

Ecological pest management for emerging pest problems

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Since the beginning of agriculture, around 12 000 years ago, humans have been struggling to reduce the adverse effects of pests on crop production and storage. The development of synthetic pesticides revolutionised pest management in agriculture. However, ecological and human health risks, together with the economic costs of heavy reliance on chemical pesticides have become more apparent. In this context, it is relevant to recall Julian Huxley's lines in his preface to Rachel Carson's revolutionary book, "Silent Spring": "Pest control is of course necessary and desirable, but it is an ecological matter, and cannot be handed over entirely to the chemists".

Meghalaya, a small state in the North Eastern region of India, is inhabited by different indigenous communities, mainly of Mongoloid origin. Of the approximately 2.3 million population, about 85 percent live in rural areas and depend on agriculture for their livelihood. Due to physiographic features, shifting cultivation and *Bun* cultivation (raised beds on slopes) have been the predominant forms of agriculture. Traditional fallow periods of 20 - 30 years have now reduced to 3 - 5 years, mainly due to pressure from increasing populations. In response to this, the state government introduced the settled form of agriculture called wet rice cultivation during the 1980s. Farmers were encouraged to use high yielding varieties and subsidised agro-chemicals. This led to a dramatic increase in the total cropped area in the state: an increase of about 42 percent during the last twenty-five years.

The emerging pest problems

Many studies indicate that fewer pest problems are experienced in shifting cultivation due to its inherent management practices, such as mixed cropping, fallowing and rotation. In contrast, continuous monocropping in settled cultivation is reported to contribute to the build-up of pests and diseases. The introduction of wet rice cultivation in Meghalaya has also brought new pests to the area. The Indian Council of Agricultural Research for North Eastern Hill Region, while studying the pests in upland

agriculture, found that paddy grown in shifting cultivation fields are almost free from insect pests, while those grown in semi-terraced lands had moderate incidences of the gundhi bug (*Leptocoris oratorius*). On the contrary, crops grown in terraces were found to be attacked by a number of pests in addition to the gundhi bug, like stemborers, the rice hispa, rice caseworms, leaf folders and hoppers. Farmers say that the terrace cultivations initially provided good harvests. However, infestation of paddy by different types of pests previously unseen, soon became a major cause of concern.

The extension and support delivery systems in the state are comparatively weak. This is probably due to poor infrastructure and the lack of extension personnel willing to work in remote, harsh areas. Even where such services are available, the upland people often cannot afford to use these services. Traditionally, farming was done for subsistence rather than for commercial benefit, and the farming system was self-sustainable with zero external inputs. Though the newly introduced settled cultivation is also mostly carried out for subsistence only, it depends on costly and inaccessible external inputs, making it much less sustainable. This is a matter of serious concern among those farmers who have adopted wet rice cultivation on a larger scale, as their long-term survival is at stake.

Participatory research was carried out to document and assess the traditional pest management practices followed by the three dominant tribes of the state: Khasi, Jaintia and Garo, inhabiting the West Khasi Hills, Jaintia Hills and West Garo Hills respectively, and to assist them in sustainable food grain production in an ecofriendly manner. The study was started in 2002 through the IFAD-funded North Eastern Region Community Resource Management Project for Upland Areas, and is still ongoing through other small grant projects.

Farmer's response

The innovative nature of indigenous communities can be seen among the farmers of Meghalaya, and is evident from the array of pest management methods they have developed to control different kinds of pests which came along with the newly introduced settled wet terrace paddy farming. Most of these methods were developed and are being developed based on locally available resources. The methods are environmentally friendly because chemical pesticides are not used, and most importantly, because they have strong foundations in well-established biological and ecological principles.

For instance, the use of fruit bearing trees to attract predatory birds (Box 1) by the Garos of the West Garo Hills district is a clear demonstration of sustainable biological control of pests. Unlike the conventional biological control methods in which the introduced predator or parasite itself may become a problem, the sustainability of the traditional method appears to be high, as it uses local plants to attract local predators. Such methods further reflect the community's understanding of food web linkages and population interactions. They harness the help of predators to remove the pests – a basic ecological principle of population control that operates in a natural ecosystem. Another important ecological principle implicit in this method is the conservation of flora and birds, even though it is not perceived by the farmers.

Box 1. Planting of fruiting trees in and around crop fields to attract predatory birds

Farmers of the West Garo Hills plant fruit bearing plants like *Bridelia retusa*, *Dendrophthoe falcata*, *Morus macroura* and *Sapium baccatum* in terraces, sometimes in home gardens and *jhum* fields. These plants attract predatory birds by providing shelter and food. The birds eventually keep pest populations down by feeding on the different kinds of insect pests, mainly larvae, caterpillars and nymphs. Though no-one can identify who started this method, the farmers unanimously agree that its development is linked with the traditional activity of hunting. A long time ago, while hunting in the forest, farmers noticed that some birds prefer particular plants, and that these birds were also seen to feed on caterpillars as well as small insects. Those farmers tried planting these plants near the crop fields, to see whether the birds would feed on the insect pests. These methods are now commonly practised. The farmers' philosophy about this method is simple: "We arrange food and shelter for the birds, in return they take care of our pests"

Rats are also controlled by employing the same principle. Branches, preferably of bamboo, are put in terraces. They act as a resting place for owls at night, which will keep the rat population in check.

The Khasis of West Khasi Hills practice another interesting method, and use cow's blood to repel birds from paddy fields. A small bird species, locally known as *phreit*, comes in flocks and damages the paddy, breaking the tillers. Usually it destroys the crop during the maturation period. To stop this, farmers put fresh cow's blood in a bamboo pipe. The pipe is tied with a stick and is placed in the paddy fields. According to the farmers, after 2 or 3 days the blood starts to emit a smelly gaseous substance, which acts as repellent to the birds. This practice also suggests an understanding and exploitation of the principle of animal behaviour, as it seems to mimic situations where alarm behaviour of the birds is used to prevent crop damage.

Perhaps the most widely-used of all the traditional pest management practices is the use of decomposing crabs to control rice bugs (as the filling of paddy grain starts, locally available crabs are smashed and put on pointed bamboo sticks in terraced paddy fields). This is practised throughout the entire state by all communities. An in-depth study of the practice suggests that it is an exploitation of the principle of food preference. This practice is environmentally friendly, as some farmers replace the crab baits as soon as they dry up, which otherwise may lead to elimination of the bug species from the natural ecosystem – not desirable from a conservation point of view. It also conserves water, as collecting the crabs lessens the



Photo: Sangita Roy

The crab bait traps can be used in combination with other traditional methods of managing pests.

loss of water through crab holes. Though other small animals like snails or frogs can also be used to attract the bugs, crabs are believed to be more effective. On-farm trials of the method

Traditional ecological management of

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Potato is an important crop in the state of Meghalaya, India, occupying a major place in the agrarian pattern as well as in the dietary habits of the population. However, the average productivity here is only 9.2 t/ha, far below the national average of 18 t/ha. Factors like rainfed conditions, non-availability of quality seed, and high disease incidence, contribute to the present poor yield level. Potato is grown in two consecutive seasons: summer is the main potato-growing season that extends from February to June-July, while autumn extends from July-August to November-December.

Common potato cultivars

Khasi tribal farmers grow improved potato varieties as well as local varieties. They usually grow a mix of these varieties according to their characteristics and suitability. For example, *Kufri Jyoti* is a high yielding potato cultivar which covers over 50 percent of the total potato growing area in the state. Farmers prefer this variety for its taste and better cooking and keeping qualities. Initially it was highly resistant against late blight, however it has recently become very susceptible, causing low yields. *Kufri Megha* is another popular variety, liked for its taste and cooking quality. However, it is slow bulking and long duration, so it cannot be included in all the crop rotations farmers use. Farmers realise that its high resistance against late blight helps assure production, and therefore income.

Hence, even if this variety is out of the breeder's seed production chain, farmers maintain its seed independently. *Kufri Giriraj* is a recently introduced variety. It is high yielding as well as resistant to late blight, and is gaining popularity. However, farmers are still doubtful about it, owing to its poor keeping quality and short dormancy.

Late blight is the major potato disease in Meghalaya. It appears in epidemic form every year around the second week of May, and causes total crop damage within 15 - 20 days of appearance. In cases of severe incidence, even the stem and tuber are affected. The affected leaves turn from green to brown or black, get dry and develop white cottony growth on the underside. The disease continues till October, affecting the summer as well as the autumn potato crop. However, the damage is higher in the autumn crop as it affects the crop in the initial growth stage.

Farmers' wisdom of traditional late blight management

Through experimentation, farmers have evolved a unique way to cope with the late blight menace. They have utilised the limitations in potato cultivation to their benefit, by adopting different crop rotations in low-lying areas and on hill slopes. In low-lying areas, farmers practise a potato-paddy rotation, whereas on hill slopes a potato-potato/vegetable rotation is followed.

For the management of the potato-paddy rotation in low-lying areas, farmers follow two practices. Firstly, they plant potatoes

revealed that by using a crab of 2.5 x 3 cm size as bait, 80 - 85 bugs can be trapped per 5 m² in five days. Impressed by the effectiveness of the method, the state government has recommended its inclusion in the formal plant protection package. They are promoting a modified trap through agricultural bulletins, and at farmer trainings. The modified technique has been incorporated in the IPM recommendations for rice bugs, and is being successfully implemented in the entire state. Though there are no figures about how many farmers have adopted the customised trap, many farmers simply use the crabs in the traditional way. In all, the whole farming community can benefit from the renewed interest in age-old traditional methods.

The way ahead

The above descriptions are just a few of the hundreds of traditional ecofriendly pest management practices developed by the traditional farmers of Meghalaya in response to the pest problems emerging from the newly introduced wet terrace cultivations. The uniqueness of these practices is their suitability to the local conditions; they are inexpensive and easy to implement. The farmers state that when they use these methods in combination, they can be very effective. As different practices are used for the same purpose (pest) at the same time, one practice complements another, resulting in less pest damage to the crops. To be recommended for wide-scale use, however, these traditional practices need further evidence and modification. Nevertheless, integration of the authenticated traditional methods and their wider applicability may ensure

a more sustainable and higher return from the fields – a step towards the reduction of rural poverty and hunger. Lastly, if the pest problems are taken care of, wet rice cultivation may prove to be a good alternative form of cultivation for the traditional farmers of Meghalaya in particular, and shifting cultivation areas in general.

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late blight in potato

comparatively early (by the first or second week of February), and harvest it in the first fortnight of June. After harvest, farmers prepare land and sow paddy by the end of June. In this way, the potato crop has three months to mature before it dies with late blight incidence. Secondly, in these low lying areas, the *Kufri Jyoti* variety is used. Although it dies before full maturity, *Kufri Jyoti* yields well, and damage to the crop is minimised by early planting and harvesting. This also allows for timely planting of paddy. After harvest, farmers sell the potato crop immediately, and fetch a premium price for the early harvest. This compensates for the yield loss due to early harvesting and late blight damage. Supplementing the practice of early planting of potato, farmers do not spray any fungicide for late blight management. Thus, potato is harvested in the first week of June and ecological sustainability is ensured.

Khasi tribal farmers select seed potato from the crop grown on the hill slopes, saying that disease incidence is lower there. These potato varieties also suit the crop rotations used on the slopes, and meet the requirements for seed potato. The majority of the farmers do not spray fungicide on hill slopes as they prefer to harvest early so as to prepare land for the second crop, such as cabbage or cauliflower. Farmers perceived that spraying fungicides on the crop could lead to increased duration of the crop, which is unfavourable for this cropping sequence. In addition, spraying the crop with fungicides may not greatly increase its yield, as late blight appears in a

devastating form by the second fortnight of May and the entire foliage of the crop is destroyed by the first week of June. By this time sufficient tuberisation has already occurred in the crop. Thus, spraying summer crops with fungicide is felt not to be cost effective.

Implications

Farmers' traditional methods for managing the potato late blight in the Meghalaya hills are successful examples of ecological disease management and an established outcome of traditional experimentations. Such farmers' wisdom ought to be given attention in formal research systems. Moreover, by avoiding chemical fungicides, but rather working with the conditions they face, they are encouraging local ecological sustainability, which is important in such rainfed and hilly areas. This provides an opportunity for late blight management scientists to examine and validate such practices.

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