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# **Guidelines for Cultivation of Pyrethrum for Smallholder Farmers**



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# Preface

In Makete district there is high dependence of farmers on woodlot management for generating income as an adaptation strategy to climate change. However, most farmers are forced to sell immature trees and fail to tend their woodlots because of poverty. A possible remedy to this situation is the promotion of alternative income generating activities. Using a participatory approach between farmers, researchers and Makete district council officials the cultivation of pyrethrum and apple trees were identified as feasible alternative income generation activities. The production of guidelines are meant to provide best practices to enhance efficiency in the production of pyrethrum and apples. Multiple income sources will enable woodlot farmers to waiting for their trees to mature contrary to the current practice of harvesting immature timber.

These Guidelines were developed through participatory approaches and technical recommendations of the researchers from: the Faculty of Forestry and Nature Conservation, Sokoine University of Agriculture; the Tanzania Forestry Research Institute; Pyrethrum Company of Tanzania LTD; and Uyole Agricultural Research Institute. Forest staff and the management of Makete District Council, also participated in this research. The research was funded by the government of Denmark through The UNEP/UNDP Climate Change and Development: Adapting by Reducing Vulnerability (CC DARE) programme. This booklet is on pyrethrum.

# Table of Contents

Preface.....	iii
Table of Contents .....	iv
1. Introduction .....	1
2. Pyrethrum Ecology .....	3
3. Raising Pyrethrum in Nursery .....	4
4. Land Preparation .....	6
5. Spacing and Fertilizer Requirement .....	7
6. Tending Operations .....	8
7. Cutting Back.....	9
8. Insect Pests and Diseases Control .....	9
9. Harvesting .....	10
10. Drying.....	12
11. Post-harvest Handling .....	13
12. Processing.....	13
13. Marketing and Prices.....	14
14. Some Potential Uses of Pyrethrum.....	15

# 1. Introduction

The development of guidelines for Pyrethrum (*Chrysanthemum cinerariaefolium*) for Farmers Field Schools (FFS) is in response to the recommendation arising from CC-DARE project phase two on woodlot management practices. The follow up study (Phase two) was designed to collaborate with communities in the identification, introduction and demonstration of forest related climate change adaptation activities as part of community forestry and natural resources management. The study revealed that, low income and lack of reliable source of alternative income influenced management of woodlots by farmers. Most farmers are forced to sell immature trees and fail to tend their woodlots because of poverty. Farmers identified an array of alternative income generating activities including: bee-keeping, animal husbandry, and cultivation of commercial crops such as apple trees, coffee and pyrethrum. Apples and pyrethrum production were prioritized by communities as suitable for climate change adaptation and mitigation measures in addition to being alternative sources of income to farmers.

Shortage of extension officers, poor awareness, negative attitude and fear of losses caused by the unpleasant pyrethrum history and inadequate inputs (seeds, seedlings and driers) were the major hindrance to pyrethrum production. Whereas poor supply of nursery material (polythene tubes and cuttings), which are important for the vegetative propagation was the challenge for up-scaling apple trees cultivation to large section of Makete district. Participatory approach

through awareness creation and on-farm training by demonstration plots at households levels were employed to establish apple trees and FFS for pyrethrum cultivation (Plate 1). These demonstrations were implemented in six villages to enhance capability for generating, adapting and extending the skill and knowledge attained within the farming communities.

It is against this back ground that these guidelines are made to provide best practices for pyrethrum and apple trees cultivation as alternative income generating activities while woodlot farmers are waiting for their trees to mature. These guidelines contain the following elements which are considered important for pyrethrum cultivation:

- Pyrethrum growing conditions;
- Raising pyrethrum in nursery;
- Land preparation;
- Spacing and fertilizer requirement;
- Tending during the growing period;
- Cutting back;
- Pest and disease control;
- Harvesting;
- Drying up;
- Pyrethrum marketing and pricing; and
- Some potential use of pyrethrum contents.



Plate 1. Farmers Field School: pyrethrum cultivation in progress

## 2. Pyrethrum Ecology

Pyrethrum growing requires an altitude of 1,800 m or above with a well distributed rainfall of 1,000 mm or more per year and temperatures that fall to levels a little above freezing. The main use of pyrethrum is to control insect pests and the active ingredient is called pyrethrin. Pyrethrin concentration in flowers increase with increasing altitude and low temperatures, which stimulate flower production. The plant prefers light, loamy soils, slightly alkaline, but it has a fair degree of tolerance to acidity (this is the ideal soil in Makete district). It needs an open field without shade. Lack of sunshine greatly diminishes pyrethrin concentration in flowers and does not compete well with weed growth.

# 3. Raising Pyrethrum in Nursery

Pyrethrum is established by two main methods: use of seeds and vegetative propagation.

## 3.1 Use of seeds

Seeds can be raised in either one of two approaches, seed beds or wooden tray.

### *Raising Seedling in Seed Beds*

When raising seedlings in seed beds the following conditions should be observed:

- The nursery should be close to reliable water sources;
- In Makete district, nursery establishment should be from August to September;
- Seed beds should be of fine soil particles;
- Beds should be raised to 15cm above the ground level;
- The width of seed bed should be 1m and the length and number of seed beds may vary according to the size of planting area;
- Seed beds should be covered with dry grasses or dry wheat straws and then burnt; this adds potash to the soil that enhances vigorous growth of seedlings;
- Two days after burning the grasses or straws, seeds should be sown after placing under sun light for 8-10 hours to break dormancy;
- The spacing should be 20cm x 20cm. The seeds are then covered with shallowly soil and dry

grasses are placed on top to regulate day and night temperatures. Seedless grass is preferred to discourage weed growth; and

- Evening watering is the most recommend practice so as to conserve soil moisture.

### ***Raising Seedling in Wooden Trays***

A convenient wooden tray is 1 x 1 x 0.15m. This size can vary to aid tray management e.g. transferring between locations. A wire mash should be installed at the bottom of the tray. The following steps should be followed in raising pyrethrum seedlings in trays:

- Fill the tray with soil leaving a height of 2cm unfilled to avoid water overflow. Add water until the soil is saturated and water is seen dripping from the bottom of the tray. Allow it to drain out completely;
- Place the seeds on the surface of the soil and cover with a 0.5cm layer of perlite;
- Cover the wooden tray with plastic material and place it in an area that receives adequate sunlight. The seeds should germinate and emerge within 30 to 60 days, at which time the plastic cover should be removed;
- Water the seedlings just enough to keep the soil moist;
- Transplant the pyrethrum seedlings into 8cm pots when they have produced their third set of leaves. Place the pots in a sunny area and keep the soil moist and mulched;
- After 10-21 days the mulch can be removed and the seedlings shaded at 30-50 cm height to avoid direct sunlight to the young seedlings; and

- Seedlings should remain in the nursery for about 3-4 months before transplanting in the field. At this stage seedlings should be at least 15-20cm tall.

### **3.2 Vegetative Propagation**

This propagation method is done by the use of old pyrethrum plants by uprooting and splitting. Plants with high yield and pyrethrin content are selected for propagation. The uprooted plant (Plate 2) is split in such a way that each split has enough roots. Dead and long roots should be trimmed-off to stimulate growth of new ones.



**Plate 2. Pyrethrum plant suitable for vegetative propagation**

## **4. Land Preparation**

Land preparation is usually done from September to October during the dry season which helps in controlling

perennial weeds that can thrive into the next cropping season. The land is usually hand hoed/ploughed with the final land preparation being forming ridges (see Plate 3). The crop is planted on ridges that are made soon after the onset of seasonal rains, which is normally December to January. The spacing between ridges is 60cm. Ridging helps to control weeds and water logging.



**Plate 3. Land preparation and making of ridges**

## 5. Spacing and Fertilizer Requirement

The plant spacing is 60x30cm (inter and intra spacing) apart. Holes are made on ridges using a stick with 5-6cm diameter making a hole of 10-12cm deep, sufficient to cover the roots. The crop thrives well on virgin land, but where soils are poor in fertility a farmer can supply 5-7gm of TSP as source of P in each hole. With the recommended spacing, plant population is 55,555 plants per hectare and 22,222 plants per acre. One acre of pyrethrum could produce an average of 500-800kg or

1,225-1,960 kg/ha of dried flowers with good planting husbandry.

## 6. Tending Operations

Pinch the tips off of new branches while the plant is actively growing. This will encourage it to produce new branches. The plants should be well weeded and may be mulched, watering only in drought conditions if possible. But given the weather conditions in Makete district, prolonged drought is not common. Pyrethrum plants prefer dry, slightly alkaline and dislike high quantities of fertilizer, with the exception of phosphorous. Limestone (to raise the pH level of the soil) and bone meal or rock phosphate (to add phosphorous) may be added to increase flower production. Not surprisingly, given its use as an insecticide when dried, pyrethrum is not troubled much by pests.

Weeding is undertaken using hand hoes on a regular basis. More weeds are prevalent in the rainfall season. First and second weeding is done by hand rather than by hand hoe to avoid damage to young roots. Weeds at 2cm height must be removed to avoid competition for growth resources with young plants. Due to cheap labor and uneconomical high variable costs of chemicals it is recommended that farmers refrain from use of herbicides.

## 7. Cutting Back

After all flowers have been picked, the stalks are cut to foliage height to stimulate re-growth. Usually cutting back has to be done at the beginning of the rainy season using sickles.

## 8. Insect Pests and Diseases Control

Pyrethrum plants are also affected by insect pests and diseases. The common **nematodes** affecting pyrethrum are *Pratylenchus penetrans* and the root knot nematodes (*Meloidyogyne hapla*). No chemicals are used to manage/kill these nematodes. However research has found that companion planting of marigold (*Tagetas minuta*) reduces the nematode levels. The marigolds are commonly incorporated into the soil and exude substances from their roots which have shown to be effective against nematodes. Other insect pests and diseases are shown in Table 1.

Insect pests and diseases affect pyrethrum in various ways. However, cost effective control measures can be achieved through introduction of resistant varieties; regular crop rotation; and, mechanical eradication, such as deep tillage of sclerotes or uprooting and destroying infested plants from the field.

**Table 1. Common insect pests and diseases of pyrethrum**

	<b>Insect Pest/Disease</b>	<b>Effect</b>	<b>Control measure</b>
<b>1</b>	Aphids	Common during the dry season of the year and they suck the plant sap to death	These are controlled by insecticide sprays as they appear
<b>2</b>	Nematodes	These are the root knot nematodes, they are commonly found when the crop is more than three (3) years old on the same land	These are controlled by crop rotation and by nematicides application like Nemara, Furadan and Temilk
<b>3</b>	Cutworms	Cutworms are the common insect pests found in pyrethrum nurseries	They are controlled by insecticides
<b>4</b>	Damping-off	This is a fungal disease noticed easily by death of seedlings. Factors that favour damping off disease include; over watering, over-shading and overcrowding in nursery	They are controlled by reducing shade and watering frequency, and singling to avoid overcrowding of the seedlings
<b>5</b>	Bud diseases	Fungi found in petals, flower buds and flowers	Control is by planting resistant varieties

## 9. Harvesting

Harvesting starts 3 months after planting. Flowers are picked selectively by hand at start. Later picking of mature flowers is done after every 7-8 days regularly. Production is low during the warmest months. The pyrethrum flowers should be picked between five and nine days after they open. Maximum pyrethrin level in the flowers is obtained when picking is done in a warm and dry day. Baskets and other handmade containers are

suitable for picked flowers since they encourage aeration. Production is highly dependent on climatic conditions. Under ideal conditions, a plant can produce 80 to 100 flowers. Ten kilograms of fresh flowers give between 2.3 and 3.3 kilograms of dried flowers. An average annual yield is 200 kg per ha of dry lowers, with yields of up to 100 kg/ha in the first year and 250 kg/ha in both the second and the third year.

### ***Pyrethrin***

All parts of the pyrethrum plant contains pyrethrins but their concentration is negligible except in the flowers. About 90% of the pyrethrins in the flowers occurs in the achenes (developing fruits) (Plate 4). Pyrethrins are only produced in the achenes in useful quantities after the flowers open, occurring when the white petals are at the horizontal level, together with 2 – 3 disc florets open. The pyrethrin content of dried flowers, which is measured prior to processing, depends on the quality of the planting material, climatic conditions and efficiency of drying and marketing operations.



Achenes

#### **Plate 4. Freshly picked pyrethrum flower**

## **10. Drying**

The picked flowers are collected in baskets then transported to the drying place. Flowers are sun-dried on mats, concrete floor, coffee tray wire or charcoal driers for an average of four to seven days, depending on the weather conditions. If it is during the rainy season, drying may take up to seven days. In some areas, particularly in Makete district where there is always a wet weather and limited sunshine hours for most of the year, natural drying may prove difficult. Indoor drying on beams over fire may be an option although not fully recommended. Where possible, drying in portable driers or barns is more efficient since it reduces the drying time from 12 days to 12 hours, or less. Drying is done to

reduce flower moisture content from 80% to 10% and maintaining the colour of the flower petals. Drying is done soon after harvesting to protect flowers from losing pyrethrins which are volatile. To attain quality, farmers are advised not to mix dried pyrethrum flowers with other materials.

## 11. Post-harvest Handling

Dried pyrethrum flowers have to be stored in bags of not more than 30kg. When pyrethrum is compacted into the same bag and weighing more than 30kg, fermentation of flowers can occur, especially for improperly dried flowers, hence lowering the grade. If pyrethrum flowers are over dried, during compacting the achenes from such flowers may be lost. The effect will be loss of pyrethrum grade and hence, income.

## 12. Processing

Tanzania does not have a facility for refining pyrethrum. Currently, most of the crop is exported after primary processing either into a powder form or as crude extract. Tanzania has only one Primary processing factory located in Mafinga in Iringa Region under the ownership of the Tanzania Pyrethrum Processing and Marketing Company (TPPMCL). However, the dried flowers can be crushed locally with a mortar and pestle or in a coffee bean grinder. It has been noted that the more finely-ground the pyrethrum powder is, the more potent it will be as a pesticide. On the other hand, coarser powder will not dissipate as quickly. A dust mask and gloves must be worn as protectives when processing the powder. For

best results, store pyrethrum powder in an airtight container and keep away from light. The powder will remain effective for at least six months. At room temperature, the fresh flowers retain their potency for about 10 days.

## 13. Marketing and Prices

As a perennial crop the demand for pyrethrum has increased recently as many countries find that this **Organic Insecticide** is safer to use for controlling insects and yet environmentally friendly compared with synthetic insecticides. It is estimated that world demand for dry flowers is about 20,000 tons against a supply of only 12,000 tons. Due to their safety record, there is a growing demand for pyrethrum-based pesticides especially in Europe, Japan and the Far East. There is a ready market for pyrethrum extracts in the Southern African region and in South Africa in particular where processing facilities exist. Tanzania has the potential to produce over 6,000 tons of dried pyrethrum flowers per year. Currently, only about 2,500 tons of dried flowers and 40 tons of pyrethrum extract are produced annually. These demonstrate the potential market for pyrethrum and prospect to farmers to improve income through increased production.

The price of dry pyrethrum flowers, like of other crops, is competitive. Mafinga Pyrethrum Company (PCT) is the main buyer in Southern highlands. The company has set a mechanism by establishing buying and collection centers within the farming areas. The farmers sell pyrethrum flowers at villages through village offices or

agents where collections are made. The price paid to growers for dried flowers depends on the pyrethrin content measured when the flowers arrive at the processing factory. At the time of purchase, farmers are paid in cash the price for the lowest grade; a second payment is made as appropriate after the pyrethrin content has been determined.

The existing grading system provides for five grades, ranging from flowers with less than 1.10% pyrethrins by increments to flowers with pyrethrin contents in excess of 1.80%. The present prices for each weighed kilogram of dried flower range between Tsh.1700 to 2050/= per kilogram.

## 14. Some Potential Uses of Pyrethrum

The pyrethrum is friendly to the environment than many synthetic insecticides. This makes it famous and popular. Its specific insecticidal properties known as pyrethrins have the following habits.

- A unique “Knock down” effect on insects
- Unlike many synthetic insecticides, pyrethrums have unparalleled safety record when used.
- Pyrethrins are environmental friendly. They have no harmful residues in the food chain.
- Few cases have been reported on insects building significant resistance to pyrethrum application.
- Have a repellent effect on insects.

- The pyrethrum powder (grist) can be used to control storage pests in cereals at the rate of 1kg into 100kg of maize or beans
- A pinch of grist can as well control stalk borers in field maize.
- Extracted grist (marc) is incorporated in manufacturing mosquito coils.