952 91 - 9/28

Seed production
Africa, SADCC countries, proceedings, vegetable seed, seed sources, seed industry, variety release, seed control, seed certification, marketing, AVRDC

MWANDILA, N. and N.A. MNZAVA

Vegetable seed production in the SADCC region: status, problems and future prospects.

In: Proc. of a Workshop on Vegetable Research and Development in SADCC Countries, Arusha, Tanzania, 1990, 178 p., AVRDC Publication No. 90-328, ISBN 92-9058-042-9

Vegetable production in the SADCC region is a neglected industry. Production, predominantely subsistent in nature, is based on small backyard gardens, although there have been increases in market-oriented production in market gardens and commercial-scale production. One of the key elements accounting for the poor performance both in quality and quantity of vegetables produced has been the lack of seed. This is a major problem encountered in the rural areas of most SADCC countries. As the vegetable industry is closely related to the size and development of commercial vegetable farming, the status of the seed industry in SADCC can be described as rudimentary, since commercial vegetable farming is only in its infancy.
Seeds used or sold are unselected by-products of vegetable farming. Most small-scale farmers traditionally save their own seed, often from the unmarketable fruits or virtually without conscious selection. Notable are the legumes, cucurbits, the solanacea and some cruciferous vegetables. The indigenous vegetables (amaranthus, etc.) are a special category where seed is exclusively produced by the farms. Market gardeners and the emerging commercial farmers must search for seed that will allow them to produce what the market prefers. Vegetable seed for biennials (e.g. carrot, cabbage, chard, onion, etc.) has to be purchased whenever available.
Reliance on importation has its own problems; among them is the introduction of unadaptable varieties previously tried in a country, introduction of pests, and seedborne diseases, and a continuous drain on scarce foreign exchange. The current trend of marketing vegetable hybrid seed has been a deterrent in promoting seed sales, because most farmers do not realize their value. Importation of hybrid seed creates a dependency on temperate-zone breeder ingenuity, and perpetual importation may not be avoided. Thus the issue of an endogenous vegetable seed supply system in SADCC deserves urgent attention at a time when the industry is at a critical take-off point.

953 91 - 9/29

Seed production
Experiments, seed technology, pepper, pollination, morphology, ripening, germination, embryoculture, storage, sowing treatments, genetic resources, seedborne diseases, commercial seeds

BELLETTI, P. and L. QUAGLIOTTI

Problems of seed production and storage of pepper.

In: Tomato and Pepper Production in the Tropics; Int. Symp. on Integrated Management Practices; AVRDC, Taiwan, P.O.B. 205, Taipei 10099; ISBN 92-9058-037-2, 1989, pp. 28-41

Capsicum annuum is a predominantly autogamous species. However, cross-pollination by insects (mainly *Apis* sp., *Bombus* sp. and *Tripetidae*) and to a lesser extent by wind, is not infrequent. Information on the rate of natural cross-pollination is important for determining the genetic composition of the population, and for identifying the most appropriate breeding methods. Moreover this information is very useful for the maintenance of the purity of cultivars and lines and for the production of commercial seed.
Results of pepper research conducted at the Institute of Plant Breeding and Seed Production (IPBSP, Univ. of Turin, Italy, and information collected from literature, are presented. (1) Pollination: although pepper displays autogamous behavior, the percentage of natural cross-pollination can be high, an important fact that must be considered for maintaining purity of lines. Natural cross-pollination (NCP) was found to vary between 1% and 46% in trials carried out by the IPBSP. Higher values were obtained under particularly favorable environmental conditions. (2) Morphology: variability in seed size, color and shape is very high, both at the inter- and intra-specific level. (3) Plant and postharvest ripening: the best ripening stage of the fruits for obtaining the highest seed yield per plant and the highest percentage of seed germination is that of the full colored (red or yellow) berries (market ripeness in Italy). (4) Germination: parameters that can express the vigor of the seed lot better than the simple percentage of germination are the mean germination time and the uniformity of germination. A viability colorimetric test (2-3-5 TTC) proved useful to differentiate at the end of germination tests between ungerminated and dead seeds. (5) Embryoculture: this technique can be very useful for shortening the reproductive cycle of plants. (6) Storage and viability; the effects of different storage conditions on seed storability are described. (7) Presowing treatments: osmo-priming, particularly with KNO_3, appears to be a useful technique for reducing germination time and improving uniformity of germination. (8) Genetic resources: the IBPGR has identified pepper as one of the vegetables to be given high priority in programs for genetic resources conservation.

Since 1981 the IPBSP has collected over 200 accessions, both local and foreign. The most important genebanks of pepper are listed and conditions for seed storage, aspects of evaluation, multiplication and rejuvenation of collected material are discussed. (9) Seedborne diseases: the most important seedborne pepper diseases are reviewed and the effectiveness of some seed treatments are discussed. (10) Characteristics of commercial seeds: in Europe the open-pollinated cultivars are decreasing both in number and in quantity.

954 91 - 9/30

Seed production
Latin America, Ecuador, case study, seed potato systems, CIP

CRISSMAN, C.C. and J.E. UQUILLAS

Seed potato systems in Ecuador: a case study.

Publ. of the International Potato Center (CIP), Lima, Peru, ISBN 92-9060-137-x, 1989, 70 p.

It is widely believed that the poor quality of the generally available seed, and the high cost of obtaining good quality seed are major limiting factors in potato production. Many seed projects have been conducted in developing countries with the aim of relieving these constraints. The results of these projects have been highly variable. CIP and other organizations have been involved in seed systems work in numerous countries. Foreign assistance has taken many forms, including the direct placement of scientists in seed programs, technical backstopping, short term assignments, financial support, training, and provision of supplies, equipment and genetic material. However, records and results of these activities are dispersed throughout the developing world and their current status is largely unknown.
Potato cultivation in Ecuador is an important but declining activity. This decline is occuring in a country near the center of origin of the potato where the potato is still the principal dietary staple for the majority of the population. A potato food system has existed in the country for thousands of years. Farmers have, over the centuries, made variety selections and developed crop management techniques that are uniquely adapted to their own production environments.
This report is one of a series of case studies on seed potato systems in selected countries. The main objective of the individual case studies is to identify strengths and weaknesses in organized seed potato programs. To do this effectively the organized potato program must be placed in the context of its environment. Thus a systems' approach is adopted in these studies to categorize and evaluate the role of an organized program within the larger seed system.
This case study series is designed to record the diversity of formal and informal seed systems and to determine how seed projects can be integrated into these systems. The intent is also to analyze the performance of different technical and institutional schemes in seed potato projects. A final objective is to document the importance to increased production of improved formal seed systems (as compared with informal systems).
The form of this study flows from the general to the specific. In Chapter 2 the status of the potato is discussed in terms of trends in area, production, and yield. What has happened to potato production in recent times? Why have yields stagnated after growing in the 1970's? Other elements of the potato food system, consumption, markets, and potato policy are also introduced.
In Chapter 3 the farm-level setting for potato production is presented and then the informal farmer-based seed potato system. Understanding the informal system is essential to any formal efforts to develop an official seed system. How does the informal

system function? Are there points at which seed can be inserted into the system for maximum effect? What varieties are needed?
Chapter 4 begins the discussions of the formal seed system with an examination of the varieties in the country and those being handled by the official system. Are these the correct varieties and how does the breeding program get its information on farmer preferences?
Chapter 5 moves to an examination of the next phase in the formal seed system, the crucial first multiplications of a variety. These first multiplications are where important technological changes have occured in seed potato production. The official seed program has incorporated some of these new techniques. Why and how has this happened?
In Chapter 6 the bulking of seed to volumes practical for release to farmers is examined. In this phase the process of seed production inevitably moves from wholly governmental control to one of interaction with farmer seed multipliers.
The final chapter introduces some issues for discussion concerning the potato seed system in Ecuador and presents conclusions of the report.

955

91 - 9/31

Seed production
Africa, Nigeria, savanna location, yam, experiments, seed multiplication, mini-sett technique, traditional method

KALU, B.A. et al.

Seed yam multiplication by the mini-sett technique in three yam species in a tropical Guinea savanna location. (Multiplicación del ñame semillero mediante la técnica de mini-esquejes en tres especies de ñame en una localidad de la sabana de la Guinea tropical).

Expl. Agric., Vol. 25, 1989, pp. 181-188

In Nigeria, the rain-forest and the Southern-Guinea agro-climate zones are the major yam producing areas, and typify the tropical environments favourable for yam production. Within these zones, recent studies have indicated promising varietal yield responses to the mini-sett technique. These reports provided useful data on the total yield of setts per hectare, but lacked sufficient information on well defined weight categories of harvested tubers grown from mini-setts, and on the number suitable for use as seed yams.
The mini-sett technique has been recommended as the most efficient and economical method of seed yam production and is fast becoming widely accepted.
The objective of this study was to obtain a quantitative assessment for three yam species of the number of seed yams of defined weight classes that could be obtained from different sizes of mini-setts (25, 20, 15 and 10 g) and from traditional method using larger setts (100 to 200 g).
Local cultivars of *Dioscorea rotundata* Poir (white Guinea yam, cv. Dan Onitcha), *Dioscorea alata* L. (water yam, cv. Obuna) and *Dioscorea cayenensis* Lam (yellow yam, cv. Oku) commonly grown in the Southern Guinea Savanna zone of Nigeria were assessed for their potential for rapid seed yam multiplication by the mini-sett technique. The traditional method involving the use of large setts and the improved mini-sett technique were compared.
The study was carried out on soil classified as Typic Paleustalf with parent material mostly sandstone over shale, located on a 2 to 4% slope.
The study indicates that the mini-sett technique has promising potential, being superior to the traditional method for seed yam multiplication.
Results obtained in this study indicate that a satisfactory number of planting setts of acceptable weight can be achieved in *D. rotundata* and *D. alata* with mini-setts as small as 10 g. With these two species, the use of 25 g mini-setts was as good as the traditional production system in terms of average tuber weight at harvest but the mini-sett technique had the obvious advantage of generating larger quantities of suitable setts from one mother tuber. Furthermore, there were no significant differences within each species in the average weight of ware yams grown from mini-setts and those produced from the traditional system.
In both *D. rotundata* and *D. alata*, significantly greater economic returns per hectare would be expected with the mini-sett technique than with the traditional method. For example, in *D. rotundata* and

with the traditional method, 20,000 tubers (or 8 tonnes) would be needed to plant up one hectare. A 400 g tuber costs about ₦1 (0.25 US$) so that the tuber cost per hectare would be approximately ₦20000 (5000 US$). With 20 or 25 g mini-setts only about 10 to 12.50% of this amount would be required and would result in almost the same total tuber production per hectare and average tuber weight as the traditional system.
Another important attribute of the mini-sett technique can be seen by the proportion of the total tuber production per hectare that can be classified as good seed yams (100 to 400 g) or ware yams (more than 400 g) and relating that back to the initial input of mother tubers per hectare. This again reveals a greater production potential from the 25 g mini-setts than from the traditional system. There is also the possibility that smaller mini-setts (10 to 15 g) might generate large quantities of seed and ware yams when further improved by agronomic research.
The results presented in this report are by no means conclusive. More detailed work is required to further assess the qualitative and quantitative attribute of tubers of the different yam species grown by the mini-sett technique, with testing across a wide range of soils and locations. This study has made a start in assessing the potential contribution of the technique to seed yam multiplication in a South Guinea Savanna area. Follow up studies could be applied to the various yam programmes in Nigeria and elsewhere in the world.

956 91 - 9/32

Seed production
Review, book, workshop, plant genetic resources, breeding, research, technological innovation, evaluation of collections, IBPGR

BROWN, A.H.D. et al.

The uses of plant genetic resources.

Cambridge University Press, 1989, pp. 382+X; Paperback ISBN 0-521-36886-3, £9.95

This interesting book addresses the broad question of the use of germplasm, and stems from a workshop on the theme Genetic Resources and the Plant Breeder, held at Montpellier, France, 9-12 September 1986, sponsored by the International Board for Plant Genetic Resources. There are 22 chapters from 31 contributors, divided into six parts. These are: 1) Role of genetic resource collections in research and breeding (3 chapters); 2) Use of collections (4); 3) Size and structure of collections (3); 4) Evaluation (5); 5) Wild relatives of crops (3); and 6) Technological or scientific innovations that affect the use of genetic resources (4).
In three case studies concerned with the actual use of collections of sorghum, potatoes, and cereals for use in semi-arid areas, their value for elucidating the taxonomic and evolutionary relationships between different species and races is described. The principal justification for their existence, however, is to assemble natural variation that can be used to broaden the genetic base for present and future crop improvement.
One viewpoint expressed in the book, by D.R. Marshall, is that it is not the lack of evaluation which constrains plant breeders, rather that breeders generally have sufficient variation for most traits in their working collections. Pre-breeding must concentrate on selective rather than systematic evaluation, and greater priority must be given to pre-packaging desirable genes into backgrounds which can be easily incorporated into breeding programmes.
The contentious issue of the size of germplasm collections is raised in two chapters. Are large collections of germplasm inefficient in terms of evaluation and utilization? The concept of a 'core collection' is described by A.H.D. Brown as one that is rationalized, refined and structured, around a small, well-defined and representative 'core' of the genetic diversity of a crop. Because collections have grown markedly in size, it is suggested that greater use of germplasm collections could be made, particularly for a wider range of characters, if a smaller number of accessions were to be given priority in evaluation and hybridization. However, given the experiences with the large collection at the International Rice Research Center, T.T. Chang gives several arguments for maintaining large germplasm collections, since such a collection is more likely to be more diverse in genetic composition and more comprehensive in eco-geographic coverage, and that such collections give the possibility of identifying genes which occur at a low frequency.
Collection strategies, the importance of wild species as sources of disease resistance, and the ecological and genetic

considerations in collecting and using wild species are discussed in relation to germplasm collections.
This book should stimulate the debate about the future of germplasm collections; however, there is little discussion of one of the most contentious issues relating to germplasm use, namely the free access to germplasm around the world. Both genetic conservationists and plant breeders will find challenging ideas presented here. Some, such as the core collection concept, are controversial, but one can hope that the increased debate about germplasm use which should stem from publication of this book will eventually lead to closer collaboration between germplasm curators and plant breeders.
Abstract by M.T. Jackson, UK, shortened

957

91 - 9/33

Seed production
Review, book, plants, biotechnology, conventional breeding, plant genetic engineering

LINDSEY, K. and M.G.K. JONES

Plant biotechnology in agriculture.

Open University Press, Milton Keynes, UK, ISBN 0-335-15817-x, 1989

This book is an ambitious attempt to describe and assess the many aspects of plant biotechnology, with considerable emphasis placed on the techniques and possible applications of plant genetic engineering. In this aim it is mostly successful.
After an opening chapter evaluating the capabilities of conventional breeding strategies for plant improvement, the authors go on to explain the basis and uses of various plant cell culture systems, including micropropagation, protoplasts and haploid production. The ensuing section is intended to introduce the reader to the principles of plant molecular biology and gene regulation. Despite being supplemented with a brief glossary, this may still prove rather concentrated for the uninitiated. However, most of it is necessary background knowledge for understanding successive chapters on the development and prospects of plant genetic engineering. These have been written in an informative and accessible style, although some of the many figures are of lesser quality, and are as up-to-date as possible in this fast moving discipline. The current state of our knowledge of various aspects of plant development is briefly given, and possible future options discussed in a commendably speculative way.
This is essentially a technical overview of plant biotechnology, relatively little consideration being given to commercial impact, or related issues such as proprietary protection. However, it will be of use to undergraduates involved in plant science or others looking to extend their general awareness of this exciting area.
Abstract by A. Hepher.

X PLANT PROTECTION

958 91 - 10/91

Plant protection
Review, tropics, pesticides, benefits, hazards, formulation, method of application, use of pesticides, case study, rice, insect pest control

AMBRIDGE, E.M.

Pesticides in the tropics - benefits and hazards

In: Chemistry, Agriculture and the Environment; The Royal Soc. of Chemistry, London, UK, 1990, pp. 453-458

With a steadily increasing world population there is a consequent need for increased food supplies. As a result pesticide use in the world is increasing rapidly, particularly so in developing countries, where much attention is given to controlling the target pest, but relatively less to the safety of the user, the consumer, and the environment.
The need for increased food supply has led to the development of improved agricultural production systems. The use of high yielding varieties of staple crops require the use of increased agricultural inputs, such as fertilizer and pest control chemicals. More intensive cropping regimes may lead to a build-up of pest problems, especially in monocropping situations.
One third of all agricultural produce is lost to pest, disease, and weed attack, even with the use of chemical pest control measures. Should pesticide use be withdrawn then a further loss in yield of one third could be expected. At that rate of loss there would be even greater shortages of food, feed, and fibre throughout the world, with consequent increases in malnutrition, and associated effects on the health and well-being of man.
Pesticides bring the benefits of timely and accurate pest control when correctly used.
The long-term ideal would be for effective biological or cultural control methods to be available to control all pests and diseases of agricultural production and public health.
Diseases such as malaria and sleeping sickness are endemic in many parts of the world. Both are carried by insects. Such diseases weaken the victims, making them unable to work to produce the food that they need to survive, thus encouraging malnutrition, which in turn increases the susceptibility to other diseases. By controlling the insect vectors of diseases it is possible to improve the health of the population so that they are able to enhance their ability to produce food, and then in turn improve standards of living for the community.
Pesticides are designed to kill pests, and, although providing benefits to agriculture, by their very nature present hazards to both man and the environment.

The main influences on human safety in pesticide usage in the field are:
- choice of active ingredient
- choice of formulation
- method of application

Pesticides are classified, by the World Health Authority, according to the mammalian toxicity, into four classes of hazard: Class 1A - extremely hazardous; Class 1 B - highly hazardous; Class 2 - moderately hazardous; Class 3 - slightly hazardous. Whenever possible pesticides in Classes 2 and 3 should be the preferred selection on grounds of safety.
Selection of pesticides for application should be made with reference to the pest to be controlled, and then the compound presenting the least hazard to the user should be chosen.
Pesticides pose hazards to the user when handling, mixing, and applying spray solutions. Pesticides are able to enter the human body through inhalation, by ingestion, and through the skin (dermal penetration).
With each type of application method there are hazards associated with handling the concentrated pesticide formulation. Contamination of the operator during pesticide application is always a possibility, and poses a threat to the health of the worker, so appropriate protective measures should be taken.
The normal precaution is the use of appropriate protective clothing.
Incidents occur mostly at small-scale farmer level. It would appear that such pesticide mis-use is a source of hazard to both the user and the environment. Incorrect dosage could encourage the build-up of resistance in the target organisms; incorrect application procedures pose hazards to the user and the environment through contamination of the soil and non-crop plants, and destruction of non-target organisms, which may otherwise be beneficial, and possibly leading to movement of residues through the food chain, with consequent detrimental effects on wildlife generally.
At the end of this paper the author discusses as a case study insect pest control in rice in South East Asia.
Concluding pesticide chemicals will continue to be applied in developing country agriculture, but alternative methods such as biological control methods should substitute these in the foreseeable future.

959 91 - 10/92

Plant protection
Asia, Malaysia, review, handbook, case study, pesticide usage, toxicity of pesticides, health hazards, pest control methods, traditional pest control, biological pest control, pesticides act, farmer education, action strategy, NGO

TECK-GHEE, L.

Pesticide dilemma in the Third World - a case study of Malaysia.

Publ. of Sahabat Alam Malaysia (Friends of the Earth), 37, Lorong Birch, Pulau Pinang, Malaysia; ISBN 967-99942-1-X, 1984, 81 p.

The intention of this booklet is to provide a general picture of the usage of chemical pesticides in Malaysia as well as an insight into the problems, health hazards, environmental damage and the pest situation resulting therefrom.
Alarming is a fact that poisonous chemicals in the region of 50,000 are present in our environment.
Each year it is reported that another 3,000 new substances are introduced. High on the list are chemical pesticides meant for the control and destruction of pests.
Pests are becoming more and more resistant to these chemicals and more humans are falling victim to the man-made poisons. In some situations the destruction attributed to pests became worse than before application of the pesticides. Irreparable damage, both to the environment and ecological cycles, has been observed in a number of cases.
Dangerous and harmful pesticides which are banned in other countries, are still being sold freely in Malaysia.
Vegetable farms, fruit, orchards, estates, plantations and other agricultural facilities in Malaysia all use chemical pesticides. Most farms use pesticides as a preventive measure. Pesticides are applied regularly even though no pest attack may have occurred.
Insecticides are by far the most widely used of pesticides, with every commercial farm using them. Herbicides, which act as weed killers in oil palm and rubber estates, come next.
Chemical pesticides are easily obtainable from shops and even sundry stalls. Malaysian farmers, mainly depend on shopkeepers to recommend them the type of pesticide and advise them on application methods. At least 72 per cent of farmers fall into this category.
More often than not the farmers are not briefed about the potential dangers to health and the long-term draw-backs of pesticides. This is partly due to the retailers themselves being ignorant of such problems as well as their lack of adequate knowledge of pesticide usage. Very few farmers ever receive advice and recommendations even from agricultural officials or from the sales personnel of the pesticide companies.
Consequently, farmers generally use more pesticides than they should, under the misconception that more chemical pesticides used would mean more pests eradicated.

Pesticide use in Malaysia is increasing at a rapid rate, as can be seen from the rising value of the import of pesticides from $40.43 million in 1978 to approximately $250 million in 1983.
The fact is that while the use of pesticides is increasing at a rapid rate, public awareness of the problem has not increased.
This book is the basis of a campaign against the over-use of pesticides and the distribution and easy availability of highly toxic pesticides.
In a situation where almost three-quarters of the pesticide users had practically no idea of the dangers of using pesticides, the problem is most acute when there are inadequate controls and sometimes non-existent safety measures in its use.
Controversy has also been built up over the dumping of dangerous pesticides in developing countries. Many of these pesticides are banned in the western countries but are exported to the Third World by the same companies which are prohibited by selling their products in their home countries.
This book hopes to increase public awareness on the health dangers associated with toxic pesticides, and appeal to all to help check this practice of the misuse and misapplication of toxic pesticides.

960 91 - 10/93

Plant protection
Asia, Philippines, case study, pesticide hazards, mortality rates, IIED

Mc CRACKEN, J.A. and G.R. CONWAY

Pesticide hazards in the Third World: new evidence from the Philippines.

Gatekeeper Series No. SA 1; Int. Inst. for Environment and Development (IIED), 3 Endsleigh Street, London WC1H ODD, UK, 1990, 11 p.

There is increasing evidence that mortality and illness from pesticides in the less developed countries are much more common than previously supposed. Many hazardous pesticides banned or severely restricted in industrialised countries are widely available in the developing countries. Organochlorine insecticides and phenoxy herbicides have largely been phased out in the industrialised countries but are still widely used in the developing world.
This study was carried out in the Central Luzon region of the Philippines. This is one of the major rice producing regions which has greatly benefitted from the Green Revolution packages of high yielding seeds, improved irrigation, and the provision of pesticides and fertilisers. Total rice production in the Philippines doubled between 1960 and 1980.
The widely used insecticides in the Philippines in the 1970s were carbofuran, endrin, parathion and monocrotophos, all classified by the World Health Organisation as extremely or highly hazardous. The hazards are compounded by the lack of legislation, widespread ignorance of the hazards involved, poor labelling, inadequate supervision and the difficulty of wearing full protective clothing in hot climates. The risk to the public is also increased by the post-harvest treatment of crops. A common practice, for example, is to treat leafy vegetables with insecticides to enhance their appearance before going to market.
The study referred to investigated mortality in several contrasting rural and urban municipalities. Organolochrine insecticides, such as endrin, can cause tonic and chronic convulsions and poisoning may be misdiagnosed as epilepsy, brain tumours and strokes. Poisoning by organophosphates, such as parathion, may be misdiagnosed as cardiovascular and respiratory diseases.
The results of the study are as follows:
- in the rural areas non-traumatic mortality rates increased among males aged 15-54 years by 27.4% between 1961-1971 and 1972-1984, but decreased among children and women.
- this increase for rural males coincided with the increase in pesticide use.

- in the rural areas, deaths diagnosed as poisoning increased 247% and those from associated or potentially confounded conditions 41% between 1961-71 and 1972-84. In contrast mortality from all other causes, except cancer, decreased 33.7%.
- while mortality attributed to stroke increased for all men in the urban and rural areas the increase was greater among younger men who are generally at low risk of stroke.
- similarly, while mortality attributed to stroke decreased for all men for the two years following a 1982 ban on endrin the decrease was significantly greater among the younger men. These changes occurred only in the rural areas.
- the incidence of leukemia, possibly also associated with insecticides, increased among rural men (but not women) over the 1961-1971 to 1972-1984 period.
- through the year, mortality patterns for rural males peaked during August, the month of greatest insecticide use in the wet-season. After double-cropping became widespread two mortality peaks occurred: in February when insecticides were used during the dry-season crop and again in August.

The longer term improvements will only come from tougher legislation, and more importantly, rigorous enforcement, coupled with education and training aimed at all levels of rural society. In the meantime some benefits may arise from changes in policy that begin to place on the pesticide user the true costs, including the wider environmental and social costs as well as the direct economic costs. As a move in this direction the World Bank has begun to advocate the removal of subsidies on pesticide use which are commonly given to importers, manufacturers, formulators and to the end users. The theory is that this will make pesticide use more efficient, reduce the tendency to overuse and hence result in less pollution, less risk of pesticide resistance and fewer human deaths and illnesses.

961 91 - 10/94

Plant protection
Review, booklet, pesticide composition, pesticide use, pesticide hazard, AGROMISA

ARENDSE, W. et al.

Pesticides: composition, utilisation et risques (Pesticides: composition, use and hazards).

Agrodok 29; AGROMISA, P.O.B. 41, 6700 AA Wageningen, The Netherlands; 1989, 66 pp. + appendices

"Pesticides: composition, use and hazards" is longer than most Agrodok booklets: 66 pages of text plus a 19-page appendix on trade names and their active ingredients, 12 pages on the properties of the active ingredients, nine pages on trade marks, and a fourth appendix of conversion tables of weights and measures.
In all developing countries chemical products are used to control pests and diseases. This booklet has been written to prevent the unpleasant or tragic consequences that can arise if they are used incorrectly. It provides information about the various pesticides used to control diseases or pests in crops, gives guidelines for their safe use, and states the measures to be taken in the event of poisoning.
The compilers are at pains to point out that chemical control is only one of the ways of suppressing or controlling diseases, pests, and weeds. It is often expensive and may not be the most appropriate means for the job in hand.
These provisions apart, the booklet is concise but comprehensive. Chapter 1 gives general information on pesticides. Chapter 2 examines the dangers of pesticides to man and the environment. In Chapter 3 advice is offered on their safe use - reading label information, protective clothing, hygiene, maintenance of spraying equipment, disposing of left-overs and storing. Chapter 4 deals with the symptoms and treatment of pesticide poisoning.
Throughout, the diagrams, line drawings, reproduction of warning symbols and pictograms and illustrations are clear and helpful.
Abstract from SPORE.

962 91 - 10/95

Plant protection
Australia, weed control, biological control, study, cage conditions

WAPSHERE, A.J.

A testing sequence for reducing rejection of potential biological control agents for weeds.

Ann. app. Biol., 114, 1989, pp. 515-526

The presently used method of testing biological control agents, particularly insects, under laboratory conditions, by exposing a group of selected plants, leads to the rejection of agents for importation and release, which would be safe to release. This is because under natural field conditions those same agents would remain restricted to their host weeds and unimportant close relatives of those weeds have problems in host specificity screening.
Insects for use as biological control agents against weeds are usually tested inside laboratories in totally enclosed cages either by placing plants of one single species in each cage or by offering a choice of plants in a cage. The plants are selected either because they are crops or because they are related to the weed or because they are considered susceptible to attack on other criteria.
If the testing is carried out under quarantine, the biological control worker has little choice but to use restricting methods. Even when testing does not have to be under quarantine, practical difficulties usually mean that some form of cage is used. Cage tests only allow a small part of the normal sequence of host selection used by the insect to be expressed.
Certain insects which appeared to be sufficiently restricted to the weed under field conditions were rejected as biological control agents, because unexpected attack occurred on one or more of the plants selected for testing.
The reverse testing sequence recommended here has the advantage that the first stage, with a large number of plants selected for testing the final host selection stage in the catenary sequence can be carried out under restricted laboratory conditions or after introduction of the agent under quarantine. The second and third stages could also be carried out under those conditions. Assuming that the great majority of the plants selected for testing are progressively deleted this would usually leave only a few plants to be tested overseas in the original home of the agent. To some extent this has already been practised in some biological control of weed programmes as in testing *O. wertheimsteini* for *Chondrilla*, *P. chalcomera* for *Carduus* and the adults of *Longitarsus* species for *Echium* and *M. inconspicuella* for *Emex*. There has not been any attempt to follow a fixed sequence nor has there been sufficient understanding or invocation of the host selection sequence to explain the reason for the testing programme or to support the

choice of plants for subsequent stages of the testing. The reverse sequence recommended here provides these features.
If the use of the reverse testing sequence is accepted it would be worthwhile in the near future to take another look at apparently specific agents which have previously been rejected because too broad a host range was indicated by the testing method employed then. In particular, agents where the stages tested had been after the critical host selection point in the sequence (i.e. larvae dissected from within plants) could be studied again and re-tested in a reverse sequence.

963 91 - 10/96

Plant protection
Review, developing countries, tropics, sustainable agriculture, integrated pest management, traditional agriculture, DSE

MEDINA, J.R.

Integrated pest management in sustainable agriculture.

In: Proc. of the Int. Training Course on Sustainable Agriculture and On-farm Experimentation, Los Baños, Laguna, Philippines, 1989, pp. 93-99

Agriculture in developing countries has shifted from traditional practices relying on natural resources to practices depending mainly on agricultural petroleum-based inputs such as pesticides and fertilizers and extensive monoculture of modern high-yielding varieties (HYVs). The introduction of a petroleum-based agriculture combined with continuous irrigation has increased agricultural production dramatically. With their overdependence on fertilizers, HYVs are more succulent and have faster vegetative growth, which attract and favor the buildup of harmful organisms. Among the pest groups, insects cause the most problems in succulent crops. The insects' uncontrollable increase and the rapid appearance of new species have led farmers to use pesticides on fixed schedules. At first, these chemicals have efficiently controlled the pests, but heavy reliance on them resulted in the development of resistant strains of pests and disease-causing organisms as well as increased cost for their control.
In the Philippines, rice is the first commodity crop on which the IPM concept has been practiced, with emphasis on the reduction of pesticide treatments based on the established economic threshold levels of some rice insect pests. However, lowering pesticide inputs alone does not ensure economic and biological stability or environmental safety.
Moreover, overdependence on pesticides has also created environmental and ecological problems. These include applicators' poisoning, adverse effects on beneficial organisms, especially on native parasitoids and predators and pesticide residues in food.
The limitations associated with pesticides prompted many countries to renew their interest in agricultural production practices that require less petroleum-based energy and material inputs. Integrated pest management (IPM) is one of the low-input agricultural strategies that evolved into a new pest program to reduce pest population.
The concept of IPM, however, originated from the discipline of entomology, which utilizes biological and chemical methods to control insect pests. Lately, the practice of IPM has revolved on two components: use of economic threshold levels or sequential sampling of some insects and use of resistant varieties to reduce pesticide applications.
For the IPM program to succeed in sustainable agriculture, a continued commitment to agroecological research, regional

technology evaluation, and continuing education is required. For agroecological research, a holistic approach focusing on natural and biological mortality factors should be expanded toward an integrated system-level of crop production. Such natural mortality factors include the existing parasitoid and predators, weather, and cultural practices to control pest population. Knowledge of the ecological interactions being studied under IPM in sustainable agriculture is best described as being low petroleum-based inputs and high information inputs. These informational inputs should tend to focus on the naturally occurring life processes that can be managed to the advantage of the farmer such as organic matter, decomposition, predation, nitrogen fixation, and the ecological factors influencing them.
The IPM program will only be sustainable after ecologically, economically, and sociologically accepted methods of pest control are understood and adopted by farmers. This means that IPM-technology generation must be regionally evaluated and taught to farmers through continuing training and participation. Otherwise, the appearance of new pest strains and resurgence of pests will continue to occur in the crop.
The key to the success of IPM in sustainable agriculture lies in the integration of the interactive production components, which requires a multidisciplinary approach. Moreover, it should also be stressed that continuing training and participation of the human element in the system are necessary to cope with the dynamic agroecosystem and the complex relation of the pest and beneficial organism in it.

964 91 - 10/97

Plant protection
Developing countries, Africa, case studies, integrated pest management, systems management, agroecosystems, economic threshold, ecological conditions, IITA

DELUCCHI, V.

Biological control: a sustainable solution to crop pest problems in Africa.

In: Proc. of Inaugural Conf. of the IITA Biol. Control Progr. for Africa, Cotonou, Peoples Rep. of Benin, 1988, pp. 51-68

In general, the integrated pest management (IPM) concept has been introduced in plant protection programs to eliminate the abuses of pesticides in disrupted agroecosystems. To reach this objective, chemical treatments are applied according to an economic treshold. Despite continual improvements and changes in terminology (integrated plant protection), as well as the consideration of additional production processes (integrated plant production), most of the IPM programs have not developed beyond what has been called in Europe "supervised pest control," which means the application of chemical pesticides under consideration of an economic threshold mainly based on personal long-term experience. The subsequent replacement of pesticide application by alternative control techniques (like mass trapping, mating disruption techniques, genetic control, etc.) brought in the long run a considerable improvement in the environment (augmentation and conservation of natural enemies), but did not eliminate the dependence of the farmers on some type of control measures.
Both pesticides and their alternatives control the symptoms of pest attack and not the causes; for this reason they perpetuate existing pest problems instead of eliminating them. The economic injury level, which is an essential prerequisite to the development of IPM, has been introduced to suppress the abuses of pesticides and not to solve pest problems.
The following case studies are discussed under the need to assess noxiousness:
- Rice pests in Madagascar
- Apple orchard pests in North Italy
Then the author refers to the need to assess the causes of pest problems.
Often it is impossible to separate a direct from an indirect cause, but this is not very important. There are causes that are related to the production system, for instance, the sowing period, the type of rotation, the quantity of fertilizers, and sanitation measures. A small modification of the production system may be sufficient to remove the problem forever, especially if the pests represent borderline cases.
In African countries, where the use of chemicals in agriculture has been limited, the faunistic survey might represent the key for solving phytosanitary problems, which always arise with

agricultural development. The pests of today may not be the pests of tomorrow, and for the same reason the natural enemies that have been eliminated from an ecosystem might be able to survive later when agricultural technologies have changed. Therefore it is important to know how original ecosystems look in order to reintegrate, any time it is necessary, those biological elements contributing the most to agricultural production.
A better knowledge of ecosystems components and behavior is necessary, along with the assessment of the noxiousness of phytophagous species associated with crops and the assessment of the causes of a pest status. Compared with IPM, systems management emphasizes long-term ecological considerations.
Inherent to this approach is ecological compatibility of management practices, minimizing disruption of the agroecosystem, and a knowledge of the economic threshold for given pest problems. IPM should be mainly a management of biological control resources, with agronomic measures and, to some extent, plant resistance contributing to the efficiency of natural enemies and to their conservation.

965 91 - 10/98

Plant protection
Asia, India, field experiment, integrated pest management, lucerne, economics, chemical control, agronomic practices, biological control.

SHRI RAM and M.P. GUPTA

Integrated pest management in lucerne (*Medicago sativa* L.) and its economics in India.

Trop. Pest Management, 36, 1990, pp. 258-262

The present state of pest control is merely chemical control, but in a forage crop like lucerne this method is not feasible because of its residual effect and the high cost of insecticides. Therefore an integrated approach has been investigated to manage the pest complex by improved cultural practices with no dependence on pesticides.
Lucerne (*Medicago sativa* L.) suffers great loss in yield. A loss of 37·7% was found due to damage caused by leaf hoppers (*Empoasca* sp.), lucerne weevil (*Hypera variabilis* Herbst.) and aphids (*Therioaphis maculata* Buckton and *Aphis craccivora* Koch).
An experiment on the integration of cultural, chemical and biological control measures for the management of the pest complex of lucerne was conducted during 1980-1 and 1981-2.
The trial was laid out in a randomized block design. Final plot size was 3 m x 2 m and the distance from row to row and plant to plant was maintained at 30 and 8-10 cm respectively.
The population of all the three major pests, leaf hoppers, lucerne weevil and aphids, may be managed effectively by improved cultural practices, viz. least susceptible variety 'IGFRI-244' and optimum fertilizer combination when the crop was sown at the optimum time of the last week of October. This increased the green fodder production. The combination of these practices with either endosulfan 0·08% or *B. thuringiensis* at 0·84 kg/ha, or both, further increased fodder production.
The economics of two treatments, improved cultural practices and their combination with a foliar spray of endosulfan 35 EC, was compared with conventional practices from the pooled mean yield. Adoption of improved cultural practices alone, the least susceptible variety 'IGFRI-244' and optimum fertilizer combination, was the cheapest, with a cost-benefit ratio of 1:2·16, whereas the ratio was 1:1·96 with the insecticide endosulfan.
It may be inferred that the pests of lucerne can be managed economically by adopting improved cultural practices, resulting in a higher yield without the danger of insecticidal residues.

966 91 - 10/99

Plant protection
Asia, India, cowpea, sorghum, fodder production, intercropping, mixed cropping, pest management

SHRI RAM et al.

Pest management in fodder cowpea (Vigna unguiculata L. Walp.) through mixed and inter-cropping in India.

Tropical Pest Management, 35, 1989, pp. 345-347

Intercropping is traditionally a low-input agricultural system and important in many developing countries. It matches the resources available to the farmer to maintain a low adequate and steady production. It is an important component of small farm agriculture in the tropics, and a low incidence of insect-pests might be one of the reasons for its evolution. Biological studies of pest incidence are essential for the improvement of intercropping systems.
An experiment was carried out to study the effect of type of cropping on the incidence of the major insect-pests of cowpea: leafhoppers (*Empoasca kerri* Pruthi) and the defoliators: flea-beetle (*Pagria signata* Motsch.), semilooper (*Plusia nigrisigna* Wlk.), tobacco caterpillar (*Spodoptera litura* F.) and grasshoppers (*Colemania shenarioides* F., *Chrotogonus trachypterus* Blanch. and *Atractomorpha crenulata* Fabr.) and yield effects.
The trial was laid out in a randomized block design for the two consecutive seasons of 1982 and 1983 with the two varieties of cowpea: EC-4216, a spreading type and HFC-42-1, an erect type and two sorghum cultivars, namely PC-19 and M.P.Chari. In within row mixed-cropping, a 1:1 ratio of cowpea and sorghum was maintained, and in two intercropping, one row of each crop was sown alternately, with an equal number of rows of each crop in each plot. Plot size was 4 m x 3 m and each crop covered $6m^2$. Row to row and plant to plant distances were 40 cm and 10-15 cm respectively. The treatments were replicated three times.
The incidence of leafhoppers and the damage caused by defoliators were most reduced in a row inter-crop, less in mixed, within row farming and least in a pure crop of cowpea. Greater green fodder and dry-matter yields of cowpea were obtained in inter-crop between rows and in mixed-crop, within row farming.
Authors' summary.

967 91 - 10/100

Plant protection
North America, USA, maize, vetch, crimson clover, wheat, soil arthropods, no-tillage methods, conventional methods, agroecosystem

HOUSE, G.J.

No-tillage and legume cover cropping in corn agroecosystems: effects on soil arthropods.

Acta Phytopathologica et Entomologica Hungarica, 24, 1989, pp. 99-104

The objective of the study was to quantify and compare the effects of conventional and no-tillage cropping practices in combination with a winter legume or wheat cover crop on soil arthropod population dynamics, community structure, and damage to corn.
Conservation tillage practices, especially continuous no-tillage, generate complex soil biotic interactions in addition to changes in soil physical and chemical properties. The large amount of organic matter left on the soil surface by no-tillage practices provides a favorable habitat for soil arthropods and other invertebrates through reducing moisture loss, ameliorating temperature extremes, and providing a continuous substrate for many decomposer organisms. Although crop damage by some pest insects such as corn billbugs, *Sphenophorus callosus* (Olivier), increase under no tillage, damage from other pests such as lesser cornstalk borers, *Elasmopalpus lignosellus* (Zeller), are reduced by eliminating tillage.
Field research was conducted from 1984 through 1987 at the coastal plain of the southeastern United States.
Soil arthropods were extracted from soil cores from corn preceded by three cover crops of wheat, *Triticum aestivum* L., crimson clover, *Trifolium incarnatum* L., and hairy vetch, *Vicia villosa* Roth.
Winter legume and grain cover crops preceding corn, *Zea mais* L., grown using conventional and no-tillage methods were investigated for their effect on soil arthropod population dynamics and community structure.
Hairy vetch, *Vicia villosa* Roth, supported higher below-ground arthropod population densities and a more taxonomically diverse fauna than either crimson clover, *Trifolium incarnatum* L., or wheat, *Triticum astivum* L.
Soil arthropods, both pest and beneficial, were most abundant in no-tillage corn preceded by hairy vetch. Arthropod predators were more numerous in no-tillage than conventional-tillage systems regardless of previous cover crops. No-tillage practices promoted a more trophically balanced soil arthropod community than conventional tillage during early- and mid-season. Soil arthropod species diversity was also higher under no-tillage than conventional tillage.

In conclusion, conventional tillage has a more consistent impact on soil arthropod community composition than no-till systems. No-till promoted and maintained a more trophically balanced soil arthropod community structure than the conventional tillage system during early and mid-season, possibly providing some measure of biological control when crops were sensitive to insect damage. A combination of continuous corn, moist soil, and planting immediately after herbiciding cover crops increased southern corn rootworm infestations in no-tillage systems, especially those following legume cover crops. Thus no-tillage requires more intensive management than conventional cropping methods, largely because information is lacking on the response of arthropods to varying cultural and climatic factors in these complex systems.

968 91 - 10/101

Plant protection
Africa, Kenya, field study, highlands, subsistence farming systems, natural enemies, biocontrol, pest control, pest population, mass production, biological monitoring

OLOO, G.W.

The role of local natural enemies in population dynamics of *Chilo partellus* (Swinh.) (Pyralidae) under subsistence farming systems in Kenya.

Insect Sci. Applic., 10, 1989, pp. 243-251

The present article provides an example of detailed population study and analysis on *C. partellus* leading to an understanding of the role and potential of its indigenous natural enemies under subsistence farming systems so as to be able to formulate appropriate biocontrol strategies for the pest under these farming conditions.
Conventional IPM programmes usually combine such components as plant resistance, cultural practices, biological control and chemical application, and have so far been developed and applied mainly in commercial crop production.
In classical biocontrol programmes, the common practice is to look for promising exotic natural enemies, have them released in the areas where the pest problem occurs, with little or no attempt to evaluate the role of local natural enemies of the pest.
In the traditional subsistence agriculture commonly practised in the tropics and where the socioeconomic structure and resources are a major constraint, appropriate IPM programmes are yet to be developed.
In this work a systematic ecological approach for developing a sound bio-control programme is proposed.
Data to illustrate the proposed procedure in developing a biocontrol programme were obtained from a 2-year field study conducted at a rural farming community in Western Kenya. The locality is about 1240 m above sea level and has a mean annual rainfall of 900 mm and a mean temperature of 26° C, and about 60% r.h.
Population studies on the stem borer, *Chilo partellus* (Swinh.) (Pyralidae), on maize and sorghum serve as a model.
Population changes of *C. partellus* and its natural enemies(parasitoids and insect pathogens) were monitored from plant emergence to harvest in maize and sorghum monocrops in the traditional maize-sorghum intercrop in nearby subsistence farms during the cropping seasons.
The proposed approach involves detailed population estimation and analysis in relation to crop phenology to determine the role of local natural enemies, evaluation of biocontrol potential of promising biocontrol agents, developing mass rearing and release technology and monitoring the impact of the biocontrol programme.
Life table analysis of data on *Chilo partellus* showed local

predators (and unidentified factors) to contribute up to 97.6% of generation mortality of the borer in the age interval from egg to early instar larva, while parasitoids and pathogens contributed less than 1% mortality in the various life stages.
A programme involving conservation and augmentation of local predators and introduction of selected exotic parasitoids of this borer seems appropriate. This represents an attempt to apply life table analysis, taking into account plant phenology, in studying interacting populations under subsistence farming conditions.
The foregoing provides a necessary step and rational ecological basis for developing a biocontrol programme for *C. partellus* under these particular subsistence cropping systems, where local predators should be conserved and their performance enhanced. Exotic larval parasitoids with a high biocontrol potential should also be introduced, while the above pupal parasitoids already adapted to these local environmental conditions should be augmented to enhance their performance. The required level of control will depend on damage thresholds yet to be established for stem borers in the subsistence farming environment.
This is, in principle, the general approach proposed for developing a biocontrol programme for cereal stem borers, and represents an attempt to apply ecological life table analysis, taking into account plant phenology, in studying dynamics of interacting populations under subsistence farming system.

969

91 - 10/102

Plant protection
Latin America, Colombia, cropping systems, intercropping, cassava, herbivore numbers, yield, CIAT

GOLD, C.S. et al.

Effects of intercrop competition and differential herbivore numbers on cassava growth and yields.

Agriculture, Ecosystem and Environment, 26, 1989, pp. 131-146

In this paper the effects of intercrop competition and differential herbivore numbers on cassava growth and yields in cropping system trials in the Dept. of Tolima, Colombia, are reported.
Cassava is a staple root crop endemic to the tropics. Its long growing season and low market value make it an unlikely candidate for prime lands. Most cassava is produced on small farms where it has been traditionally grown in mixed crops.
Cassava is a poor competitor in early growth and plant competition must be reduced through spacing of intercrops.
Only limited information has been available on how cassava pests respond to different cropping systems.
Most cassava herbivores attack stems and leaves and are indirect (e.g. non-root-feeding) pests.
Pest attack is equally damaging at any part of the crop cycle although early attack may reduce root number.
The cassava whiteflies, *Aleurotrachelus socialis* Bondar and *Trialeurodes variabilis* (Quaintance), are outbreak pests on cassava in the Dept. of Tolima, Colombia causing yield losses up to 80%.
Intercropping trials were located at the Instituto Agropecuario Colombiano in Nataima (Dept. of Tolima), Colombia.
In this study competition between cassava and its intercrops was present for 35% of the cassava cycle. Yield reductions between protected and non-protected plots resulted primarily from whitefly attack.
Cassava intercropped with cowpea had higher yields and sustained lower yield losses than other systems. Yields of regional cassava intercropped with maize, grown in monoculture, or mixed with cassava cultivar CMC 40 were equivalent in both protected and non-protected environments. Yield losses closely followed population trends of cassava whiteflies. Whiteflies were attracted to more vigorous plant assemblages, as in monocultures, with lowest numbers in cassava/cowpea systems. The data indicate that under stress, cassava favours top growth over roots, and large plant size did not insure high yield. Land equivalent ratios exceeded 1.5 for intercropped systems.
Intercropping with cowpea reduced leaf longevity and this contributed to lower yields. In contrast, leaf longevity was greatest in cassava/maize systems.

In this study an aggressive cowpea intercrop provided high levels of competition, reducing growth rates in cassava. This in turn made the cassava less attractive (or suitable) to whiteflies and greatly reduced yield losses, relative to other treatments. As a result, cassava associated with cowpea outyielded cassava in the other systems. These data demonstrate that under conditions of high insect attack, reductions in herbivore numbers can more than offset the negative effects on yield brought on by intensive interspecific competition between intercrops.

970 91 - 10/103

Plant protection
Latin America, Nicaragua, tomato, cropping system, integrated plant protection, polycultural system, AVRDC

ROSSET, P.M.

Evaluation and validation of a tomato and bean polycultural cropping system as a component of IPM for tomatoes in Nicaragua.

In: Proc. of Int. Symp. on Integrated Management Practices on Tomato and Pepper Production in the Tropics, AVRDC, Tainan, Taiwan, 1989, pp. 289-302

The purpose of this study was to evaluate the potential of a tomato and bean polyculture as a prophylactic component of an integrated management program for tomato pests in Nicaragua. A related objective was to evaluate the yielding properties of this cropping system.
A major focus of research involving polycultures has been the effect of plant community diversity on the populations of herbivorous insects.
Basic ecological studies show decreased herbivore abundance with increased plant diversity.
A number of basic mechanisms leading to lower herbivore populations emerge. They can be grouped into three general categories as follows:
- Attraction: A wide variety of factors can reduce the attractiveness of the crop in a polyculture, including greater percent ground cover, physical barriers, high diversity of chemical cues, presence of diversionary hosts, complex crop architecture, etc.
- Tenure time: In the case of highly mobile pests, the length of time that they remain in the crop may be reduced by such factors as contact with non-hosts, chemical repellents, increased shade, etc.
- Mortality: A higher natural enemy abundance may lead to greater mortality in a polyculture.

In this study, damage on tomatoes cause by *Heliothis, Spodoptera and L. sativae* was monitored in polycultures and monocultures, to see if the damage was indeed reduced by intercropping.
Polycultures may also reduce disease spread, by decreasing the proportion of susceptible hosts in a field. On the other hand a polyculture may improve the microclimate (temperature, humidity) for microbial pathogens, and lead to greater problems. A secondary feature of this study was therefore to monitor pathogen attack.
This experiment was conducted at the Sébaco Valley Regional Experiment Station, near San Isidro, Matagalpa, Nicaragua during the 1982-83 dry season. The experimental field had been previously cultivated with rice, and therefore had a high density of the weed purple nutsedge, *Cyperus rotundus* L. (Cyperaceae).
Separate monocultures and polycultures of beans and tomatoes were direct-seeded.

The polyculture overyielded significantly, with a land equivalent ratio (LER) of 1.72 ($P < 0.03$). Beans as a companion crop did not affect the yield of tomatoes in the polyculture (relative yield, or RY = 0.97), while the intercrop bean yield was 75% of the monocultural production (RY = 0.75). The use of the polyculture greatly reduced the incidence of three principal tomato pests: the *Heliothis* spp. [*LEPIDOPTERA: NOCTUIDAE*] fruitworm complex ($P < 0.015$); the spodoptera spp. [*NOCTUIDAE*] armyworm complex ($P < 0.10$); and *Liriomyza sativae* Blanchard [*Diptera: Agromyzidae*], the vegetable leafminer ($P < 0.005$). A large-scale validation trial, conducted in 1984 in the Department of Managua showed a similar pattern of strongly reduced incidence of fruitworms and armyworms (> 90% reduction in damage). There was no effect of intercropping on tomato diseases.

An economic analysis showed that the polyculture was between 1.1 and 2.2 times more profitable than the tomato monoculture, depending on the wholesale market price of tomatoes.

At no price, the monoculture is more profitable than the polyculture. From an economic perspective the polyculture is an effective buffer for the farmer against fluctuations in the price of tomatoes (and in the yield of tomatoes).

The result of a validation confirms and supports the conclusion that the polyculture cropping system strongly reduces fruitworm and armyworm damage.

Overall, the results of this evaluation and validation in terms of yields, pest incidence, and profitability indicate that tomato and bean intercropping should be strongly considered as part of tomato IPM in the tropics.

971

91 - 10/104

Plant protection
Asia, India, field trials, integrated pest management, cowpea, fodder production, economics, cultural practices, leafhoppers, defoliators

SHRI RAM and M.P. GUPTA

Integrated pest management in fodder cowpea (*Vigna unguiculata* L. Walp) in India and its economics.

Tropical Pest Management, 35, 1989, pp. 348-351

In cowpea the integration of cultural, chemical and biological methods was studied for the control of the pest complex.

The cowpea, *Vigna unguiculata* (L.) Walp. is severely damaged by leafhoppers (*Empoasca kerri* Pruthi) and the defoliators; flea-beetle (*Pagria signata* Motsch.) semilooper (*Plusia nigrisigna* Wlk.), tobocco caterpillar (*Spodoptera litura* F.) and grasshoppers (*Colemania sphenarioides* B., *Chrotogonus trachypterus* Blanch and *Atractomorpha crenulata* Fabr.).

The losses in green fodder yield were estimated to be about 30%. The repeated use of insecticides for controlling these pests, though feasible, is undesirable due to the high cost of application and to their residual effect, especially when the crop is intended for use as fodder.

A trial was laid out for 2 years, in a randomized block design at the Indian Grassland and Fodder Research Institute, Jhansi (U.P.). The plot size was 4 m x 3 m. The distances from row to row and plant to plant were at 40 cm and 10-15 cm respectively. There were 17 treatments, replicated thrice.

The major insect pests which damage the cowpea crop and reduce its yield, can be managed by adopting the following practices without the use of insecticides. Growing the least susceptible variety (IGFRI-450), using an optimum fertilizer combination of 30 kg N, 100 kg P_2O_5 and 40 kg K_2O/ha, with two weedings at the appropriate stages of crop growth, 15 and 30 days old, and sowing the crop at the optimum time, the first week of July.

The infestation of these pests was further reduced and yields increased with the integration of these practices with the insecticide endosulfan at 0·075% or the biological insecticide B. thuringiensis at 0·84 kg/ha.

The incidence of cowpea pests was most reduced by the use of improved cultural practices with endosulfan and *B. thuringiensis* and the highest green fodder and dry-matter yields were obtained.

It is interesting that the integration of all three cultural practices was found to be as good as the integration of these practices with either endosulfan or biological insecticides in reducing the reinfestation of insect pests as well as enhancing the green fodder and dry-matter yields.

It may be inferred that by adopting improved cultural practices alone, the insect-pests of cowpea can be managed economically without any danger of insecticidal residues in cowpea fodder.

972 91 - 10/105

Plant protection
Review, book, tropics, catalogue, integrated pest management, training and extension, crop protection methods, host plant resistance, chemical crop protection, small scale farmers, biological control, cultural control, mechanical control, CTA

VAN ALEBEEK, F.

Integrated pest management.

Publ. of the Departm. of Entomology, Wageningen Agricult. University and the Techn. Center for Agric. and Rural Cooperation (CTA), Ede, Netherlands; ISBN 90-72620-01-1 and 92-9081-018-X, 1989, 320 p.

The need for sound crop protection methods in tropical small farmers circumstances is generally recognized. Integrated Pest Management (IPM) the integration of biological, cultural and mechanical control, the use of host plant resistance and selective chemical crop protection, can bring about a substantial improvement in the food production of small scale farmers. Nevertheless, implementation of IPM systems in the (sub-)tropics advances at a slow pace. One of the major constraints in a further development of sound crop protection methods and techniques is the lack of information. The need for information is felt most at the level of national research institutes, plant protection services, agricultural extension services, and all levels of agricultural education. Materials used in IPM training and extension were compiled into a catalogue to meet this need for information. In the catalogue, more than 350 handbooks, field manuals and pocket guides are being described. More than 120 slide sets, and 50 posters, films and video's concerning IPM in (sub)tropical crops are listed. For each item information is provided on the title, author or composer, year of publication, on its contents (including crops, geographical region and target groups it is aimed at), on its price and ordering information.
Some 50 international journals concerning crop protection are listed, including information on their contents, subscription rates and editorial addresses. In addition to this, a worldwide directory of more than 150 IPM information and research centers is provided, listing their major research topics, publication activities and full address.
Five indexes (e.g. on title, on crop and on geographical region) provide quick and easy entrances to the information in the catalogue.
Abstract from ILEIA.

973 91 - 10/106

Plant protection
Africa, review, sustainability, pest control, development, management, organisation, programs, IITA, ISNAR

TAYLOR, T.A.

Organization and management constraints in the development and implementation of sustainable pest control in Africa.

In: Proc. of the Inaugural Conf. of the IITA Biological Control Program Center for Africa, Cotonou, People's Rep. of Benin, 1989, 14 p.

The purpose of this presentation is to develop a vision of sustainable pest management that is possible and viable in tropical Africa. The development of sustainable pest control must be seen as an important element of the strategy for improving the quantity and quality of food in sub-Saharan Africa and the improvement of the economic welfare of its peoples.
Sustainable pest management which is not substantially different from integrated pest management, is largely based on ecological theory, population, biology, biological control, physiology, ecosystem analysis, economics and resource management, and a variety of operational research themes, including modeling.
The most conservative estimates of losses due to pests and weeds in tropical Africa are at least 20%, and it is well recognized that pests constitute a major limitation on the productivity of the agricultural sector.
Sustainability in the control or management of pests of agricultural importance is not a new concept. Sustainability essentially means the management of pests species at such sub-economic levels that, although they continue to exist within the agroecosystem, they cease to cause such significant crop losses as to warrant the intervention of man and the use of pesticides and other means of control. The concept is based on the use of natural, self-sustaining, and self-renewing regulatory mechanisms, which require the least intervention by man and the least disruption of the balance of nature.
Pest control research, advisory, and training services in Africa are organized principally on international, regional, and national levels.
The different levels of organizational structure for pest control and programmes are discussed in this paper.
Networking has become a vehicle for international cooperation in several fields in recent years. It is particularly appropriate in the development of sustainable pest management strategies.
Networking in this context would facilitate knowledge sharing, materials interchange, rapid assistance in the case of outbreaks, and evaluation of impact.
Networking should be able to explore and exploit this potential to the maximum for the benefit of the agricultural sector.

Another management task is to disseminate information among farmers, producers, and managers of farming enterprises.
Concluding the author states that most organizational structures for pest management at national, regional, and international levels have failed or declined largely because of policy, organization, and management constraints.
The focus in the future should be on consistent high-level manpower training and development, interdisciplinary program planning and organization, complementarity of national, regional, and international programs, and establishment of viable national capacities. Networking is an effective mechanism for alleviating management and organizational constraints. Research continuity is important, and scientists, farmers, and other producers should be involved in the development of sustainable pest management strategies.

974 91 - 10/107

Plant protection
Africa, sustainability, economics, pest control strategies, evaluation, IITA

REGEV, U.

Economics of sustainable pest control.

In: Proc. of a IITA Conference, Cotonou, People's Rep. of Benin, 1989, pp. 97-106

Historically, pest management problems have been analyzed in a classical static profit maximization framework, where pesticides have been included as inputs in a production function of a single crop. The concepts of economic and action thresholds have transformed the solution to the problem into simplified decision rules, to be used by a single farmer with or without the aid of research station support. The major difficulty that stems from this approach is that the biological aspects of the problem are not considered explicitly.
This paper focuses on two major economic issues at the heart of the problem. The first is the motivation of the farmers and the resulting conflict between short-term and long-term pest control strategies. Since long-term vision is a necessary condition for sustainable agriculture in general and pest control in particular, it is this conflict which creates the problem. The actual resolution of this conflict is the source of a large part of the non-sustainable pest control tactics, which lead to an ever-increasing pesticide use followed by increasing pest damage over time.
The second issue is the problem of economic estimation and evaluation of various elements of the ecosystem. The main problems here are those appropriate definitions of benefits and costs of pest control measures, as well as their estimation. The difficulty in the latter is to distinguish between damage incurred by various pests and to single it out from other environmental and ecological factors that affect the yield.
Natural ecosystems are adapted to long-term sustainability, while agricultural ecosystems, as has been shown here, are managed with short-term perspectives. The necessary ingredients for developing sustainable agriculture are
- better understanding of ecosystem,
- economic understanding of farmers' motivation and behavior,
- interdisciplinary cooperation of biologists and economists, and
- political vision and strength for implementation of sustainable agricultural policies.

An economic analysis of a long-term pest management strategy estimates the future gains and losses resulting from present control policy. Such modeling and estimation are basic to any sustainable pest management policy.

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Plant protection
Tropics, subtropics, developing countries, insect vectors, rice, viruses, rice hoja blanca, rice yellow nottle, rice grassy stunt

THRESTH, J.M.

Insect-borne viruses of rice and the Green Revolution.

Tropical Pest Management, 35, 1989, pp. 264-272

This paper considers the impact of insect-borne viruses of rice in tropical and sub-tropical areas. It discusses some of the factors influencing the apparent increase in prevalence of rice virus diseases and outlines current approaches to control.
In recent decades there have been big increases in total rice production and these have been achieved mainly by greater yields per hectare rather than from a big increase in the area cultivated.
The achievements would have been even greater but for the losses due to pests and diseases, including some that were previously unrecognized or unimportant. Nematodes, insects, birds, rodents, weeds, viruses, bacteria and fungi have all caused serious problems in at least some areas. The problems seem to have increased and this has necessitated changes in cropping practices and breeding policies and the use of control measures that can be expensive, inconvenient and sometimes inappropriate.
This paper considers the five important virus diseases of tropical rice, some of the reasons for their increased prevalence and the measures being adopted for their control.
Applied biologists and especially those concerned with methods of crop protection have an obvious role to play in any further discussion on the future of the 'green revolution' and on the overall strategies adopted. The losses caused by *N. lugens*, rice hoja blanca, tungro and other diseases first drew attention to some of the undesirable consequences of intensifying crop production, of promoting the widespread and indiscriminate use of insecticides and of introducing a limited number of varieties for use on a very large scale to replace the diverse array of landraces grown previously. The challenge now facing those concerned with rice and also other staple food crops is to find ways of exploiting the advantages of new improved high-yielding varieties, intensive cropping systems and other technical innovations without any of the associated disadvantages. There are unlikely to be any quick or easy solutions and a multidisciplinary effort will be required involving not only biologists and agriculturalists, but also economists, sociologists, engineers and those concerned with public health. The outcome will be of crucial importance to the future well-being of mankind given current prognoses of world populations and food requirements.

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Plant protection
Africa, Kenya, diagnostic survey, case study, sorghum, maize, cowpea, insect pest management, food crop production, small-scale farmers, socio-economy

SAXENA, K.N. et. al.

Insect pest management and socio-economic circumstances of small-scale farmers for food crop production in western Kenya: a case study.

Insect Sci. Applic., 10, 1989, pp. 443-462

There is an urgent need for reducing food losses in Africa through the management and control of insect pests of food crops.
It is, therefore, essential to develop strategies for the management of insect pests of food crops which are environmentally safe and economically sound as well as technically feasible for the resource-poor, small-scale farmers.
Sorghum, maize and cowpea serve as staple food in Africa and are grown mostly by small-scale farmers. A major constraint on the production of these crops is attack by insect pests among which crop borers are most important, causing 30-80% yield losses. Use of pesticides to control these pests is hazardous and not feasible for the farmers. Alternative strategies for the integrated pest management (IPM) are being developed at the International Centre of Insect Physiology and Ecology (ICIPE) and include the following components: (1) Intercropping and other cultural practices, (2) Plant resistance to insect pests, and (3) Biological control. These IPM components have now been developed to a stage where they can be taken for on-farm trials under farmers' management for subsequent use by them. But, adoption and diffusion of agricultural innovations requires a prior knowledge of the farming systems and the socio-economic circumstances in which the target farmers operate, and their bearing on the use of innovations.
A diagnostic survey of the farming systems in Kenya was undertaken.
A few results of the survey are submitted below:
- the insect borers are the most serious pests, according to the farmers' perceptions as well as the field observations recorded during this survey. It is, therefore, very important to reduce the food losses caused by the borers by controlling them through appropriate methods.
- Cultural practices like early planting, intercropping of appropriate crop combinations and destruction of crop residues help to suppress borer attack. Although some farmers in the project area practise early planting, others do not; unless all the farmers in one locality plant their crops early and simultaneously, the advantages of early planting are lost. Many farmers however, cannot adopt early planting because they lack labour and appropriate farm implements, especially ox-ploughs. This essential cultural practice could be promoted through

increased dissemination of information and by helping all the farmers to procure essential farm implements.
- Destruction of crop residues, though practised by some farmers, is not practised by the others, either because they are not aware of the advantages for pest control or because they use the crop residues in other ways. It is, therefore, important that the farmers in the project area are fully informed about the benefit of proper disposal of crop residues in check by pest attacks.
- Growing cultivars resistant or tolerant to pests is another important and widely accepted component of insect pest management. But most of the cultivars in use have little resistance to the borers. There is an urgent need to make the farmers fully aware of the existence of resistant cultivars and to provide seed for cultivation.
- Pesticides are hardly used by most farmers in the project area. In view of their hazardous effects, and the dangers of misuse due to poor information, their use by the farmers should be discouraged.

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Plant protection
Latin America, Colombia, cropping systems, intercropping, cassava, cassava hornworm, stemborer, varietal mixtures, CIAT, IITA

GOLD, C.S. et al.

Effects of intercropping and varietal mixtures on the cassava hornworm, *Erinnyis ello* L. (Lepidoptera: Sphingidae), and the stemborer, *Chilomima clarkei* (Amsel) (Lepidoptera: Pyralidae), in Colombia.

Tropical Pest Management, 36, 1990, pp. 362-367

Cropping system effects on population levels of the cassava hornworm, *Erinnyis ello* L., and cassava stemborer, *Chilomima clarkei* (Amsel) were studied in three growing seasons between 1983 and 1985 in the Department of Tolima, Colombia.
In this paper the authors report the effects of intercropping on *E. ello* and *C. clarkei*. Yield losses attributed to hornworm may reach 50% while those caused by stemborers may exceed 60%.
Under the small farm conditions in which cassava is most often grown, integrated pest management strategies are based on host plant resistance, biological control, and manipulation of multiple cropping systems. Research in diversified agroecosystems has demonstrated that these systems tend to support herbivore load rather than corresponding monoculture.
In cassava cropping systems, intercrops are harvested relatively early, leaving cassava in effective monoculture for many months. Cassava has no critical period for yield formation and yield loss is correlated with duration of insect attack. Therefore, of special interest are residual effects of the intercrop on herbivore numbers which persist after the intercrop has been removed from the system.
The effect of intercropping on the cassava hornworm and stemborer were studied in three overlapping trials.
In the first trial, herbivore density was compared between cassava/maize intercrops and monocultures grown at two different densities. In subsequent experiments, cassava monoculture and intercrops with maize and cowpea grown at one cassava density. In the first trial, hornworm and stemborer numbers per square metre were higher in denser plantings of cassava. However, pest density per plant was greater in sparse stands. Effects of intercropping on hornworm incidence varied with cassava and maize varieties with reduced levels in some combinations but not others. Stemborers were lower in intercrops than in monoculture; however, this cropping system advantage disappeared after intercrop harvest. Cassava varieties differed in levels of both herbivores but varietal mixtures had no overall beneficial effect vis-à-vis pest levels in pure stands. Nevertheless, distinct herbivore preferences for different varieties suggest the possibility of trap cropping in regions where these pests cause significant yield losses.