X PLANT PROTECTION

684 90 - 10/51

Plant protection
Temperate zones, tropics, crop protection, pests, diseases, weeds, IPM, CTA, IITA, FAO, UNDP, WMO, fruit orchards, citrus groves, greenhouse, arable crops

MATHYS, G.

Novel approaches in crop protection.

Proc. of the Seminar on Agrometeorology and Crop Protection in the Lowland Humid and Sub-humid Tropics, Cotonou, Benin; Sponsors UNDP, FAO, CTA; 1987, pp. 29-36

Farming requires a high degree of awareness of numerous inputs such as choice of crop, cultivar, seed rate or planting density, fertilizers, soil husbandry, growing and protection techniques. Crop protection is thus one input which cannot be considered in isolation because of the various inter-dependences between the crop production/protection components in relation to soil and weather.
Under tropical conditions losses due to pests, diseases and weeds exceed often 50%, as demonstrated on millet in North Central Mali. Similar figures were found in Burundi in 1985 on extended maize and sorghum fields.
Farming which is currently practised aims at producing the largest amount of commodities as cheaply as possible, whereby the chemical components (fertilizers and pesticides) play an important role. Over-dependence on chemicals has entailed various undesirable consequences which have become increasingly serious in the last decade:

- pollution of soil, water and air with fertilizers and pesticides;
- residues of fertilizers, heavy metals and pesticides in and on food;
- lower populations of natural enemies of pests and other beneficial organisms;
- harm to wildlife, both flora and fauna;
- development of pesticide resistant pests;
- pest resurgence and development of new pests;
- deterioration of the quality of certain mass-produced foods and commodities;
- increasingly large inputs of fossil fuel energy and other non renewable resources into agriculture.

Over-dependence on chemicals has entailed serious environmental and other problems showing the vulnerability of such a one-sided control strategy. To avert these inconveniences, a better understanding of the various inter-relationships between the abiotic elements and the complex of biotic elements is needed. The integrated pest management (IPM) is based on this fundamental

knowledge and aims at conciling the economic interests of the farmer with sound ecological and toxicological concepts while taking best advantage of naturally occuring elements exerting containment on pests. It is shown how bio-agents have been successfully developed and are currently in use. Various research avenues are discussed including the encouragement of the development of selective, biodegradable compounds, means of delaying or averting the introduction of resistance to pesticides, and improvement of application technology. It is also very important to develop refined forecasting techniques with automated meteorological data recording and due consideration of economic thresholds based on simple population assessment methods.
Practical examples of breakthroughs in IPM are given; they refer to deciduous fruit orchards, citrus groves, greenhouse production and arable crops. In some cases true integrated production systems have been developed.
Progress is slow because of the intricacy of interactions of which advantage has to be taken, but many of the proposed integrated techniques have already been incorporated into present day pest control practices.
Considerable efforts are currently made by the European Community, by American Universities in North and South America, and in Australia.
However, fungal diseases and weed control remains to a considerable extent dependent upon chemicals and failures due to resistance to fungicides. This strategy is meant to safeguard the lifetime of powerful control agents and to grant an economically sound and an environmentally safe plant protection.

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Plant protection
Africa, Niger, Sudan, Burkina Faso, Senegal, Mali, Gambia, pearl millet, IPM, pests, subsistence farming systems, natural enemies, plant resistance, insecticides, traditional practices, cultural methods

GAHUKAR, R.T.

Problems and perspectives of pest management in the Sahel: a case study of pearl millet.

Tropical Pest Management, 34, (1), 1988, pp. 35-38

Pearl or Bulrush millet (*Pennisetum americanum* (L.) Leeke) is widely grown, along with sorghum, covering over 13 million ha in the sub-saharan region of West Africa. This region is characterized by annual rainfall below 500 mm with its unequal distribution during the crop seasons, and droughts are common. Pearl millet is a major food crop. The average yield per ha is about 450 kg, but yields up to 2 tons have been obtained through improvement of local or introduced genotypes, for example, IBV-8001 and IBV-8004 in Senegal.
Generally, drought is a major constraint, but weeds, plant diseases, insects and birds cause considerable damage to the crop. In order to reduce yield losses, pest management studies began in 1980-81 under an Integrated Pest Management Project (FAO/CILSS/USAID) in member countries of the CILSS (Comité Permanent Inter-Etats pour la Lutte contre la Sécheresse dans le Sahel).
The present paper reviews the pest complex of pearl millet and discusses pest management strategies in the context of subsistence farming.
Abstract information is presented on the economic importance, biology and ecology of insect pests attacking pearl millet in the Sudano-sahelian zone of West Africa, stem borers (*Acigona ignefusalis*) and spike worms (*Raghuva albipunctella*) are important. Sporadic pests cause considerable losses during certain seasons.
At present, no control package is available for farmers' use. Farmers are aware of only few pests and use mainly traditional practices in outbreaks; information on the costs and benefits of these practices has not been worked out.
Current strategies for control of pests of pearl millet in Sahel are:

- Hairy caterpillars	Hand picking and burning of larvae.
- Stem borers	Removal and destruction of dead hearts.
- Army worms	Spreading of wood ash on seedlings of late millets.
- Grasshoppers and locusts	Driving away flying grasshoppers/locusts with tree branches. Digging trenches around fields and burying or burning the grasshoppers inside trenches. Broadcasting bran to attract grasshoppers and killing them. Cleaning areas around fields. Spreading ash on leaves.
- Blister beetles	Removal of dry grasses around fields to avoid hiding beetles. Hand picking and/or burning of beetles in fields. Placing split green fruits of Baobab (*Adansonia digitata*) on the ground to attract beetles and killing them. To repel beetles by the smoke from burning fruits of Notto (*Parkia biglobosa*), leaves of Wollo (*Terminalia sp.*), grasses, creosote, old tyres, cowdung etc.
- Termites	Use of petrol mixed with powdered Notto fruits. Putting the ash of millet or wild plants near plants. Saltwater spread around silos.
- Seed treatment	Seed soaking in a preparation from the bark of *Balamite aegyptica* or the leaves/roots of *Euphorbia paganorum* in hot water. Seeds are dried and mixed with ash. Seed dressing with powdered cowpea pods, corn stems, leaves of tobacco, or *P. biglobosa*.
- Storage pests	Seeds are mixed with goat dung, ash or powder of neem (*Azadirachta indica*) fruits. Spreading fresh cowdung around silos to attract insects and then killing them.

In some areas, farmers use insecticides supplied free by government departments, and insecticides are sometimes available in the local markets which are used in case of urgency.
In developing IPM for pearl millet in the Sahel, the following difficulties need to be solved in order to apply it on subsistence farms:
- Ploughing: Deep ploughing after harvest or before planting next year's crop reduces the population of diapausing pupae of spike worms, but can result in soil erosion and destruction of grazing areas.
- Planting period: Delayed planting of short-medium cycle millets could reduce the coincidence of peak moth flight and millet heading. The erratic rains in the Sahelian zone do not allow this practice.
- Fertilization: Application of fertilizer and manure to millet favours plant development and results in healthy spikes if cultural practices are properly followed. These crops are less attacked by spike worms but more attacked by stem borers. Farmers apply cowdung in fields close to their houses but fertilizer application is difficult to recommend due to the cost involved.
- Crop sanitation: Destruction and burning of crop residues after the harvest may not be possible in the present situation since the stems are used for fencing and roofing and used for animal bedding.

- Intercropping: The borer infestation was not affected when millet was intercropped with sorghum , but the association of millet with grain legumes should be studied from the point of view of pest attack.
- Sun drying: There is higher infestation of storage pests in general during the rainy season, when sun-drying is impossible.

Surveys have revealed the presence of certain natural enemies.
In case of stem borers, parasitism might be useful but only 10% larvae are killed. Surveys are necessary to identify indigenous natural enemies of the millet stem borer.
Various chemicals and *Bacillus thuringiensis* were tested against spike worms but they failed to increase grain yields.
In the present situation, chemical control appears impractical and costly, and alternative measures need to be considered. Partial burning of green stems for use in fencing and roofing, destruction of crop residues before the rains, planting of resistant varieties intercropped with grain legumes is recommended for stem borer control. Midge populations may be limited by destruction of infested spikes, avoiding delayed planting and by encouraging larval/pupal parasites. Traditional methods applied on varieties with bristles is suggested for the control of blister beetles. Insecticide applications should be used to control sporadic attacks and epidemics of pests. However, the economic injury level should be determined in relation to the grain price, farmer's preferences, the scarcity of food, purchasing power etc.
A combination of efficient pest forecasting and monitoring with IPM should help the Sahelian farmer to reduce yield losses in pearl millet and increase the crop production.
Author's Abstract, extended

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Plant protection
Asia, India, sugarcane, smut, intercropping

MISRA, S.R. et al.

Effect of intercrops on dispersal of smut (*Ustilago scitaminea*) spores in sugarcane field.

Ind. Journal of Agric. Sc., 59, (2), 1989, pp. 114-117

Since sugarcane is planted in rows 90 cm apart, there is sufficient space for raising another short duration crop between 2 rows of sugarcane. A number of such intercrops are being grown successfully both in autumn- and spring-planted sugarcane. These intercrops grow faster than sugarcane and may interrupt free movement of air loaded with spores of sugarcane smut incited by *Ustilago scitaminea* Syd. within the sugarcane crop. Since information on this aspect is lacking, a field experiment was conducted to determine the role of intercrops as well as a smut-resistant sugarcane variety in arresting the dispersal of smut spores from the focus of infection to adjacent healthy rows of sugarcane.
The effect of raising a resistant variety of sugarcane or non-host crop in between healthy and diseased rows of a susceptible variety on dispersal of teliospores of the smut fungus, *Ustilago scitaminea* Syd., in a sugarcane field was studied.
The field experiment was carried out in randomized block design.
Dissemination of the teliospores was interrupted when the resistant variety 'Co 1148' or the intercrops such as bread wheat (*Triticum aestivum* Linn. emend. Fiori & Paol.), Indian mustard [*Brassica juncea* (Linn.) Czern & Coss. Subsp. *juncea* Linn.] and coriander (*Coriandrum sativum* Linn.) in the autumn season, and maize (*Zea mays* Linn.), sorghum [*Sorghum bicolor* (Linn.) Moench] and pigeonpea [*Cajanus cajan* (Linn.) Millsp.] in the spring season were grown in between diseased and healthy rows of 'Co 1158' sugarcane. Secondary infection of smut was minimum when 'Co 1148' was grown between diseased and healthy rows of 'Co 1158' in both planting seasons. Among the intercrops Indian mustard was most effective in arresting the spread of smut spores from the source of inoculum to adjoining healthy rows of sugarcane.

687 90 - 10/54

Plant protection
Book, review, pesticide use, natural selection, environment, resistance, forecasting, pest management

BRENT, K.J. and ATKIN, R.K.

Rational pesticide use.

Cambridge University Press, 1987, 348 pp. Price £ 27.50

This book is the official proceedings of the ninth Long Ashton Symposium held in Bristol in 1986. It is a multi-author, hard bound volume printed from camera-ready copy. The typescript is all standardized and the figures, although varied in style, are all of acceptable quality. Every page has a running headline with author and chapter titles which is useful for quick references in a book of this nature.
The contents consist of: Editors' foreword; inaugural (entitled lecture by P.T. Haskell; Section 1 'Environment' (four chapters); Section 2 'Application' (five chapters); Section 3 'Resistance to pesticides' (five chapters); Section 4 'Forecasting and Pest Management' (nine chapters); subject index.
Peter Haskell, in his inaugural lecture, provides a good overview of the subject to introduce the book. By 'natural selection' he means the effects of external pressures upon people involved with pesticide use and their influence upon policies and practice. He presents reasoned arguments for the advantages of integrated pest management - a theme which is re-iterated throughout the book.
The high profile of environmental issues in the public eye is assuaged by the first section of the book in which ecological, toxicological and industry viewpoints are aired. The other three sections are more practically based and include chapters by authors from the agrochemical industry, public sector research and private consultants. In spite of being a multi-author volume and a conference proceedings this book manages to be a well-balanced whole. Crop protectionists have needed these topics to be brought together in one place, and this has been satisfactorily realized. In addition, Section 3 covers pesticide resistance problems and management for insecticides, herbicides and fungicides more thoroughly than has been available before. Another 'plus' is the fact that both developed and developing country agricultural systems are considered.
By the very nature of the conference and its participants the book is academic. The authors question or analyse the rational of existing principles and make recommendations or predictions for the future. "Consequently, Rational Pesticide Use" would be most suitable for researchers, consultants, teachers and students incrop protection. For these groups it can be recommended as a useful reference text and one which is unlikely to be superseded for some years to come.
Abstract by S. Ball, shortened

688 90 - 10/55

Plant protection
Africa, Nigeria, rain forest, cowpea, IPM, weeding regimes, post-flowering insect damage, seed yield

OFUYA, T.I.

Effect of weed removal regimes on post-flowering insect damage and grain yield of cowpea, *Vigna unguiculate* (L.) Walp. in a rain forest area of Nigeria.

Trop. Agric. (Trinidad), 66, 2, 1989, pp. 142-144

This paper reports results of field plantings at Akure, Nigeria, showing the effect of different regimes of weed control on post flowering insect damage and seed yield of cowpea.
The control of the frequently devastating insect pests of cowpea, *Vigna unguiculate* (L.) Walp. in the tropics and subtropics is currently being geared towards developing practical integrated pest management systems. Low levels of resistance combined with carefully timed minimum insecticide applications that will not disrupt the natural enemy balance and appropriate cultural practices would produce practical integrated pest management packages. A useful cultural control input into any such package could be effective weed management. Preliminary observations in Nigeria have shown that weeds in grain legume fields are positively correlated with insect damage. In Nigeria, the cowpea crop is most vulnerable to pest attack during the post-flowering period, when over 70% loss in yield attributable to insects is caused.
The effects of different regimes of weed removal on infestation or damage by four major post-flowering insect pests and grain yield of cowpea, *Vigna unguiculata* (L.) Walp., were determined in field plantings during the early and late seasons of 1986 in Akure, Nigeria. In cowpea plots subjected to two, three or four weedings, percentages of flower infestation by *M. testulalis*, pod damage by hemipterous bugs and seed damage by *C. ptychora* were significantly lower than in non-weeded plots. Seed yield in all weeded plots was significantly higher than in non-weeded plots. Yield in plots weeded once was also significantly lower than in plots weeded twice, thrice or four times.
Two manual weedings, at three and six weeks after planting, may be adequate for optimal yield realization and reduction of post-flowering insect damage in cowpea in this rain forest area of Nigeria.
The recommendation of weed removal for minimum post-flowering insect damage in cowpea must be made with caution. Some pre-flowering insect pests of legumes such as leafhoppers and aphids have been observed to be less abundant in weedy than in weed-free plots. Pre-flowering insect infestation and damage, however, were not recorded in this study. Depending on which pest is of greater importance, the weed management system could easily be manipulated for minimum pest depredation.

689 90 - 10/56

Plant protection
Developing countries, potato, CIP, IPM, insect pests, host plant resistance, sex pheromones, repellent plants, biological control

RAMAN, K.V.

Integrated insect pest management for potatoes in developing countries.

CIP-Circular, 16, 1, ISSN 0256-8632, 1988, pp. 1-8

Insect pests are among the most variable and complex problems facing potato farmers in developing countries. The use of chemical insecticides is increasing rapidly, particularly where production methods are being intensified in increased market output, and where the crop is expanding into new agroecological zones.
Over-reliance on the use of chemicals has resulted in the development of insect resistance and pest resurgences, and the emergence of secondary pests as natural control mechanisms are disrupted. There are also economic problems for individual farm families or cooperatives who are led onto an "insecticide treadmill" of escalating costs of pest control.
In many developing countries, the control of insect pests of potatoes has been based on a fixed pattern scheme without paying attention to insect presence and numbers.
For example, in Brazil, almost 50 kg of insecticide (active ingredient) is being used for seed potato production during one single season. In Colombia, more than US $ 22 million is spent annually on insecticides for control of Andean potato weevil.
In Peru, in the Cañete Valley on the coast, the leafminer fly, *Liriomyza huidobrensis* (Blanchard), has emerged as a major pest over the past ten years as a result of overuse of insecticides, which have destroyed its natural enemies. This pest has now developed resistance to all classes of insecticides, and its population builds up very rapidly. In an attempt to control leafminer fly and avoid devastating losses, farmers have become trapped in classic example of the pesticide treadmill.
The interdisciplinary research team on integrated pest management (IPM) at CIP is developing new technologies to be used in flexible combinations with the least possible application of pesticides. These include the identification and use of host plant resistance, biological control, use of insect-repellent plants, sex pheromones, and the manipulation of crop environment with cultural practices.
Such systems must be compatible with specific farming and storage needs and should provide alternatives to the present overreliance on chemical insecticides.

690 90 - 10/57

Plant protection
Latin America, Brazil, Colombia, cassava, hornworm, biological control

CIAT

Control biológico al gusano cachón de la yuca. (Biological control halts cassava hornworm).

CIAT Report, 1987, pp. 34-36

The cassava hornworm is a major cassava pest in southern Brazil causing losses as high as 50% of the crop. The chief means of control has been insecticides, but this is costly, especially for the country's small farmers. Scientists now believe that the pest can be controlled by efficiently using natural enemies of the hornworm in an integrated pest control program. A new method of biological control, using a virus found in the hornworm's larvae, may totally replace chemical methods. The practice is producing excellent results in hornworm-infested areas of Brazil. The virus, when applied to the crop, kills 90%-100% of the hornworms.
The hornworm virus, *Baculovirus erinnyis*, naturally infests cassava hornworm larvae in Brazil, especially in the Santa Catarina area. Treatment against the hornworm initially entailed collecting its infected hornworm larvae, liquefying them in a blender, then combining the homogeneous mixture with water, and spraying it on the cassava crop. Recently, researchers have found that infected larvae can also be frozen and stored for a period of time. Furthermore, they can be put through a process of liquefaction, separation, filtration, centrifugation, and vacuum-drying, and turned into powder.
A field experiment was conducted in Colombia to evaluate three forms of virus preparations: two-year-old powdered virus, infected hornworm larvae frozen for four years, and recently collected infected hornworms.
It was found that the recently collected infected larvae were best for hornworm control. There was 100% mortality within 7 days after application. The virus from 4-year frozen hornworm larvae produced 67% mortality, which indicates that the virus can be stored in infected hornworms for a considerable period.
The powdered form of the virus resulted only in a 20% mortality which possibly was due to the low concentration used.
Frozen virus is now available on a semicommercial basis in Brazil. The method of use has been described in pamphlets, newspapers, and audiotutorial units, and has been broadcast on TV and radio programs in some areas of Brazil. Farmers are shown how to collect, prepare, store, and apply the infected hornworm larvae. Today the hornworm virus is being used effectively in many areas of Brazil as a safe and cost-efficient means of pest control.

691 90 - 10/58

Plant protection
Africa, review, IITA, cassava green mite, control methods, biological control

YANINEK, J.S. and H.R. HERREN

Introduction and spread of the cassava green mite, *Mononychellus tanajoa* (Bondar) (*Acari: Tetranychidae*), an exotic pest in Africa and the search for appropriate control methods: a review.

Bull. ent. Res., 78, 1988, pp. 1-13

In the early 1970s, a species of spider mite not seen previously in Africa was discovered attacking cassava in Uganda. The mite was identified as the cassava green mite, *Mononychellus tanajoa* (Bondar). The mite has since spread throughout the African cassava belt and now threatens a crop that is frequently grown in marginal soils and is often the last crop available for harvest during severe droughts.
This exotic mite of neotropical origin has spread to 27 countries, causing an estimated 13-80% reduction in cassava yield. The history of its introduction and spread in Africa is reported, and present knowledge on the taxonomy, biology, ecology and pest status of the mite, and the evolution of strategies to control it are reviewed. While attempts have been made to control *M. tanajoa*, it remains a serious pest in most areas. The prospects for classical biological control as an appropriate control strategy are discussed.
Early research on *M. tanajoa* concentrated on modifying agronomic practices to reduce mite losses. Many resulting recommendations are useful, but they are not widely practiced because they are often difficult to implement. Resistance breeding is more recent and is likely to require many years to select or screen for agronomically attractive and acceptable cultivars. Since host-plant immunity to *M. tanajoa* is not known, breeding and screening research should be integrated with other appropriate control measures for maximum impact.
Theoretically, biological control has great promise as a control strategy for introduced mite pests, even though the experience in field crops, especially in the tropics, is limited. It can provide relatively rapid control and persist in a stable and permanent manner once successfully established. Biological control would be especially appropriate for pests of cassava because it requires neither special knowledge nor economic input by growers. The speed and degree of success that can be expected from such an approach depends on many factors, including the background information available on the pest and its natural enemies at the start of a control campaign.
Concluding the data on *M. tanajoa* are at present rudimentary and largely incomplete. This suggests a control campaign will be lengthy unless a deliberate and focused effort is made to generate the necessary biological information. An ecologically and economically sound biological control campaign requires the

integration of expertise from many disciplines such as systematics, crop physiology, mite behaviour, field ecology, economics and simulation modelling. The aim of such a multi-disciplinary approach is to learn more about the process of biological control as an important component of an integrated approach to reduce cassava losses due to *M. tanajoa* in Africa.

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90 - 10/59

Plant protection
Latin America, Mexico, Costa Rica, field experiments, laboratory experiment, weed management, plant parasitic nematodes, allelopathy

ROSADO, F.J. and GLIESSMAN, S.R.

Weed management as an alternative for controlling plant parasitic nematodes.

In: Proc. of the 6th Conf. of IFOAM, California, USA, 1988, pp. 515-523

Weed and nematode control is primarily accomplished by chemical means. However, this strategy has led to serious economical and ecological problems.
Herbicides are among the most heavily used chemicals, and many nematocides are considered to be persistent in the environment and harmful to humans.
The ecological role of naturally occuring allelopathic plants (mainly annuals) as they affect populations of soil microorganisms through the release of secondary compounds has received little attention. Yet this approach can lead to a significant reduction in the use of pesticides and does not involve the problems of introducing new species into environments for which they are not adapted.
In a field experiment carried out in Tabasco, Mexico (lowland humid tropics), the authors tested the effect of *Bidens pilosa* on the productivity of corn and the population of nematodes.
Several weeding treatments were established in a corn crop, including the traditional practice in the area.
There were no significant differences in the percentages of fungi incidence. A strong significant correlation was found between the population of nematodes and the dominance of *B. pilosa*. Nematodes did not negatively affect corn yield but *B. pilosa* did. This suggests that higher dry weight of *B. pilosa* leads to fewer numbers of nematodes, but also to lower yields. Soil fertility was also tested before planting and after harvesting the corn, but there were no differences between treatments, suggesting that the weed was not causing corn yield reductions through nutrient competition.
In a laboratory experiment carried out in San Vito, Costa Rica, nematodes were extracted from a soil in which the organic matter had been removed and beans planted. Aqueous extracts from leaves, roots, and the whole plant of *B. pilosa* were made using distilled water in a three-hour soak. The concentration used was 1 g fresh weight of *B. pilosa* in 10 ml of water (10%). Nematodes were then transferred into the extract in a 50 x 9 mm Petri dish. The behavior of the nematodes was recorded each hour for a five-hour period in the control (water only) and the three treatments.
All treatments negatively affected the movement of all seven genera of nematodes examined; extracts from leaves appeared to be stronger than those from other parts of the plant. After five hours in the extracts, all nematodes stopped movement completely. They were then

transferred back into distilled water; after two hours in water, all of them recuperated normal movement.
Bidens pilosa is considered one of the world's worst weeds and is known to have allelopathic properties.
Results described in this paper indicate that secondary compounds from *B. pilosa*, cause nematodes to stop all movement. The compounds seem to enter the soil when the weed is cut and left on the soil surface (i.e., not incorporated into the soil); rain leaches out the compounds, and in the presence of sunlight the compounds become phototoxic and then enter the soil. Root exudates and leachates from living plants can also be the source of the allelochemicals. The reduction of nematode populations could be explained with acetylcholinesterase activity in the nervous system of the nematodes. The compounds could also stimulate the activity of natural predators of nematodes.

693 90 - 10/60

Plant protection
USA, California, field trials, collards, hyperparasitism, parasitoid, tillage, weed management

HORN, D.

Parasitism of cabbage aphid and green peach aphid (Homoptera: Aphididae) on collards in relation to weed management.

Environmental Entomology, 17, 2, 1988, pp. 355-358

In general, weeds interspersed among crop plants seem to reduce colonization of the crop by phytophagous insect specialists while harboring higher densities of their natural enemies. The distinctive entomofauna of *Brassica* spp. is useful for investigating the impact of vegetational manipulation on the relative abundance of herbivores and their predators.
In North America, the dominant *Brassica*-infesting aphids are the cabbage aphid (CA), *Brevicoryne brassicae* (L.), a specialist feeding exclusively on Cruciferae, and the green peach aphid (GPA), *Myzus persicae* (Sulzer), subsisting on over 300 host plant species representing a broad variety of families. When collards are planted into either tilled soil or against a background of weeds, the collards among weeds develop lower intensities of CA and GPA.
In Davis, Calif., cabbage aphids, *Brevicoryne brassicae* (L.) and green peach aphids, *Myzus persicae* (Sulzer), were sampled from collards planted October 1982 and March 1983 in replicated plots (3 b 7 m) where weeds were subjected to one of three treatments-mowed, tilled, or unmanaged. In the October planting, collards and weeds began growth simultaneously, and weeds had no apparent impact on collard growth or on colonization by either aphid species. Parasitism of aphids by *Diaeretiella rapae* (McIntosh) was significantly higher in plots containing unmanaged weeds only once (6 December), and during early November secondary parasitism, mostly by *Alloxysta fuscicornis* (Hartig), was greater in tilled and mowed plots (18-38%) than where weeds were unmanaged (0-5%). In the March planting, collards were planted among preexisting weeds; collard growth among weeds was retarded as was the development of aphid populations. Primary parasitism was negligible (as were aphids) in unmanaged weedy plots and greater in mowed (7.2%) than in tilled plots (3.6%). The overall impact of parasitism on aphid populations was minimal. Secondary parasitism (again mostly by *A. fuscicornis*) averaged 40.8% in tilled, 7.5% in mowed, and none in weedy plots.
Patterns of aphid colonization and subsequent parasitism probably represent complex responses of insects to plant size, plant spacing, and physical and chemical contrast with the surrounding environment. Larger plants supported higher aphid populations, and both D. rapae and secondary parasitoids may concentrate their activity on larger plants as well. Additional research is needed on whether the small-plot relationships are consistent with those seen in treatments covering a larger area.

694 90 - 10/61

Plant protection
Central America, Costa Rica, field trial, beans, tomatoes, agroecosystem, insect herbivores, plant community diversity

POWER, A.G. et al.

Population response of bean insect herbivores to inter- and intraspecific plant community diversity: Experiments in a tomato and bean agroecosystem in Costa Rica.

Turrialba, 37, 3, 1987, pp. 219-226

It has long been of concern to entomologists studying the effects of cropping systems on pest populations. While it is clear that plant diversity can play a key role in the determination of insect abundance, its effects are not always predictable. The majority of these studies have indicated that increased plant diversity lowers key pest populations; however, a significant number have shown the reverse.
In this study the effects of plant community diversity on populations of *Auchenorrhyncha* (Homoptera) attacking common bean (*Phaseolus vulgaris* L.) in Costa Rica were examined. Insect populations in bean monoculture, mixtures of two varieties of beans, and polycultures of beans and tomato (*Lycopersicon esculentum* M.) were monitored. Both interspecific and intraspecific diversity were manipulated, since species will tend to differ in size, shape and odor, while varieties may have more subtle differences such as nutrient content. Spatial array in the interspecific polycultures were also manipulated in order to help narrow down the components involved in insect response. In general, it was attempted to determine the composition of the Auchenorryncha community on beans to examine the population response of this community to plant diversity, and to identify important components of this interaction for further research. *Auchenorryncha* were the most common herbivores, constituting between 45.4% and 78.3% of the collected individuals over the course of the season. Increased interspecific diversity positively affected overall auchenorrynchous insect numbers. *Empoasca kraemeri* Ross and Moore (Homoptera: *Cicadellidae*) was primarily responsible for this trend. However, *Hortensia similis* Walker (Homoptera: *Cicadellidae*), the second most common species, had the opposite response to interspecific diversity. Increased intraspecific diversity (varietal mixture vs. single varieties) did not affect numbers of *Auchenorryncha* at the level of entire plots. Still, there was a significant differential distribution within the varietal mixture plots, demonstrating the importance of local rather than long-range orientation. Various mechanisms responsible for, and the implications of, these results are discussed.
It is clear from the results of this study that the effects of plant diversity on insect abundance depend on the particular

behavioral response of an insect to the range of chemical, spatial, and structural changes that accompany increased diversity. It is also apparent that insects have species-specific responses to these variables. Thus, in the design of cropping systems, each pest behavior must be studied. Beyond this, the behavioral response must be examined on at least two levels, inter-patch and within-patch. The percentage of bare ground in the patch appears to be an important determinant of the colonization behavior of *E. kraemeri*, whereas for *H. similis* the disruptive effect of nonhost plants on within-plot movement may determine abundance. Insect preference at the intra-specific level appears to occur as relatively fine discrimination between food items within a patch.

695 90 - 10/62

Plant protection
USA, Michigan, Chinese cabbage, field trials, agronomic practices, population density, planting date, bacterial soft rot

FRITZ, V.A. and S. HONMA

The effect of raised beds, population densities, and planting date on the incidence of bacterial soft rot in Chinese cabbage.

J. Am. Soc. Hort. Sci., 112, (1), 1987, pp. 41-44

Bacterial soft rot (*Erwinia carotovora* spp. *carotovora*) is a soil-borne bacterium that multiplies in the rhizosphere of Chinese cabbage (*Brassica campestris* Group *pekinensis*) and other vegetables and weeds as it feeds on plant root leachates. The bacteria can be introduced into uninfected fields by insect vectors and enter the petioles in the phylosphere via insect wounds or natural openings. The region of the phyllosphere, which is most commonly colonized, is the abaxial surface of the older petioles near the point of attachment to the main stem, which is in contact with the soil surface. Once inside the leaf, the disease-producing pathogen progresses basipetally, usually rotting-out the main stem. Plants can become completely rotted in as little as 3 days.
Environmental parameters that affect the susceptibility of Chinese cabbage to bacterial soft rot are host plant stage of development, air temperature, and relative humidity in the immediate phyllosphere.
The approach to control the disease is mainly preventive by breeding for resistance. Copper compounds and antibiotics also have been used in the control strategy; however, Cu had marginal effects on the pathogen, and antibiotics are cost-prohibitive. Early experimentation has suggested that endogenous Ca concentrations may have an inhibitory effect on the incidence and progression of the disease in potatoes.
The objective of this study was to determine the effects of planting date, use of raised-bed culture, and population densities on the incidence and progression of bacterial soft rot. Several cultivars tropical in origin also were evaluated for their tolerance to high air temperatures and degree of resistance to soft rot.
Raised beds were, in some instances, beneficial in reducing the incidence and progression of soft rot. Phyllosphere air temperatures on raised beds were slightly lower than on flat culture; however, the effect on reducing soft rot incidence is unclear. Plants grown at 30-cm within-row spacing produced fewer marketable heads than plants at 46, 61, or 76 cm. Plants from seed sown after mid June had a significantly higher incidence of soft rot when compared to earlier planting dates.
Most of the tropical cultivars evaluated for summer production bolted; however, 'Tropical Pride' and 'Asveg No. 1' performed well.

696 90 - 10/63

Plant protection
Asia, Philippines, experiment, IRRI, rice, weed seeds, seedling nursery, transplanting, weed seedlings

RAO, A.N. and MOODY, K.

Dissemination of weeds with rice seedlings.

Trop. Pest Management, 34, (3), 1988, pp. 288-290

The predominant mechanisms for the dissemination of weed seed are wind, water, animals, and the action of man through tillage practices and passive transportation with crop seed and implements. Because grasses such as *Echinochloa* spp. cannot be easily distinguished from rice seedlings during the early growth stage, they are often transplanted into the field with the rice seedlings. In this report, the observations on the movement of weed seedlings, shoots of perennial weeds, and weed seeds with rice seedlings from rice seedling nurseries to the field in Guimba, Nueva Ecija, Philiipines, are presented.
Possible ways of reducing dissemination of weeds with rice seedlings are to:
- Use weed-free seed.
- Use the dapog method of raising seedlings. In this method pregerminated seeds are sown on banana leaves or plastic sheets which cover the soil or a concrete area: the only source of weed seed contamination is in the sown seed, provided water that is free of weed seeds is used for irrigation.
- Prepare the seedling nursery more thoroughly to reduce weed seed reserves in the soil.
- Control weeds in the seedling nurseries by either hand weeding or the use of herbicides.
- Separate weed seedlings from the crop seedlings either while pulling the seedlings or before transplanting. This would probably be very laborious and, therefore, uneconomic.
- Maintain standing water in the seedling nurseries during the pulling of seedlings so that the roots can be cleaned thoroughly before transplanting.
- Grow a crop in the seedling nursery area after the seedlings have been removed and keep it as free of weeds as possible during crop growth if this is not being done already.
- Shift the seedling nursery each season to areas of the field that have been kept relatively weed free during crop growth.

Studies are in progress to develop practical solutions to the problem.

697 90 - 10/64

Plant protection
Africa, Savanna, experiments, Cowpeas, host-plant resistance, insect pests

IITA

Host-plant resistance of cowpeas to post-flowering insect pests.

IITA Ann. Report and Research Highlights, 1987,/88, Ibadan, Nigeria, ISSN 03311-4340, 1988, pp. 70-75

Several insect pests have co-evolved with the cowpea plant - natural to the savanna region of West and Central Africa - and they constitute a formidable obstacle in the realization of its yield potential, unless protected with insecticides.
Major field pests of cowpeas can be found in most of the crops' production range in Africa and four of them - aphids, flower thrips, the pod borer (MPB) and pod sucking bugs (PSBs) - are usually more widely encountered. Considered together, these pests can cause up to 100% yield loss. The post-flowering pest species (thrips, pod borers, and pod bugs) of the cowpea pest complex cause the greatest yield losses, often ranging between 50 and 85%. The pod borers and pod sucking bugs are two of the most important and difficult insect pests encountered in the development of crop resistant varieties worldwide.
Excellent sources of resistance have been identified for the pre-flowering pests (aphids, leafhoppers) and these have subsequently been incorporated into a wide range of elite cowpea varieties. In addition, moderate-to-low levels of resistance have been identified for the storage beetle (*Callosobruchus maculatus*) and flower thrips while low levels (generally in varieties with poor plant and seed characteristics) are available for the MPB and PSBs.
Most cowpeas on the world market are grown in small holdings by peasant farmers whose meager cash resources impose upon them the need to adopt low input and economical production technologies. In this context, and in view of the persistently damaging role played by insect pests, varietal improvement centered around host-plant resistance appears to hold the greatest hope for cowpea production in the region.
Using bioassays, fresh pod tests have shown that the resistant lines suffer much lower levels of seed damage compared with the susceptible cultivated lines.
IITA has a cowpea germplasm collection of over 10,000 accessions. The lack of success in finding useful levels of resistance to MPB and PSBs notwithstanding, this resource represents tremendous genetic variability - an important asset in host-plant resistance work. The discovery of high levels of resistance in the wild cowpea relatives underscores the co-evolutionary adaption on insect pests alongside cultivated cowpea varieties. This calls for an intensified search for greater and more diversified germplasm sources. The high levels of resistance present in the wild cowpea species have to be transferred to cultivated species so that the

value of this resource can be fully exploited to the advantage of cowpea growers.
Collection und evaluation of new germplasm using the recently developed techniques and efforts to incorporate present levels of resistance in high yielding, disease, and insect resistant varieties (e.g. to aphids, thrips and storage weevil) continues as part of IITA's future research agenda. Also, additional resources have been allocated for the work on genetic engineering to fully exploit the potentially extensive arsenal of pest resistance presently locked up in the wild cowpea and other closely related species.

698 90 - 10/65

Plant protection
Africa, Ivory Coast, field trials, leaf mulches, weed control

BUDELMAN, A.

The performance of the leaf mulches of *Leucaena leucocephala*, *Flemingia macrophylla* and *Gliricidia sepium* in weed control.

Agroforestry Systems, 6, 1988, pp. 137-145

This paper describes the results from two trials comparing the leaf mulches of *Leucaena leucocephala*, *Flemingia macrophylla* and *Gliricidia sepium* for their effectiveness to reduce weed growth.
Of the species in observation *G. sepium* is used by farmers in Western Nigeria in the role as support for yam plants and is found as a planted fallow. In the latter function the tree is known to be effective against invading Speargrass (*Imperata cylindrica*). A further development is the design of integrated cropping systems matching trees and annual crops such as alley-cropping.
All three species are accepted by ruminants as fodder, either in cut-and carry feeding-systems, or as plants suitable for dry season browsing. The latest perspective is to link crop and livestock production in systems centered around the use of multi-purpose trees and shrubs. Such mixed production systems may eventually become part of a strategy to replace shifting cultivation practices.
One of the possible functions of perennials in cultivation systems is to regularly apply the biomass produced as a mulch layer in order to control weed growth. For that purpose the leaf mulch must have a certain persistence. Especially when high rainfall is combined with high temperatures, the decomposition of organic material is accelerated, and, consequently, the effective life of the mulches is shortened.
The length of the period during which a mulch layer yields significantly less weed biomass compared to the control plots is called the 'effective life-span' of the mulch. Of the three mulch materials only that of *F.macrophylla* shows promise in retarding weed development.
In the second trial *F. macrophylla* leaf mulch was applied at rates of 3, 6 and 9 tons dry matter per ha. The effective lifespan of a mulch layer of 3 tons is between 12 and 13 weeks. The treatments 6 and 9 tons have effective life-spans of over 14 weeks.
For moderate quantities (up to 5 tons of dry leaf mulch per ha) the effective life-span is estimated at about a 100 days.The value of mulching in weed control is limited to the control of weed species that multiply by seed. Regrowth originating from roots or stumps from former vegetation is unlikely to be checked by a mulch layer.
The data presented show that the success of mulches in weed control depends at least partly on intrinsic, or material-specific factors, such as its behaviour when drying and the chemical compositon of its dry matter. *Flemingia macrophylla* is an example of a source of material that combines a notable durability with a favourable ratio

between volume and weight. Compared to other sources one needs relatively small quantities to achieve complete soil cover.
It is likely that other factors can be mobilized as well that improve effect and/or durability of mulches. In that respect one can think of material with allelopathic properties, material high in tannin content, or to test plant species with sclerophyllous leaves, such as *Ficus benjamina*, that are tough and resistant to decay during the first stage of decomposition.
The suggestion here is to make an inventory of plant species that have one or more of the properties mentioned and to see whether these species can be integrated to serve in low external input cropping systems.

699 90 - 10/66

Plant protection
Asia, India, study, water hyacinth, biological control, sustainability

JAYANTH, K.P.

Successful biological control of water hyacinth (*Eichhornia crassipes*) by *Neochetina eichhorniae* (Coleoptera: Curculionidae) in Bangalore, India.

Trop. Pest Management, 34, (3), 1988, pp. 263-266

Water hyacinth (*Eichhornia crassipes* (Mart.) Solms. Pontederiaceae), which ranks among the top ten weeds worldwide is considered to be the most serious aquatic weed in India.
This free-floating plant infests more than 200 000 ha of water surface creating a large number of problems, particularly related to the use and management of water resources. In the absence of regulatory mechanisms like natural enemies, which keep the weed under check in its native home, water hyacinth multiplies at such an alarming rate that manual, mechanical and chemical methods have failed to bring it under control.
The present paper describes results of a 3 year field study carried out at Bangalore.
Successful biological control of this weed was achieved in a fully infested tank covering 20 ha at Bangalore. More than 95% of the infestation was cleared within 32 months by releases of *Neochetina eichhorniae* Warner. The insect also spread along a water channel and controlled water hyacinth infesting a nearby tank. Drying up the tank after the insect population had spread throughout and increased to 3-1 adults/plant hastened weed control. Fresh plants emerging after rains were suppressed by the residual population of insects.
The results of this study indicate that with sustained efforts biological control of water hyacinth can be achieved throughout India. Field releases with *N. eichhorniae* and the related *N. bruchi* Hustache are in progress in all the water hyacinth infested tanks in and around Bangalore and the results obtained so far are encouraging. In addition the insects are being despatched to other centres in the country for multiplication and releases in the respective areas. So far 14 centres located in 12 states have been supplied with the insects. Suppression of water hyacinth by *N. eichhorniae* has also been reported in the USA and Sudan.

700 90 - 10/67

Plant protection
Africa, Kenya, insect pest management, survey, sorghum, maize, cowpea, crop borer, intercropping, agronomical practices, plant resistance, biological control farmer, socio-economic conditions

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, 4, 1989, pp. 443-462

Sorghum, maize and cowpea serve as staple food for people 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.
The survey involved interviews with 150 farmers, (75 in each Division. In Kendu Bay 27 were men and 49 women whereas in Oyugis 40 were men and 35 women.) and was based on a questionnaire which comprised six sections. Five sections covered the farmers' background, farming practices, pest problems and their control, socio-economic conditions,and accessibility/willingness of the farmers to participate in the project. The last section included field observations on the insect pests of sorghum, maize and cowpea.
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.
On the basis of the information obtained on above-mentioned aspects, criteria were defined and assigned appropriate weightage for selecting 25 farmers in each Division for on-farm trials. The selected farmers included 12 men and 13 women in Kendu Bay while in Oyugis 13 men and 12 women were selected.
The following measures that need to be taken to counter the limitations and thereby assist the farmers in increasing food production have been recommended:
- Cultural practices like early planting, intercropping of appropriate crop combinations and destruction of crop residues help to suppress borer attack.
- 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.
- 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.

701 90 - 10/68

Plant protection
Latin America, Ecuador, study, castor, maize-pests, pest control, small scale farmers, traditional pest control

EVANS, D.C.

Traditional pest control in Ecuador: effects of castor leaves on Coleoptera pests in corn.

Tropical Pest Management, 35, 1989, 146-149

Corn cultivation in Ecuador's highlands over 2000 m is characterized by risk-averting traditional agricultural practices due to continual frost, drought, hail and other natural disasters. Cash inputs are minimized because only surplus production beyond a family's basic needs can be sold to repay production costs. No pesticides or chemical fertilizers are applied and farmers rely on their own seed varieties which have been locally developed over centuries. Land preparation is with animal traction or by hand, with minimal use of tractors.
Small-scale farmers in northern Ecuador, place leaves of castor beans (*Ricinus communis*) in germinating corn fields to reduce two Coleoptere pest species (*Pseudothinobatis rufinasus* (Kirsch), *Tenebrionidae*, and an unknown genus, subfamily *Naupactini*, (*Curculionidae*).
The objective of this study was to evaluate the effects of castor leaves and to determine if they are toxic to a particular beetle pest (*Pseudothinobatis rufinasus* Kirsch).
In a preference study under laboratory conditions, P. *rufinasus* preferred castor leaves to leaves of corn, cabbage or paper, yet they did not appear to consume the castor. Approximately 80% of the beetles associated with castor leaves for 12 h or more exhibited paralysis. In the laboratory, castor leaves were not directly lethal to *P. rufinasus*. Similar levels of mortally occured when beetles were kept in vials with the test materials for 10 days. In the field, castor leaves were placed between rows of recently planted corn, as local farmers do. Mortality of *P. rufinasus* collected from exposed leaves was compared to *P. rufinasus* mortality from similar leaves protected from the sun by small shelters.
P. rufinasus are highly attracted to castor leaves even though they do not eat them. The leaves are not directly toxic but paralyze or drug the beetles. The actual chemical involved is unknown, but it may be similar to gyplure, the male gypsi moth attractant extracted from ricinoleic acid, the principal ingredient in castor oil.
Farmers in northern Ecuador exploit the natural characteristics of castor leaves to increase beetle mortality in their fields and to protect their corn during its initial six-week vulnerable period. *P. rufinasus*, normally a nocturnal species, becomes paralyzed and unable to hide after a short exposure to the leaves. By the disruption of their normal behaviour, the beetles are exposed to direct sunlight which significantly increases their mortality.

Whether it also results in greater predation of the exposed beetles was not determined.
Although the origins of this control techniques are unknown, virtually all corn farmers in the area now use it. Castor leaf application, while not 100% effective, is the best available alternative because of the low cost compared to chemical pesticides. It illustrates a case in which natural chemicals, from easily renewed local resources, are used to manipulate a pest population by disrupting their behaviour.
Natural chemical, that disrupt or modify insect behaviour, should have an increasingly important role in the manipulation and regulation of pest species.

702 90 -10/69

Plant protection
Latin America, Brazil, field trial, VA-mycorrhiza, integrated plant protection, rubber trees

FELDMANN, F. et al.

Utilization of VA-mycorrhiza as a factor in integrated plant protection.

Agriculture, Ecosystems and Environment, 29, 1989, pp. 131-135

The natural growth area of rubber trees is the tropical rainforest of Brazil in which very poor soils are present. In preliminary studies it was shown that rubber trees form a VA-mycorrhiza under natural growth conditions. The influence of VAM on plant pathogen interactions has been studied for a number of plants but rarely on woody plant species and therefore no conclusive data for trees like *Hevea brasiliensis* are available. Young *Hevea* trees reveal a rhythmical growth pattern, in which leaf flushing occurs. Leaves are produced every 6 to 8 weeks and need about 4 weeks for maturation. Within this phase four developmental stages (A to D) can be distinguished by morphological characteristics. The leaves are showing an expressed leaf age resistance to fungal attack. Stages A and B are generally susceptible to a high number of fungal pathogens, stage C is of intermediate resistance and stage D is not infectible by biotrophic leaf pathogens. In this study the influence of VAM inoculation, additionally to the indigenous VAM populations, plant growth, leaf development and resistance behaviour against *Microcyclus ulei*, the causal agent of the South American Leaf Blight, was evaluated.
VA-mycorrhiza infected rubber trees reveal an increase in resistance against a foliar disease (South American Leaf Blight) caused by the ascomycete *Microcyclus ulei*. The lesion size and the production of spores of the pathogen were significantly lowered in VAM inoculated plants, whereas the number of lesions remained unchanged. This suggests that the resistance response of the plant is significantly influenced by VAM treatment and demonstrates that enhanced resistance is not due to inhibition of penetration or early growing phases of the pathogen but to the modification of late resistance responses.
The data presented here unequivocally show that the VAM-association causes physiological changes relevant to the resistance reactions in the leaves, even when no macroscopic modification of the plant can be seen.
The enhancement of the resistance of the plant along with the reduction of the pathogens spore production, here caused by a VAM-fungus, is an important epidemiological factor for the control of the South American Leaf Blight in rubber plantations of Brazil. The combination of VAM-inoculum with well designed plant management measures, crown budding, mixed cropping and the use of hyperparasites can lead to a complex system of integrated plant protection in Brazilian rubber cultivation.

703 90 - 10/70

Plant protection
Latin America, Colombia, integrated plant protection, intercropping, predator, cassava whitefly

GOLD, C.S. and M.A. ALTIERI

The effects of intercropping and mixed varieties of predators and parasitoids of cassava whiteflies (Hemiptera: Aleyrodidae) in Colombia.

Bull. ent. Res., 79, 1989, pp. 115-121

In this paper, the responses of natural enemies of cassava whiteflies to different cropping systems and their role in bringing about reduced whitefly load in cassava intercropped with cowpea are reported.
In this regard, the effects of different cropping systems on the whitefly predator *Delphastus pusillus* (Le Conte) and on the combined action of the parasitoids *Amitus aleurodinus* Haldeman and *Eretmocerus aleyrodiphaga* (Risbec) are discussed.
The predator D. *pusillus* was low in numbers during the intercrop period and was significantly lower in cassava-cowpea plots than in other treatments for much of the trial. Correlation analysis of predators and prey indicated that the beetles displayed a functional response. *D. pusillus* was abundant for many months but was unable to control whitefly populations. Ratios of whiteflies to predators coupled with information on prey consumption suggest that predators played only a minor role in whitefly population dynamics. Bettle arrival in the field lagged behind that of the whiteflies, and the highest populations of *D. pusillus* were in the final month of the trial, reflecting a lack of synchronicity between predator and prey.
D. pusillus attacks a range of whitefly species, but within the systems employed in this study it can be considered a relative specialist because neither cowpea nor maize provided alternative hosts. *D. pusillus* was never observed on the associated crops, suggesting that they did not provide nectar or pollen to this bettle. However, the presence of cowpea and maize intercrops may have enhanced the activity of this predator. A functional response strongly suggested by beetle distribution in the postintercrop period was not in evidence when intercrops were in the field, and predator: prey ratios were highest in cassava-cowpea systems at this time.
Parasitism of *A. socialis* was a far more important mortality factor than predation. The role of parasitism in this species was even more important on CMC 40, where predator populations were very low, than on MCOL 2257. Rates of combined parasitism of *A. socialis* by *Amitus aleurodinus* and *E. aleyrodiphaga* were equal between treatments. Overall mortality of the pupal stage was also similar across cropping systems. Parasitism of *T. variabilis* was negligible, and for this whitefly D. pusillus was the most important natural enemy.

Inter-cropping cassava with cowpea reduced populations of the cassava whiteflies *Aleurotrachelus socialis* and *T. variabilis*. The effect of the intercrop was residual, with lower populations persisting for six months after cowpea harvest. However, predators were opportunistic, with higher populations correlated with greater numbers of prey in monocultures. Parasitism levels were independent of cropping system. Therefore, the natural enemies hypothesis can be rejected in explaining the lower populations of whiteflies found on intercropped cassava. Furthermore, the residual effect of the cowpea intercrop on whitefly populations cannot be explained by a build-up of natural enemies in this system during the intercrop period.
A. socialis and *T. variabilis* larvae suffered substantial mortality in addition to the effects of predators.
Differences in whitefly populations in various cropping systems, including residual effects, cannot be attributed to mortality factors.
In this regard, the effects of different cropping systems on the whitefly predator *Delphastus pusillus* (Le Conte) and on the combined action of the parasitoids *Amitus aleurodinus* Haldeman and *Eretmocerus aleyrodiphaga* (Risbec) are discussed.

704 90 - 10/71

Plant protection
Review, book, pest control, pesticides, small-scale agriculture, developing countries, integrated pest management, CTA, TOOL

SCHOUBROECK, F.H.J. et al.

Managing pests and pesticides in small-scale agriculture.

Co-publication of CTA, The Netherlands, the Centre for Development Work (CON), The Netherlands and TOOL, The Netherlands; ISBN 9070857189, 1990; available from TOOL, Entrepotdok 68a/69a, 1018 AD Amsterdam, The Netherlands

The book, Managing Pests and Pesticides in Small-Scale Agriculture, is a joint publication of CTA, the Centre for Development Work (CON), in the Netherlands and the Technical Development with Developing Countries (TOOL). It is aimed at helping development workers in rural areas to assist small-scale farmers to develop sustainable agriculture. The book is more a basic information tool for on-site elaboration rather than a handbook with all the answers.
After a brief introduction to farmers, agriculture and pesticides in the Third World, the first part emphasizes the social background of crop protection in the Third World. Part II is dedicated to Integrated Pest Management (IPM) which alone provides alternatives to chemical crop protection. This section also offers a variety of practical suggestions for reducing the use of chemicals and for increasing their safe use. Part III deals with possible training methods for IPM, and gives information on background research in IPM.
Because in the Third World, pesticides are often sold without adequate instructions for use, and because the use of these chemicals is sometimes prohibited in the North, part IV looks more closely at government measures and pesticide legislation, including FAO's Code of Conduct. The final part, Part V, gives two case studies, in pest management, in Peru and Sri Lanka.
There are four useful appendices: the 50 most commonly-used pesticides and their dangers; a list of organizations involved in crop protection; a bibliography (with abstracts); and a glossary of terms used in plant protection. This is a useful paperback, fully illustrated with photographs, diagrams and cartoons; everything is designed for clarity and easy access.
Abstract from SPORE

705 90 - 10/72

Plant protection
Canada, integrated plant protection, pest control models, study, sterile release, pheromone trap, insecticides, biological control

BARCLAY, H.J. and P. VAN DEN DRIESSCHE

Pest control models of combinations of sterile releases and trapping.

Insect Sci. Applic., 10, 2, 1989, pp. 107-116

Integrated Pest Management (IPM) is built on the principle that favourable aspects of different control methods complement each other and thus make the limitations of each method less important. Many IPM programmes involve the use of insecticide plus an insecticide-resistant natural enemy. Alternatively, other IPM programmes involve the use of insecticide in combination with cultural methods.
The two methods of pest control that are modelled here are the release of sterile pest individuals and the use of traps to attract the pests and either kill them or sterilize them and allow subsequent release. The traps contain either sex pheromone or non-sex-specific attractants such as food, host odour, CO_2, etc.
This type of combination was also modelled by Knipling using very simple numerical models with the time frame extended over a few days during adult emergence. The models presented in this paper are an extension and elaboration of Knipling's models.
The models presented here are designed to test the generality of the principle of complementarity of methods outlined above as well as to explore the feasibility of the specific combinations in pairs of control methods. The combinations represented in the models here are: sterile releases in conjunction with the mass trapping of pests with subsequent killing or sterilization of the pests. The traps are to be baited with either food (or other non-sex-specific attractive odour) or female pheromone to attract males. Pheromone-baited traps are expected to act in a manner similar to sterile males, since their effectiveness depends on the ratio of the pheromone in traps to the total pheromone (traps plus virgin wild females) and thus should be most effective at low pest densities. Food baited traps on the other hand do not compete with sex ones but rather with a fairly constant food supply (at least in the short term) and thus should be relatively independent of pest density.
The efficiency for control or eradication is greater when control methods are used in combination than when either control method is used in isolation. The most efficient combination for pest species with high fertility rates is the release of steriles together with the use of pheromone traps containing sterilant. For pest species with very low fertility rates and high survivorship, such as tsetse, sterile releases combined wiht food traps containing insecticides are most efficient.

706 90 - 10/73

Plant protection
USA, study, pest management, agricultural development, economics

REICHELDERFER, K.H.

Economic contributions of pest management to agricultural development.

Tropical Pest Management, 35, 3, 1989, pp. 248-251

This article focuses on the contribution of pest control inputs and pest management skills to the transformation of traditional agriculture. The topic is covered in a general manner because little empirical evidence is available for use in providing specific illustrations of general relationships. The term 'pest' is used to refer to any organism which causes damage to or loss of crops or livestock, and includes insects, weeds, and plant pathogens.
The transformation of traditional agriculture to agricultural systems which foster growth and development requires the availability of improved crop production and crop protection inputs, as well as the skills to safely and effectively utilize these inputs. The typical progression of agricultural development involves an initial focus on increasing crop yields, with pest management as a secondary consideration and the safety and health aspects of agricultural practices as tertiary considerations. This common hierarchy can lead to inefficiencies because of the close interrelatedness of crop production and crop protection in determining the profitability and stability of new agricultural systems.
In attempting to introduce new factors for improved agricultural production, the tradeoffs among crop production, crop protection, and resource conservation need to be explicitly considered. An independent focus on any one of these is an inappropriate long-term strategy.
Most cereal production has relied on labour, mechanical and genetic approaches to pest control. Relatively higher pesticide to wheat price ratios since 1976 should cause this to continue for wheat. However, for rice and other major food crops, the constantly falling price of pesticides relative to crop prices is encouraging more pesticide use.
Pesticide use can reduce production variability, and good pest management is a more lasting, less expensive long-term crop protection strategy than is reliance on continuous breeding programs. However, fairly sophisticated management skills are required to safely and effectively use pesticides in an intensive production system. Under poor management, pesticide use can increase crop yield variability, decrease agricultural productivity, and constrain development as a result of adverse external effects.

Ideally, the production protection, safety, and environmental aspects of pest control should be simultaneously addressed at early stages of agricultural development. This can only be achieved by increasing farmers' awareness and understanding of the pest control opportunities they can afford, while implementing policies and programs that preclude an unilateral approach to crop production, protection, or environmental quality.

707 90 - 10/74

Plant protection
Africa, Senegal, field trials, integrated plant protection, pearl millet, plant diversity, intercropping

GAHUKAR, R.T.

Pest and disease incidence in pearl millet under different plant density and intercropping patterns.

Agriculture, Ecosystems and Environment, 26, 1989, pp. 69-74

Pearl millet, *Pennisetum americanum* (L.) Leeke, which is a major food crop in the Sahel, is planted unter various farming systems. In some areas, pearl millet is mixed or intercropped with cowpea, *Vigna unguiculata* (L.), under different configurations. Cowpea is one of the major grain legumes used for human consumption. It is generally planted just after the first rains or about 2 weeks later. Plant densities of the crops vary considerably from region to region. Information on incidence of insect pests and diseases of pearl millet grown under these circumstances is fragmentary or lacking.
The insects and diseases were studied in Senegal under various cropping patterns so that appropriate practices may be used in their management under Sahelian condition.
Trials were conducted during the 1986 crop season in south-central region of Senegal.
Pearl millet cv. 'Souna' was planted in a split plot design with five replicates. The plot was 8X4 m. There were four row x hill spacings (80X80, 80X40, 80X10 and 40X10 cm) in the main plots and each plot was divided into two subplots. Plant population was adjusted by thinning 10 days after plant emergence.
In another trial pearl millet cv. 'Souna' and cowpea cv. '58-57' were planted on 13 July in a distance of 60 cm between rows and 30 cm between hills for both the crops (1 plant per hill). This trial consisted of six treatments (= configurations) with five replicates arranged in a randomized complete block design. Each plot had 10-m rows, the number of rows depending upon the intercropping configurations, i.e. one row of pearl millet followed by two, 10 or 30 rows of cowpea and vice versa.
Pearl millet planted in narrow (40X10 cm) or wide spacing (80X80 cm) with 1 or 3 plants per hill did not influence the incidence of the millet stem borer, *Acigona igneusalis* (Hamps.), and spike worm, *Raghuva albipunctella* (De Joannis). When pearl millet was intercropped with cowpea under different configurations, activity of flower thrips, *Megalurothrips sjostedti* (Tryb.) and *Frankliniella schultzei* (Tryb.), in cowpea was affected. Also, stem borer population and spike worm infestation rate in pearl millet were reduced by planting 1 row of millet with either 10 or 30 cowpea rows. Head smut, Tolysporium penicillariae (Bref.), infection was favoured by higher population of millet plants in the plot.

708 90 - 10/75

Plant protection
Latin America, Honduras, study, sorghum, foliar diseases, yield loss assessment, crop loss assessment, subsistence farming research

WALL, G.C. et al.

The relationship of yield loss to foliar diseases on sorghum grown by subsistence farmers in southern Honduras.

Tropical Pest Management, 35, (1), 1989, pp. 57-61

In this study the effects of sorghum diseases on yield under subsistence farming conditions are described. Disease severities were estimated using the critical-point approach to predicting yield losses.
Data collected from individual plants in subsistence farmers' fields in southern Honduras were used to estimate the variation in yield due to the prevalent diseases: gray leaf spot, covered smut, rust, and oval leaf spot. Collecting data from plants with various levels of disease, the effect of disease severity on yield was established. By developing a model that accounts for variation in yield based on preselected parameters, including disease severity, one can estimate yield levels for a given severity of disease.
Several models were tested to explain variation in yield based on a range of variables measured on individual plants. Data were first subjected to principal component analysis, and the major principal components were used as independent variables in a multiple regression model, with yield the dependent variable. The best model included the following variables: per cent severity of the 4 diseases, panicle length, and plant height. Using the model, yield differences of up to 7% were predicted when comparing the minimum- and the maximum-disease severities observed and holding plant height and panicle lenght at their mean values. Using the observed plant height and panicle length corresponding to actual disease severities, yield differences estimated were 14·6%, 3·6%, and 5·5% for gray leaf spot, rust, and oval leaf spot, respectively.Actual losses from smut were insignificant.
The general model developed in this study meets the objective of estimating yield at given levels of disease severities in different fields. In this present form, it can be applied to data obtained in the same manner as for this study (based on the same standard area diagrams, etc.), in similar environments, from fields similar to those studied, where one of the diseases in the model predominate, and for the 1985 cropping season; only gray leaf spot and smut could be considered simultaneously, since only these two diseases occured together in the fields studied.
A model applicable to other years and environments can be developed in a similar fashion by including data from several seasons and environments. In future studies the model should ideally be validated with data from fields not included in assembling the model.

709 90 - 10/76

Plant protection
Latin America, Colombia, field trials, cassava, cowpea, maize, intercropping, monoculture, whitefly, insecticide, land equivalent ratio, yield assessment

GOLD,.C.S. et al.

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

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

Diversified agro-ecosystems, including intercrops, often support lower herbivore numbers than corresponding monocultures.
Only limited information has been available on how cassava pests respond to different cropping systems and intercropping effects on differential herbivore numbers and yields.
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%. Yield reduction is attributed to loss of phloem, reduction in leaf photosynthetic capacity, and associated sooty moulds.
There the effects of intercrop competition and differential herbivore numbers on cassava growth and yields in cropping system trials in the Dept. of Tolima, Colombia is reported.
Application of the insecticide monocrotophos to protected plots allowed determination of yield losses under different cropping systems and separation of the effects of intercrop competition and differential herbivore numbers. Intercropping with cowpea lowered yields of a regional cultivar of cassava (MCOL 2257) in protected plots. However, in non-protected plots regional 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 favors top growth over roots, and large plant size did not insure high yield. Land equivalent ratios exceeded 1.5 for intercropped 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 field 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.

710 90 - 10/77

Plant protection
Africa, Ethiopia, field trial, maize, maize stalk borer, sowing date, crop damage

GEBRE-AMLAK, A. et al.

The relationship between sowing date, infestation and damage by the maize stalk borer, *Busseola fusca* (Noctuidae), on maize in Awassa, Ethiopia.

Tropical Pest Management, 35, (2), 1989, pp. 143-145

The maize stalk borer, *Busseola fusca* (Fuller) is an economically important pest of maize and sorghum in Ethiopia.
The amount of damage and average loss of yield by this and other stem borers has been variously reported as 10%.
Identification of the proper time of sowing has long been recommended for various pest and disease problems. However, conflicting reports on the relationship between sowing time and borer infestation and damage have been made.
Research data on the relationship between planting date, infestation and damage by the maize stalk borer, *Busseola fusca* are not available from Ethiopia.
This study compares levels of infestation and crop loss due to *B. fusca* on successive sowings of maize. It is intended to identify sowing dates that would result in infestations low enough to avoid economic loss of the crop so that the application of insecticide would be unnecessary.
Successive sowings of maize variety A 511 were made at 10 days intervals between April 10 to July 7 in 1985 and 1986. There were ten different planting dates with three replications, using a randomized complete block design. Plots were 7·25 m x 5·25 m. Spacing between plants, rows and plots were 0·30, 0·75 and 1·0 m respectively. In 1986 a spacing of 0·25 m was used between plants while others remained constant.
There were two sets at each sowing date in both years. The first set was treated with cypermethrin 1% G at the rate of 0·30 kg a.i./ha when the plants were four weeks old. The same rate was repeated after 10 days. The second set was not treated.
Data on infestation was collected every two weeks. Per cent infestation on leaves and stalks were determined by taking counts of infested and uninfested plants in each plot. Dead-hearts were also determined in a similar fashion. The number of cobs was recorded from all plots in both treated and untreated sets. Cobs infested by the second generation larvae of B. fusca were inspected and the percentage was computed at harvest. Heights in cm of 10 randomly selected plants were measured at two week intervals from each plot.
Different degrees of infestation by *B. fusca* were recorded from all sowing dates. Early sowing in April and the early part of May had significantly lower infestations of first generation larvae. Levels

of infestation by second generation larvae were significantly higher on late sowing dates. High infestation by second generation larvae appeared to be connected with the high biotic potential of the moths of the first, non-diapause generation. Second generation larvae caused crop loss ranging from 22·5 to 100% while it was only 0-22·6% due to the first generation.
The current study clearly shows that sowing date had a strong influence on the damage caused by the pest in Ethiopia. Later sowing dates had significantly higher infestations and damage by the second generation larvae.
To obtain better yields without application of insecticide, this suggests that maize planting should not be later than April in Awassa. Similar studies are necessary in other climatic regions of Ethiopia where the maize stalk borer is considered to be an important pest.

711 90 - 10/78

Plant protection
Africa, Niger, study, cowpea, millet, intercropping, Brachidae development

LEROI, B. et al.

The influence of intercropping millet (*Pennisetum typhoides* Burm) with cowpea (*Vigna unguiculata* Walp) on the egg-laying and development of *Bruchidius atrolineatus* (Pic) (Coleoptera: Bruchidae).

Agriculture, Ecosystem and Environment, 31, 1990, pp. 39-48

The present paper examines the consequences of intercropping millet with cowpea on the reproduction and development of *B. atrolineatus*.
In the Sahelian region, cowpea is generally associated with millet (*Pennisetum typhoides* Burm). *Bruchidius atrolineatus* oviposit on the pods and larvae develop inside the seeds. Thirty to forty percent of seeds are attacked when harvesting, 90-100% after several months of storage. *B. atrolineatus* adults consume millet pollen and take shelter in millet spikes. The presence of millet could thus lead to the concentration of adult bruchids, thereby increasing infestation of the cowpea.
The study took place in the Niamey region of Niger, within a vast zone where millet is traditionally associated with cowpea. The crops are grown on ferruginous, slightly leached soils, developed on the sandy cover of a low terrace of the Niger.
The results of this study show that there is no difference in bruchid oviposition between millet-cowpea intercropping and cowpea monoculture. The percentage of egg-infested pods as well as the average number of eggs deposited on the pods are the same in both crops.
The microclimatic conditions, particularly low light intensity, within the dense millet canopy above the cowpea pods do not seem to influence the oviposition of *B. atrolineatus* females.
The presence of a dense millet leaf cover at the beginning of September probably favours egg and larval development of *B. atrolineatus*, particularly during the period when the neonate larvae penetrate the cowpea pods. The rate of adult emergence is always higher in mixed crops than in monocultures. Low relative humidity and high temperatures during the day in monocultures increase mortality during development. The rates of parasitism are similar in both cropping systems in contrast to some other associations.
In this study, mixed cropping, as practised in Niger, seems unfavourable for cowpea. In the varieties studied, the presence of millet reduces cowpea yield probably because of the shading effect and causes a slight increase in seed losses from the Bruchidae. These studies must be repeated using different varieties of cowpea and millet and under differing growing conditions, before it is possible to draw more general conclusions.

712 90 - 10/79

Plant protection
Africa, South African Republic, survey, weed biocontrol, insect-plant associations

DENNILL, G.B. and V.C. MORAN

On insect-plant associations in agriculture and the selection of agents for weed biocontrol.

Ann. appl. Biol., 114, 1989, pp. 157-166

One of the central issues in biological weed control is the selection of successful agents. Insect and mite herbivores are selected on the basis of how successful they are expected to be. Subsequent to their release, the agents are evaluated to determine what level of success has been achieved, and why. Knowing why a herbivorous species is successful or unsuccessful facilitates the future selection of effective agents.
The present paper firstly examines the actual frequency of recruitment of new herbivore species onto selected crop plants in the field to assess the feasibility of establishing new herbivore plant associations in weed biocontrol situations. Secondly it determines the impact of these new herbivores on their new host plants to assess the potential destructiveness of new associations in relations to old ones. Thirdly, it determines the proportion of oligophagous species among the recruited insect and mite herbivores on the crop plants to determine whether new associations are characterised by polyphagy and hence unfit for use in weed biocontrol. In addition, new principles and procedures are discussed that can be routinely and practically applied in the selection of agents for weed biocontrol.
The herbivores on 14 introduced crop plants which have salient similarities to the major weeds in the south-western Cape were surveyed: (a) 68% of the 188 insect and mite herbivores are indigenous species in new associations with these host plants, and (b) of the five most damaging pests on each of 13 of the crop plants, 53% are in new associations with the plants. Of the 40 most important agricultural pests in South Africa, 58% are in new associations, confirming these results. About 50% of the insect and mite herbivores in new associations with their host plants are oligophagous, indicating that new associations are not necessarily characterised by polyphagy and hence unsafe for use in weed biocontrol.
It is concluded that new associations between herbivore species and host plants have strong potential in weed biocontrol because (a) their frequency in agriculture indicates that they can easily be established in weed biocontrol situations, (b) they are as damaging as old associations and (c) they are not necessarily unsafe as regards host specificity. Therefore the use of both the classical approach and that of Hokkanen & Pimentel is advocated. Novel guidelines which can be routinely and practically applied in the selection of agents for weed biocontrol are provided.

713 90 - 10/80

Plant protection
Pacific, Western Samoa, survey, biological control, coconut hispid beetle, ecology, economy, evaluation

VOEGELE, J.M.

Biological control of *Brontispa longissima* in Western Samoa: An ecological and economic evaluation.

Agriculture, Ecosystems and Environment, 27, 1989, pp. 315-329

The coconut hispid beetle *Brontispa longissima* is considered a major pest in several South Pacific countries.
This study intends to contribute to a better understanding of the current situation in the field by investigating various questions.
The main objective,however, was to analyse the impact of this biological-control programme from an economic point of view and to discuss likely future developments.
Several beneficial insect species, including the pupal parasite *Tetrastichus brontispae* and an eulophid larval parasite (*Asecodes* sp.), were collected in other Pacific countries, mass reared and released in W. Samoa.
An extensive damage survey comprising 37.000 coconut trees showed that *B. longissima* is well under control and does not at present cause any significant yield losses. Initially production losses in outbreak areas were estimated to be as high as 50-70%. The benefit-cost ratio of this project was 3.9:1 during the implementation period (1981-1986) and 9.9:1 for the period from 1987 to 1990. The internal rate of return (IRR) calculated for a 10-year period (1981-1990) exceeds 40%, thus highlighting a very successful biological-control project. The average coconut grower in Western Samoa obtains an estimated WS$ 24 ha^{-1} $year^{-1}$ with no additional cost involved.
The results indicate that in mature coconut trees the parasites are able to keep the *Brontispa* population below an economic treshold level. Young seedlings, however, may in some cases require additional protection. It is therefore recommended that *Metarhizium* is applied in 4-monthly intervals until the seedlings are about 2 years old.
Another result of the field studies was the fact that approximately 90% of the recaptured parasites were larval parasites (*Asecodes* sp.). This particular species has not been reported from other countries as yet. With regard to release programmes in the future, *Asecodes* certainly has to be considered a very valuable enemy of *B. longissima*. This species may well be able to improve further the situation in countries where the pupal parasite *T. brontispae* was successfully introduced many years ago, such as in French Polynesia or in some islands of Indonesia.
The data further indicate that the current level of control is likely to remain stable within the period used for the economic

calculation. On the one hand it is extremely difficult for the parasites to find small host populations which remain almost inaccessible until some of the damaged leaves have dried up. On the other hand, parasites appear to be very successful in locating larger subpopulations of B. longissima. These two factors combined make it very unlikely that both the host and parasite density will fluctuate drastically within the near future.
The economic analysis is based on the assumption that, owing to the effectiveness of the parasites, a 10% yield loss was prevented. In a sensitivity analysis this figure was reduced to only 1%. However, positive accumulated net returns were achieved within 7 years after introduction of the parasites.
The classical biological control approach as presented in this case study from Western Samoa is both ecologically and economically sound. Once established, the beneficial organisms remain active without continuous support. All farmers benefit from the method without expenses or training involved.

714 90 - 10/81

Plant protection
Review, book, proceedings, seminar, pesticides, food, environment pollution, pest management

IAEA

Pesticides: food and environmental implications.

Internat.Atomic Energy Agency, Wagramerstr. 5, P.O.B. 100, A 1400, Vienna, Austria, 1988, 332 pp.

'Pesticides: Food and Environmental Implications' is the proceedings of 'International symposium on changing perspectives in agrochemicals: isotopic techniques for the study of food and environmental implications', jointly organized by the International Atomic Energy Agency and the Food and Agriculture Organization of the United Nations held at Neuherberg during 24-27 November 1987. It consists of 6 invited papers of review type, 17 research papers, and 10 poster presentations along with a summary report of research co-ordinating meeting held on completion of the symposium.
In the invited paper on 'Global pest management in the future', P. Kraus emphasized that increased food demands can be met only by intensifying production out of the same area by rational use of biological and cultural practices in addition to pesticides. This needs integrated research strategy of various disciplines, based upon future-oriented market analysis. The author has given global pesticide information to support his ideas. Miller in his paper 'Effects of pesticides on fauna and flora' suggested effective environmental monitoring in the evaluation and management of pesticides. He showed that the regenerative power of tropical ecosystem does not depend on the type of pesticide and its formulations, but on the extent of sprayed area and ecophysiological capacity of different organisms in the tropical food chains. In another invited paper, 'Current trends in pesticide usage in some Asian countries', M. Soerjoni pointed out that, based on the current trends in the demand, supply and consumption of pesticides in Asian countries, there is urgent need to develop strategies for research and studies for appropriate integrated pest management, in which pesticides could still be used as an important tool. Other invited papers touching various aspects of pesticide residues, were of general nature, reviewing mostly dissipation, persistence, metabolism, movement and leaching of pesticide residues in the treated environment.
Among the research papers presented, few were of general nature, depending on use of nuclear techniques - especially labelled compounds for studying the persistence of pesticides - in some regions of the world. Several papers dealing with specific pesticides are really novel and informative. Others dealing with residues of aldicarb in cotton and of malathion on stored grains dealt with some novel aspects of residues. The best use of radio-labelled insecticides was shown however in several papers describing new types of controlled release of formulations, which

are capable of maintaining a steady concentration of the pesticide in the environment. This clearly indicates a new trend in pesticide formulations. The poster presentations were short and unremarkable. The seminar recommended that research on the development of controlled formulations of pesticides for the control of tsetse fly, aquatic weeds and insect pests of rice should continue. The laboratories preparing controlled release formulations of pesticides should maintain close contact with research coordinators involved in the field of testing these formulations under local environmental conditions. On the whole, the proceedings of the symposium will be useful to research workers engaged in the pesticide field in exposing them to certain global aspects of effect on environment in relation to pesticide management, and giving briefly some details of new chemicals and new formulations. The get-up of this book is excellent and it should be a good acquisition for the libraries.
Abstract by S.K. Handa

715 90 - 10/82

Plant protection
Africa, Nigeria, study, rainforest zone, cowpea, weed infestation, seed yield, leafhopper, flea beetle, integrated pest management

TOM I. OFUYA

Efecto de malas hierbas sobre la infestación con insectos en la prefloración y el rendimiento de semilla des caupi (Vigna unguiculata) en una zona de bosque húmedo de Nigeria. (Effect of weeds on pre-flowering insect infestation and seed yield of cowpea (Vigna unguiculata) in a rainforest area of Nigeria.)

Expl. Agric., 25, 1989, pp. 343-347

This paper reports on the results of field experiments carried out in 1986 and 1987 in Akure, Nigeria, showing the effect of weediness on pre-flowering insect infestation and seed yield. Insect pests constitute a major limiting factor in cowpea (*Vigna unguiculata* (L.) Walp) production. The pest spectrum is wide and in Africa both the leafhopper, *Empoasca dolichi* Paoli, and the flea beetle, *Ootheca mutabilis* (Sahlberg), are major pre-flowering pests of the crop. *Empoasca dolichi* sometimes causes yield losses of up to 40% in susceptible varieties whilst *O. mutabilis* may cause extensive defoliation and may also transmit virus diseases.
There are several insecticides which can provide adequate control of the pre-flowering insects pests of cowpea. Concern for the environment and the fact that cowpea are cultivated in Africa by smallholders who seldom use pesticides because of financial and technical limitations have necessitated moves towards the development of integrated pest management systems. One useful cultural component of any such system may be effective weed management. Observations in Nigeria have shown that weeds in cowpea fields are positively correlated with post-flowering insect damage.
The study was carried out in the rainforest vegetation zone of Nigeria. The average temperature is 27°C, with about 1600 mm rainfall and two distinct cropping seasons, from April to July and from September to December, each year. Cowpea, cv. Ife Brown, was planted in 10 plots each surrounded by 2.0 m wide non-planted strips.
Five plots were randomly chosen for the no-weeding treatment and the other five were kept weed-free throughout the growing season by hoeing and hand removal. The main weeds were *Synedrella nodiflora, Eleusine indica, Talinum triangulare, Amaranthus hybridus* and *Digitaria horizontalis*. No fertilizer was applied. Nuvacron (monocrotophos) was used at 0.75 kg a.i. ha^{-1} to control post-flowering insect damage.
Weediness generally reduced infestations of both the leafhopper, *Empoasca dolichi*, and the leaf beatle, *Ootheca mutabilis*. Seed yield was reduced in the weedy plots despite heavier pre-flowering insect populations in the plots kept weed-free.
Cowpea yields in farmers' plots in the rainforest region of Nigeria rarely exceed 400 kg ha-1, even with adequate manual weed removal.

This is because farmers cannot afford to spray the crop, which is also subjected to even heavier post-flowering insect damage. However, the two insecticide sprays recommended for the control of pre-flowering cowpea insects may be unwarranted or reduced if the growth of weeds such as E. indica and A. hybridus is manipulated within or around cowpea fields as a form of integrated pest management which can be readily adopted by farmers.

716 90 - 10/83

Plant protection
Latin America, Colombia, study, rice, integrated pest management, pests, pesticides

CIAT

Integrated pest management to counter excessive pesticide use.

CIAT Report 1989, Centro International de Agricultura Tropical, Ap. Aéreo 6713, Cali, Colombia, 1989, pp. 22-25

CIAT's research program benefits national programs, many with limited resources, by developing improved lines and rice-growing methods that can be adapted for local use. These lines incorporate resistance or tolerance to principal stresses which may upset rice production. Lines adapted to acid soils could improve rice productivity in the tropical savannas. Recognizing the interdependence between agriculture and the environment, the Program develops integrated crop-management technologies which contribute to sustainable cropping systems.
Excessive use of pesticides over many years to control the rice pest *Sogatodes oryzicola* has caused it to develop resistance to them. A study by CIAT Rice Program scientists has found that ten times the level of insecticides were required to kill insects collected from two high-insecticide-use areas of Colombia than was necessary for a control group unexposed to these. Past evidence shows that many Colombian rice growers are misusing insecticides on their crops, which can lead to a dramatic ecological imbalance and actually increase production costs without improving yields.
The use of too much pesticide in an area can cause a resurgence of insect pests due to the extermination of their predators and parasites. In the case of S. oryzicola, misuse has likely caused the pest to develop resistance to insecticides, causing farmers to apply more chemicals to achieve the same level of control. In some areas of Colombia, farmers have been increasing their use of chemicals against the pest, suggesting that resistance has indeed developed.
To confirm this, scientists began by determing the dosage of the insecticide monocrotophos required to kill half (LD50) the insects taken from a population of insects reared in a controlled environment and which had not been exposed to insecticides for three years. Other LD50s were determined for colonies established with insects collected from several rice fields in Tolima, Colombia, where insecticides had been extensively used for many years. By comparing their LD50s with that of the control group, it was found that those insects collected in Tolima had resistance to monocrotophos.
The conclusion: the irrational use of pesticides sets off changes in the environment which have unknown consequences, besides reducing the profitability of the crop. A better solution is to use an integrated crop management plan which can include the judicious use of insecticides. This will not only make farmers more aware of

the benefit of proper crop management, but it will also help stem the evolution of resistance to insecticides and prolong the useful life of these compounds.
This concept has led to integrated pest-management (IPM) demonstrations in Colombia and Ecuador, countries where national rice plans are in effect. Farmers, seeing the success, are beginning to adopt IPM practices. Already there is evidence that there is a substantial reduction in the amount of pesticide used in these experimental areas.

717 90 - 10/84

Plant protection
Asia, Philippines, review, rice, green revolution, insect pests, pesticides, chemical control, varietal resistance, multiple cropping, cultural control

LITSINGER, J.A.

Second generation insect pest problems on high yielding rices.

Tropical Pest Management, 35, (3), 1989, pp. 235-242

Traditional lowland rices of Asia are photoperiod sensitive and ripen at the end of the monsoon rainy season, producing stable but low yields even under environmental extremes. The dry season fallow of these single rice crop systems breaks insect and plant virus disease cycles limiting pest buildup. Modern rices developed in the sixties to feed a growing human population attain their high yielding potential with good water control but are intolerant of drought or floods.
Production of modern rices in Asia has kept pace with human population growth. Modern photoperiod insensitive varieties are encouraged by irrigated system development to realize their high yielding potential through dry season cropping and increased yield per crop. But multiple rice cropping over large areas raised the carrying capacity of the environment by allowing yearround pest development. Numerous outbreaks subsequently occured over the past two decades through resurgence caused by the increased use of government-subsidized, broad-spectrum insecticides killing natural enemies. Selective insecticides were not available. Insect resistant varieties under the intensive pest pressure could not prevent these outbreaks as the pests rapidly select new biotypes.
Pest management needs to be founded on organizing community-wide planting schedules for each irrigation system to create rice-free periods each year mimicing the traditional dry season fallow. But with irrigation, non-rice crops can be grown during this rice-free period. The result is to lower the carrying capacity of rice agroecosystems to pests, allowing pest resistant varieties longer field life. The need for insecticide control will also be reduced, sparing more natural enemies. In the future, the broad-spectrum, petroleum-based insecticides should be replaced by biologically-based products which are selective, safe, and inexpensive.
Author's abstract

718 90 - 10/85

Plant protection
Africa, Asia, Latin America, review, crop production, pest control, biological control, agronomical practices, traditional methods, CIAT, CAB, IITA, FAO

HUSSEY, N.W.

Produción agricola en el Tercer Mundo - un desfio para el control natural de plagas. (Agricultural production in the Third World - a challenge for natural pest control).

Expl. Agric., 26, 1990, pp. 171-183

Farmers survive because they grow sufficient to sustain losses of 40% both before and after harvest.
The small, mixed cropping systems can be very productive since they contain elements of pest and disease control which have evolved over the centuries. Traditional control methods involve addressing spirits, avoiding sowings on the anniversaries of deceased parents, application of ashes or salt, hand-picking, use of non-crop plants as repellants or attractants, seeding rates, time of sowings and mixed cropping.
In view of the difficulties of purchasing and applying pesticides in the Third World it is not surprising that most observers have concluded that biological control has a unique contribution to make to small farmer agriculture.
The best recent example concerns the cassava mealybug *Phenacoccus manihoti*.
Following five years of effort by the CAB International Institute of Biological Control and the Africa-wide Biological Control Programme based at the International Institute for Tropical Agriculture (IITA) and Centro Internacional de Agricultura Tropical (CIAT), a parasite, *Epidinocarsis lopezi*, was located in Paraguay. This parasite, following quarantine in the UK, was released near Ibadan in 1982 and within six years had dramatically reduced mealybug numbers and hence damage over 0.6 million km² in 18 African countries. In 1986 FAO calculated that cassava production had risen in Nigeria by about 10% and this increase was largely attributed to biological control of the mealybug.
Now that the parasite has been introduced to many countries in the cassava belt it is expected that, in the humid lowlands, the mealybug problem will be reduced to only sporadic outbreaks. In drier areas and on high ground spread of the parasite has been slower so that the final outcome is still in doubt.
Any consideration of the potential of direct natural control methods must include the use of native plants, many of which, like neem (Azadirachta indica), are known to have insecticidal and nematological properties.
The challenge to all those concerned with crop protection in the Third World is to adopt a more pragmatic philosophy designed to develop methodologies based on immediately available and free resources which can be manipulated by the simplest systems.

719 90 - 10/86

Plant protection
Review, pest control, human factor, integrated pest management, social barriers, indigenous needs

GABRIEL, T.

Pest control, pest management and the 'human factor'.

Tropical Pest Management, 35, (3), 1989, pp. 254-256

This paper reviews some key issues involving human social organization in relation to pest management.
The paper suggests that knowledge of human social and cultural processes in relation to pest management is crucial for rural development efforts. Concepts of human interaction in this activity have passed from notions of pest 'control' to pest 'management'. Recent farming systems research with small farmers has demonstrated that these indigenous systems have much to offer to problem-solving efforts in farming and human health including innovations derived from indigenous pest management practices.
Despite the enormous volume of literature published about pest eradication, little attention has been devoted to human social issues in this process. Instead the pest problem has been the concern of the agronomist, entomologist, biochemist, or other natural scientist. Their approach has tended to focus exclusively upon the pest, it's physiology, environment or behaviour, in their search for 'control' measures.
Introduction of new technologies or new practices is more clearly understood as a multi-dimensional process. Longterm goals include concepts of an ecologically-sound, economically gainful and socially acceptable environment in which rural development programmes identify and respond to local needs wherever possible. 'Management' strategies view pests within their total context, social as well as natural. Planned developments have come to recognize that human knowledge of the pest, attitudes towards it, and towards the pest-crop-farmer-market system, and the local criteria for making decisions, are all essential data needs. This involves both higher-level economic criteria (e.g. determining cost-benefits and cost-effective levels of pest treatment), and micro social and cultural issues (e.g. how farmers and indigenous populations view the pest 'problem' and their range of responses). Local initiatives are now regarded as valuable to rural development efforts in ways that were not possible before.
A recent response to this range of inter-connected problems has been the establishment of an international research and development network, Perception and Management of Pests and Pesticides (PMPP).

720 90 - 10/87

Plant protection
Africa, Kenya, survey, weed population, maize, sorghum, cowpea, intercropping

DISSEMOND, A. and H. HINDORF

Weed population in intercrops of maize (*Zea mays* L.), sorghum (*Sorghum bicolor* (L.) Moench) and cowpea (*Vigna unguiculata* (L.) Walp) at Mbita/Kenya.

Angew. Botanik, 64, 1990, pp. 133-138

The knowledge of species and individual number of weeds is essential to solve weed problems. For that reason the weed population in South Nyanza/Kenya was determined.
A check list of weeds was established. The weeds were collected in fields.
Investigation on the weed population was carried out twice each rainy season before weeding took place by hand, approximately 30 and 50 days after emergence of the crop. The plant material was preserved in a herbarium and the identifications confirmed by the National Herbarium, Nairobi.
The weed population in intercropped fields of maize, sorghum and cowpeas was determined. The survey resulted in 107 different species belonging to 83 genera and 26 families.
Dicotyledons were more frequent and covered 14 % than monocotyledons with 5%.
The following species occured with frequencies exceeding 10% in the total population during the long and short rains in both years. *Commelina benghalensis* (70.8%), *Boerhavia erecta* (42.8%), *Echinochloa colonum* (35.0%), *Corchorus olitorius* (34.8%), *Portulaca* spp. (31.5%), *Cyperus* spp. (26.0%), *Cynodon dactylon* (21.0%), *Amaranthus graecizans* (18.5%) and *Euphorbia geniculata* (12.8%). Other weeds which appeared only during the short rains of 1983 with a frequency of occurrence above 10% were: *Flaveria australasica, Launaea cornuta, Eleusine indica* and *Schkuhria pinnata.*
The percentage cover was always higher in cereals than in legumes. The inclusion of cowpea as an intercrop with cereal reduced the weed cover significantly to sometimes 50% of that in pure stands.
The weed population in crops has advantages and disadvantages. A balanced soil coverage by plants prevents evaporation and erosion. Advantageous is also the fact that several weeds represent host plants for predators and increase biological control efficacy. In addition some native weeds like *Portulaca oleracea, Solanum nigrum, Corchorus olitorius* or *Gynandropsis gynandra* are consumed as vegetables by Africans. The disadvantages should be examined for negative effects like competition for nutrients, light intensity, water supply, especially in the case of *Commelina benghalensis*, and must be considered as well as the fact that weeds can act as alternative host plants for insects, nematodes and fungi causing pests and diseases to crops.

721 90 - 10/88

Plant protection
Review, Africa, Asia, Latin America, integrated pest management, social science, pesticides, resistant varieties, crop loss assessment, pest surveillance, IARC's

GOODELL, G.E.

Social science input into IPM.

Tropical Pest Management, 35, (3) 1989, pp. 252-253

Some of the socio-economic obstacles and a sampling of the types of problems that stand between IPM on the drawing boards and IPM's actual contributions to increased food production for small farmers in developing countries are discussed.
It is predicted that the wide-spread adoption of more accurate pest management practices would eliminate half the losses which the Third World currently suffers in basic food crops. This prediction cannot be realized if IPM researchers are unable to adapt their technology to the socio-economic realities of the small farmer in the developing countries of Latin America, Asia and Africa.
IPM is based largely on resistant varieties and the judicious use of chemical compounds.
IPM researchers should bear greater responsibility for simplifying surveillance and early warning systems. Either farmers should sample themselves or government services should assure that their scouts are actually performing their jobs.
A third area in which research needs to take a greater responsibility in resolving the socio-economic constraints of IPM is in improving crop loss assessment techniques appropriate for Third World conditions. Because of the great difficulties of calculating potential yields, many developed countries no longer conduct crop loss assessments, but Third World IPM programs cannot afford not to use some measure of the proportion of potential yield increases that might be expected from IPM adoption. At present, in the absence of accepted procedures for assessing crop losses due to specific pests and diseases, it is difficult for Third World IPM programs to establish research priorities scientifically.
In revising existing crop loss assessment techniques for use in IPM programs, there is a need to broaden this concept to include farmers' perceived crop losses in terms of their overall family income, as well as the yield increments they expect from improved crop protection. These dimensions critically affect farmers' adoption rates and hence should affect researchers' technology generation efforts.
In short, IPM researchers working within the context of the Green Revolution must accept that all technology is contingent upon the socio-economic (including institutional) environment in which it is used. If this environment lacks the possibility of supporting technology adoption with critical services, then it is necessary to design IPM recommendations accordingly.

722 90 - 10/89

Plant protection
USA, California, avocado, dying back, study, traditional methods

WAGER, V.A.

***Phytophthora Cinnamomi* and wet soil in relation to the dying-back of avocado trees.**

Hilgardia, 14, 9, 1942, pp. 519-531

A dying back or decline of avocado trees has been a serious problem to growers in some parts of southern California.
The possibility that at times the decline of the trees is caused by too much water, cannot be overlooked.
Cultures were made from 156 roots from affected avocado trees growing in seven different localities.
The *Phytophthora* species found in the cultures was identified as *Phytophthora Cinnamomi* Rands. The *Pythium* species were identified as *Pythium vexans* de Bary (on 20 roots) and *Pythium ultimum* Trow. Two other fungi which very frequently appeared in these cultures were *Fusarium oxysporum* Schl. and *Cylindrocarpon radicicola* Wr.
A series of experiments was therefore planned with the idea of simulating possible field conditions, where, as a result of continuous heavy rains or faultry irrigation practice, the soil becomes flooded and waterlogged for a short period of time. Tests were primarily with *Phytophthora Cinnamomi*, but a few tests with *Pythium vexans* were included in experiments.
Concluding, it appears to be recognized fact that avocado trees cannot stand excessive water at their roots. Dying-back, or decline, of the trees can generally be expected under such a condition, whether this be the result of faulty irrigation practice, heavy or continuous rains, a leak in a pipe line, or lack of drainage due to impervious subsoil fairly near the surface. Dying-back may occur even in sandy soils under excessively wet conditions. Many of the roots may be destroyed without apparently affecting the tree until several months later, when, with drier weather, the depleted stock of roots is unable to supply the tree adequately with nourishment, and dying-back becomes evident. The cause of the decline may then appear baffling, for at that time no sign of the excessive water conditions can be observed or would perhaps even be suspected.
The results of the present experiments may possibly throw some light on the problem. Too much water, alone, may not be the cause of the death of the roots, for it would seem that the fungus *Phytophthora Cinnamomi* plays an important part. The results of these experiments have confirmed those of earlier tests and show that this fungus does not attack the roots or affect the health of plants grown in soil where drainage is good and water is not excessive. But when the roots are allowed to stand in nonmoving water for even as short a period of time as 24 hours, they become susceptible to attack by the fungus; and the longer the period, the more drastic the results.

723 90 - 10/90

Plant protection
Review, brochure, neem tree, natural insecticides, pest control, caterpillars, larvae of beetles, grasshoppers, plant- and leafhoppers

GTZ

Nim un insecticida natural. (Neem a natural insecticide).

Publ. of German Agency for Technical Cooperation (GTZ) GmbH, Postf. 5180, 6236 Eschborn 1, F.R.G., 1989, 35 pp.

The neem tree (*Azadirachta indica* A. Juss) thrives almost anywhere in the tropical lowland, up to 800 m above sea level. It is resistant to extreme drought and grows where the annual rainfall is as sparse as 300 mm. Moreover, it grows very quickly and makes few demands on the soil fertility. The neem tree, therefore, grows in a wide variety of places. Hilltops and infertile, depleted land (e.g., eroded hillsides) are as suitable as stony, flat land or hard laterite. The neem tree may be used to line avenues, to border roads or fields and in mixed cultivation with fruit trees.
The average annual fruit yield from a mature neem tree is above 20 kg. Apart from insecticides, neem oil may be extracted from the seed. 30 kg neem seeds produce 6-8 kg oil. The resulting residue can be used to make insecticides in a similar way as from the whole neem seeds described earlier.
All parts of the neem tree can be utilized. Insecticidal substances are present in various parts of the tree; the highest concentrations are, however, contained in the seeds.
Azadirachtin, the most important insecticidal substance contained in the plant, has, even in very small doses, a growth disrupting effect on many insect larvae, i.e. insects which eat this substance are unable to develop to the next larval/nymphal stage and die off. Other pests, such as grasshoppers, avoid or reduce feeding as a reaction to azadirachtin. As tests have repeatedly confirmed, due to its special mode of action, the neem extract is quite harmless for useful insects. Unlike synthetic pesticides, tests carried out over a longer period indicate that development of any resistance to the neem extract is in the short term unprobable. However, where intensive vegetable cultivation is practiced, the exclusive use of neem extract is inadvisable.
One great advantage of the neem extract is that even after repeated application on vegetable crops, it remains perferctly harmless for humans.
Apart from its previously described application for storage protection, neem oil is extremely suitable for the manufacture of soap. The oil is processed into soap in the usual way with potash or soda.
This brochure contains information on the use of insecticides from the neem tree. It shows how substances which are already present in nature can be used to control and drive away caterpillars, larvae

of beetles, grasshoppers, plant- and leafhoppers and other plant pests.
Further information is available from the coordinator of the project:
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