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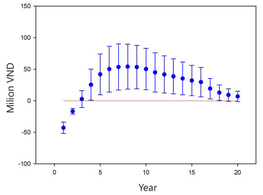
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HARVESTING

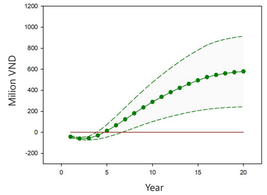
- Grafted macadamia usually bears nuts from the 4th years of planting. Before harvesting, it is necessary to clean up and do weeding around tree base. To some macadamia varieties, ripe nuts will crack and fall to the ground naturally, collect them in the morning. However, some do not, when nuts ripen (dark green skin and begin to crack), using a long pole to dislodge mature nuts. After collecting, immediately remove the green skin, dry nuts in a cool and dry place, avoid direct exposure to the sun.
- Coffee bear fruits after 2 year of planting. It can be harvested when there are about 40-50% of fruits are ripe. Collect berries in 3-4 times to reduce labor cost and actively manage trees for next year.
- Time to harvest soybeans is when leaves turn to yellow, exposing the matured pods. Cut off and take the plant and pods, leave other residues on the field.

ECONOMIC EFFICIENCY

Total investment cost of the agroforestry option is 39 million VND per ha (containing materials and labor cost) and the option could pay back of the loan/credit to farmers in the 5th year. The first 5-years of data have been used for simulations up to 20 years based on different scenarios. The results have showed that that profits of the agroforestry option increases progressively and peaks in the 8th year, up to more than 50 million per ha per year. From the 5th to 15th year, the agroforestry option could get profits of more than 30 million per ha per year then decrease steadily.



A profit simulation of the agroforestry option over 20 years



A cumulative profit simulation of the agroforestry option over 20 years

PESTS AND DISEASES PREVENTION

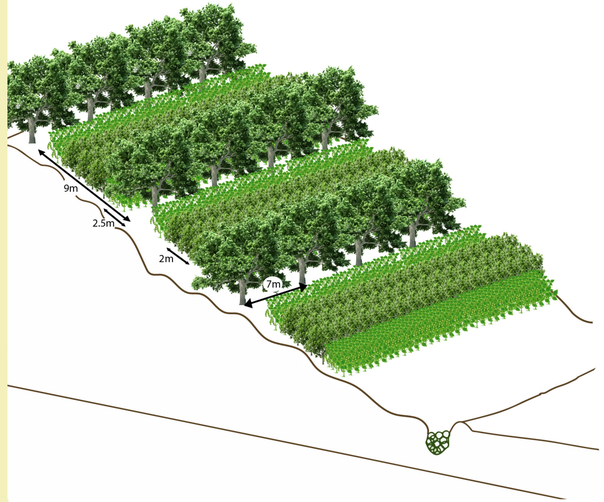
1. MACADAMIA

Macadamia in the Northwest are less affected by pests and diseases. There are few might occur:

- Stem borer/ twig borer (in *Cerambycidae* family): Manage by weeding and pruning, apply dense limewater mixture on the stem/ base.
- Sap bleeding: Caused by fungal (*Phytophthora spp.*) in soil. Prevention by weeding, pruning properly branches blending to the ground, apply dense lime-water mixture on the stem/base. Using fungicides with active ingredient *Copper oxychloride* or *Copper hydroxide* according to using instructions (For example: Champion 37.5 SC, Viben - C 50 WP).

2. COFFEE

- Stem borer (*Xylotrechus quadripes*)/ twig borer (*Zeuzera coffea*): Normally, stem borer occurs and harms coffee trees from the third year onwards; the larvae destroy bark and bore into wood and cause trees to die; twig borers attack the base and bark/branches of tree; tree will wilt and die. Using pesticides with *Cartap* active ingredients according to the instructions (for example, Padan 95SP, spray evenly entire tree for prevention in April-May, October-November).
- Coffee green scale (*Coccus viridis, Saissetia hemisphaerica*): Attacks leaves and young shoots, sucking sap and causing defoliation and attracting black fungi. Prevent by weeding, cutting off branches bending downward. Do not intercrop coffee with cassava, orange, guava, tangerine, mango, or tea.Treat with pesticides having the active ingredient *Chlorpyrifos ethyl* according to using instructions (for example, Pyrinex 20EC).
- Mealybugs (*Planococcus spp.*): Attack fruit stem, fruit and flower, young parts of tree and cause fruit rot, leaf death and tree death. Use pesticides with the active ingredient *Chlorpyrifos ethyl* according to using instructions (for example, Pyrinex 20EC).
- Coffee red mite (*Oligonychus ilicis*): occurs in dry season and attacks leaves. The leaves lose their glossy appearance and turn a brown, yellow, or bronze color, and fall. Prevent by planting under shade of other trees, and apply adequate fertilizers. Use pesticides with *Emamectin benzoate* active ingredients according to using instructions (for example, Azimex 20EC, Autopro 700WP).
- Coffee rust (*Hemileia vatatrix*): Coffee rust is fungus that attacks coffee leaves. The first symptom is the formation of pale yellow spot on the underside of leaves; when expanding they become powdery, yellow to orange in color and cover the whole leaf causing severe defoliation, and a decrease in crop production. Usually occurs in March-April and November-December. Prevent by weeding and increasing amount of organic fertilizers. Using pesticides with *Copper hydroxide* active ingredients according to using instructions (for example, Map-Jaho, Norshield 86.2WG).
- Anthracnose (*Colletotrichum gloeosporioides* Penz.): Causes wilting, withering, and dying fruits, branches and leaves. It may be caused by lack of adequate nutrition or a fungus. Manage by applying adequate fertilizer and destroy diseased branches. If caused by fungus, using pesticide with *Valydamicyn* or *Mancozeb* active ingredients according to using instructions (for example, Suitcase, Valigreen or Vimonyl 72WP).
- Root knots caused by nematode (*Meloidogyne spp.*): Symptoms are chlorosis and defoliation in leaves, splits and rot in root system. Often occurs in one-year and two-year trees. Attack by root-knot may facilitate invasion by fungal pathogens (such as *Rhizoctonia solani*). Prevent by properly applying adequate fertilizer and lime-water sufficiently. Limit grubbing soil to avoid damaging the roots.



AGROFORESTRY TECHNICAL MANUAL

OPTION: MACADAMIA - COFFEE - SOYBEANS

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World Agroforestry

INTRODUCTION

Macadamia (*Macadamia integrifolia*) is a woody plant originating from Australia. Macadamia grows well in regions where average temperature ranges from 20-25°C, the hottest day temperature is 30-35°C, the coldest day temperature varies from 10-18°C and rainfall is from 1,400-2,500 mm. Thus, areas with suitable conditions for macadamia are Central Highlands provinces and from Ha Tinh province to northern Vietnam, including Northeast and part of the Northwest (except for some areas with lowest average temperature below 10°C, absolute minimum temperature down to -5°C like in Muong Te, Sin Ho, Phong Tho and Tua Chua). Macadamia adapts to most types of soil which has good drainage, soil thickness is about 1 m, not degraded, saline, sulfuric or laterite.

Arabica coffee (*Coffea arabica*) has high economic value. In northern Vietnam, catimor, TN1 and TN2 cultivars are planted popularly. Coffee trees are adapted to tropical highland climates where the average temperature ranges from 20-25°C, the minimum temperature is not less than 0°C. Rainfall averages between 1,200-1,900 mm per year and is evenly distributed throughout the year. Ideal relative humidity is 70% and coffee is negatively affected by strong winds. After the rainy season, coffee starts to differentiate flower-buds and requires the low temperatures and shorter day-lengths. Hence, when designing an agroforestry option including coffee, it is necessary to intercrop with windbreaks and shade trees to increase coffee productivity and quality.

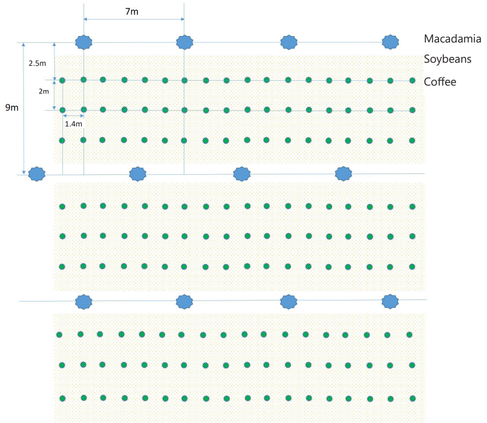
Soybeans are intercropped between coffee trees when the canopy has not closed, usually in the first 3 years. Soybeans contribute to soil fertility improvement, diversify products and increase income for households.

DESIGN

Contour planting is designed in the agroforestry option to minimize soil erosion.

Macadamia tree is planted in row. Row spacing is 9 m and tree spacing is 7 m (density is about 154 trees ha^{-1}). Between two rows of macadamia, there are three rows of coffee, which are 2.5 m apart to the macadamia row. Plant spacing of coffee row and tree are 2 m and 1.4 m, respectively (coffee tree density is about 2.160 tree per ha).

Soybeans are intercropped between coffee rows, about 30 kg of seeds/ha/season.



Distance and layout of trees and crops in Macadamia - Coffee - Soybeans option

PLANTING TECHNIQUES AND FERTILIZING (1)

1. MACADAMIA

Planting hole: The size of a hole is 80 cm x 80 cm x 80 cm.

Basal fertilizer application: Apply 15-20 kg manure, 0.5 kg NPK in the ration of 5:10:3 (or equivalent) and 0.5-1 kg lime powder per hole before planting 30 days and cover by soil.

Top dressing fertilizer application:

- From the first to third year: Apply 0.5 kg NPK in the ratio of 5:10:3 (or equivalent) per tree and divided into three times: March-April, June-July and September-October.
- From the fourth year onwards: Considering each tree condition and its yield, it is possible to apply about 15-20 kg manure, 1-2 kg NPK in the ratio of 5:10:3 (or equivalent) per tree.

2. COFFEE

Planting hole: The size of a hole is 40 cm x 40cm x 40 cm.

Basal fertilizer application: Apply 5-6 kg manure and 0.6 kg NPK per hole before planting 30 days and cover the hole by soil.

Top dressing fertilizer application: Apply three times per year in the beginning, at mid and end of rainy season (March-April/ June-July/ September-October).



Macadamia for fruits in Macadamia - Coffee - Soybeans option at Son La province

PLANTING TECHNIQUES AND FERTILIZING (2)

- First year: Apply 30 kg Urea, 360 kg Superphosphate, 21 kg Potassium chloride per ha.
- The 2nd year: Apply 54 kg Urea, 180 kg Superphosphate, 33 kg Potassium chloride per ha.
- The 3rd year: Apply 108 kg Urea, 180 kg Superphosphate, 102 kg Potassium chloride per ha.
- Harvest years: Apply 180 kg Urea, 180 kg Superphosphate, 180 kg Potassium chloride per ha.

3. SOYBEANS

- Planting along contour line between coffee rows. Dig the holes for sowing seeds at distance of 70 cm between rows and plant spacing is 20 cm.
- Basal fertilizer application: Apply 16 kg Urea, 100 kg Superphosphate, 30 kg Potassium per ha, cover by 2-3 cm of soil before sowing.
- Top dressing fertilizer application: When soybeans plant has 3-4 leaves, apply fertilizer of 16 kg Urea and 30 kg Potassium per ha, 3-5 cm away to plant and cover by soil.

PRUNNING AND CANOPY FORMING

1. MACADAMIA

Pruning after harvesting, remove broken and diseased branches/limbs, cut off branches/ limbs/twigs growing at ground level up to 1m at tree trunk and 1.5 m height around canopy to reduce pests and diseases and easy to harvest. Limit tree growing too high by cutting off tree crown/ top to avoid falling down or broking.

2. COFFEE

- Regularly remove suckers/ shoots growing at ground level on the trunk below graft union. Keep only main trunk, if the main body breaks, alternate by a healthy and strong branch.
- Remove suckers, dead, damaged, broken and diseased/ weak twigs, crossing branches, downward growing branches pruning secondary branches if too thick.
- Cut away all the dead and dry primary branches, branches growing downward.
- Prune off the top of the tree if it is taller than 1.6 to 1.8 m, remove new shoot growing out.
- Regularly pruning, particularly after harvesting.
- If coffee trees are old and no longer yield productively, it is possible to prune off old trees for rejuvenation after harvesting 2-3 months. Use a saw to cut off and remove trunk about 20-25 cm away from the ground, cut on the bias 45°, crossing face should avoid sunlight direction. Take care of buds that grow as seedlings.



Macadamia - Coffee - Soybeans option at Son La province