# X PLANT PROTECTION

188 88 - 10/1

Plant protection
Biological control, crop protection, sustainable agriculture, antagonistic interaction, predation, parasitism, biological control, limitations, potentials
CALTAGIRONE, L.E. et al.
Biological control as a component of sustainable agriculture.
In: Proc. of the 6th Internat. Sci. Conf. of IFOAM, Vol. II, eds. P. Allen and D.v.Dusen; 1988; Agroecology Program, University of California, Santa Cruz, USA

In this paper the potential of biological control as a pest management strategy is discussed.
Biological control is the regulation of populations as a result of antagonistic interactions such as parasitism (in its broadest sense), predation and competition. It is a natural phenomenon and occurs widely. As a tactic for pest control, it is the use of natural enemies - parasites, pathogens, phytophages and predators - to control pests.
Natural enemies can replace chemical and pesticides entirely, as in the control of the Klamath weed (Hypericum perforatum) or reduce the amount and kinds of chemical used, as in the case of control of spider mites (mainly Acari: Tetranychidae) in deciduous trees by manipulating predaceous mites (mainly Acari: Phytoseiidae).
Under certain circumstances, some natural enemies are able to reduce pest populations below the economic injury level. This has been demonstrated in the many cases of successful biological control (e.g. Klamath weed, olive scale (Parlatoria oleae), walnut aphid (Chromaphis juglandicola), Rhodes grass mealybug (Antonia graminis), sugarcane borer (Diatraea saccharalis), sugarcane leafhopper (Perkinsiella saccharicida), purple scale (Lepidosaphes beckii) and in all cases of potential pests that are kept under satisfactory control by resistent natural enemies. But this does not mean that every natural enemy, by itself, can control the pest upon which it feeds. To believe that this is possible is unjustified romanticism.
Success in biological control depends on biological and economic factors. In many cases of classical biological control (i.e., the colonization of exotic natural enemies for control of exotic pests) the natural enemies become established without sufficiently reducing the population of the target species. For example, for the past 80 years and at irregular intervals, a number of parasites have been imported to California in an attempt to control black scale (Saissetia oleae). Many of these parasites became established and now are part of the resident complex of natural enemies of the scale. However, economic control of the scale has not been achieved consistently.
The biological factors in biological control can be modified as a result of intensified research, which can result in procurement of new species or biotypes of natural enemies or successful manipulation of resident natural enemies (e.g. predaceous mites) or periodic colonization of natural enemies (e.g. biological control of pests in greenhouses).
Realistic economic analysis of pests and accurate assessment of the biological attributes and capabilities of natural enemies are esential to develop effective crop protection programs applicable in sustainable agriculture.



189 88 - 10/2

Plant protection
Africa, cassava, pest management, biological control, mealybug, green spider mite, yield losses, protection measures
IITA
Cassava pest management and a special Africa-wide biological control program .
In: Research Highlights 1981-1984, Root and Tuber Improvement Program, pp. 38-44, IITA, Ibadan, Nigeria

Because of the current problems with cassava mealybug (CM) and green spider mite (CGM), which have decimated yields in over 60% of the cassava-growing areas of Africa with estimated losses amounting to about two billion US dollars annually, IITA has launched a two-pronged attack on these cassava pests.
Some success has been reported on both fronts. First, there is the conventional breeding program in which sources of resistance to the pests have been identified and are being incorporated into improved cassava breeding lines. Also, attempts are directed toward using both cultivated and other Manihot species in the development of higher levels of resistance.
Secondly, a biological control approach introduces host-specific natural enemies from the pests' area of origin in South America, as a means of effectively reducing pest populations to tolerable levels which exist on that continent. Based on the progress made so far, an emergency biological control program is in the initial stages of development and testing before launching it on a large scale.
Most promising as natural enemy against the mealybug in field tests in Nigeria so far is the parasitoid wasp, A. lopezi. A green spider mite predator is now undergoing preliminary testing.
The Africa-wide Biological Control Project of Cassava Mealybug and Green Spider Mites, developed by IITA with the assistance of international and national organizations, is designed to achieve a reasonably rapid and significant reduction in populations of CM and CGM over the next few years through the release of millions of their natural enemies (predators and parasitoids) at ground level and from aircraft. Twenty countries in West, Central and East Africa have requested trial releases of natural enemies, indicating a high degree of confidence in the need for biological control of cassava pests.
Plans have been drawn up for a centrally located mass production insectary to provide the supply of the natural enemies. Several

options for mass production systems have been investigated by IITA. Preliminary specifications for a tunnel insect production system have provided for a capacity for production of up to 15 million beneficial insects and/or mites per day on 5,000 cassava plants.
As these insects and mites emerge from the tunnel system, they would be transferred to a packaging room with facilities that automatically package up to four species in the same release unit. Up to 1,500 natural enemies, depending on the species, can be put into small plastic capsules which, in turn, are placed in cassettes. The loaded cassettes (each with 361 capsules) are kept in specially designed containers with their own cooling system and later transferred into the aircraft.
Aerial release of the natural enemies is expected to be of benefit not only to farmers along major roads (where ground releases are easy to make) but also to farmers in remote areas.
The plane flies over cassava fields at a speed of 250-330 km/hr and releases about one capsule per second. The wind tunnel tests showed that accelerations and the air currents did not harm the insects.
Research and operations are closely linked to insure a steady flow of the latest results of research into the control campaign and feedback of observations from the campaign to research. The Inter-African Phytosanitary Council plays a major role in informing governments and the public about the problems of cassava mealybug and green spider mites, as well as in standardizing the procedures of the campaign.

190 88 - 10/3

Plant protection
Review, guide, Asia, rice, integrated pest management
REISSIG, W.H. et al.
Illustrated guide to Integrated Pest Management in rice in tropical Asia.
IRRI, Los Baños, Philippines, 1986, 411 pp., ISBN 9 + 1-104-120-0

This interesting multi-authored book describes its contents precisely. It is a pictorial manual covering the whole range of pre-harvest pest and disease problems on rice in tropical Asia. The book contains a minimal amount of text, designed for ease of translation into the multitude of languages used in Asia, and above all for ease of comprehension. According to the authors, the book is aimed at field workers in Integrated Pest Management (IPM) as a `source book for the training of extension officers' but also, they hope, it will encourage applied research scientists to develop more effective IPM technology. Once an initial adverse reaction to the pictorial style is overcome, one realizes how much information has been packed into a relatively small book. Sometimes the format is hard to follow because headings do not stand out between all the diagrams, but practice will make the book easier to use.



The book begins with a history of rice pest problems, giving some of the reasons for the upsurge in tropical Asia: expansion of the rice growing area, new irrigation schemes, new high-yielding varieties, increased use of fertilizers and poor pesticide application. This background is used to introduce the concept for pest management as opposed to eradication, and economic thresholds and integrated pest management are also mentioned. A second section covers the basic structures and growth stages of the rice plant. The bulk of the book is devoted to insect pests of the growing rice crop. General characteristics of insects are dealt with first. Here the choice of what to leave out must have been almost impossible, as almost everything is left out. What is left are a few structural details - body divided into three parts, six legs, two or four wings, two antennae. Incomplete versus complete metamorphosis warrants a mention, as to basic types of insect feeding and the fact that many adults do not feed on rice. Given the limited space, one cannot think of anything else to place here, except an early mention of beneficial arthropod groups.
The insects themselves are divided into pests in the soil, those attacking the plant during its vegetative stage, and those that attack the plant during ripening. The basic biology of each pest is briefly covered: life cycle, alternative hosts, distribution in tropical Asia, etc. Some of this is useful, but some will confuse. For example, Nephotettix spp. are divided into four species, but the pronounced sexual dimorphism and considerable natural variation in the extent of the black markings are not mentioned. Hence, identification from this pictorial key would be very unreliable. In contrast, the fact that adults feed on the upper portion of the rice plant, are attracted to light, oviposit under the leaf sheath, transmit several virus diseases, etc., are all important biological features that are mentioned. Each section on a pest ends with notes on the possibilities for cultural control, existence of resistant varieties, natural biological control and existing chemical control. Diseases, weeds and rats are dealt with in a similar way in smaller sections. The book has sections on general cultural control, resistant varieties, biocontrol of insects, and pesticides. Finally, these are brought together in two brief sections on integration of control measures for all pests and a scenario for the implementation of an IPM programme.
The emphasis throughout is on brevity, in order to achieve such a tremendous coverage of such a broad problem. Obviously, corners are cut, contentious issues dealt with in a simplistic manner, and an often frustrating lack of detail is given. However, the book will be extremely useful to field IPM workers, especially concerning problems they have little experience with. Research scientists will find the bibliography in the preface too brief but will find the book useful as a simple, convenient source of IPM information outside their areas of specialization.
Abstract by S.V. FLOWLER, revised.

191 88 - 10/4

Plant protection
Developing countries, pest control, economics, pre-harvest, post-harvest, project cycle
HEBBLETHWAITE, M.J.
The application of economics to pre- and post-harvest pest control programmes in developing countries .
Trop. Sci. 25, 1985, pp. 215-230

Subsistence farmers in developing countries seek to reduce losses from pests by mixed cropping, planting extra-dense stands, hand-picking of pests, and use of traditional remedies and rituals. These practices do not always prevent serious crop damage.
Within the last decade, integrated pest control (IPC) has become increasingly advocated and accepted amongst developed countries and international agencies, and to varying degrees amongst developing country governments. This is integration of the various available methods, cultural, chemical, and manipulation of pest behaviour, for an optimal control strategy which takes account of biological, environmental and economic factors and user safety in addition to short-term crop loss avoidance. Although usually applied to pre-harvest situations, IPC as a concept is also relevant post-harvest.
With increasing emphasis upon IPC, an interdisciplinary approach is more than ever necessary, not only integrating the various pest control technologies but also incorporating pest control economics. The volume and scope of work in pest control economics and constraints to increased efforts are reviewed. It is contended that the economic threshold concept and the valuation of pest-induced losses should not form the principal focal point for pest control economics in developing countries. Rather, a wide potential economic contribution is seen, in programmes ranging from the identification of projects to the evaluation of pest control practices after their adoption.
Within the economics contribution, concentration on a small number of specific concepts, narrowly tied to pest control, should be avoided. While these can play a role, concepts and methodologies developed in other fields of applied economics and socioeconomics should be exploited in the pest control field. For economics of pest control in developing countries, the harnessing of concepts and methodologies developed for such countries will often be more productive than those arising in a developed country. As communication is the cornerstone of interdisciplinary work and as it is a two-way activity, biological scientists should be willing to develop a reciprocal appreciation of economics.
With an accepted overall framework for the economist, an increasing number of contributions for pest control should be forthcoming. This, in turn, will further demonstrate the practical utility of the social science contribution, consolidating the interdisciplinary dimension. In this way, an erosion of constraints of attitude between biological and social scientists could be foreseen, hopefully drawing economists into the pest control field to a greater extent than they are at present.



192 88 - 10/5

Plant protection
Pest control, soil fertility practices, agricultual pests
LUNA, J.M.
Influence of soil fertility practices on agricultural pests.
In: Proc.of the 1986 IFOAM-Conference, Santa Cruz, USA, pp. 589-595; distributor: Agroecology Program, University of California, Santa Cruz, CA 95064, USA

The influence of soil fertility practices on insect pests and plant diseases is of fundamental importance to the development of sustainable agriculture systems. Currently practised systems of industrial agriculture have separated the processes of plant nutrition and plant protection, with plant nutrition dependent on massive amounts of synthetic chemical fertilizers, and plant protection dependent on similarly massive amounts of synthetic pesticides.
Insect, weed and disease pests are seen as competitors for the resource which must be controlled. In spite of recent advances in the development of integrated pest management programs for many crops, synthetic chemical pesticides continue to be used extensively. In the United States alone, more than 340 million kg of pesticides are used annually for control of agricultural pests. Less than 0.1% of these pesticides actually reaches the target pests. More than 99% of the applied pesticides move into ecosystems to contaminate the land, water and air.
Proponents of organic and ecological agricultural systems, on the other hand, stress the holistic nature of agroecosystems and emphasize the importance of promoting biologically active soils. A fundamental paradigm, or operating principle, of ecological agriculture is that healthy soils grow healthy plants which are resistant to insect pests and diseases. Although "health" in soils and plants is difficult scientifically to define and quantify, a "healthy" soil is generally considered to have sufficient levels of organic matter, a diverse biotic community, balanced levels of plant growth macro- and micronutrients, and good physical structure. "Healthy" plants are considered to be vigorous and nutritionally balanced.
Relative availability of plant growth nutrients in soils can cause dramatic variation in percent composition of nutrients in the plants. Deficiencies or excesses of one element can also cause deficiencies of another element within the plant. In other words, the elemental composition of a growing plant is dynamic, highly varying, and dependent on the availability and relative balance of nutrients in the growth medium.
Farmers employ various practices in an effort to maintain and improve soil fertility. Although the application of fertilizer materials, including synthetic chemical fertilizers, manures and various natural products such as rock phosphate and bonemeal, is used extensively in farming, other practices such as crop rotation and growing green manure crops are also important in improving

soil fertility. Soil fertility practices not only affect the yield and quality of the crops; they can also have dramatic effects on crop pests. Soil fertility practices can have direct effects on pest populations by altering the physical or chemical habitat, or indirect effects by enhancing natural biological control agents, or by altering the host plant biochemistry.
Increasing soluble nitrogen levels in plant tissue commonly decreases pest resistance, and increasing potassium levels commonly increases resistance, but these are not universal phenomena. The relative balance of nutrients within the plant, however, appears to have more bearing on resistance than absolute levels of individual nutrient elements. Manipulation of fertilization and other cultural practices to produce a more balanced nutrient uptake should be considered in a comprehensive integrated pest management strategy.
These interrelationships and effects are discussed in detail in this paper.

193 88 - 10/6

Plant protection
Humid and subhumid tropics, lowlands, pests, weather effects, migrant insects
PEDGLEY, D.E.
Weather effects on migrant insect pests of agriculture.
In: Proc. of the Seminar on Agrometeorology and Crop Protection in the Lowland Humid and Sub-humid Tropics, Cotonou, Benin, 1986, organized and sponsored by the National Meteorological Service, Benin, IITA, WMO, UNDP, FAO and the Technical Centre for Agricultural and Rural Cooperation (CTA), pp. 43-48.

Progressively more insect pest species are becoming recognized as migrants over distances up to hundreds of kilometers. Many of these are pests of field crops. Migration affects pest management strategy and is itself affected by the weather. Long-distance migration is downwind and can be studied by means of synoptic-scale windfield maps. Hence, national meteorological services can assist in understanding insect pest migration and in reducing crop losses through development of management strategies that take account of migration.
Agrometeorologists do not often invoke synoptic meteorology when helping to solve problems of agriculture. Individual weather events can indeed be significant, e.g. having rain causing wash-out, or strong winds causing lodging, but plant growth and crop yield are determined largely by cumulative weather influences over weeks or months. Even so, winds on particular days can bring insect pests into a crop, so pest management should take account of the possibilities of windborne movements.
Management of insect pests in crops is primarily concerned with preventing population density exceeding a threshold beyond which damage becomes significant. Population density alters mainly due to birth and death, but also by movement. Many insect pests are known to move by flying, yet flight is seldom considered in pest



management planning or operations. Long-distance flight, or migration, by insects is certainly difficult to take into account because for most species it is understood either poorly or not at all. Yet insect migration is potentially very important if it leads to the spread of more damaging strains, or of resistance to insecticides, or of virus diseases. Moreover, mass migrations can cause sudden and overwhelming destruction of crops. Well-known examples of mass migrants are the desert locust, Schistocerca gregaria, and the African armyworm moth, Spodoptera exempta. These are pests primarily of the semiarid tropics, but at times of plague they may invade neighboring parts of the semihumid or humid tropics.
Migrant insects may move hundreds of kilometers in a lifetime, and even in a few days or nights; they have great fecundity; and they are often adapted to hosts that are temporary, either because of seasonality of growth due to rain or cold, or because of a limited duration of the edible stage, such as flowers or fruits. Such temporary hosts provide many of the main food plants for man and his lifestock - cereals, pulses and roots; hence, insect pests of field crops are likely to be migrants, at least in part. Migration is a strategy that enables these species to avoid times of environmental stress by seeking out places where hosts are still available. The tendency to migrate is affected by daylength (latitude), and it is also controlled genetically in ways yet hardly understood. Diapause, or suspended development, is another avoidance strategy, and some species use both strategies in various degrees.
Pest management organizations can take account of migration in their control strategies. For example, a defensive strategy would be to monitor pest arrival, both of adults by means of traps, and of the subsequent generations by means of sampling in the crop. Trapping not only gives early warning but also is less expensive and time-consuming than crop sampling for first arrivals. Both methods should be used. Action is taken when the threshold density is exceeded. Alternatively, a preventive strategy would be to reduce the numbers of insects migrating by taking early action at their sources, especially the largest or most vulnerable populations. This implies a knowledge of the sources. Both strategies require the ability to monitor pest populations and to report back information in time to be useful.
It is obvious from this brief survey that both research into the understanding of migration and its application to operational pest monitoring, forecasting and control can benefit from close collaboration between pest management services and meteorological services. There is considerable potential for greater involvement of meteorological services in the control of migrant pests.

194 88 - 10/7

Plant protection
Review, manual, developing countries, weed management, techniques, training experience, instructor use
FAO
Instructor's manual for weed management.
FAO Training Series No. 12, 1986, 149 pp., ISBN 92-5-102279-8, Rome, Italy

Modern weed management is diverse and complex. In developing countries, improved land preparation and weed management technologies have not reached the small-scale arable farmer, who has been left with technologies that have altered little with time, that are extremely laborious and that at times exert an adverse effect on the agroecosystem.
A great contrast in crop production between high technology farming in developed nations and small-scale, subsistence farming in developing countries lies in land preparation and weeding methods. In developed countries, the use of improved technologies has allowed greater flexibility in crop production while maximizing the benefits of costly inputs of nutrients and moisture.
FAO recognizes the constraints and the difficulties of transferring appropriate technologies, owing to the lack of people with the desired expertise and the large number of small-scale farmers to be trained. To overcome these constraints, there is no alternative but to direct a wider effort toward training at all possible levels.
This instructor's manual for weed management is based on many years of teaching and training experience. Its aim is to fill an existing gap, namely the lack of a suitable publication adapted to developing countries. It has been prepared by the International Plant Protection Center of Oregon State University in collaboration with FAO and UNDP, through its Action Programme for Improved Plant Protection, and with partial support from USAID.
It is intended to be a beginning outline for experienced instructors teaching weed management courses to extension staff and future trainers in developing countries where small-scale arable farmers need to learn about improved land preparation and weed management technologies.

195 88 - 10/8

Plant protection
Review, book, tropics, subtropics, natural pesticides, neem tree, tropical plants, research results, mode of action, neem effects
SCHMUTTERER, H. and ASCHER, K.R.S.
Natural pesticides from the neem tree (Azadirachta indica A.Juss) and other tropical plants.
Proc. of the Third International Neem Conference, Nairobi, Kenya (1986), GTZ Schriftenreihe No. 206, Eschborn, 1987, 691 pp., ISBN 3-88085-372-X; Distributor: TZ-Verlagsgesellschaft, Postfach 1164, D-6101 Roßdorf, FRG



Insect pests are an important component of the adverse environmental factors in Africa and elsewhere. They greatly reduce crop yields in the field and also destroy stored food. Small farmers suffer especially from the depredations of insect pests, as they have hardly any means to fight them. In addition, insect pests transmit the causal agents of many dangerous human diseases, which further undermine the health of the populations already suffering from malnutrition.
In the field of crop protection, most developing countries currently depend heavily on imported pesticides. This dependence should be reduced in favor of greater self-sufficiency.
Natural products readily available in the tropics and subtropics can help to reduce the need for imported pesticides and thus gradually increase the developing countries' self-sufficiency.
Intensive research on the products of the neem tree (Azadirachta indica or Antelaea azadirachta), a rapidly-spreading multipurpose plant, has indicated that it is a nearly ideal model for use on plant products in agriculture and other areas. Especially over the last five years, results of field trials have demonstrated the great potential of neem for pest control. These results give rise to the hope that in developing countries, where sufficient neem trees are available, the use of imported synthetic pesticides could be replaced partially by the use of locally produced neem. Naturally, like any other pesticide, neem cannot solve all pest problems. For the numerous smallholders there seems to be no other resource, because of the lack the financial means to buy synthetic products now and in the foreseeable future.
The book is divided in various sections:
- Overviews of neem research and cultivation
- Phytochemistry, ecotypes, extraction and formulation
- Mode of action
- Effects on feeding and egg-laying behavior, metamorphosis and fecundity
- Effects on spider mites
- Effects on ostracods
- Effects on nematodes and earthworms
- Effects on fungi
- Properties of ingredients of Melia Spp. and other tropical plants
- Resolutions

As confirmed by the Proceedings of the Third International Neem Conference, the use of neem products in rural areas of the developing world, especially at the peasant farmer's level, may develop to a real alternative in biological and integrated pest control where sufficient raw material is available. A number of problems of neem application are still not satisfactorily solved but hopefully international cooperation will provide the necessary answers within the next few years.

196 88 - 10/9

Plant protection
Review, book, plant pathology, diseases, air pollution, disease forecasting, crop loss assessment, cultural practices, chemicals, weeds, plant quarantine, bibliography
JONSTON, A. and BOOTH, C.
Plant pathologist's pocketbook.
Commonwealth Agricultural Bureaux, Farnham Royal, Slough SL2 3BN, England, 1985, 435 pp., ISBN 0-85198-517-3

The first edition of this pocketbook was well received and appears to have filled a gap in the plant pathological literature. It has long been out of date, so a second completely revised and updated edition has been prepared.
The contents are divided into:
- Fungus diseases
- Bacterial diseases
- Virus diseases
- Mycoplasma-like organisms as plant pathogens
- Non-infectious disorders
- Effects of air pollution on crops
- Some major plant diseases
- Disease forecasting
- Crop loss assessment
- Post-harvest losses
- Fungicides
- Application of chemicals for plant disease control
- Cultural practices for the control of crop diseases
- Biocontrol of fungal plant pathogens by fungi
- Plant quarantine
- Regional and country lists of plant diseases
- Plant-parasitic nematodes
- Insect and other arthropod pests
- Weeds
- Parasitic higher plants
- Plant pathogens and biological control of weeds
- Fungi as a cause of human and animal disease
- Selected bibliography of plant pathology
- Glossary of plant pathological terms
- Mycological techniques
- Collection and despatch of cultures and specimens for identification
- Inoculation
- Design of experiments
- Seed health testing
- Mycological media and methods
- Addresses
- Index.

As was the case in the first edition, so also the second edition embodies the experience of the members of the staff of the Commonwealth Mycological Institute. It also includes sections contributed by specialists outside the institute. The information included has been selected with a view to including such material as is



likely to be useful to a plant pathologist in his day-to-day work. Numerous bibliographies and lists of references have been included so that further information on any subject can easily be found.

197 88 - 10/10

Plant protection

North America, Canada, review, allelopathic mechanisms, biological control
PATRICK, Z.A.
Allelopathic mechanisms and their exploitation for biological control.
Can. J. Plant Pathology, 8, 1986, pp. 225-228

Details surrounding allelopathy, its many ramifications and controversies make fascinating reading and have been the subject of many reviews. The present discussion focuses on the involvement of allelopathic mechanisms in plant pathogenesis and the possibility of their exploitation for biological control.
A wide range of injurious effects on plants has been reported in which phytotoxic allelochemicals were implicated; these effects include delay or complete inhibition of seed germination, stunted overall growth, injury to the root system, chlorosis, wilting and killing of plants. Phytotoxic allelopathic effects on plants have been associated with certain agronomic practices where specific plant species grown in rotations were found to be compatible while others were incompatible to those that followed. One of the best-known examples of allelopathy associated with specific plants is the injurious effect of black walnut (Juglans nigra) on tomato and other plants growing in its vicinity. Allelopathic-type substances have also been implicated in the so-called soil-sickness problems, fatigued soils and replant problems.
It has been shown, for example, that pre-emergence damping-off involving Pythium and Fusarium species is increased considerably by allelopathic substances formed in the soil during the early stages of decomposition of plant organic matter, and that these substances disappear with time, enabling disease severity to be reduced by later planting. This is also true of black root rot disease of tobacco caused by Thielaviopsis basicola and probably other diseases. Poor seed germination and seedling injury caused by phytotoxic allelochemicals have also been reported with stubble mulch and conservation tillage practices. Conservation and minimum tillage can increase, decrease or otherwise affect plant diseases. In some years, poor weed stands are obtained with minimum tillage, and plants from areas containing large amounts of crop residue are much smaller than those from low-residue areas. Raised seedling crowns and stunted roots that grow away from the soil are characteristic of the problem. This condition is often accompanied by root rot caused by Rhizoctonia, Fusarium and Pythium species, or by root rot caused by phytotoxic compounds in which parasitic organisms are not involved. This condition is particularly severe during the early stages of straw decomposition and in wet years.

It has also been shown that during decomposition of crop residues in the field, phytotoxic concentrations of short-chain aliphatic acids, acetic, propionic and butric acids (recognized allelochemicals) are produced and are partly responsible for the problem. Ploughed soils and fields with less crop residue seem to suffer relatively little from this syndrome. Many other examples of similar effects have been reported worldwide.
One of the more promising and frequently used methods of attaining biological control of soil-borne plant pathogens is with the aid of plant residues as organic amendments added to the soil. Reduction in disease severity is often obtained with such substances, apparently through their effects on microbial antagonisms, competition, antibiosis and the many other dynamic soil mechanisms affected by the amendments, which in some manner are ultimately detrimental to the pathogen. Sometimes, however, such treatments reduce root growth and increase disease. The variable and often unpredictable results obtained in the field with organic amendments have frustrated attempts to use them for practical biological control. Despite the considerable research done in this area, the precise reasons for the variability are not fully understood and this, no doubt, has prevented the exploitation of organic amendments for biological control to its full potential. Of the many factors and consequences associated with soil augmentation with organic materials, the possible role of allelopathic mechanisms has received only limited attention from plant pathologists.
It has been shown that a variety of phytotoxic allelochemicals may be produced during the decomposition of many types of plant materials in the soil under certain conditions. Stunting, root necrosis and increased disease severity result if plants are planted during the period when these substances are being produced and if conditions are favorable for their accumulation. However, many of these substances, no matter how toxic they may be, are soon inactivated, destroyed or transformed by the soil microflora. If planting is delayed to allow for the phytotoxic phase to pass, the injurious effects to plants will not occur. This may explain some of the contradictory results obtained with organic amendments and should be explored further.
Many studies have shown that during decomposition of crucifers in soil, volatine compounds with phytotoxic as well as antifungal properties are obtained. Some of these substances, for example, also had strong inhibiting effects on mycelial growth, zoospore mortality and germination of infective propagules of Aphanomyces euteiches, and resulted in suppression of pea root rot.
Phenolic acids, as well as coumarins, terpenoids, cyanogenic glycoisides, latones and a plethora of other compounds have been detected in soil during decomposition of crop residues and have been identified as allelopathic agents. Many of these compounds have also been shown to stimulate the germination of chlamydospores, oospores and other fungal propagules which, in the absence of susceptible hosts, are soon lysed. In addition to germination-stimulation other adverse effects on fungal propagules have been obtained following the addition of organic amendments to the soil. All these effects contribute to reduction of inoculum levels and provide the basis of biological control.



Another aspect of allelopathy that also may have practical implications in biological control relates to some of the secondary compounds that occur naturally in specific plants. In addition to being effective allelopathic agents, in that they are phytotoxic, they can also selectively inhibit the growth of microorganisms and thus protect the plant against attack or invasion by disease organisms. For example, juglone (5-hydroxy-1,4 naphthoquinone) present in black walnut has long been recognized as an allelopathic agent toxic to many plant species. It has also been shown to be a host factor associated with resistance of pecan (Carya illinoensis) and other hickory species to scab caused by Cladosporium caryigenum. Also, juglone and hydrojuglone glucoside have been correlated with resistance of juvenile leaves of black walnut (Juglans nigra) to anthracnose caused by Gnomonia leptostyla. Chlorogenic, ferulic, butyric, caffeic and other similar phenolics that occur naturally in plants are toxic to selected pathogens and are associated with disease resistance. They are also the materials most often cited as the toxic chemicals in allelopathic interactions.
Many other examples have been reported in which the allelopathic secondary compounds may also protect against specific pathogens. It may be possible, therefore, to incorporate allopathy for disease control by breeding and cultivar selection. To utilize this approach, however, it will be necessary to incorporate into the cultivars allelochemicals that impart disease resistance but have minimal phytotoxic effects. This may be possible by incorporating the desired allelochemicals into certain plant tissues at sites where the protective function is activated only by the activity of the specific pathogen at that site.
These allelochemicals encompass a wide range of chemical types with a broad spectrum of effects and activities. In relation to plant disease, some allelochemicals, the phytotoxic compounds, may predispose plants to disease. Others may act as antimicrobial agents; they produce adverse effects on the pathogen and hence play protective roles against attack by disease organisms. Allelopathy therefore represents a type of chemical warfare among plants and microorganisms, the outcome of which can be detrimental not only to plants but also to pathogens. The dual aspect of allelopathy as it relates to plant disease has received little attention in the plant pathological literature. As well, research on ways to manipulate allelopathic mechanisms to minimize the phytotoxic effects and capitalize on the beneficial ones has been minimal.

198 88 - 10/11

Plant protection
Review, article, tropics, subtropics, integrated pest management, traditional farming systems, multidisciplinary approach
BEETS, W.C.
Aspects of traditional farming systems in relation to integrated pest management.
ICRAF Working Paper No. 21, 1984, 12 pp., ICRAF, P.O.B. 30677, Nairobi, Kenya

The usual approach to pest management is pest-oriented rather than crop-oriented. However, since crops are more important than pests, it is suggested that the subject should be approached through experimental variation of crop management rather than of pest-control possibilities, and emphasis on data on cropping system charateristics rather than on pest populations.
The subject is highly complex and a multidisciplinary approach seems necessary. It is therefore recommended that agricultural pest management always be viewed in its ecological context and that the whole farming system be studied before it is manipulated with external pest control measures, particularly toxic chemicals.
When considering the incidence of pests and diseases in traditional multiple cropping systems, there are two widely contrasting possibilities:

- multiple cropping provides a longer period of plant life which is likely to increase insect and disease problems; and more intensive cropping could increase pest problems by creating a more favorable environment for pests and diseases by increased disturbance of the ecosystem; and
- crop diversity may lead to greater pest stability, and longer period of plant life may allow naturally occurring biocontrol agents to sustain higher population levels.

In multiple cropping systems, pests are a concern throughout the cropping period. The pests of the various crops often do not affect only one crop. In sequential cropping systems, the pests of one crop might be influenced by the previous crop, while in mixed cropping systems, the pests of one crop might be influenced by the other component of the association.
Experiments conducted over the past two decades have shown that there are a number of more or less practical ways to manage pests by other means than applying insecticides. They can be summarized as follows:

- planting a trap or diversionary crop (crop A can trap insects for crop B where they are harmful on crop B but not on crop A);
- planting a crop which attracts or repulses insects through visual stimuli (action the same as under 1);
- planting a physical barrier which reduces mobility of harmful insects (as in strip cropping);
- planting a pest-resistant camouflage crop to hide a susceptible second crop;
- planting genetically diverse crops to buffer the explosive build-up of pests and diseases (as in multiline varieties) and to create more ecological niches for predators;
- planting a crop that changes the microclimate of a second crop so that the growth conditions for insects become less favourable;
- planting alternate host crops for predators;
- planting crops with a repellant action (crops that emit chemicals that aversely affect pests);
- planting pest- and disease-resistant crops or cultivars;
- practising crop rotation with crops that host different pathogens.



Certain aspects of traditional farming systems have advantages over "modern" systems. However, in view of population pressures, shortages of land and the ever-increasing quest for food, it is often necessary to modernize traditional systems to some extent. When this is done, it is necessary first to make an in-depth study of the traditional systems, then identify useful components of these systems, and finally try to modify the systems in such a way that the beneficial components are maintained and that the new, modern component can be accommodated without unduly disturbing the equilibrium.
Agroforestry and multiple cropping by definition involve the management of heterogenous plant/animal populations (either simultaneously or in rotation). As seen above, this makes possible the use of the various opportunities provided by heterogenous plant/animal populations. Furthermore, there is a need to remember that pest control is not necessary just for the sake of reducing pests; rather, it should be seen in the context of reducing yield losses and thus increasing overall productivity. Agroforestry offers opportunities for sustained production of both food and wood and also integrated pest management.

199 88 - 10/12

Plant protection
Europe, F. R. Germany, field trial, maize, comparison crops, biological weed control, yield, interplant competition
WERNER, A.
Die Nutzung zwischenpflanzlicher Konkurrenz in Form von Mischkultursystemen zur biologischen Unkrautbekämpfung im Mais und der Einfluß der Beipflanzen auf die Ertragsbildung der Kulturpflanze (Utilization of interplant competition in mixed cropping systems for biological control of weeds in maize and the influence of companion crops on yield of the main crop).
Dissertation, University of Bonn, FRG, 1986, 198 pp.

The effects of growing companion (cover) plants between crop rows on weed population and yield of the main crop, maize, was investigated with a view to assessing the applicability of such mixed cropping systems in biological weed control and discovering the type of interplant growth relations which occur in mixed stands.
A factorial field trial was conducted in 1982 and 1983 on the experimental farm Dikopshof near Wesseling with the factors: variety of companion plant, duration of competition, and supplementary plant nutrition. The major findings were:

- Within the companion crop cover, depending on the growth period and species of companion crop, the number of weeds and degree of weed cover were decreased. The earlier the companion plants were removed, the stronger was the subsequent weed growth. Systems involving grass cover could, with increasing length of growth period, completely suppress weed growth. White clover systems, even with constant growth, permitted a medium level of weed infestation.

- The spectrum of wild plant varieties was markedly higher in the tested white clover variant than in the herbicide control. Under extremely dry weather conditions, grass systems act much like broad-spectrum herbicides in suppressing all species of weeds.
- The companion plants growing simultaneously with the maize extracted large amounts of nitrogen and water from the soil already in the early stages of maize development. The extent of extraction depended on the species of companion plant, the duration of its growth period, and the intensity of nutrient supply.
- By extracting nutrients, the companion plants competed with the maize. Unfavorable weather conditions in the form of drought intensified this effect. The ontogenesis of maize was delayed and the total dry matter production of the maize and the companion plants was less than in pure maize stands. In systems with grass cover, complete failure of maize is possible. Supplementary supply of nitrogen and water can partially reduce these competitive effects.
- The growth of the companion crop cannot be completely terminated by the measures applied (mulching and burning). If early suppression of the companion crop can be achieved by suitable means, maize development is not delayed under normal weather conditions and, as a result, maize yield is not depressed.
- The presence of companion plants favored maize growth in the two-leaf stage, but this advantage was not maintained after the competitive effects set in.
- Companion plants can be used as a means of biological weed control. Negative effects on maize yield must be prevented by suitable measures to control the companion plants.
- Regressional and differential equation systems permit modelling of interplant growth conditions. They aid in interpreting plant interactions and in further developing such mixed cropping systems for integrated plant protection.

200 88 - 10/13

Plant protection
Africa, Nigeria, field trials, cowpea, maize, sorghum, cotton, crop mixtures, pest control, protection regimes, yield
FISCHER, N.M. et al.
Insect pest control for cowpea in crop mixtures.
Expl. Agric., 23, 1987, pp. 9-20

There have been indications from field observations and experiments that mixed, untreated cowpea escapes some of the insect damage to give higher yields than those of unprotected sole crops. The present experiments were designed to quantify the possible insect pest escape from mixed cropping and to compare companion crops for the cowpea in both protected and unprotected regimes.
In 1981 and 1982, three crop protection regimes were compared with an unsprayed control for cowpea grown alone and in mixtures with maize, sorghum and cotton.
In neither 1981 nor 1982 was there any evidence that mixed cropping without insecticide treatment could support useful yields of



cowpea where sorghum or cotton were the companion crops. Although there was evidence of escape from pest damage for the cowpea with maize in 1981, this was not repeated in 1982 and the variety which performed relatively well in 1981 (TVx1948-01F) was disastrous in 1982.
With pesticide protection, LER values for mixtures of cowpea with sorghum and cotton averaged 1.02 and 1.03, respectively, suggesting that there is little to be gained from growing these as mixtures. Even given the advantage that the cotton/cowpea crops 'share' insecticide sprays if the cotton is sown about 4 weeks before the cowpea, this does not seem worth pursuing as these have an LER of 1.19, indicating a useful advantage for this mixture.
The very dry conditions of 1983 are illustrated by comparing the 126 kg/ha of cowpea in mixed rows with 778 kg/ha for the equivalent cropping pattern and varieties in 1982. There simply was no water for the cowpea to exploit after maize in 1983. Nevertheless, the comparatively good cowpea yield and higher LER in the alternate row systems do suggest that, even in a dry year, this arrangement may have value. It greatly simplifies spraying but seems to incur some loss of maize yield.
In 1982 TVx1948-01F gave 29% more yield than Acq 1696 as sole crop but 21% less when averaged over the mixed row treatments and 43% less in the alternate row mixtures. In both years, therefore, the yield advantage of the improved medium-maturity TVx was greater in sole crop than in mixture when compared with the late photosensitive variety 1696, which probably has a sufficiently deep rooting system to exploit water at depths not reached by maize roots and is sufficiently intermediate to recover after maize matures.
Fungicide treatment apparently gave better yields from mixed cowpea in all years but not from sole crops in 1982 and 1983. Only in 1981 was a serious incidence of scab apparent but leaf spot caused by Septoria vignae was present in all years, especially on Acq 1696. Brown blotch (Colletotrichum capsici) was not important in any year. It may be that fungicide is even more important for cowpea grown under the humid conditions created by the canopy of a companion crop than for the sole crop. However, fungicide treatment is expensive and would probably not be justified at mixed cowpea yield levels. Genetic disease resistance would seem to be a more appropriate long-term goal.
At the yield levels achieved in these trials, sole maize production was very profitable but sole cowpea was not, mainly because of the greater costs associated with spraying, weeding and harvesting. Sprayed maize/cowpea may be a little more costly to grow than sole cowpea but is more profitable, with a gross margin estimated at 7% more than the mean of sole crops.
The above analysis is for the traditional mixed row cropping patterns for cowpea. The 1983 results strongly suggest that alternate row systems give better cowpea yields and they raise the possibility of savings in insecticide cost per hectare.

201 88 - 10/14

Plant protection
Review, proceedings, integrated pest control, landscape structure, plant protection
INRA
Impacts de la structure des paysages agricoles sur la protection des cultures (Impacts of landscape structure on protection of crop).
Les Colloques de l'INRA, No. 36, 1986, 190 pp.; available from: INRA Publications, Route de St Cyr, F-78000 Versailles, France

With a view to integrated pest control, it is most important to acquire better knowledge of the influence of the landscape like hedges, woods, paths and crop rotations on pests.
This publication presents the texts of 16 papers presented at the Colloquium in Poznan. Some of them lead to practical conclusions: e.g. sowing of nematicidal plants, or utilization of resistant cultivars to control nematodes, adjacent cultures of alfalfa or phacelia to protect cabbage.
The primary interest of these papers, though, is to demonstrate how difficult it is to generalize in the field of integrated pest control. For example, if the woody zones are, on the one hand, favorable to insectivorous birds or slow down the dissemination of pathogenic fungus, the proximity of hedges, on the other hand, promotes for example the development of the carrot's fly or the leek moths.
Abstract from Alternatives Agricoles (GEYSER)

202 88 - 10/15

Plant protection
Review, alternative methods, plant protection, biological control, case studies, practical methods
MILAIRE, H.G.
Les méthodes alternatives en protection des cultures: cas des ravageurs phytophages (Alternative methods in plant protection: some cases of phytophagous insects).
Phytoma Défenses des Cultures, N. 390, juillet-août 1987, p.22-24

The author of this article underlines first the importance of adopting alternative methods: increasing resistance of pests and building up "useful fauna". He then describes the methods of biological control (insects, nematodes, pathogens, entomophages) and the biotechnical means of control (attraction and pheromones of insects), always based on precise cases (vegetable crops, olive trees, maize and other crops). The article gives an extensive view on intervention and protection means in practical biological control.
Abstract from Agricultures actualité (GEYSER)



203 88 - 10/16

Plant protection
Tropics, subtropics, guide, sweet potato weevil, IPM, practical approach
TALEKAR, N.S.
How to control sweetpotato weevil: a practical IPM approach.
AVRDC International Cooperator's Guide, 1988, 6 pp., AVRDC, P.O.B. 42, Shanhua, Tainan 741, Taiwan, R.O.C.

Sweet potato weevil, Cylas formicarius F. is the most destructive pest of sweet potato wherever it is cultivated throughout the tropics and subtropics. The insect damages sweet potato roots in the field and in storage. The major damage occurs in the field. Even slightly infested sweet potato roots are usually unfit for human consumption. Therefore, for successful cultivation of sweet potato, an effective control of the weevil in the field is necessary. Because of the concealed mode of life history and damage, this pest is difficult to control by ordinary methods. The Asian Vegetable Research and Development Center (AVRDC) has conducted intensive research on this pest, and has developed a simple and practical control method which is effective and inexpensive. The details of this method are described in this guide:
Practise rotation: From an agronomic and disease prevention point of view, it is a good practice to avoid a cropping pattern of sweet potato after sweet potato. In places where sweet potato is a staple food and must be planted continuously, then make sure that the field is clean after the harvest of the first sweet potato crop. Remove all debris such as small roots and pieces of root and stem. Flooding the field for one to two weeks soon after the harvest causes rotting of the leftover plant materials and makes the field free of weevil. If water is not in short supply, flooding the field is the surest method of destroying the weevil.
Do not plant sweet potato in the vicinity of another sweet potato field where effective control measures are not being practised. Before planting and throughout the season, control the morning glory (Ipomoea spp) in the vicinity of your field. Since these weeds are perennial and have long vines which produce roots at practically every node, it will be most useful if these plants are uprooted along with their vines and roots and burned. Thereafter, it will be easier to control these plants. Once the entire area becomes free of weevil for a few years, these beautiful flowering plants will not pose a serious threat. But until that time, these plants should be thoroughly removed if weevil is to be controlled successfully.
Use weevil-free cuttings to plant new sweet potato. This step is an important one. For this, take cuttings from a sweet potato field where there is no weevil infestation. It is impossible to do this, then dip sweet potato cuttings in a suitable insecticide solution diluted in water to give a concentration of 0.01 to 0.05% active ingredient. Insecticides should have adequate (about 100 ppm) solubility in water. Most organophosphorus and carbamate insecticides are suitable for this purpose.

Banking: Due to drought stress or enlarging of the roots, the soil may crack around the main stem. These cracks facilitate entry of weevil to lay eggs in roots. Survey the field for land cracks during the period from one month after transplanting until a week before harvest. Filling cracks with soil will deny the weevil access to roots and prevent weevil damage.
Sex pheromone: Recently scientists in the United States Department of Agriculture (USDA) have discovered a sex pheromone chemical that attracts male weevils. AVRDC tested this chemical in large-scale trials and developed a simple, relatively inexpensive trap to capture the male weevils. After initial use of this trap, one may be able to modify the trap design and construct one from locally available inexpensive material. The sex pheromone is coated on a rubber septum and is placed in the trap. The trap should be placed in the sweet potato field in such a manner that the septum is always 10-20 cm above the plant canopy. The traps are placed 10-15 m apart in the field. Keep the water container always filled with water to trap the weevil continuously. Start placing the traps in the field as soon after planting as possible. This will help reduce the weevil population from the field and the surroundings before sweet potato starts producing roots. One septum coated with 50 micrograms of pheromone is enough for a 100-200 $m^2$ area for one cropping season. To get better control, move the traps from place to place but try to maintain 10-15 m distance between any two traps. If there are not enough traps, initially place the traps near the border against the usual wind direction. The wind passing over the traps will attract males from some distance. Move the traps every two days along the border, always against the wind direction.
Note that this sex pheromone is specific to Cylas formicarius and may not work on Cylas puncticollis and Cylas brunneus, which are prevalent in Africa.
AVRDC has been able to get the sex pheromone synthesized and will supply five pheromone-coated septa to any researcher or extension worker who is interested in trying this method of weevil control.
If all farmers rigorously follow the above control measures, it is possible to eradicate the weevil in 5-6 years. Denying weevil access to the Ipomoea plant is the key to successful eradication. In this connection, it is absolutely necessary to ensure that all Ipomoea weeds are removed from the cultivated and surrounding areas, that weevil-free cuttings are used, and that no sweet potato roots or cuttings from other areas are allowed into the area during the experimental and subsequent period.



204 88 - 10/17

Plant protection
Africa, Kenya, plant protection, cropping systems, mixed cropping, sorghum, maize, Vigna, pests, weeds, diseases
DISSEMOND, A.
Der Einfluß von Mischkulturen aus Sorghum, Mais und Vigna auf den Befall durch Schädlinge, Krankheiten und Unkräuter in Kenya.
(The influence of mixed cropping with sorghum, maize and Vigna on pests, diseases and weeds in Kenya).
Diss., University of Bonn, FRG, 1987, 196 pp.

Field experiments with pure crops and intercrops of sorghum, maize and cowpea were carried out from 1983-1985 at Mbita Point Field Station of the International Centre of Insect Physiology and Ecology and surrounding farmers' fields.
The incidence of pests, diseases and weeds as well as the growth of the crops were recorded and microclimatic reords supported the results. The climate of the study area is semiarid. The results were as follows:

- Antherigona soccata (sorghum shootfly): The level of infestation ranged from 3% to 46% plants with damage symptoms, depending on the cropping season. The infestation increased as long as new shoots were produced by the young plants.
- In all seasons, the stem borers (Chilo partellus with 66.7%, Busseola fusca with 13.9%, Eldana saccharina with 18.8% and Sesamia calamistis with 0.6% of the whole complex) damaged the plants considerably; 18% of the sorghum plants showed leaf damage symptoms, 1.4 larvae/stem were found by the end of the season, and 47.7% of the heads were attacked; the corresponding figures for maize were 14%, 1.7 and 70.8%. Differences in attack between the seasons, between the assessment dates within the seasons, and between the different cropping patterns occurred frequently. The ratings of infestation for cereal/legume intercrops were mostly lower than those of cereal intercrops or pure crops, although the differences were rarely significant as a result of the high variability.
- The most important cowpea pests were thrips (Megalurothrips sjostedti and Hydatothrips adofifriederici). They reached population levels of 130-860 adults/100 buds. Within a season, the number of adults thrips caught in buds increased quickly from the first to the last observation date. Infestation in the cowpea pure crop (2950 adults/100 buds) was markedly higher than that in the sorghum/cowpea/maize intercrop (1701 adults/100 buds) by the end of the season.
- The infestation by aphids (Aphis craccivora) - 23 aphids/100 buds - was generally lower than that by thrips. The infestation was irregular but the spread seemed to be slowed down by intercrops. Nevertheless, the cowpea pure crop, which initially had a higher level of infestation, showed the lowest level by the end of the flowering period.
- Leafhoppers (Empoasca sp.) gained considerable importance only during the shorts rains 1984/85, when they destroyed the cowpea crops completely. The counts increased from 35 to 158 leafhop-

pers/10 plants. The cowpea pure crop (78 leafhoppers/10 plants) clearly showed more attack than the intercrops (62 and 55 leafhoppers/10 plants).

- The cowpea pods and buds were regularly attacked by the pod borer (Maruca testulalis). Therefore, the plants were damaged at an early stage. An average of 16 larvae/100 buds were found, and about 30-45% of pods had boreholes, but the differences between the cropping patterns were not statistically significant.
- Sorghum rust (Puccinia purpurea) and maize rust (P. sorghi): the first pustules appeared about 50 days after emergence (DAE). The level of attack remained low and only in extreme cases reached more than 15% attacked leaf area. Generally, the sorghum/maize intercrop (rating 3.18) was less heavily infested than the sorghum/cowpea intercrop (rating 3.80). The rust on maize was low (rating 1.40) and even decreased during the vegetation period. Plant growth was obviously able to compensate for the attack.
- Leaf spots on sorghum and maize were caused by several pathogens which could not be identified. Normally, they did not gain much importance.
- Maize streak virus appeared more seriously during the long rains of 1984 and infected more than 12% of the maize plants.
- The mean plot area covered by weeds was almost 20% and the fresh weight of the weeds averaged at 311 $g/m^2$. The dicotyledons which covered 14% of the area were more important than the monocotyledons with 5% covered area. The most important weed was Commelina benghalensis. The cropping patterns with cereals and legume (12% and 228 $g/m^2$) generally showed a slightly lower weed infestation than the pure crops (15-25% and 275-535 $g/m^2$).
- The germination rate of the seed was 93%. The emergence varied between the seasons and thus the planned plant density could not be established. The grain yields differed considerably depending on the environmental conditions. Sorghum (21.9. dt/ha) and maize (22.3. dt/ha) gave similar yields but the cowpeas yielded only 322 kg/ha. In some of the seasons, differences between the cropping patterns could be found; in this case, the pure crops gave higher absolute yields. By using the land equivalent ratio (LER) the absolute yields were expressed on a relative and, thus, comparable basis. The intercrops with cowpea clearly outyielded the cereal crops by 30% in terms of LER. Head and cob weight, 1000-seed weight, cob length and number of seeds per cob were recorded but, apart from distinct differences between the seasons, no differences between the cropping patterns could be found.
- The daily and seasonal course of the air temperature showed slight but significant differences between the cropping patterns sorghum/cowpea. Means and minimum and maximum values, however, did not differ. Clearer variations between the cropping patterns in soil temperature were found: the highest were recorded in the upper soil layers.
- The relative humidity also showed marked differences between the cropping patterns. On average, it was 5%-10% higher in the sorghum/cowpea intercrop than in the sorghum pure crop. Also the daily leaf wetness periods were about an hour longer in sorghum/cowpea than in sorghum pure crop.



- The crop with cowpea shaded the ground generally better than the cereals alone.

205 88 - 10/18

Plant protection
Book review, integrated pest management, ecological theory, host-plant resistance, biological control, economics
KOGAN, M.
Ecological theory and integrated pest management practice.
Wiley, Chichester, UK, 1986, 362 pp.

Books on integrated pest management (IPM) are mainly American; this is no exception. Based on recent symposium presentations by 12 leading ecologists, it attempts to bridge the gap between ecological theory and the practice of IPM. The need for an ecological approach sets the scene, followed by three chapters on theory relevant to understanding pest outbreaks. Trivial movement is emphasized with the use of partial differential equations as a framework in exploring these movements in agroecosystems. Five chapters include such areas as the mechanisms of host-plant resistance assisting valid theory useful in practice; the dynamics of host-pathogen associations; biological control and the interaction among insect pests and plant pathogens; cultural control and the need for basic research in plant-herbivore interaction. Ecological analysis of the effects of pesticides and their use as important components of IPM is followed by agroecology and the economics of pest losses. Finally, the structure, analysis and modelling of agroecosystems is discussed. There are stimulating current reviews, although some require adequate mathematical background of the reader; all are well referenced and edited. A text for specialists, but specific chapters are for a wider readership, including students.
Author's summary

206 88 - 10/19

Plant protection
Review, multiple cropping systems, insects, weeds, plant diseases
ALTIERI, M.A. and LIEBMANN, M.
Insect, weed, and plant disease management in multiple cropping systems.
In: Multiple Cropping Systems (ed. C.A. Francis), New York, Macmillan, 1986, pp. 183-218

Multiple cropping systems are agricultural systems diversified in time and space. Much evidence suggests that this crop diversity often results in significant reduction of insect pest problems. A large body of literature cites specific crop mixtures that affect particular insect pests, while other papers explore the ecological mechanisms involved in pest regulation. Much knowledge has been accumulated, and this information is slowly providing a basis for

designing crop systems so that pest problems and need for active control measures are minimized.
Research on the effects of multiple cropping on weeds, pathogens and nematodes has started to emerge, and studies indicate that their populations change in response to diversification of cropping systems. The effects of intensive systems on pests and weeds can be neither generalized nor predicted because of the enormous variety of systems utilized throughout the world. As the temporal and spatial dimensions of vegetational diversity change, so does the magnitude of effects on pest population. For example, strip cropping systems can preferentially act as trap crop or as sources of natural enemies which move from one strip to another. In intercropping systems where crops are more closely intermingled, other mechanisms (e.g. repellency, masking, natural enemy enhancement, physical barriers) may affect insect pests. Moreover, a particular crop mix might be of value in controlling one pest in one area [e.g. Heliothis virescens in corn (Zea mays)/cotton (Gossypium sp.) strip cropping in Peru], while increasing the same pest in other areas (e.g. H.virescens in Tanzania).
Insect herbivore species were found to be less abundant in multiple crops than in monocultures. Predictive trends for weed populations are harder to establish because of the relative lack of quantitative studies. Plant pathogens, in turn, seem to be buffered in multispecies crop associations, especially in systems of high genetic diversity and with high populations of antagonists in the soil.
There are many reviews examining the effects of diversifying agroecosystems on insect pest abundance. This review concentrates on the dynamics of insect, pathogen and weed communities in intercropping systems. The scarce information on effects of multiple cropping on weed abundance and disease incidence is also assembled.
A considerable amount of work has emerged in the last decade, showing that diversification of crop habitats frequently results in reduced pest incidence. The studies have disproportionately focused on insects dynamics, with little attention given to the effects of multiple cropping systems on disease epidemiology and especially weed ecology. Research projects that integrate the simultaneous effects of polycultures on all biotic components of the agroecosystems are sorely lacking. There is every reason to expect an increase of multitrophic-level interactions as the crop systems become richer in plant, insect and microorganism species diversity. Unraveling these complex relationships can lead to pest management systems that integrate cropping practices, weed control measures and soil management to provide effective and harmonious means of disease, weed and insect control.
It is clear that the complex systems affect insect populations by either interference with herbivore movement and colonization or by increased herbivore mortality caused by natural enemies. Whatever mechanisms account for pest reduction, data are of some predictive value. However, generalizations and recommendations are difficult for yet untried systems. It is here where studies of traditional polycultures may be of value in guiding the design of pest resistant cropping systems. Evidence suggests that, in many areas, peasants have kept pest damage within acceptable bounds by employing a wide variety of traditional management practices centered around the use of polycultures. Some mixtures, like the maize/bean/squash of Central America and Mexico or the genetically rich potato fields of the Andes, have persisted for centuries, exhibiting an array of stabilizing properties.



It has been suggested that multiple cropping potentials are restricted to less developed countries where low-input agriculture is practised, because these production systems are capital-restricted, labor-demanding and management-intensive. It is also implied that these systems cannot be efficiently mechanized, limiting their adoption in developed countries. One of the main reasons why cotton/alfalfa strip cropping, which efficiently reduced lygus bugs in California, was not adopted was because of added costs for alfalfa cutting and different water needs of both crops, thus upsetting irrigation schedules. Some agronomists argue that mixed agriculture cannot be implemented within the present structure of US agriculture (large farms with capital-intensive operations). In an area of increasing costs of chemical-based agriculture and accelerating concern about the contamination of the environment, these multiple species systems provide an alternative on farms of all sizes. Further research is needed to explore the application of multiple cropping systems as one component of a management-intensive approach to insect, pathogen and weed control.

207 | 88 - 10/20

Plant protection
Review, manual, Latin America, Colombia, IPM, monitoring system, rice, cultural practices, biological control, damage assessment, economic threshold
CIAT
Manual de manejo integrado de plagos (Integrated pest management manual).
Informe CIAT, 1987, pp. 16-19, CIAT, Apt. Aereo 67-13, Cali, Colombia

Colombia's Instituto Colombiano Agropecuario (CIA), Federación National de Arroceros (FEDEARROZ) and CIAT Rice Program scientists have introduced a two-step pest monitoring system in Colombia. The system can potentially reduce by ten the amount of pesticides growers use and from five applications to less than one per crop. This field-monitoring system on the farm level is part of the Rice Program's general Integrated Pest Management (IPM) approach which includes short-, medium- and long-term control practices. Also involved are changes in cultural practices, breeding tolerant varieties and increasing the use of biological control. The system, with local refinements, is adaptable to other rice-growing regions of Latin America.
There are more than 60 species of insects in Latin America that are potential rice pests. To control them, growers habitually use preventive pest measures, i.e., they apply pesticides without necessarily analysing the need. A CIAT survey of insecticide use

and pest control on rice in Latin America found an average of 3-6 insecticide applications per crop in tropical and Central America and slightly fewer in more temperate areas. In almost all countries, 60-80% of the applications were unjustified by actual damage and were considered `preventive'. This practice increases production costs, contaminates the environment and, because of its impact on the biological control agents, can result in pest outbreaks and pest resurgence rather than pest control. Another consideration: 42% of the most commonly used pesticides are highly toxic and are health risks to humans.
CIAT rice scientists are advocating the replacement of preventive pest control by pest management, which means evaluating pest populations and prescribing control only when pests surpass established economic thresholds.
The CIAT system makes it possible to evaluate pests in the field by using a two-step system of pest monitoring. Two manuals are used: an evaluation book for insect and damage assessment, and a decision book for distinguishing tolerable pest levels from those surpassing economic thresholds and outlining recommended actions against pests.
In the evaluation process the farmer or technician only evaluates the kind of damage done to the crop. This avoids the problem of specifically identifying pests which would severely limit the application of IPM in developing countries. The farmer or technician can also monitor spider levels in the paddy as these provide an excellent indicator of the functioning or disturbance of biological control.
To realize its full potential, the IPM system has to be incorporated into an overall crop management scheme. This requires its use on a regional basis. Once in place, 5-7 field assessments per crop are required. The introduction of IPM is best done through a nationally designed and promoted production plan. In this way, the use of IPM as part of an improved and integrated management program on rice production can result in considerable reduction in production costs, less environmental contamination, and lower health risks for growers and consumers.

208 88 - 10/21

Plant protection
Africa, Nigeria, field trial, split-plot experiment, nematodes, sole cropping, mixed cropping, cropping systems, maize, cowpea
EGUNJOBI, O.A. et al.
Interaction between Pratylenchus sefaensis, Meloidogyne javanica and Rotylenchulus reniformis in sole and mixed crops of maize and cowpea
Revue Nématol., 9, (1), 1986, 61-70

The interaction between Pratylenchus sefaensis Fortuner, Meloidogyne javanica (Treub) Chitwood, and Rotylenchulus reniformis Linford & Oliveira on cowpea and maize grown sole and in association was studied in a split-plot experiment having nematodes as the main plots and cropping system as the subplots.



P. sefaensis levels under mixed cropping were lower than those under maize sole cropping, and M. javanica and R. reniformis levels under mixed cropping were lower than those under cowpea sole cropping. Within cowpea roots, P. sefaensis and R. reniformis population levels were lower under mixed cropping than sole cropping. Within maize roots, R. reniformis population level were higher under the mixed system.
The nematodes in concomitance inhibited one another, especially where the three occurred together. P. sefaensis penetration into the roots of cowpea and maize was inhibited more by M. javanica alone than by M. javanica occurring together with R. reniformis. P. sefaensis enhanced the entry of R. reniformis into cowpea and maize roots. The lowest yields of maize and cowpeas were obtained where P. sefaensis and M. javanica, respectively, occurred alone. Yields of cowpea in treatments that included M. javanica alone or in combination were lower than those in treatments not involving M. javanica. Shoot and root weights and plant heights were lowest for treatments receiving P. sefaensis alone or in combination with the other nematode species.
Author's summary

209 88 - 10/22

Plant protection
Fed. Rep. of Germany, field trials, maize, companion plants, weeds, integrated biological weed control
WERNER, A.
Einfluß von Beipflanzen zwischen den Reihen von Mais auf die Unkrautpopulation und deren Verwendung zur biologischen Unkrautbekämpfung im integrierten Verfahren. (Influence of comparison plants between maize rows on weed population and their use in integrated biological weed control).
Proceedings, EWRS Symposium, Economic Weed Control, 1986, 169-177

On account of the slow initial development or cultivation form of some crop plants, complete ground cover is achieved only late in the development cycle. This leads to well known problems, e.g. in maize, of severe weed pressure, unproductive evaporation, nutrient leaching and soil erosion. In addition, the high selectivity, good effectiveness and low costs of herbicides entice farmers to grow maize in close crop succession or in monoculture. This can lead to the selection of specific problem weeds and even to genuine resistance of some weeds to herbicides. Radical removal of all other plants except the crop plant can result in a reduction of the species spectrum of wilde plants. Furthermore, the high persistence of these herbicides in the soil places a burden on the biological system. Therefore, in the long run, alternative means of weed control must be sought.
Problem weeds or weeds resistant to herbicides can establish themselves, among other reasons, because they lack regulatory competition from other (weed) plants. In 2 years of field trials, the effectiveness of companion cover plants in a maize crop in terms of regulating the weed population was investigated. The

total number of weeds could be reduced by the companion plants. The number of species was also influenced. Grasses as companion plants suppressed weed growth to a greater extent than clover. Reducing the growth of the companion crop at the 2-leaf stage of maize development led to the best results in terms of weed control with the least detriment to the maize. Within the crop sequence the consequences of insufficient weed control were evident even after 2 years, for example, in the case of early-seeding weeds when the suppression of the companion crop was too late.



# XI WATER MANAGEMENT

210 88 - 11/1

Water management
Review, book, dryland, water conservation, soil conservation, erosion, wells, water lifting, surface water storage, organization for action
CHLEQ, J.-L. and DUPRIEZ, H.
Vanishing land and water.
Macmillan Publishers/Terres et Vie, 1988, 117 pp., ISBN 0-333-44597-X; distributor: CTA, P.O.B. 380, 6700 AJ Wageningen, Netherlands

Rains are infrequent in the semiarid regions such as the Sahel and Sudan savanna zones, which stretch across Africa from the west coast to the horn of Africa in the east and which include the Kalahari and Namib areas of southern Africa. The rains last 3-4 months of the year and are often erratic and torrential. Man is powerless to alter the rate of precipitation. Of the other hand, he is not powerless when it comes to holding back, storing and using sparingly the rainwater that falls on his fields, Using methods to trap water and stop the loss of soil around the village, he can ensure water penetration for the benefits of crops, store water for periods of drought, and make sure that fertile clay stays in the settlement.
This book sets out to show how artisan crafts dealing with water supply problems can play an important role in village life in dry lands. Water crafts are direct and indirect sources of revenue. They are a direct source of income for water craft artisans and an indirect source of income for cultivators and pastoralists who benefit from the water resources on their land, thanks to the advice and skills of local artisans.
This book was inspired by village schemes in Sahelian Burkina Faso. They extended over a long period and involved close collaboration between villagers, artisans and technicians. These people worked together to find solutions to the problems of water runoff, and the use and exploitation of water resources. The techniques described are limited. Many other techniques exist and have been described in other publications. But what is striking about the experience of the GARY (Groupement des Artisans Ruraux du Yatenga = Group of Yatenga Rural Artisans) is that the level of practical skills acquired by villagers is quite high.
This book advocates cooperation between all the people concerned. The technical aspects, sometimes described in great detail, are only meaningful if they are accepted as something to be thought about by water technicians and their village partners. In other words, this book is not designed just for technicians. Its whole aim is to spark off useful discussions between the parties concerned. If this exchange is initiated, technical solutions will be found - maybe the solutions put forward here, or maybe others inspired by these solutions.