a multidisciplinary effort. Therefore, a multidisciplinary approach to agricultural research is needed while maintaining focus on IPM.

For Networking

- PESTNET has proven to be a good model for arriving at R & D priorities and for pest management technology transfer, and should be reinforced by, among others, representatives at the highest policy level of the participating countries.

- Because of its role as a source of pest management technology and as a catalyst and facilitator of technology transfer, the ICIPE should continue to be a nodal point in the evolving PESTNET system.

- In further acknowledging the effectiveness of PESTNET as a vehicle for technology transfer, the forum recommends that PESTNET activities be expanded in the next decade to cover livestock pests and disease vectors.

For Donors

- The Forum strongly recommends continued support to ICIPE by the donor community and governments to enable it to continue to implement its programmes.

- To enhance efficiency in resource utilisation, the Forum strongly recommends that existing mechanisms for donor coordination be strengthened.

General

- The Forum endorses ICIPE's idea of regular consultation with its constituents and urges that it forges closer consultative links on a regular basis with NARS.

- In order to strengthen the efforts of NARS and the ICIPE, appropriate mechanisms should be devised for enlisting the industry's support in developing appropriate pest management technologies and in the commercialisation of new products.

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Appendix

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Appendix

PROGRAMME

Except where specified, all sessions of this Forum will take place in the Rachel Galun Hall in the R&D Complex at Duduville, Nairobi

FORUM CHAIRMAN

Hon. Anna Abdalla, M. P.
Minister for Agriculture,
Livestock and Cooperatives,
Republic of Tanzania

Tuesday, 3 September 1991

All day	Arrival of Participants in Nairobi
1800–2000 Hours	Official Opening of the Forum
	CHIEF GUEST: Hon. Prof. George Saitoti, E.G.H. M.P. Vice-President of Kenya and Minister for Finance
	Opening Address (Rachel Galun Hall, R&D Complex, Duduville)
	Reception (Caroll Wilson Courtyard)

Wednesday, 4 September 1991

0830–0900	Registration of Participants
	INAUGURAL SESSION
	PRESIDING:
	Hon. Anna Abdalla Minister for Agriculture, Livestock and Cooperatives, Republic of Tanzania
0900–0920	Opening Statement by the Forum Chairman
0920–1000	KEYNOTE ADDRESS: ICIPE's R&D Partnership with National Programmes in Meeting Pest Management Challenges in the Tropics
	Prof. Thomas R. Odhiambo Director, ICIPE
1000–1030	GROUP PHOTOGRAPH
	TEA/COFFEE BREAK
	SESSION I
	PRESIDING:
	Hon. Anna Abdalla, M.P.
1030–1100	The Scope of Tropical Pest Problems and Priorities in Integrated Pest Management (IPM) Research and Development
	Dr. A.K. Raheja Director of IPM Institute Indian Council for Agricultural Research, India
1100–1115	Discussant: Dr. D.M. Wanchinga Southern African Centre for Cooperation in Agricultural Research (SACCAR), Botswana
1115–1145	General Discussion
1145–1215	The Practice of Integrated Pest Management (IPM) within Resource-Limited Livestock Farming Situations
	Dr. H.G.B. Chidzyuka Director of Veterinary and Tsetse Control Services, Ministry of Agriculture and Water Development, Zambia

1215–1230	Discussant: Dr. R.C. Saxena Crop Pests Research Programme ICIPE
1230–1300	General Discussion
1300–1400	LUNCH
	SESSION II
	PRESIDING:
	Dr. Ouayogode V. Bakary Directeur des Programmes de Rechercher et de la Formation Côte d'Ivoire
1400–1430	Models for High-Level Capacity Development in Africa
	Prof. Siyanbola Tomori Economic Planning and Development Consultant Association of African Universities Ghana
1430–1445	Discussant: Prof. Shibru Tedla Director Institute of Pathobiology, Ethiopia
1445–1515	General Discussion
1515–1545	TEA/COFFEE BREAK
	SESSION III
	PRESIDING:
	Dr. Osman M. Osman Deputy Director of Veterinary Services Ministry of Animal Resources, Sudan
1545–1615	The Role of Extension in Integrated Pest Management, R&D in Africa
	Prof. Fesseha Gebreab Faculty of Veterinary Medicine Addis Ababa University, Ethiopia

1615–1630	Discussant: Mr. J.J. Ondieki Chief Executive Pest Control Products Board Ministry of Agriculture Nairobi, Kenya
1630–1700	General Discussion

Thursday, 5 September 1991

	SESSION III (CONTD.)
	PRESIDING:
	Dr. Osman M. Osman Deputy Director of Veterinary Services Ministry of Animal Resources, Sudan
0900–0930	Mechanism for Implementation of Interactive R&D in Tropical Insect Science and its Application
	Dr. H.O. Abdel Nour Director General Forestry Department Khartoum, Sudan
0930–0945	Discussant: Dr. J.O. Ong'iro Director of Agriculture Division PTA for Eastern and Southern Africa, Zambia
0945–1015	TEA/COFFEE BREAK
1015–1045	ICIPE's Experience in Interactive R&D: PESTNET as a model
	Dr. E.O. Omolo PESTNET Coordinator ICIPE, Nairobi, Kenya
1045–1100	Discussant: Dr. Ahmed Sheikh Hassan Director of Research Somalia
1100–1130	General Discussions on the Two Papers Above

SESSION IV

PRESIDING:

Prof. K.N. Saxena
Programme Leader
Crops Pests Research Programme
ICIPE, Kenya

1130–1200	Criteria for Priority Setting in Funding Third World Agricultural Research and Development in the 1990s—A SAREC Perspective Prof. Bo Bengtsson, Director General Swedish Agency for Research Cooperation with Developing Countries (SAREC), Sweden
1200–1215	Discussant: Mr. Jacob Kampen Senior Agriculturist World Bank Regional Office Nairobi, Kenya
1215–1230	Discussant: Dr. John K. Omuse Director Kenya Trypanosomiasis Research Institute (KETRI)
1230–1300	General Discussion
1300–1400	LUNCH
1400–1430	Interface Between Research and Industry: The Brazilian Experience Dr. Clayton Campanhola Director Plant Protection Research (EMBRAPA/CNPDA) Campinas Sao Paolo, Brazil
1430–1445	Discussant: Dr. M.N.B. Ayiku Coordinator, Council for Science and Industrial Research, Technology Transfer Centre, Ghana
1445–1515	General Discussion

1515–1530	TEA/COFFEE BREAK
1530–1600	Interface Between Research and Industry: An Africa Perspective Dr. A. Lamorde Director National Veterinary Research Institute, VOM near Jos Nigeria
1600–1615	Discussant: Prof. Fassil Kiros Head, Social Science Interface Research Unit, ICIPE, Kenya
1615–1645	General Discussion
1645–1700	ICIPE Video Documentary "Learning in Partnership"

Friday, 6 September 1991

	SESSION V
	PRESIDING: Hon. Anna Abdalla, Minister for Agriculture Livestock and Cooperatives Tanzania and Forum Chairman
0830–0845	The ICIPE Strategic Framework Mrs. R.A. Odingo Chief Planning Officer ICIPE
0845–1030	Discussion of ICIPE's Strategic Framework
1030–1045	TEA/COFFEE BREAK
1045–1245	Discussion of ICIPE's Strategic Framework (cont'd)
1245–1400	LUNCH Meeting of Working Group to draft Recommendations

1400–1530	(Visit to ICIPE's R&D facilities)
1530–1630	Report by Chairman of the Working Group and Discussion of Draft Recommendations
1630–1700	TEA/COFFEE BREAK
1700–1800	Adoption and Endorsement of Recommendations and Closing Remarks by the Forum Chairman

List of Participants

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