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Preparation of neem biopesticides at farm level

1. GENERAL INFORMATION

I.I Title of practice or experience

Preparation of neem biopesticides at farm level

1.2 Category of practice/experience and brief description

The neem tree is indigenous to India. Indians have revered the neem tree for a very long time. To millions of Indians, neem has miraculous powers. Indian farmers have kept away insects with different neem extracts. The tree is considered so invaluable that it is found in every part of the country, every roadside, every field and almost every house. India has shared its "free tree" and knowledge of its utilisation with the world community. The freedom of diverse species to exist and the freedom of people to exchange knowledge about them are best symbolised in the neem.

After the introduction of chemical agriculture, the use of such neem-based extracts and other products has diminished to a large extent. Farmers have been made more and more dependent on chemical inputs and have lost confidence in their age-old methods. However, the current crop of pests has developed resistance to a wide range of pesticides available. Farmers are thus caught in a vicious circle the moment they start using chemicals.

The Centre for Indian Knowledge Systems (CIKS) has attempted to identify the technologies that farmers were using for pest control before chemical agriculture came into the picture. It has tested these technologies in farmers' fields and developed them in such **a** way that farmers can be totally self-reliant with these technologies. They need no longer be dependent on the pesticide companies. The preparation of these products is extremely simple, as is their application. In terms of efficiency, these products are very good and, in certain cases, are even more efficient than the commercially available products.

1.3 Name of person or institution responsible for the practice or experience

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1.4 Name and position of key or relevant persons or officials involved

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1.6 Name of person and/or institution conducting the research

As in 1.3 above

1.7 Details of research person/institution

As in 1.5 above

2. THE PROBLEM OR SITUATION BEING ADDRESSED BY THE PRACTICE/INNOVATIVE EXPERIENCE

The Persian name for the neem of India is Azad-Darakth or the "free tree". Its scientific name, *Azadiracta indica*, is in fact derived from Azad-Darakth. The Indian people have for millennia used this tree in agriculture, public health, medicine, toiletries, cosmetics and livestock protection. However, there is a threat that the "free tree" will no longer be free. The Azad-Darakth is now the intellectual property of Western scientists and corporations. Patents have been granted for products and processes based on the various properties of neem.

These properties of the neem have been known and have been in use for centuries in India. Even the processes that have been patented are only minor modifications of those that have been used for centuries to prepare extracts.

How can we protect the people's right to neem and ensure that common people continue to derive benefits from this tree centuries into the future as they have done in the past? Defending people's rights in an age of biopiracy needs a two-pronged strategy – a strategy of resistance to global monopolies and a strategy of rejuvenation of local traditions.

The technology and practices that are being promoted are aimed at rejuvenating local low-cost use of neem as a biocontrol agent. It is meant to serve as a sustainable-agriculture initiative. The Centre for Indian Knowledge Systems has been involved in various efforts relating to the use of natural products for pest control and crop protection. Over the last several years, the centre has conducted a series of seminars and workshops for farmers, voluntary organisations and academics to propagate the use of neem.

CIKS has been involved in an effort to test the efficacy of different plant extracts, such as those of neem, in farmers' fields. Currently, a number of neem products are commercially available in the market. CIKS' work has been to see that the extracts developed by farmers in their own backyards are as efficient as or more efficient than what is available in the market. Its motive has been one of self-reliance. This is also an innovation which is economically viable for small farmers.

3. DESCRIPTION OF THE PRACTICE/INNOVATIVE EXPERIENCE AND ITS MAIN FEATURES

Neem has attracted worldwide attention in recent decades mainly due to its bioactive ingredients that find increasing use in modern crop and grain protection. Research has shown that neem extracts have an effect on nearly 200 species of insects. It is significant that some of these pests are resistant to pesticides, or are inherently difficult to control with conventional pesticides (floral thrips, diamondback moth and several leaf miners). Most neem products belong to the category of medium- to broad-spectrum pesticides, i.e., they are effective over a wide range of pests.

The practice describes a range of neem products such as the neem leaf extract, the neem seed kernel extract, the neem cake extract, the neem oil emulsion and also neem in combination with other plant extracts for the control of a variety of pests. The technologies using neem are extremely simple and these products can be made by the farmer in his own backyard. They have been tested in the farmers' fields and satisfactorily proven to be effective in controlling a wide range of pests. They have also been used in controlling stored grain pests.

Preparation of extracts

Neem kernel extract

Fifty grams of neem kernel are required for use in 1 litre of water. The neem kernel is pounded gently in such a way that no oil comes out. The outer coat **is** removed before pounding. This is used as manure. If pounded with the seed coat on, one and a half times the amount of seeds (75 g) is required. The seeds that are used for the preparation of neem kernel extract should be between three and eight months old. Otherwise, the quantity of azadirachtin in the seeds is quite low and hence they cannot be efficiently used for pest control. The pounded neem kernel powder is gathered in a muslin pouch and soaked overnight in water. The pouch is squeezed and the extract is filtered. To the filtrate, an emulsifier like khadi soap solution (a soap with no detergent) is added. One millilitre of emulsifier is added to I litre of water. The emulsifier helps the extract to stick well to the leaf surface.

Remarks: The kernel extract should be milky white in colour and not brownish. The kernel extract does not control sucking insects like aphids, white flies and stem borers. In these cases, one could use the neem oil spray solution.

Neem leaf extract

For 5 litres of water, 1 kg of green neem leaf is required. Since the quantity of leaves required for the preparation of this extract is quite high (nearly 80 kg are required for 1 hectare), this can be used for nursery and kitchen gardens. The leaves are soaked overnight in water. The next day, they are ground and the extract **is** filtered. The extract is suited for use against leaf-eating caterpillars, grubs, locusts and grasshoppers. To the extract, emulsifier is also added.

Remarks: The advantage of using neem leaf extract is that it is available throughout the year. There **is** no need to boil the extract since boiling reduces the azadirachtin content. Hence the cold extract is more effective. Some farmers prefer to soak the leaves for about one week, but this creates a foul smell.

Neem cake extract

A hundred grams of neem cake are required for 1 litre of water. The neem cake is put in a muslin pouch and soaked in water overnight. It is then filtered and an emulsifier is added at the rate of 1 millilitre for 1 litre of water, after which it is ready for spraying.

Neem oil spray

Thirty millilitres of neem oil are added to the emulsifier and stirred well to ensure that the oil and water can mix well. After this, 1 litre of water is added and stirred well. It is very essential to add the emulsifier with the oil before adding water. It should be used immediately, otherwise oil droplets will start floating. **A** knapsack sprayer is better for neem oil spraying than a hand sprayer.

Pongam, aloe and neem extract

One kilogram of pounded pongam cake, 1 kg of pounded neem cake and 250 g of pounded poison nut tree seeds are put in a muslin pouch and soaked overnight in water. In the morning, the pouch is squeezed and the extract is taken out. This is mixed with 1/2 litre of aloe Vera leaf juice. To this, 15 litres of water are added. This is again mixed with 2-3 litres of cow's urine. Before spraying, 1 litre of this mixture is diluted with 10 litres of water. For an acre, 60-100 litres of spray are used. This is effective in the control of pests of cotton and crossandra.

Custard apple, neem, chilli extract

Five hundred millilitres of water are added to 2 kg of ground custard apple leaves and stirred. This is filtered to get the extract and the filtrate is kept aside. Separately, 500 g of dry fruits of chilli are soaked in water overnight. The next day, this is ground and the solution filtered to get the extract. One kilogram of crushed neem fruits is soaked in 2 litres of water overnight and the extract is filtered. All the three filtrates are subsequently mixed with 50-60 litres of water, filtered again and sprayed over the crops.

Note: For all the above extracts, 250 millilitres of khadi soap solution should be added as an emulsifier before spraying.

General remarks about spraying

(a) Spraying should be undertaken in the morning or late in the evening. Under hot conditions, the frequency of spraying should be increased. In winter, spraying once in 10 days and every day in the rainy season is recommended.
(b) Insects lay eggs on the underside of the leaves. Hence it is important to spray under the leaves also.

(c) While using a power sprayer, the quantity of water used should be halved.
(d) It is better to use low concentrations of extracts frequently.
(e) As a general guideline, it can be said that each acre of land to be protected can be sprayed with 60 litres of ready-to-use solution (not the concentrate). Of course, the volume may have to be varied depending on the exact conditions prevailing, such as the intensity of the pest attack.

Treatment of stored grains

Grains and pulses can be stored by mixing them with neem products like dried leaf powder, kernel powder or oil. The neem oil used against stored grain pests should be 1% by weight of the grain. If the grain is used for seed purposes, 2% can be used. Using oil is easier than using leaves. The active ingredients of the neem plant are located in their maximum amounts in the seed and kernel.

Treatment of jute bags for storing grains

The jute bag is dipped into a 10% neem kernel solution (here, no emulsifier need be added to the solution) for 15 minutes. After having been dried in the shade, the bag can now be used for storing grains. The stored grain pests will be repelled by the action of neem. If the jute bags are new, they should be soaked for half an hour. For jute bags with close meshes and small pores, a thinner solution can be used. It should be ensured that the bags are soaked on all sides in the extract. If the seeds or grains are kept inside the house or in a godown, where the temperature is stable and sunlight minimal, longer residual action of the neem product is obtained and the repellent effect will persist for four months. In storerooms, along with the cowdung that is used for cleaning the mud floor, neem cake or neem oil can be used straightaway (in the same concentration as used for spraying purposes). The same could also be used for the mud walls. Neem cake solution or neem kernel extract could also be sprayed. If one is using bamboo bins for storage, then one can paint the bins with a solution prepared from neem cake. To the dry neem cake powder, water is added, and a thick paste of this is painted all over the grain bin. If one wishes to store it for more than four months, the process should be repeated every four months.

Neem products work by intervening at several stages of the life of an insect. They may not kill the pest instantaneously but incapacitate it in a number of ways. The precise effect of various neem extracts on insect species is often difficult to pinpoint.

Biological effects of neem on insects

The action of neem products as pest control agents can be manifested at different levels and in different ways. This is a very important point to be noted since the farmer would be used to the "knock-out'' effect of chemical pesticides. Neem extracts do not exhibit this type of effect on pests but affect them in several other ways.

Insect growth regulation

Regulation of the insects' growth is a very interesting property of neem products which is unique in nature, since the products work on juvenile hormones. The insect larva feeds and as it grows, it sheds its old skin. This particular shedding of old skin is the phenomenon of ecdysis or moulting and is governed by an enzyme, ecdysone. When the neem components, especially azadirachtin, enter the body of the larva, the activity of ecdysone is suppressed and the larva fails to moult, remains in the larval stage and ultimately dies. If the concentration of azadirachtin is not high enough, the larva will die only after it has entered the pupal stage. If the concentration is lower still, the adult emerging from the pupa will be 100% malformed, and absolutely sterile.

Feeding deterrent

The most important property of neem is feeding deterrence. When an insect larva sits on a leaf, it will want to feed on it. This particular trigger of feeding is given through the maxillary glands. Peristalsis in the alimentary canal is thus speeded up, and the larva feels hungry and starts feeding on the surface of the leaf. If the leaf is treated with a neem product, because of the presence of azadirachtin, salanin and melandriol, there will be an anti-peristaltic wave in the alimentary canal which produces something similar to a vomiting sensation in the insect. Because of this sensation, the insect does not feed on the neem-treated surface. Its ability to swallow is also blocked.

Oviposition deterrent

Another way in which neem controls pests is by preventing the females from depositing eggs. This property is known as oviposition deterrence, and comes in very handy when the seeds in storage are coated with neem kernel powder and neem oil. The seeds or grains obtained from the market may already be infested with some insects. Even these grains could be treated with neem seed kernel extract or neem oil. After this treatment, the insects will not

feed on them. Further damage to the grains will be halted and the female will be unable to lay its eggs during the egg-laying period of its life cycle. There are also other known modes of action:

(a) the formation of chitin or the hard part covering the insect (exoskeleton) is inhibited;
(b) mating as well as sexual communication are disrupted;
(c) larvae and adults of insects are repelled;
(d) adults are sterilised; and
(e) larvae and adults are poisoned.

The use of neem products does not give immediate results, unlike chemical insecticides. Some patience is required after the application of neem products.

Besides its insecticidal and nematicidal properties, neem is also a promising agent for control of plant diseases. It has also been demonstrated to possess anti-fungal properties.

One of the problems with the use of chemical pesticides has been their impact on "non-target" species. Often they have proven harmful to various other species in the ecosystem that could be beneficial. However, neem extracts are devoid of these effects.

Neem leaves and seed kernels, when incorporated into potting soil containing earthworms, increased the earthworm population by 25%. Neem products have proven to be remarkably benign to spiders and also other insects such as bees that pollinate crops and trees, ladybug beetles that consume aphids, and wasps which act as parasites on various crop pests. Neem products have to be ingested to be effective. Those insects which feed on plant tissues, therefore, easily succumb. However, natural predators like spiders feed only on other insects while bees feed on nectar. Hence they rarely come in contact with significant concentrations of neem products.

4. DESCRIPTION OF THE INSTITUTION RESPONSIBLE AND ITS ORGANISATIONALASPECTS

The Centre for Indian Knowledge Systems is an institution devoted to exploring and developing the contemporary relevance and application of traditional Indian knowledge systems. One of the major activities of the centre has been action research and training programmes on the use of natural products for pest control and crop protection. **A** number of plant products, including neem, have been tested out in farmers' fields. The institution currently conducts a fairly large number of training programmes for farmers and non-governmental organisations (NGOs) on the use of non-chemical methods for pest control and crop protection.

CIKS also has been practising organic farming in its field centre in a village near Madras. Here, it has been demonstrating the use of neem and other plants for the control of a variety of pests. Training is also provided in this field station. **A** number of publications on the use of neem and other plant products have been brought out by the centre. It also publishes a newsletter called *Pesticide Post* which talks about alternatives to pest control and crop protection. The centre also works on the setting up of rural gene banks for the conservation of traditional seed varieties, development of the use of biological control agents for the control of pests in the paddy ecosystem and domestic pests, and research on the applications of Vrkshayurveda (traditional Indian plant science). **A** study of the indigenous breeds of cattle of Tamil Nadu and their status and efforts to propagate them is also ongoing.

The centre is also involved in research and publications on medicinal plants. From time to time, training programmes on the use of traditional medicine for various groups are also conducted. The centre also currently publishes newsletters, manuals and monographs on traditional health care and traditional agriculture.

5. PROBLEMS OR OBSTACLES ENCOUNTERED AND HOW THEY WERE OVERCOME

Farmers have gotten used to purchasing pesticides/fertilisers as a prepared product from a shop rather than preparing them themselves. They have been conditioned to use these prepared products which they can pick up from the shelves. They are also used to the knockdown effect of the chemical pesticides. They are currently in a situation where they have lost confidence in their own technologies.

Initially, farmers were sceptical about the efficacy of the extracts which were prepared in their backyards. They were used to buying pesticides from shops rather than preparing them themselves. Some of them initially felt that preparing these extracts would be quite laborious and would increase their workload. They also felt that only a product that is available commercially would work well. Farmers are also used to the knock-out effect of chemical pesticides while plant-based pesticides such as neem do not work in the same way. These extracts may cause disturbances in the physiology of the insect, rendering it inactive. Although the insect might still be present in the plant, it would not cause any harm. But the farmer may not be convinced about this, hence the need for education. After several demonstrations over a period of time, however, the farmers were quite convinced of the efficacy of these products. They were also attracted by the economics of the technology.

6. EFFECTS OF THE PRACTICE/INNOVATIVE EXPERIENCE

This practice of farmers making their own neem-based products for pest control would reduce their dependence on external inputs for agriculture.

It would also bring down their cost of pest control to almost zero, leaving only labour as a potential expenditure item. Pests can also be controlled without the use of toxic chemical pesticides, which will reduce the harm posed to humans and the environment alike.

There is wide scope for innovation in developing neem. There is enough information to encourage the use of different neem extracts. Currently a number of formulations manufactured by companies are also available in the market. The aim of CIKS throughout has been to provide users with recipes for preparing neem extracts on their own – for use in agriculture.

A few companies may secure patents for products and processes that have been developed out of centuries of experimentation and innovation by Indian farmers. There is also the danger that the raw material in the form of neem seeds and leaves may be cornered in large quantities by commercial operations. This may render what was once a commonly available product into a scarce resource, with the farmer having to compete for it with large commercial firms. In this context, the current effort of dissemination of farmer-based technologies is equally important since it is combined with action at grassroots levels to plant neem, and to disseminate and strengthen its use in the context of agriculture.

7. SUITABILITY AND POSSIBILITY FOR UPSCALING

The neem products can be manufactured on a cottage scale in the village by the villagers themselves. The seeds can be collected by village women and youth, providing them with a supplementary source of income. Besides this, pure neem products can be made available for pest control. Small oil expellers can be installed at village level for manufacturing pure neem oil. Efforts can be made to utilise landless labourers in the manufacturing process on a cottage scale, giving them an additional source of income. This also ensures that the products are available to the other farmers when required. There is also a good market for neem oil and neem cake.

8. SIGNIFICANCE FOR (AND IMPACT ON) POLICY-MAKING

A number of plant-based commercial products have come into the market in recent years manufactured by medium-sized laboratories. However, so far, there has been no attempt to acquire ownership of formula since under Indian

law, agricultural and medicinal products are not patentable.

In the last few years, a sudden enthusiasm has erupted from the West to study the pesticidal properties of neem and other plants. Several **US** patents have been issued for neem-based solutions. P.J. Margo has set up a plant in India which will process neem seed for export to the **US,** which has a pesticides market worth an estimated **US$2** billion. At the moment, biopesticides such as pyrethrum, together with their synthetic mimics, constitute about **US$450** million but this figure is expected to rise over **US$800** million by 1998. Making money out of the neem ought to be relatively easy.

Various companies claim that their respective projects benefit the Indian economy by providing employment opportunities at the local level and higher remunerations to the farmers. This is due to the increase in prices of neem seeds and other plant products as a result of the value added during the production process.

The increase in the price of plant products is now turning a hitherto often free resource into an exorbitantly priced one, with local users now competing for the products with an industry supplying consumers in the North. As the local farmer cannot afford to pay the high price, the diversion of seed as raw material from the community to industry will ultimately establish a regime in which a handful of companies holding patents will control access to the raw material and the production process.

The current technology and practices described are aimed at protecting people's right **to** these plants and ensuring that common people continue to derive benefits from these plants centuries into the future as they have done in the past. Providing and experimenting with authentic information to rejuvenate self-help techniques based on plant products in the context of agriculture, especially plant protection, is an immediate need. The current practice and innovation fulfils this need.

The use of non-chemical methods for pest control and crop protection is already gaining importance in several countries, including India. The integrated pest-management programmes developed and promoted by the government departments have the use of botanicals such as neem extracts as one of their major components. The governments are also promoting the manufacture of plant-based pesticides today. If an effort is made towards production of neem products on a cottage scale, this can be an economically viable option for unemployed youth in the village. Rejuvenating the local low-cost use **of** neem can also defend people's rights in an age of biopiracy – a strategy of rejuvenation of local traditions.

9. POSSIBILITY AND SCOPE OF TRANSFERRING TO OTHER COMMUNITIES OR COUNTRIES

Neem as an alternative to chemical pesticides has been used in several parts of the world. The experience of Indian farmers can be easily transferred from community to community. The technology that is being promoted is extremely simple and is easily transferable. **A** neem manual produced by CIKS has been translated into Tamil and Hindi. There is also a request from Ethiopia for translation into the Arhanic language. Farmers from different parts of the globe can experiment with this technology and can share experiences with each other for improving it.

10. OTHER COMMENTS

CIKS has come out with a user's manual on neem authored by K. Vijayalakshmi, K.S. Radha and Vandana Shiva. This is currently being used by a number of farmers, NGOs and other extension workers from across the world. The Centre also produces a number of other publications on plant-based pesticides. These publications are also being used by a large number of NGOs and extension workers and are being produced in the local language and Hindi. There are efforts to undertake research on increasing the shelf life of these neem extracts using village-level technology. The Centre has also established a unit for preparation of neem oil and neem cake in a village it is working with. This unit currently caters to nearly 30 villages around that area.

List of publications of the Centre on plant-based products:

1. Vijayalakshmi, K., K.S. Radha and Vandana Shiva, (1995) *Neem: A User's Manual,* Centre for Indian Knowledge Systems, Chennai. 96 pp.
2. Vijayalakshmi, K., B. Subhashini and Shivani Koul, (1996) *Plants in Pest Control: Garlic and Onion,* Centre for Indian Knowledge Systems, Chennai. 38 pp.
3. Vijayalakshmi, K., B. Subhashini and Shivani Koul, (1996) *Plants in Pest Control: Persian Lilac,* Centre for Indian Knowledge Systems, Chennai. **30** PP.
4. Vijayalakshmi, K., B. Subhashini and Shivani Koul, (1997) *Plants in Pest Control: Pongam, Tulasi and Aloe,* Centre for Indian Knowledge Systems, Chennai. 33 pp.
5. Vijayalakshmi, K., B. Subhashini and Shivani Koul, (1997) *Plants in Pest Control: Turmeric and Ginger,* Centre for Indian Knowledge Systems, Chennai. 34 pp.

6. Vijayalakshmi, K., B. Subhashini and Shivani Koul, (1997) *Plants in Pest Control: Tobacco, Papaya and Thumbai,* Centre for Indian Knowledge Systems, Chennai. 33 pp.
7. Vijayalakshmi, K., B. Subhashini and Shivani Koul, (1998) *Plants in Pest Control: Custard Apple,* Vitex, Sweet Flag and Poison Nut, Centre for Indian Knowledge Systems, Chennai. 34 pp.