Key points

- All stakeholders need to be involved in a partnership to develop effective sustainable systems for cocoa production.
- Farmer 'reluctance' to take up research generally reflects inappropriate research recommendations.
- Participatory approaches provide the knowledge and confidence for farmers to make their own crop management decisions.

partnership to develop effective sustainable systems for cocoa production. Farmers are often seen as 'reluctant' to take up research recommendations. But generally this reflects a lack of understanding on the part of research and extension of the constraints under which cocoa farmers operate.

Farmer participatory training aims to give farmers the agroecological knowledge and the confidence to make their own crop management decisions, rather than following (sometimes inappropriate) recommendations. Farmers conduct experiments to evaluate or adapt new technologies, based on their own needs and circumstances. The extension officer becomes a facilitator rather than a messenger. Greater farmer involvement at all stages of the research process from setting the agenda to interpreting the results allows for better relationships between all stakeholders and ensures the research agenda is relevant to the needs of the farmer.

Farmer participatory approaches to training and research in cocoa have been successful in Central and South America, and a project is under development in Ghana.These approaches have demonstrated effective methods of promoting sustainable crop management.

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PAN UK web site sets out cocoa pests and its diseases in more detail, www.pan-uk.org

We are grateful to tony Little for compiling this PMN, and for the support of the CABI Bioscience Technical Support Group to the Global IMP Facility, which is funded by the Swiss Agency for Development and Cooperation (SDC)

PESTICIDE ACTION NETWORK *UK*

Sustainable cocoa production systems, PMN Nº 12, July 2001.This briefing is one of a series prepared by Pesticide Action Network UK(PANUK), which is responsible for its contents, as consultants to DG Development of the EC. PAN UK is an independent charity working to reduce pesticide problems in developing countries. Its quarterly journal Pesticides News reports on pesticides and IPM.

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PEST MANAGEMENT NOTES *No.12*

Sustainable cocoa production systems

A briefing for the IPM in Developing Countries Project funded by the European Commission (Environment in Developing Countries budget).

Cocoa is a crop of small-holder farmers, but low prices and high input costs have had a major impact on production and incomes.This briefing looks at sustainable options for farmers.

Cocoa and chocolate

Cocoa is believed to have originated from several localities in the area between the foot of the Andes and the upper reaches of the Amazon, in South America. It was being grown in eh region at least 1000 years ago by the Maya Indians who roasted the seeds (or beans), producing an aroma so divine they believe the tree was a gift from the god Quetzacoati. From the roasted beans, they made a drink,m often used in ceremonies and rituals, call xocolati, from which he word 'chocolate' is derived. More than a millennium later, chocolate is big business. Consumers in the US alone eat between 1-1.4 million tonnes every year, and the annual global trade in confectionery, of which chocolate ha the lion's share, is estimated at about US$80 billion. Cocoa is a vital export crop for many countries, particularly in West Africa. It is also a major foreign exchange earner for some Central and South American countries and, to a lesser extent, for South and Southeast Asia.

A cocoa farmer making agro-ecological observations in Ghana. Photo: Julie Flood.

The chocolate tree

The cocoa tree belongs to the genus Theobroma, meaning 'food of the Gods' in Greek. There are several species in this genus, but only one, Theobroma cacao, is grown commercially. The bast majority (estimates vary from 70% to 90%), is grown by smallholder farmers cultivating less than three hectares,a nd the remainder is grown on estates. Cocoa is a forest plant,a nd has evolved to grow under shady conditions. Most is still grown under shade trees including: forest trees left standing after the initial clearance of land; food crops such as plantain; herbaceous plants and shrubs; and specially planted shade trees. Some cocoa, particularly in Côte d'Ivoire, is grown in direct sunlight. Under this system trees are more productive in he short term. However, management requires much higher inputs, partly because some insect pests and weeds are much more problematic tan in shady conditions,a nd production is lower in the long term.

Cocoa in crisis

The cocoa market is notoriously volatile and world prices have plummeted over the last 20 years, dropping from a high of about US$4000 a tonne in 1979, to about US$880 a tonne in October 2000.This, combined with the high cost and limited availability of inputs and lack of workable credit facilities in many areas has led to, at best, minimal profit margins for small farmers. Many farmers have virtually abandoned their cocoa trees, only investing the bare minimum of time and money to maintain the crop. This neglect has exacerbated many pest and disease problems such as cocoa capsids, cocoa swollen shoot virus (CSSV) and black pod disease.

Sustainability is an economic necessity

Pest and disease management in cocoa has been heavily reliant on chemicals. In Ghana, for instance, the government mass spraying campaign to control capsids between 1959 and 1962 used lindane (a highly persistent, toxic insecticide, since banned in many countries) at no cost to the

farmer. This contributed to high production in the 196/65 season, but quickly became unsustainable economically and logistically. Current recommendations suggest farmers spray lindane four times a season for capsid management,a nd spray copper-based fungicides up to seven times a year to control black pod. But most farmers cannot afford to treat their cocoa, or make only one or two application a year. With no prospect of substantial price increases, ti is imperative that crop management approaches are low cost and sustainable to bring even marginal financial benefits to farmers.

Options for sustainable cocoa production

Maintaining crop hygiene

Keeping the crop 'clean' is probably the single most important method for managing key cocoa diseases,. Removing and destroying harvested and diseased or infested prods can substantially reduce black pod, particularly that caused by Phytophthora palmivora. In Southeast Asia this practice can help reduce levels of the cocoa pod borer (Conopomorpha cramerella) in the subsequent season. In Ghana destroying trees visibly affected by CSSV and their symptomless neighbours is the most effective way of controlling this disease. In South America monitoring and removing pods infected with frosty pod disease is very effective, although early action is essential. Pruning and destroying infested branches is very important for managing local problems.

Using resistant varieties

Cocoa varieties with resistance to various pest and disease problems have been developed. In Latin America, Centro Agronómico Tropical de Investigación y Enseñanza (CATIE) maintains the largest cocoa germplasm collection in the world and is engaged inb reeding resistance for witches' broom. Efforts in West Africa have focused on black pod and CSSV resistance. The identification and development of cocoa varieties that are tolerant or resistant to capsid damage has potential and could be incorporated into breeding programmes.

A typical cocoa cropping system in Ghana including food crops as temporary shade-trees. Photo: Janny Vos

Managing shade

The impact of some pests can be reduced by managing shade. Sunny conditions and light shading (10 large or 15 medium trees per hectare),m can help reduce capsid damage. Maintaining shade can reduce weeds and some parasitic plants that attack cocoa and, with pruning, is one of the most effective ways to manage mistletoes in Africa. Shade trees, particularly forest trees left after clearing the land, have a very important role to play in the conservation of the forest and associated fauna. When all forest trees have been removed, fast growing, permanent shade trees such as Gliricidia sepium, Terminalia ivoirensis, Ricinodendron leuclotii and Spathodea campanulata may be planted, Food crops such as bananas and plaintains,a nd herbaceous plants and shrubs can provide temporary shade in young plantations.

Biological Control

Most o the work on biological control to manage cocoa diseases has been focused on Central and South America. It takes two distinct approaches. On the one hand, non-pathogenic fungi can be applied to the trees to reduce the levels of infective spores (the inoculum) of disease-causing fungi. In Ghana, certain species of the fungus Trichoderma have been found to inhibit growth of the black pod under laboratory conditions. A commercial formulation of Trichoderma stromatiucum, developed by CEPLAC (Comissão Executiva do Plano de Lavoura Cacaueira) in Brazil, is on he market to control witches' broom. Farmers are using the technology enthusiastically.

The second approach introduces a beneficial fungus into the tissues of the cocoa tree. The fungus has no deleterious effect on the plant, but helps protect it by attacking the pathogen or inducing resistance. CABI Bioscience is investigating the potential of several such fungi to control witches' broom in South America.

The potential of natural enemy species for biological control of insect pests is being investigated. Malaysia has had considerable success controlling cocoa mirids Helopeltis theivora with the black ant Dolichoderus thoracicus.

With regard to biopesticides, there are still a number of technical, commercial and conceptual issues that need to be addressed before they can be used more widely. Amongst perceived constraints are that they kill only a very narrow range of pests, poor performance relative to cost,and inconsistent product quality.

Rational Pesticide Use (RPU)

Rational pesticide use aims to reduce harm to human health and the environment, together with the expense of pesticide use. Important approaches are improved timing and targeting of pesticides, and using biologically specific products. Spray application of pesticides (biological or chemical) is usually highly inefficient, and the techniques used by smallholder farmers for tree crops, including cocoa, is often especially poor,. Many farmers use knapsack prayers fitted with nozzles that 'squirt' the tank mixture onto higher branches: most of the liquid then falls back onto the ground and is wasted. CABI scientists are building a database on the performance of appl ication equipment currently in use.

The use of biopesticides for cocoa may provide ideal technical solutions, but effective products are not available for all pests. In the short term the question remains 'What would b e recommended if cocoa prices were to rise dramatically enough for farmers to want to use pesticides again?' Unfortunately there has been very little impartial research into pesticidal control over the past decade. For diseases, most farmers would still resort to copper fungicides which are neither particularly effective nor environmentally sound. Since the days of high cocoa prices whole new chemical classes of compounds have been introduced to the chemical pesticide market. Patents on useful native ingredients, such as triazole fungicides, have expired, raising the prospect of using products that were previously considered too expensive. The short to medium term goal is therefore to assemble a 'tool kit' of practical, efficient and safe solutions to key problems, and encourage farmers to adopt them.

Maintaining fertile soils

There is often little or no effort to replenish the lost nutrients in soil. Experiments in Nigeria and Ghana have shown that judicious use of inorganic fertilisers can improve production. However, relying solely on inorganic fertilisers has a number of problems: they are relatively expensive, and many cocoa farmers cannot afford to buy them; and the organic matter in the soil becomes depleted after long periods of cultivation leading the the solid becoming acidic and unproductive.

Mulching with organic material such as cocoa pod husks and the use of leguminous plants as cover crops, which also smother out weeds, are options for maintaining good fertile soils. Cocoa pod husks are an excellent source of nutrients, and composting them provides a cheap source of organic fertiliser.

Developing sustainable systems

An important lesson of the last few years is that all stakeholders ne3ed to be involved in

Major pest and disease problems of cocoa

Globally, there are many hundreds of insects and pathogens recorded on cocoa. Of these, only a faction is economically important, and diseases, rather than insects, are the biggest pest problem.

Black pod infected pods. Photo:Mark Holderness

Fruiting bodies of Crinipellis perniciosa, which causes witches' broom. Photo:Harry Evans

Cocoa diseases

Black pod is an important fungal disease in Africa, responsible for estimated losses of about 44% of global production every year, and attacks pods at all stages of their development.Brown pod rot is much less serious, and can only infect through a wound, or through infections caused by other diseases. Cocoa swollen shoot virus (CSSV) in Africa is transmitted by sucking pests, mostly mealybugs. It affects leave and pods and causes stem and root swellings, with losses up to 25% in the first year and dieback within 2-3 years. Witches'broom is a major constraint in Central and South America.A fungus attacks developing buds or flowers forming structures called 'brooms' and can cause almost total crop loss. Frosty pod, or monilia pod rot, in the Americas affects younger pods. Damage varies from less than 25% to total loss of production. Vascular streak dieback, caused by the fungus Oncobasidium theobromae, is a problem in South and Southeast Asia. It attacks the vascular tissues which transport water and nutrients around the plant:new shoots of infected plants rarely grow more than 20cm before dying.

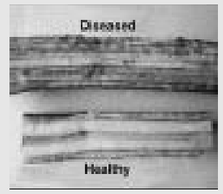
Insect pests

Cocoa capsids (Distinthiella theobromae and Salbegella singularis) in West Africa are the most important insect pests, In outbreak years losses can be up to 75%.Mealybugs (Planococcus and Stictococcus spp.) in West Africa are mainly a problem as vectors of CSSV: other inset pests include shield bugs, leaf hoppers and thrips. Pod borers, such as te cocoa moth are very important, particularly in South nd Southeast Asia.The larvae bore into the soft tissues in the pod wall. Pod borers are occasionally pests in Africa, as they help to spread damaging diseases.

Parasitic plants

Mistletoes thrive in bright sunlight and low moisture, and are a particular problem in West Africa in young plantations established after the primary forest is cleared.

Frosty pod disease. Photo:Harry Evans



Vascular streaking. Photo:Chris Prior