Food and Agriculture Organization of the United Nations

How to buffer impacts of climate variability and dry spells in home gardens by using botanical pesticides and liquid compost, Cambodia

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Summary

Chemical insecticides are usually used to fight pests and save the crops from damage. However, chemical pesticides are harmful to farmers' health and to the environment. An alternative to chemical insecticides is botanical insecticides, which are made from plants and are useful against insect pests without harming the environment or having side effects on famers' health.

This practice, in preparing botanical insecticides, allows farmers to sustainably minimize insect damage to crops, especially during more frequent and severe outbreaks that are expected to happen as a result of climate change and increased climate variabilities. Additionally, this practice describes how to prepare composts for soil enrichment, thereby improving yield and productions of fruit trees and vegetables, and also help to reduce the input cost of chemical fertilizers.

Description

1. Background

Due to climate change, Cambodia faces more and more frequent droughts and floods as well as higher temperatures and more humidity. These conditions will be problematic for Cambodians in many ways. Droughts and floods threaten food security. Therefore, it is important for farmers to adopt new technologies to sustain their crops through such conditions.

Protecting crops from pests is crucial and may become even more serious as climate change causes more severe and frequent pest outbreaks. A hotter and wetter climate represents an ideal condition for the expansion of several pests and pathogens.

In order to protect crops from pests, farmers use chemical insecticides. However, in Cambodia, there is still a healthy balance of beneficial and destructive insects. It is therefore important that farmers are careful when eliminating pests in their fields.

A poor use of chemical pesticides can harm beneficial insects and microorganisms. Therefore, there is a need to move away from the use of chemical insecticides in order to protect the existing balance and the environment.

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1.1 Botanical Insecticide

Botanical insecticides are an attractive alternative to synthetic insecticides because they are environmentally friendly and do not have negative effects on health. They are derived from plants and are useful against insect pests in crops and gardens.

The advantage of botanical insecticides is that even though they may be toxic to certain insects when applied, they break down into non-toxic compounds when exposed to sunlight. Furthermore, some ingredients could be found locally around the farmer's house/village.

There are several ways to prepare botanical insecticides by using different plant materials. They are divided into four groups depending on their methods of controlling pests: poison the pests, irritate the pests, discourage pests from eating, and make pests sick through ingestion of the insecticide.

2. Production of botanical insecticides

The steps to produce and apply the botanical insecticide are as follows:

2.1 First Step: Grow or collect the plants needed

The following plants are used as botanical insecticides (see also sample Figures below).

- Poisonous plants: yam (tuber); wood star gooseberry (bark); strychnine plant (fruit/bark); downy thorn apple (fruit) and derris (leaf).
- Irritating plants: chili (fruit) (Figure 1) and galangal (rhizomes).
- Unpalatable plants: boraphed (Figure 2) and neem (fruit/bark).
- Upset stomach of pest: basil; custard apple (bark); dodder and Siam weed.

Figure 1. Selected chilli (plant)

Figure 2. Selected boraphed (plant)

2.2 Second Step: Grow or collect the plants needed

Chop up the collected plant material into small pieces (Figure 3). Ideally, the pieces shouldn't be bigger than 3 cm. Next, put them in a clay jar (or any other container made of plastic or cement) which can hold a minimum of 560 litres and can be sealed.

The amounts of each plant used for the botanical insecticide are indicated in the table below. These are recommended quantities, but slight variations depending on availability of specific plants will not affect the efficacy of the botanical insecticide. Add 30 to 50 litres of animal urine and 100 litres of water (Figure 4).

Figure 3. Farmers chop plants into small pieces

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Figure 4. The small pieces are put into a plastic tank

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Table 1. Botanical insecticide material

Categories	Plant name	Weight (kg)
Poisonous	Yam (tuber)	3 Kg
	Wood star gooseberry (bark)	5 Kg
	Strychnine plant (fruit/bark)	5 Kg
	Downy thorn apple (fruit)	4 Kg
	Derris (leaf)	3 Kg
Irritating	Chili (fruit)	2 Kg
	Galangal (rhizomes)	2 Kg
Unpalatable	Boraphed	3 Kg
	Neem (fruit/bark)	5 Kg
Stomach Disruption	Basil	0,5 Kg
	Custard apple (bark)	1 Kg
	Dodder	2 Kg
	Siam weed	2 Kg

Source: Cambodia HARVEST, 2012

2.3 Third Step: Fermentation

After allowing the ingredients to settle in the jar overnight night, add 200 litres of water. The next day, add another 200 litres of water. Mix up the solution and seal the jar. Leave the mixture for 15 to 20 days fully covered to be fermented (Figure 5). Note that during this time it is important to stir the solution for ten minutes each day.

Figure 5. The solution is left to ferment for 15 to 20 days

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2.4 Fourth Step: Making the solution

After fermentation, filter the solution through a cloth. Then mix one litre of the insecticide solution with 15 litres of water. Next, add 5 g (half of a spoonful) of laundry detergent. Thoroughly mix the solution together.

2.5 Fifth Step: Utilization/ Application

Botanical insecticides can be used on all vegetables and rice to control and manage pests. Spray the insecticide on the crops at least two times a week. It is recommended to dilute 1 litre of the insecticide produced in 'Step 4: Making the solution' with 100 litres of water. It is best to spray in the late afternoon or evening. It is also important to make sure the insecticide is also sprayed under the leaves, as this is where most pests hide. With time, the botanical insecticide gradually loses its power so it's best to use it within one month after fermentation.

3. Benefits of Botanical insecticides

Botanical insecticides are recommended for farmers to control pests on their crops.

In terms of benefits, the farmers contribute to a safer environment, save the costs of chemicals, and reduce health risks to themselves and their family, and even consumers.

Botanical insecticides are nontoxic to the environment because the toxicity breaks down when these insecticides are exposed to sunlight. Food is also safer for households since it contains no chemical residues.

Farmers must use more labour but spend less on purchased other inputs, thus resulting in a cost reduction at farm level per unit of production. Lower production costs may therefore result in a better profit margin for the farmer.

Many farmers in all areas of Cambodia have used botanical insecticides and these practices are promoted by several NGOs. Botanical insecticides are locally made and are recommended by the Cambodian NGO Srer Khmer as an appropriate technology for Cambodia's sustainable agriculture in the future.

3.1 Recommendation for use

Botanical insecticides are just a repellent for insects, so it is suggested to farmers to keep monitoring their crop and apply the insecticide timely to prevent damage.

4. Compost fertilizers to help increasing soil moisture and fertility and counteract the impacts of droughts

Composting is a low-cost practice and is easy to produce. The application of compost fertilizers is crucial in the context of the traditional farming system in Cambodia. Composts are used in back-yard farming and home gardening for soil enrichment, improving yield and productions of fruit trees and vegetables. It can also help to reduce the input cost of chemical fertilizers. Compost has significant positive impacts on dry spells and agricultural droughts since it increases and maintains the soil moisture which reduces water needs.

There are many different methods of composting, but the process is the same. Micro-organisms break down raw, organic materials, such as kitchen scraps, urine and animal waste, plant stalks, crop residues, poultry and fish waste, straw and so on. Depending on different factors, including the raw materials used and the temperature within the compost pile, composting can take two weeks to three months and produces a rich, black organic fertilizer.

Microorganism activity that carries out the composting process may be stimulated by managing the carbon to nitrogen ratio, amount of oxygen and moisture, the pH balance, and temperature within the compost pile. Properly managed composting increases the rate of natural decomposition and generates sufficient heat to destroy weed seeds, pathogens, and fly larvae.

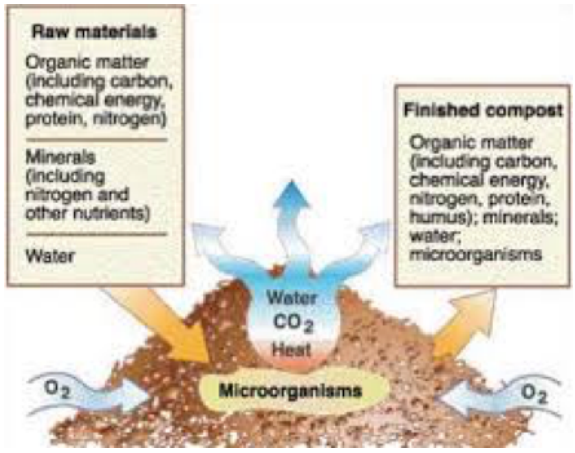
While Cambodian farmers may not have the means necessary to control these characteristics precisely, there are several basic recommendations that may be followed to promote a healthy carbon to nitrogen ratio, the correct temperature, as well as oxygen and moisture levels. Some of these recommendations are listed below in the section outlining the implementation of heap composting.

There are several ways to compost. Some of the most common methods are composting in a cage, heap or pile, pit, or creating compost in a liquid state. Each of these methods takes a different amount of time to produce compost. All of the methods however require organic materials, such as Siam weed (*Chromolaena Odorata*), plant

stalks, kitchen scraps, fish and poultry scraps (cooked and uncooked), animal wastes, and straw that can be collected from around the house at little or no cost.

Among them, the heap composting and liquid composting are the most preferable compost methods in Cambodia. It is easier to construct with locally available materials in relatively short time. It can be applied to all kinds of crops while economically improving farmer's returns.

Figure 6. Compost pile or heap,



Source: Organic Garden Info, 2013

5. Heap compost production steps:

5.1 First Step. Selection of the compost site

The compost pile should be situated in the fruit tree garden or vegetable garden and near the pigpen or cowshed (if present) to minimize the time needed to transport animal waste needed for compost production, and where access to water is easy. It is best to make it in the backyard to avoid the smell.

5.2 Second Step: Construction of a compost shelter

After choosing the location, build a compost storage or compost shelter to prevent the compost pile from drying out too quickly, and protect it from heavy rains. Some farmers build a compost shelter in the backyard of their house. This practice is not only helping farmers to save the organic materials, but also helps to keep the area around their houses clean and free of organic litter.

Compost shelter is composed of two elements:

1. the cement or clay "container" where the organic material will be deposited, and the compost will be formed (recommended size: 2 m x 3 m); and
2. the zinc roof to protect the pile.

It could cost about USD 70 to USD 100 but will last for many years.

Another low-cost alternative is using clay to build compost shelter with palm leaves or coconut leaves roof, this could cost about USD 15.

Figure 7. Compost shelter

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5.3 Third Step. Preparation of the raw materials

Collect, cut or chop the raw organic materials into small pieces of dry and fresh materials. Some materials that may be used are plant scraps, animal wastes, food wastes, and straw. Then place those materials into compost shelter.

5.4 Fourth Step. Preparation of the compost

The compost pile is formed by layers of organic materials such as cow and poultry manures, plants, rice straw, chicken wastes. This material is put into the "container" in the shelter and new organic material is added every day until the pile is 1 m high. Farmers are recommended to keep the used water from the kitchen to water their collected organic material daily.

5.5 Fifth Step. Mixture of the layers of compost

Seven to ten days after arranging the substance as a pile, the compost will become hot. It should be stirred up and turned over. If the compost is not heating, fresh animal manure (in case of dry manure, water it a little bit) should be added and mixed in.

The compost pile should be stirred and turned every week if possible or every ten days. This will provide the proper amount of oxygen and help the pile reach the correct temperatures. After two months or three months (it depends on the types of raw materials used) the compost should have cooled down and is ready to use.

5.6 Points to remember when making heap compost

- It is good to make a heap in the rainy season when there is plenty of green plants such as weeds and other organic materials and when there is plenty of water available.
- The compost heap should be on the ground with its base in a shallow trench to hold the foundation layer.
- The compost-shed can be made under the shade of a tree and covered with wide leaves or plastic in order to protect the heap from strong winds and raining and from damages or washing away.

6. Steps for liquid compost production:

6.1 First Step: Preparation of materials:

Collect and chop Siam weed and mix with fresh cow manure (Figure 8). The quantity of Siam weed is about two buckets and one bucket of fresh cow manure.

Figure 8. Fresh cow manure

Figure 9. Bin of 300 litres for storing liquid compost

6.2 Second Step: Mixture of the raw materials

Put the chopped Siam weed and fresh cow manure into the sack and tie it tightly. Use a bin or water container of 150 or 300 litres for storing liquid compost.

Next leave the sack in the bin with 100 to 250 litres of water depending on the quantity of the Siam weed and manure and the storage size of the bin. Then place a stone above the sack in order to press it down and enable the materials inside the sack to decompose.

6.3 Third Step. The use of liquid compost

The liquid compost should be stirred two to three times per day. This will provide proper amount of oxygen and help the compost to reach the correct temperatures. After 10 to 14 days, the liquid compost is useable. It is recommended to apply one litre of liquid compost mixed with four litres of water and apply it at the base of the vegetables when it is not too hot, preferably in the evening.

7. Preliminary results for the joint good practice botanical pesticide in combination with liquid compost

The performance of this joint good practice was assessed at farm-level in Cambodia. The net benefits obtained from producing vegetables using botanical pesticide and liquid compost were measured through a cost-benefit analysis (CBA), and compared to the net benefits of the usual home gardening practice.

The CBA calculates the cumulative net benefits obtained from 1 m^2 of vegetable garden over a period of 11 years (ten percent discount rate), as well as the benefit-cost ratio (BCR), which is the ratio between total discounted benefits and total discounted costs over the appraisal period.

Figure 10 provides an overview of the outcome of the CBA. In particular, it shows that:

- the good practice brings 18 percent higher net benefits as compared to the usual practice;
- and the BCR of the good practice (1.9) is higher than the BCR of the local practice (1.8), meaning that the good practice brings greater benefits relative to costs, as compared to the usual practice.

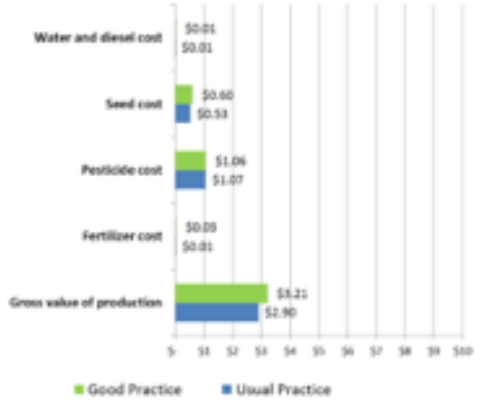
The assessment was conducted in farms that were not affected by hazards during the monitoring period.

Figure 11 provides additional comparative information on the costs and benefits of the good practice and the local practice. The costs and benefits are presented as discounted average annual values per each square meter of home garden.

Figure 10. Cumulative Net Benefits and Benefit-Cost Ratio of GPO as compared to Local Practice, 2015-2025

Source: FAO 2017

Figure 11. Average Annual Costs and Gross Value of Production (USD/m^2)



Source: FAO 2017

7.1 Additional results

7.1.1 Sustainability

All farmers interviewed except one said they would replicate the GPO in the coming seasons.

A woman farmer is not sure about replicating the good practice because she would need more help.

7.1.2 Knowledge

100 percent of farmers interviewed considered that they acquired new knowledge by taking part of the project and implementing the GPO.

7.1.3 Socio-economic benefits

Most farmers found that this good practice brings several benefits, including more crop production (86 percent), more income (86 percent), better and more diverse food (96 percent), more resistance to climate constraints (79 percent), and safer livelihood practices (64 percent).

7.2 Economic and Social feasibility

7.2.1 Benefits

For botanical insecticides:

- Very low cost simply produced from locally available plants.
- Reduced input costs from purchasing chemical insecticides.
- No health and environmental side effects compared to chemical products.

For compost fertilizers:

- Easy to make using locally available resources such as cow and poultry manure, kitchen wastes, Siam weed and to name just a few.
- Low cost to produce compost and saves money from purchasing chemical fertilizers.

7.2.2 Cost

For botanical insecticides:

- It takes at least two weeks to be useable.
- Botanical insecticide works best for one month after fermentation when it has become liquid.
- Some farmers want immediate results, so it takes time and efforts to convince them.

For compost fertilizers:

- It takes time to be ready to use (at least from 10 to 20 days).
- It is hard to find organic matters in the dry season, and it might also be a challenge for farmers who do not possess cattle.
- Compost is more suitable for small home gardens, but it might be difficult to apply for big commercial farms as it requires a large amount of compost.
- Making solid compost can be labour intensive, and it might be a challenge for female-headed households.

7.2.3 Suggestions

For botanical insecticides:

- As botanical insecticides take time to be useable, it is suggested that farmers prepare botanical insecticides well in advance before growing vegetables.

7.3 Increasing resilience

7.3.1 Benefits

For botanical insecticides:

- Botanical insecticides are not just repelling insects, but also boosting plants to grow well and fresh.

For compost fertilizer:

- Organic materials in compost help to maintain soil moisture and improve soil the structure.

- Using compost fertilizer reduces the need for irrigation of crops due to a higher soil moisture retention capacity and thus saves 10 to 15 percent of irrigation water.

7.3.2 Suggestions

For botanical insecticides:

- Botanical insecticides are just a repellent for insects, so it is suggested to farmers to keep monitoring their crop and apply the insecticide timely to prevent damage.

7.4 Environmental Suitability

7.4.1 Benefits

For botanical insecticides:

- Safer alternative approach to manage insects on vegetables: farmers feel safe and confident as it is made of organic matters.
- Reduce health risks to farmers themselves, their families and consumers.
- No chemical residue remaining on plants.

7.4.2 Suggestions

For botanical insecticides:

- Follow bio-security precautions (e.g., do not spray in windy or rainy days, keep away from food and water sources, use clean and undamaged equipment) while applying botanical insecticide as farmers would when using chemical insecticides.
- Rinse the vegetables thoroughly to remove any substances that may remain before eating crops.

8. Validation of the practice

Lessons learnt from demonstrations of botanical insecticides and compost fertilizers.

8.1 Kampong Speu

Thirty botanical insecticides were tested and in combination with liquid compost and home gardens.

Seventy two solid compost demonstrations combined with SRI (sustainable rice intensification).

8.2 Oddar Meanchey

60 botanical insecticides were tested and combined with liquid compost and home gardens.

Statement of a farmer about the Good Practice Botanical Insecticide.

8.3 A farmer's experience

Mrs. Pach Sarim, a 35-year-old farmer with four small children living in Toul Prasath village, Tomnub Dach Commune, Trapaing Prasath District, Oddar Meanchey Province.

"Before, I used chemical insecticides for my vegetables, and it made me feel dizzy sometimes after spraying as I was not wearing a mask to protect myself. After learning at the Farmer Field School (FFS) of the DIPECHO II project organized by the Provincial Department of Agriculture, I started preparing botanical insecticides for my home garden.

I find it easy to apply because I have all of the required organic plants around my house. With organic insecticides, I observed that they are not only repelling insects, but it also make my vegetables grow well, and keep the leaves soft and green. I feel safe with them and do not worry about chemical residues remaining on my vegetables, which could have harmful effects on the health of family members and I, particularly my lovely children".

8.4 Statement of a farmer about the Good Practice Heap Compost

Mr. Yin Nheuk, 64 year old farmer living in Krous village, Kraing Chek commune, Odong district, Kampong Speu province.

"At first, I thought it is useless and costly to build a compost shelter. But after learning from PDA, I wanted to try this practice. I spent USD 90 to build the compost shelter size 2 m x 4 m with an aluminium roof. I find it easy to store all organic matters such as cow and poultry manures, kitchen wastes and plants. It is good for my family because we have five cows.

Before, my backyard was smelly and messy with cow manure as there was no place to keep it. Now, I collect all manures and waste to put in the shelter. I will use the compost for rice and vegetable production next year. Normally, I spent roughly USD 100 on chemical fertilizer annually for a hectare of rice plot. With organic compost fertilizer, I could save at least 30 percent of money from buying chemical fertilizers and I can feel that the compost can also improve the soil quality."

8.5 Statement of a farmer about the Good Practice Liquid Compost

Mr Aut Vuth, a 63 year old farmer living in Sous Ney village, Cheung Ras commune, Kampong Speu province.

"Before, I spent lot money to buy chemical fertilizers for my vegetable garden; and I was also not interested in compost fertilizer. After learning how to make liquid compost from the PDA staff, I started preparing and applying liquid compost to my vegetables. Normally, the vegetables can grow well in rainy season because of high humidity and lower temperature compared to the dry season.

My garden experienced a dry spell from June to August in 2015. However, I noticed that the vegetables still looked fresh and green. Thanks to the compost, I had a good yield, the quantity was doubled compared with last year on the same plot.

I do not have to go to the market to sell my vegetables; people in my village come to buy directly from my garden. I applied liquid compost every two days and observed that the vegetable beds with compost added to them looked healthier and greener than the vegetable beds with no liquid compost. I am very happy now that I can get more income and also save some money from purchasing chemical fertilizers."

9. Further reading

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10. Agro-ecological zones

- Tropics, warm

11. Objectives fulfilled by the project

11.1 Women-friendly

Farmer women can apply this practice easily in their garden or field. Botanical insecticides do not cause any harm to farmers' health.

11.2 Resource use efficiency

To produce botanical insecticides, farmers use plants from their garden and they reduce their costs on chemical insecticides.

11.3 Pro-poor technology

Costs for production of botanical insecticides or heap composts are marginal, therefore this technology is very useful for poor farmers to save their crops against pests at low-cost.