AGROECOLOGY CASE STUDY

*A famer standing with **Tithonia diversifolia***
Propagating Securidaca longepedunculata

Using Pesticidal Plants for Pest Management in Africa

Pesticidal plants, also referred to as botanical pesticides, have been used for centuries for pest management. Evidence of their use in agriculture dates back to Greek, Roman and Egyptian empires. They were the main method of crop pest management in modern times until the development of synthetic pesticides in the mid-twentieth century. Synthetic pesticides were designed to overcome many of the problems with natural plant products, i.e. to be more stable and resist breakdown by sunlight and to be generally fast acting. Although synthetic pesticides can work very well, overuse and misuse of synthetics has led to considerable human and environmental health problems. This calls for a shift in pest management towards practices that are more sustainable and based on sound agroecological principles

Challenge

Food production and storage are limited by numerous constraints. Insect pests are a constraint over which even the poorest farmers can have some direct control with low-cost interventions. When left unmanaged, insects cause severe damage to crops and livestock.

Commercial insecticides are usually effective but have limited distribution in rural areas. Worse still they are often adulterated (diluted to ineffective concentrations by unscrupulous traders) or applied at inappropriate application rates due to illiteracy and poor labelling. Synthetic pesticides are becoming increasingly ineffective as pests are growing more resistant to their effects. Health and safety is also a serious issue since insecticides are typically applied with no protective clothing. There is no mechanism to ensure food safety for consumers, and little concern for the lasting effects of exposure. The environmental impact for wildlife, crop pollinators and natural enemies is also severe, while the cost of quality synthetics is high. Farmer surveys about synthetic insecticides in Africa highlight that all of these problems are well understood by farmers. Many are now avoiding commercial products altogether and looking to alternatives. Pesticidal plants, already used widely across Africa, are a proposed alternative to synthetic chemicals for the control of pests. Their promotion, with improved application practices, better access to plant materials through propagation and cultivation, and superior delivery services, could have a considerable impact on pest management and ultimately food security.

A boy spraying synthetic pesticides without protection

A bottle of endosulphan, a synthetic insecticide, with degraded label, making instructions for use impossible to read

Although there are regional and cultural differences in practice, plant materials are generally known by farmers to be environmentally harmless, safer, and more cost-effective when compared to synthetic pesticides. They are also difficult to adulterate, particularly when produced or harvested by farmers. Most persuasive of all is that their cost to farmers is much lower than synthetic products and can be calculated simply in terms of time to harvest and process. Generations of farmers have used plants in this way, making the technology familiar, trusted and acceptable. However, compared to synthetic pesticides, pesticidal plants are a low priority in agricultural policy. This is due to knowledge gaps as well as the lack of commercial incentives or revenues to drive policy and uptake. Successful commercialisation has been realised for some products such as Pyrethrum and Neem. However, various constraints hinder the large-scale uptake of pesticidal plants, particularly extending knowledge on how best to use them, the quality and reliability of control to be expected, and whether they are cost-effective. Optimising the use of pesticidal plants by understanding the chemistry of the plants, how best to process and apply them, as well as their limitations and reliability can help inform farmers, giving them more sustainable choices for their pest management needs.

Process

At the Natural Resources Institute of Greenwich University, we have used a multi-disciplinary approach to tackle the various bottlenecks and constraints limiting the uptake of pesticidal plants for pest management. Areas of focus are:

1. Knowledge on the chemistry of different plant species that are traditionally used for pest management. This is necessary for understanding whether the plants are safe (some plant compounds are toxic to humans), whether the compounds can be extracted in water, and how quickly the compounds may break down. It is also important to be able to understand how the chemistry varies according to season/location of collection

2. Lab, field and farmer participatory trials to evaluate the efficacy of different pesticidal plant species. Trials in many African countries determined the best ways of collecting and processing plants, what concentrations to use, efficacy on different crops and insect pests, cost-benefit analyses in comparison to using synthetics or doing nothing. Trials looked at the use of pesticidal plants in different systems, e.g. crop production, post-harvest protection, livestock parasite control, and investigating impacts on ecosystem services (effects on pollinators, predators).

3. Availability: some plant species used for pest management are commonly available, e.g. weeds. However, others have been over-collected or have suffered from habitat degradation through overgrazing, bush fires, timber collection or unsustainable harvesting methods. Some of the rare indigenous species are difficult to propagate. We investigated ways of growing these species and conservation strategies that could help improve their natural supply and/or cultivation on farm land margins.

*Sieving a pesticidal plant mixture of **Tephrosia vogelii**, soap and water. A botanical farm trial in Malawi*

> Our family's maize store now lasts about three months longer since we started using '*Palaga*' (*Securidaca longepedunculata*) powder to keep out weevil infestation. The quality of the maize remains excellent even after nine months of storage.
> **Mrs Bintu Atarigiya, Farmer, Bawku, Ghana**

> We thank the research team for coming to our village to show us how to use pesticidal plants to protect our tomato and bean plants. Several of the plant treatments really reduced insect numbers and we could see that these resulted in much higher yields than the untreated plants.
> **Moses Timve,Farmer, Mitundu, Malawi**

4. Commercial issues such as enabling farmers to grow and sell pesticidal plant products to other farmers
This has not been straight forward as pesticidal plants are regulated in the same way as synthetic products in all African countries. So, although the same plant species are often found in traditional medicines which people readily consume, there are considerable difficulties in allowing people to sell pesticidal plant products to spray on crops or mix with their stored grain. Further challenges here are related to developing local value chains in pesticidal plant production and marketing that ensures quality.

It is very important to understand the chemistry of plants and to undertake experimental trials to understand how certain plant species perform under local conditions.

Because there is considerable natural variation in plants, it is not always easy to guarantee the same plant is equally effective in all locations for all farmers and all crop pests. Using pesticidal plants is not like using a synthetic pesticide and farmers can do their own experimentation to find the best local plants and application methods. Pesticidal plants will not often kill insects as quickly as synthetics or may simply repel insects or stop them from feeding and damaging plants. Using them for crop pests may require repeated applications because the compounds can break down more quickly than synthetics. Thus, encouraging farmers to innovate and observe the effects of using pesticidal plants is very important for extending knowledge on the use of pesticidal plants for crop protection.

Recommendations

General recommendations when using pesticidal plants for pest management:

1. Collect different plant parts. Active ingredients vary in different plant parts for different plant species, so it is important to research the plant species intended for use. For many species, the leaves are most effective, but sometimes it can be flowers, fruits, seeds, bark or roots. Collecting leaves is generally sustainable, while collecting other plant parts can reduce the long-term sustainability of the plant. Using bark or roots should be avoided unless the plant is plentiful and known to grow quickly and propagate easily. Care should be taken, when using flowers, seeds and fruits, that not all are removed so that the plant can continue to propagate. With some weedy, invasive plant species there is generally no danger of over-collection and collecting for use as a pesticide could be considered very beneficial to the environment.

2. Shade-dry the materials. Avoid drying in sun as sunlight breaks down the active chemicals in the plant.

A farmer holding ***Dolichos kilimandschuricus***

Using freshly collected plant material can work, but the water content reduces effectiveness. In some cases, when smelly plants are used as repellents, fresh material may be more effective. Dry materials should be stored in dry, dark conditions, where they can keep for several months and be applied when needed.

3. Grind and sieve plant parts to a fine powder shortly before use. Grinding increases the extraction of the plant chemicals. Whether using pesticidal plants in powder form or making a water extract, the finer the powder the better. Farmers should do this in a well-ventilated area, wearing a mask or cloth over the face to avoid breathing in the dust. An exception to grinding may be in the case of using some smelly plants in post-harvest protection where using whole material can lead to a slower release of chemicals that repel insects over time.

> I am happy to let you know that we managed to get farmers from the coast (Kwale, Kenya) to plant Neem (*Azadirachta indica*) seedlings. The nurseries are planted by youth groups. On the 14th May 2015, with the said youth groups, we are planting 2500 Neem seedlings for its pesticidal benefits.
> **Mrs Asinatu Gamaliel,Foundation Coordinator, Kenya Tea Development Agency (KTDA) Foundation**

Results

Increased crop yield
Several demonstrations with farmers on tomato, bean, brassicas and other vegetable crops have shown that pesticidal plant applications increase yield when compared to doing nothing about pest management. In some cases, yield has been higher with pesticidal plants than when using commercial synthetic treatments.

Increased cost-benefits
Pesticidal plant species are relatively easy to process and apply, particularly when farmers use abundant weedy species that are growing nearby their crop fields. The equivalent monetary costs of inputs (time and labour) required for collecting and processing pesticidal plants, are lower than the cost of purchasing the usual synthetic pesticides. As pesticidal plants generally work as well as synthetics in terms of yield, the marginal rate of return is more cost-beneficial.

Increased ecosystem services
Several demonstrations have shown that pesticidal plants have much less impact on predators of pests in comparison to synthetics. This is one reason why yields remain comparable with synthetics despite the lower effectiveness of pesticidal plants. Pollination is also less affected, and this can mean even higher yields for some crops in comparison to synthetic pesticide use.

More and higher quality stored produce
Many farmers sell their stored produce quickly as they are often unable to maintain quality during on-farm storage due to insect damage. Using pesticidal plants means that farmers can store their produce for longer. This means they are able to get a higher market price later in the season and can sell higher quality grain, fetching higher prices. Families who don't sell their produce will have more food for longer. The nutritional quality of food treated with pesticidal plants is higher (as insects normally eat the germ of stored produce), thus improving food security. Using pesticidal plants in storage can also reduce the prevalence of moulds and aflatoxins that affect quality and food safety.

Going Forward
We know that pesticidal plants work, are cost-effective, sustainable and safe. Our experience is that certain cultural groups in Africa are already well equipped with knowledge on how to use them. In fact, many African farmers are already routinely using pesticidal plants for pest management. However, because of language barriers and communication problems, the knowledge is not always shared. So there is a role for State actors, NGOs and extension groups to help spread the word and knowledge on how to use pesticidal plants. Preserving and passing on traditional knowledge in Africa is a challenge that must be overcome.

> As organic farmers we have always used local plants for pest control in our family. We encourage many wild plant species to grow on our fallow land and field margins that we can use as pesticides. We can then harvest them as needed. Many of the plants have other uses too such as increasing soil fertility (*Tephrosia vogelii*) or their flowers (*Tithonia diversifolia*) helping support pollinators that maximise our crop yields.**Mr Jones Thompson,Farmer,Choma, Zambia**

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