Soil Management for cassava in Organic Farm

Introduction

Organic agriculture is a holistic production management system that promotes and enhances agro-ecosystem health, including biodiversity, biological cycles, and soil biological activity. It emphasizes the use of management practices in preference to the use of off-farm inputs, taking into account that regional conditions require locally adapted systems. This is accomplished by using agronomic, biological, and mechanical methods, as opposed to using synthetic materials, to fulfill any specific function within the system.

Methods of organic farming vary. Some farms follow the strict production guidelines of a particular regulatory code, others develop their own independent systems. However, all organic systems share common goals and practices:

- No use of synthtic fertilizers or pesticides, and No GMOs;
- Protection of soils (from erosion, nutrient depletion, structural break down);
- Promotion of biodiversity (e.g. growing a varieties of crops than a single crop);
- No drug (e.g. antibiotics, hormones) and access to outdoor grazing, for livestock and poultry.

Within this framework, farmers develop their own organic production system, determined by factors like climate, crop selection, local regulations, and the preferences of the individual farmer.

In many parts of the world, organic certification is available to farms for a fee. Depending on the country, certification is either overseen by the government, or handled entirely by private certification bodies. Where laws exist, it is usually illegal for a non-certified farm to call itself or its products *organic*.

It is important to make the distinction between organic farming and organic food. Farming is concerned with producing fresh products - vegetables, fruits, meat, dairy, eggs - for immediate consumption, or for use as ingredients in processed food. The manufacture of most commercially processed food is well beyond the scope of farming.

It is also important to note that organic farming is not "new". In fact, it is a reaction against the large-scale, chemical-based farming practices that have become the norm in food production over the last 80 years. The differences between organic farming and modern conventional farming account for most of the controversy and claims surrounding organic agriculture and organic food. Until recently, the comparison looked something like this:

	Organic	**Conventional**
Size	relatively small-scale, independent operations (e.g. the family farm)	large-scale, often owned by or economically tied to major food corporations
Methods	low use of purchased fertilizers and other inputs; low mechanization of the growing and harvesting process	intensive chemical programs and reliance on mechanized production, using specialized equipment and facilities
Markets	often local, direct to consumer, through on-farm stands and farmers' markets (see also local food), and	wholesale, with products distributed across large areas (average supermarket produce travels

through specialty wholesalers and retailers (eg: health food stores)	hundreds to thousands of miles) and sold through high-volume outlets

The contrast is as much economic as it is between methods of production. To date, organic farming has been typically small business, often based in local economies, and conventional farming is big business (often called agribusiness or, negatively, corporate farming) that is closely integrated with all aspects of the global food production chain. However, the situation is changing rapidly as consumer demand encourages large-scale organic production.

Development of modern organic farming techniques is also a function of economics. Most of the agricultural research over the last several decades has concentrated on chemical-based methods - little funding and effort have been put into using current scientific tools to understand and advance organic agricultural approaches.

Principles of plant cultivation, in many situations identical to those of organic farming, are applied - often, though not necessarily, at a smaller scale - in the plough-less practice of organic horticulture.

Organic farming incorporates scientific knowledge and comprehensive traceability with traditional farming practices, based on knowledge and techniques gathered over thousands of years of agriculture to improve the social, economic and ecological sustainability of agricultural systems. It is easiest to describe by contrasting it with modern commercial techniques.

In general terms, organic farming involves natural processes, often taking place over extended periods of time, and a holistic approach, while chemical-based farming focusses on immediate, isolated effects and reductionist strategies (some

would argue that this reductionism is greedy reductionism). In large commercial operations, technology is used to regulate local conditions—hybrid seed, synthetic chemicals, high-volume irrigation—while sophisticated machinery does most of the work, and operators' feet may seldom touch the ground. Beyond the strictly technical aspects, the philosophy, day-to-day activities and required skill sets are quite different.

Cassava is one of the major crops for the Thai economy. It is second only to rice and rubber. Not only is cassava a food crop, it is also used as animal feeds and raw materials for a number of industries. Cassava yearly output ranges between 18-20 million tons, 80 percent of which are exported to the overseas markets, earning about 21,400 million baht per year for the past 5 years.

• Thailand ranks the third of the world's cassava producers, the first and second ranks belong to Nigeria and Brazil. However, for the exports of cassava, Thailand has come to the first rank for over 30 years, capturing about 88 percent of market shares during the years 1996-2000. Nigeria and Brazil, on the other hand mainly grow this crop for domestic consumption.

• In 2000, prices of cassava in the world market continued to decline from the previous year due to the following reasons:

• The world's cassava output has increased.

• European Union, the world's biggest importer of cassava, cuts down cassava imports as they have shifted to their home-grown crops for a replacement. Additionally, the Euro dollar has weakened compared with the US dollar.

• Prices of fresh cassava roots sold in the country over the first half of

2001 increased by 18.1 percent as a result of decreased supply and growing demand from overseas markets, particularly the demand for chips outgrew the decline of pellet supply.

• Exports of Thai cassava for the past 10 years have changed significantly. Exports of pellets declined from 88 percent in 1991 to 72 percent in 2000. While exports of flour jumped from 10 percent to 26 percent. The biggest importer of pellets from Thailand is the European Union whose imports accounted for 90 percent of Thai pellets export value.

• Average productivity of Thai cassava stands at 2.4 tons per rai (during 1997-1999) compared with the world's average rate, 1.6 tons per rai. In addition, Thailand has always been striving for better development of cassava species apart from the improvement of cassava products in the form of flour for exports. Lastly, the authorities should establish measures to enhance Thai competitiveness focusing on important aspects, for instance cassava production zones, improvement of cassava species to achieve high yield per rai, and the government support for quality production as well as product transform to obtain higher value added.

Thai Government under the leadership of Police Lieutenant Colonel Thaksin Shinawatra had announced to the cabinet in February 26, 2001 about the agricultural policy refer to rehabilitate and strengthened of mixed and organic farming in order to promote Thailand to be the center of organic product.

Land Development Department (LDD) who responsible for land use policy and give advise in soil and plant relationship therefore produces a manual of organic cassava to be used as the guideline and transferring to other sectors.

Land use in Thailand for growing cassava

Cassava, a root crop from which tapioca is made is one of the important crops in north-east Thailand. Thai output of cassava root in 1984 was more than 19 million tons, second only to Brazil in world production. The main growing areas were Chon Buri and Rayong provinces, southeast of Bangkok, but substantial quantities were also grown in parts of the Northeast. In 1986 Thailand signed a 4-year tapioca trade agreement with the EEC calling for export of 21 million tons of tapioca during the 1987-91 period**.** Cassava is a tropical root crop, requiring at least 8 months of warm weather to produce a crop. Total ares of cassava production in Thailand is 11,970,600 rai with the yield of average 2,497 kg/rai is relatively low.

Production of cassava in organic way then will bring better soil fertility, low investment and more income.

Lands that had been used for cassava

1. **Upland clayey soils** (Soil series group 28, 29 and 31)

These groups of soils are well drained and deep fine-textured that occupies erosional surfaces and alluvial terraces or fans in dry areas of the country where slopes are less than 20%. Soil fertility is moderately low. Soil reaction ranges from strong to very strong acid.

Upland crops and fruit trees are commonly found in the areas.

Problems: Low fertility, lack of water in dry season and soil erosion on steep slope, strong acid in some places

2. **Upland loamy soils** (Soil series group 35, 36 and 40)

These groups of soils are well drained, deep medium-textured (sandy loam to sandy clay loam) and occupies on uplands where precipitation is low and slopes are less than 12 %.. Fertility of these soils are relatively low. Soil reaction is very strong to strong acid.

Dry-land upland and tree crops are commonly found in the areas.

Problems: Low fertility, lack of water in dry season and soil erosion on steep slope, strong acid in some places.

3. **High precipitation areas sandy upland soils**. (Soil series group 41, 43 and 44)

These groups of soils are well drained or moderately well drained, deep coarse-textured that developed from alluvial deposits of wash materials on undulating terrain where slopes are less than 12 %. Major characteristics is thick sandy horizon which extend to 1 m. below soil surface. This sandy layer is commonly underlain by medium-textured soils which has lower permeability, causing impeded drainage in the surface and sometimes water-logging. These soils are low fertility whereas the soil reaction is strong to medium acid.

Majority of land uses are dry land upland crops and fruit trees i.e. maize , sorghum, cassava, legumes, mangoes and jackfruits.

Problems: Low fertility moderately thick sandy soils , lack of water in dry season and soil erosion in heavy rain.

4**. Shallow upland soils.** (Soil series group 46, 48 and 52)

These groups of soils are shallow to coarse-grained bed rock. They commonly occur on erosional surface, hills and mountains where slopes are less than 20%. Soil fertility is generally low.

Majority of the land use is natural forest. Upland crops are found in some parts of the areas Yields are relatively low due to restriction of shallowness, poor fertility and erosion.

Problems: Low fertility shallow soils to skeletal layer (0-50 cm), gravels or rock fragment on the soil surface, lack of water in dry season and soil erosion on steep slope. Very shallow, gravelly or lateritic

5. Lowland soils. (Soil series group 17 and 25)

These groups consist of poorly drained to somewhat poorly drained, coarse textured (sandy loam to sandy clay loam) soils that occupy mostly on low - lying terrain of alluvial terrace. They are low fertility and strong acid. Most of the areas are covered with paddy rice.

Problems: Massive structure, low fertility, strong acid in some places, lack of water in dry season and water logging in rainy season that are not suitable for growing cassava.

6. **Bunded areas with somewhat poorly to moderately well drained soils**. (Soil series group 40b)

Soils in this group is loamy and similar to those of groups 35, 36 and 40 but topsoil was leveled and bundded for paddy rice. If the price of cassava is good these lands will be used to grow cassava by draining to avoid water logging

Soil Management system for organic cassava

Cassava is traditionally grown in a savanna climate, but can be grown in extremes of rainfall. In moist areas it does not tolerate flooding. In dry areas it looses its leaves to conserve moisture, producing new leaves when rains resume. It takes 18 or more months to produce a crop under adverse conditions such as cool or dry weather. Cassava does not tolerate freezing conditions. It tolerates a wide range of soil pH 4.0 to 8.0 and is most productive in full sun. Although cassava can produce a crop with minimal inputs, optimal yields are recorded from fields with average soil fertility levels for food crop production and regular moisture availability. Cassava in Thailand was always grown on low fertility sandy soils without any soil improvement or soil and water conservation. Soils that had been growing cassava for long time will then contain less and less fertility.

Cassava will be well grown in well drained sandy loam soils with 10-12 hours daylength, 10-30^{o} C temperature and 500-2500 mm./yr precipitation.

Responses to macro-nutrients vary, with cassava responding most to P and K fertilization. Vesicular-arbuscular (VA) mycorrhizae benefit cassava by scavenging for phosphorus and supplying it to the roots. High N fertilization, more than 100 kg of actual N/ha may result in excessive foliage production at the expense of storage root development and a low harvest index.

Normally, cassava requires 10-20 kg/rai N, 6-10 kg/rai P and 8-12 kg/rai K. Phosphorous will be available to cassava at pH 6-7. Potassium is very important in transfering carbohydrate from leaves to roots and hydrocyanite reduction in the roots.

1. Land preparation

1.1 Site selection: One piece of big areas full of natural fertility with water resources that had not been under chemical control for a long time is recommended. Soil and water analysis before organic production is necessary to avoid residual effect of chemical substances.

1.2 Land planning is necessary in management during growing period i.e walking spaces to transport the product, contouring in slope land etc. It is to be sure that there is enough working space between plant rows during weeding and other activities.

1.3 Leveling the land to avoid water logging.

1.4 Guard rows by fast growing trees to avoid air contamination, wind and insects from outside.

1.5 Soil preparation: Thick sandy loam upland soils is ideal for cassava. If the soil is clayey, drainage is necessary. At land preparation, you can add organic manure to the soil to increase soil nutrients, improve soil structure, and improve the ability of the soil to hold water. If you cannot avoid growing cassava on steep slopes you can grow cassava varieties with early, low, and much branching habit to cover the ground quickly and properly against

rain erosion. You can also make ridges across the slopes and mulch the ridges to reduce erosion.

1.6 **Soil improvement** with organic matter: Organic manure can be in the form of green manure or other dead plant or animal manure. In green manuring, plant foliage (fresh leaves and young green stems) is ploughed into the soil. Green manure improves soil properties as the foliage rots. *Egusi* melon and leguminous crops, for example, groundnuts and beans, make good green manure.

For organic farming these are recommended:

1. Mix crop residue and any organic matter with soil. Burning is not recommended.

2. Green manuring:

2.1 8-12 kg/rai broad bean with spraying 5 litre/rai (1:500 or 1: 1,000 dilution) LDD liquid organic fertilizer. The 35 days (flowering) broad bean will be cut and mixed with the soils before planting cassava.

2.2 Spraying 5 litre/rai (1:500 or 1: 1,000 dilution) LDD liquid organic fertilizer, 15 days and every 1 month after 15 days.

2.3 Inter cropping 1-2 weeks cassava with broad beans, cow pea then cut and mix green manure with soils at its flowering stage.

3. Planting:

3.1 **Stem cuttings:** When cutting up cassava stems into stem cuttings for planting, make sure each cutting is at least

20–25 cm long and has about 5–8 nodes from more than 8 months stems. You should handle cuttings carefully during transportation to prevent bruises and damage to the nodes. This can be done by packing them on cushions of dry leaves**.** The cutting stems then will be soak in (1:500 or 1: 1,000 dilution) LDD liquid organic fertilizer for 24 hours. They will be dried before planting.

3.2 **Spacing:** Cassava stem cuttings may be planted vertically, at an angle. Vertical planting is best in sandy soils. In such soils, plant stem cuttings vertically with 2/3 of the length of the cutting below the soil. The spacing between plants will depend on whether you are growing cassava alone (sole crop) or with other crops (intercropping). If cassava is being grown alone, plant 1 meter apart from each other. If cassava is being grown as an intercrop, consider the branching habit of both the cassava and the other crops and make sure there is enough space for the plants. In Thailand, the proper time to plant cassava is June and

to harvest is April. For Rayong 60 variety, 60*100 cm. spacing and from June to February growing period are recommended. For Kasetsart 50 variety, 80-100 cm. . spacing and from June to may growing period are recommended.

2. Crop management

Disease control : Some cassava varieties tolerate weeds, pests and diseases.

- **Cassava bacterial blight** is caused by a bacterium which occurs inside cassava stems. The disease damage symptoms are angular leaf spots on the under leaf surfaces, leaf blighting and wilting , gum exudate on the stems, and shoot tip die-back. Avoid selecting stem cuttings from plants with these symptoms. This disease will affected 30-90 % yield reduction. To control is to choose the tolerate varieties and application of plant extract i.e lemongrass, Boesanbergia pandurata Holtt, Samanea samarn Etc
- **Brown leaf spot** is caused by a fungus Crecosporidium henningsii. The disease damage symptoms are angular leaf spots on the veins and leaf drying. This disease will affected 14-20 % yield reduction. To control is to choose the tolerate varietes and application of plant extract i.e lemongrass, Boesanbergia pandurata Holtt and *Cerbera odollum Gaertn.*

Other diseases that are found i.e. bright leaf spot from fungus *Cercospora visosae,* white leaf spot from fungus *Phaeoramularia manihotis* , stem rot from *Glomerella cingulata,* and root rot from many kinds of fungi.

Insect control:

Insects that attacks cassava will be found in dry condition. They are:

- **Red spider mite** : 2 kinds of red spiders that destroy cassava are *Tetranychus truncates* and *Oligonychus biharensis.* Cassava green mite damage symptoms include yellow chlorotic leaf spots on the upper leaf surfaces, narrowed and smaller leaves and stunted cassava plants. To control is to apply of plant extract i.e *Curcuma longa,* Simese rough bush, *Thunbergia laurifolia L, Derris elliptica (*Roxb.*)* Bent*h. Derris scandens* Benth*.* Jute and *Azadirachta indica* Valeton*.*
- **Strip mealy bug** occurs on cassava leaves, shoot tips, petioles, and stems. The bugs are covered with white waxy secretions. Cassava bug damage symptoms include shortened inter node lengths, compression of terminal leaves together into “bunchy tops” , distortion of stem portions, defoliation, and “candlestick” appearance of shoot tip. To control is to apply of plant extract i.e *Curcuma longa,* Simese rough bush, *Thunbergia laurifolia L, Derris elliptica (*Roxb.*)* Bent*h. Derris scandens* Benth*.* Jute and *Azadirachta indica* Valeton*.*
- **White fly** damages cassava by sucking sap from the leaves. Colonies of the insect occur on the undersurfaces of cassava leaves and are covered with white waxy secretions similar to those of the

cassava mealy bug. Whitefly eggs occur in spiral patterns of wax tracks, mostly on the undersurfaces of leaves. Symptoms of whitefly damage are black sooty mold on the upper leaf surfaces, petioles, and stems and premature leaf fall of older leaves.

To control is to apply of plant extract i.e *Curcuma longa,* Simese rough bush, *Thunbergia laurifolia L, Derris elliptica (*Roxb.*)* Bent*h. Derris scandens* Benth. Jute and *Azadirachta indica* Valeton.

Weed control: Weed will critically disturb cassava at 2-3 beginning months. To control weed in cassava can be from 15 day after planting and 2-3 times before the canopy is closed or inter cropping with green manure. The other way to control weed is to apply of plant extract i.e quinine, *Cassia tora* Linn., *Acalypha indica* Linn., Chinese rose, *Euphobia hirta* L.

5. Post harvest:

Harvesting of cassava can be from 8 months due to farmers need. Normally it will be harvested at 10-12 months. Rhizomes and stems should be cut and transport to factories immediately or not more than 3 day. Up-right stems ca be collected under shadow for 30 days waiting to be used as stem cutting. Leaves and branches and residue will be mixes with soils to add organic matter.

6. Field records:

Field records during management for organic farming is necessary to be used to ask for organic product certification. The record can be prototypes to another organic farmers.

7. References:

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Appendix

Vareites of cassava

Cassava in Thailand can be divided into 3 groups:

1. **Ornamental cassava**: This group of cassava is used in house landscape gardening. The first ornamental variety is albino with beautiful white and yellow strips along the its leaves. The orther one is called wild cassava that is use for shading.

2. **Sweet cassava:** Mealiness refers to the cooking ability of cassava storage roots without processing. Mealy varieties are commonly called "sweet" cassava. Roots of sweet cassava is edible because of the good taste and less cyanic acid. They are burned, boiled or syruped . 3 varieties of sweet cassava are found in Thailand they are Munsuan, Munhanatee and Rayong 2. Rayong 2 is a variety that was approved to be cooked as a snack like potato chips.

2. **Bitter cassava**: Non-mealy varieties are called "bitter" cassava. Bitter cassava requires processing before consumption and this is related to the total cyanide content (referred to as cyanogenic potential, CNP) in the storage roots. The higher the CNP of a variety, the greater the need to process its storage roots for safe consumption. Formerly, local varieties were widely grown in Thailand. Rayong 1 is bitter cassava that gives very high yield from Rayong Province. Rayong 2, 3, 5, 60 and 90 were developed later by Department of Agriculture while Sriracha 1 and Kasetsart 50 were developed by Kasetsart University.

    2.1 **Rayong 1**: was developed in 1975 from local variety

that gives high yield and good adaptability. They have tall, strong and erect stems that are easy to be managed. Their cutting stems are in good quality. Starch percentage is about 18 in rainy season and 24 in dry season. Fresh yield is about 3.22 ton/rai (1.03 ton/rai dry cassava) with 31.1 % dry matter. Starch production is about 1.03 ton/rai. Moderately resistant to bacterial bright.

2.2 **Rayong 60**: was developed in 1987 from Mcol 1684 x Rayong1 that gives high root dry matter and low cyanide in both 8 and 12 month. They have 2-4 tall, strong and erect stems that are easy to be managed good in propagation. Starch percentage is about 18 in rainy season and 24 in dry season. Fresh yield is about 3.52 ton/rai (1.12 ton/rai dry cassava) with 32 % dry matter. Starch production is about 1.12 ton/rai.

2.3 **Rayong 90**: was developed in 1991 from CMC 76X V43 that gives high root dry matter and 5 % higher yield than Rayong1. They have bent stems that are not easy to be managed and will be flowering within 1 yaer. Starch percentage is about 24 in rainy season and 30 in dry season. Fresh yield is about 3.65 ton/rai (1.31 ton/rai dry cassava) with 35.7 % dry matter. Starch production is about 0.88 ton/rai. Moderately resistant to bacterial bright.

2.4 **Kasetsart 50**: was developed in 1992 from Rayong 1 x Rayong 90 that gives high root dry matter, high yield and good adaptability. They have tall, strong and erect stems that are easy to be managed and good quality in propagation. They have bent stems that are not easy to be managed and will be flowering within 1 yearr. Starch percentage is about 23.3. Fresh yield is about 3.67 ton/rai (1.32 ton/rai dry cassava) with 35.4 % dry matter. Starch production is about 0.87 ton/rai. Moderately resistant to bacterial bright.

2.5 CMR 25-105-112: is a high yield, good stem cutting, flowering in one year and good adaptability variety. Starch percentage is about 22.3. Fresh yield is about 4.02 ton/rai (1.41 ton/rai dry cassava) with 34.6 % dry matter. Starch production is about 0.87 ton/rai. Moderately resistant to bacterial bright.