GROWING VANILLA PLANT

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1. The History of Vanilla

Vanilla is native to southern-eastern Mexico, Guatemala and other Central American countries where the vines grow wild. The Aztecs used it to flavor chocolate and Cortez first tasted it in the court of Montezuma in 1520. The Spaniard imported vanilla beans into Spain in the later part of the i6th century for flavoring chocolate. It was first taken to England around 19733 and it received serious attention. In 1807, cutting from veins grown in Charles Graville's collection in Paddington were sent to Botanical gardens in Paris and Antwerp. From Antwerp, two plants were sent to Buitenzorg (Bogor), Java in 1819 but only one survived the journey. It flowered but did not fruit as its natural pollinator, a special genre of Mexican bee is not found in Indonesia and the technique to hand pollination was still unknown.

From Paris, plants were taken to Reunion and from there to Mauritius in 1872 and to Madagascar in 1840. The plants grew well in their new homes but they did not produce fruits because the absence of the natural pollinator. In 1836, Prof. Charles Morren of Liege first discovered a method of artificial pollination and in 1841 Edmond Albius developed a practical version of this method. Since then, commercial production of vanilla beans was undertaken in all these countries and Albius' method of hand pollination is performed throughout the tropics even to this day.

Vanilla cultivation on a systemic basis was introduced into Java in 1846 by Teysmann, Director of Buitenzorg (now Bogor) Botanic Gardens. By the last century, vanilla has been tried throughout the tropics whenever climatic conditions are suitable but except Indonesia, Madagascar, Mexico, Reunion, Tahiti, Seychelles, Uganda, it has not gained a foothold. It is grown in Central America, Trinidad, Brazil, Guadeloupe, Dominica, Fiji, Sri Lanka, Tonga, Malaysia, Philippines and now China and India but only in very small amounts.

The price of vanilla was fluctuated by the demand of international markets. In 1987 the first grade of dried beans was about $55/kg and in 2000-2001 increased to about $125/kg. In 2003 the price dramatically inclined by up to $ 260/kg or even the last information said about $300/kg since the lack of production in producing countries and the new coca cola industry, which generated new coca cola brand "Vanilla Coke", has probably ignited the sharply increased of the price.

2. Botany

2.1. Taxonomy

Vanilla belongs to the orchid family and needs the same climatic-ecological environment as any other orchid plant for survival. A complete taxonomy of vanilla includes 110 species of which only three are commercially cultivated. These are:

Vanilla planifolia* Andrews**, the most common species was originated in Mexico and has spread througout the tropics including Indonesia. It is also known as ***Vanilla fragrans* (Salisb) Ames, *Epidendrum vanilla L. and ***Myrobroma Fragrans* Salisb**.

***Vanilla pompana* Scheide**, also originated in Mexico but is of an inferior quality. Its cultivation is now limited to only Central America and Northern South America.

Vanilla tahitiensis* J.W. Moore** is grown only in Tahiti and to a limited extent in Hawaii. This variety is also inferior to ***V. planifolia* Andrews.** Both *V. pompana* and *V. tahitiensis* have lower prices than ***V. planifolia.

2.2. The Plant, the Flower and the Beans

Vanilla is a creeping plant and it can climb as high as 15 m but the commercial variety is controlled to grow too much lower height so that the flower can be reached for pollination. The leaves are long, thick and elliptical. The stems are green, flexible and succulent with many branches. The veins throw out aerial roots which grow opposite the leaves and by which they cling to trees or other supports.

The flower stems (*racemes*) produce as many as 20 or more flowers each which are greenish-yellow in color and are not as conspicuous as other orchids. The last only 24 hrs. The structure of flowers is such that except for a special genre of small Mexican bean which are not found anywhere outside Central America, it is almost impossible for a natural agent to pollinate them. A thin flap, *rostellum*, separate the male organ (*anther*) from the female organ (*stigma*) and unless the *rostellum* is removed, the pollen from the *anther* can not reach the *stigma*.

Successful pollinated flowers produce fruits in the form of capsules or pods which are commercially known as beans. These are long and cylindrical, 10 – 25 cm long and 8 – 14 mm in diameter. Commercial vanilla beans are produced by hand pollination throughout the world.

Figure 1. The flower that is ready to be pollinated (left), and the fruits set is formed after pollination (right)

2.3. Ecology

Vanilla grows best between 10^{o} and 20^{o} latitude north and south, from sea-level up to about 700 m. Depending on the climate, vanilla can be grown successfully up to an elevation 800-1000 m.

Vanilla thrives in a hot, moist, tropical climate with frequent but not excessive rains. Raid conditions and violent winds are detrimental to the plants. The optimum temperature is 21-31^{o}C with an average of around 27^{o}C and with an evenly distributed rainfall of 2000-2500 mm per annum. Two to three drier months are necessary to check vegetative growth and bring the vines to flower.

The most suitable land for vanilla is a gently sloping site with light friable soil, adequate but not excessive drainage, and a thick surface layer of humus or mulch in which the roots can spread. Water logging is harmful. On plains. Rows of embankments sloping on either side can provide the necessary drainage for vanilla plants.

Partial shade is necessary and this is usually provided by the shrubs or small trees up on which the vines are trained.

3. Methods of cultivation

3.1. Propagation from stem cuttings

Commercial vanilla is always propagated by stem cuttings. It can be grown from seeds but it is a long and complicated procedure. At present, seeds are only used in laboratories for research on hybridization.

The cuttings are taken from healthy, vigorous plants and may be cut from any parts of the vein. Indonesian farmers insist that cuttings from branches which are yet to flower give better results. The length of the cutting is usually determined by the amount of planting material available. Short cuttings, 30 cm in length will take 3-4 years to flower and fruit. Cuttings, 90-100 cm in length are preferable and have almost become the standard length of cuttings and will flower for about 2-3 years. Experiments have shown that in 12 month period, cuttings with two internodes grew 4.7 feet, those with four internodes, 7.7 feet, and those with eight internodes 16.7 feet. Since the longer cuttings bear flowers much sooner than shorter ones, it is more economical and profitable to plant longer cuttings whenever material is available.

It is customary to remove two or three leaves from the base of the cutting which inserted into the humid layer and mulch. With short cuttings, at least two nodes should be left above ground. The portion above ground should be tied to support until aerial roots have obtained a firm grasp. Cuttings are usually planted directly in the plantation grounds but they can be started in nursery beds also. Because of its nature, cuttings can be stored or transported for a maximum of two weeks if required.

3.2. Supporting trees

Vanilla creepers require both some form of support along which they can climb and also checkered shade. Full sunlight and dense shade are both harmful to healthy growth of a plant.

Usually small trees are planted to provide support before planting vanilla cuttings. The ideal tree should be quick-growing, provide checkered shade, have a sufficient number of low branches over which the vine can be trained so that the vines hang down and provide easy access. The supporting trees should be strong enough to support the vines in heavy winds and be easily pruned. Supporting trees are more quickly established by using cuttings rather than starting from seed.

The two trees most commonly used in Madagascar are *Jatropha curcas* L (*Jarak)* which can be propagated from cuttings or grows rapidly from seeds, and *Casuarina equisitifolia* L. The most extensively used trees in Indonesia are *Lamtoro*, more commonly known as Ipil Ipil (*Leucena glauca*) , *Gamal* or *Glyricidia sepium*, and dapdap or *Erytrina orientalis*.

Figure 2. Dapdap (*Erytrina orientalis*) is used as supporting tree.

3.3. Planting

Planting is done at the end of the dry season at the onset of rains. The ground around the supporting tree is first leveled before adding a heavy layer of vegetable (cutting trees) mulch to the surface Several nodes of the vanilla cutting are covered with soil and leafmold at the base of the supporting tree. At least two nodes are left above ground and this portion is attached to the support by tying it at several places. During the next few weeks, the vines grow and send out aerial roots which fasten the vine to the support.

In the past, the vines were planted close to each other and one supporting trees was used for two or three vines. But this was identified as one of the cause of fungus disease problem. The present practice is to maintain sufficient distances between

plants and along rows. Correll (1953) describes distance patterns in different parts of the world which are shown in the Table below.

Distance along row	Distance between rows	No of vines per hectare	Production per hectare (@ 0.44 kg per plant)*
2.74 m	2.74 m	1,326	583.44 kg
1.50 m	3.00 m	2,150	946.44 kg
1.20 m	2.40 m	3,360	1,478.40 kg
1.00 m	1.50 m	5,000	2,200.00 kg

* Optimum expected yield in Bali and elsewhere in Indonesia

** The distance is usually used in Indonesia.

From the Table it can be seen that although general maintenance and disease control are more effective with more liberal spacing of the vines, the economic benefits are lower. On the other hand, the last row showing the density of Indonesian vines may be too high and the vines are probably more susceptible to infection from disease plants than they are more widely spaced.

3.4. Maintenance

The vines must be trained to grow within easy reach of workers who must be able to pollinate the flowers, pruned the vines and harvest the fruit without difficulty. The vines should never be exposed to direct full sunlight but rather, should always have checkered shade provided by the supporting trees.

It is important to keep a layer of vegetable mulch on the surface of the ground, especially over the roots of the plant. Cultivation of the soil is risky since the roots grow at the surface level and can be easily damaged. Weeds and other vegetable growth should be clipped and spread over the ground as additional mulch.

Nine or ten months before the flowering season, the lip of the vine is cut off to induce vine to flower. The blossoms are produced in the axils of the leaves on long hanging branches. When the plants are in flower, the need daily attention. After flowers are selectively pollinated and desired number of pod are set on each vine, the remaining flowers and buds must be removed. This prevents any loss of plant vitality through the production of useless blossoms, avoids pollination of too many blossoms and saves workers from having to examine superfluous flowers. All undesirable or malformed pods should also be removed. After flowering and fruiting, old stems should be trimmed away. This will be replaced the following year with new and productive stems.

Vines reach their maximum production about seven or eight year and May, if given proper care, continue to produce for several years more.

3.5. Pollination

The stamen (male organ) carrying pollen and the stigma (the female organ) in a vanilla flower are separated by flap-like rostellum. Self-pollination of there flowers is, therefore, impossible. In Mexico and Central America where vanilla is indigenous, some of the flowers ore pollinated by bees of the genus *Melipona*. However, the percentage of fruits set by this method is so small and, therefore, the Mexicans do not depend too much on insect pollination but use hand pollination instead. In the rest of the world, hand pollination is universally practiced.

Hand pollination is a simple operation. The only implement needed is a splinter of bamboo, a stem of stiff grass or a thin piece of wood the size and shape of a toothpick. Pollination is accomplished by lifting the thin flap-like restellum that extend between the anther and the stigma and pressing the pollen against the lower stigmatic surface. An average worker pollinates between 1000 and 2000 flowers a day. Under ideal conditions, a good strong vanilla plant in full vigor can produce a maximum 200 bunches or racemes of flowers at a time. Each bunch carries between 15 and 20 flowers.

3.6. Fruiting

The number of fruits left to mature on individual plants varies in different regions. An average cultivated plant will optimally produce 25 perfect beans. If a plant is forced to produce an excessive number of beans in one season, the beans produced in the following season will be inferior and the vines will be quickly exhausted.

After fertilization, the ovary elongates rapidly, growing as much as a 3-cm in a week until the full length of the beans is attained in for to eight weeks, Depending on the region where the plants are grown, and it takes from six to ten months for the beans to become fully mature. For example, the fruits mature in six moths in low land and nine months in high land. Beans should be harvested when the begin to ripen and turn yellowish-green in color and are firm, thick and quite odorless.

3.7. Diseases

Correll (1953) reported that the two most serious diseases which affected vanilla plants in different parts of the world and have caused extensive damage are:

Anthracnose or *Calospora vanillae* which attacks the stem apex leaves and roots and result in wilting and fruit fall. Excessive moisture, prolonged rainy weather, insufficient drainage, too much shade and overcrowding all favor this disease.

Fusarium batatatis is identified to cause root rot and stem rot. The disease causes the browning and death of underground roots and later of the aerial roots. The plant stop growing new shoots; the stem and leaves become flaccid and the stems begin to shrivel and eventually droop and dry out. The disease is caused by drought, too much sun, malnutrition, over-pollination and subsequent excessive fruit production.

The remedies are to provide sufficient space between vines to prevent over-crowding, control the shade cover to allow about 30-50% full sun light to penetrate, provide good drainage, always maintain a layer or heavy mulch on the ground, avoid over pollination, and provide irrigation during extended dry periods. Diseased parts of the plant should be cut off and immediately burned. In addition constant use of fungicide is recommended.

Figure 3. Vanilla plant is attacked by root rot disease.

The estimated cost for land preparation, planting and maintenance of vanilla plants for one hectare

Year	Main activities	Labor, facilities and equipments required.	Estimated cost/unit (Rp)	Total cost (Rp)
1 (250 days)	➢ Opening the land	Labor	5,000,000	5,000,000
	➢ Planting windbreak trees	Labor	1,000,000	1,000,000
		200 Planting materials (trees)	3,000	600,000
	➢ Planting supporting trees(1.5mx 2.0 m)	Labor	1,000,000	1,000,000
		Supporting trees *Glyricidia sepium (gamal)* 1.5 m length each of 3,333 stems	1,500	5,000,000
	➢ Maintenance of supporting trees: Bending and pruning, clean weeding and mulching	Labor	2,000,000	2,000,000
	➢ Planting vanilla stems	3,333 vanilla stems or vines (1 m each)	6,000	20,000,000
		Labor	1,000,000	1,000,000
	➢ Intercropping	Vegetables, pineapple ect. and Labor	1,500,000	500,000
2	➢ Maintenance; mulching, looping, pruning and intercropping (100 days)	Labor	2,000,000	2,000,000
3	➢ Maintenance; cleaning of the intercropping materials; mulching, looping and pruning (100 days).	Labor	2,000,000	2,000,000
	➢ Artificial pollination of vanilla flowers (20 days).	Labor	600,000	600,000
4	➢ Maintenance; cleaning of the intercropping materials; mulching, looping and pruning. (120 days)	Labor	2,000,000	2,000,000

Year	Main activities	Labor, facilities and equipments required.	Estimated cost/unit (Rp)	Total cost (Rp)
	➢ Pollination 40 days	Labor	1,200,000	1,200,000
	➢ Harvesting (10 days)	Labor	400,000	400,000
5	➢ Maintenance (130 days	Labor	2,500,000	2,500,000
	➢ Pollination (70 days)	Labor	2,000,000	2,000,000
	➢ Harvesting (20 days)	Labor	800,000	800,000
TOTAL COST FOR FIVE YEARS				**49,600,000**

** The cost of the land is not included which is relative depend on location

Estimated Cost for processing facilities up to 50 tons green beans per season

Main activities	Facilities and equipments required.	Estimated cost/unit (Rp)	Total cost (Rp)
➢ Building/shade** and open field	➢ Steel construction (40 m x 15 m) ➢ Open field for sun drying 800 m^2 *		100,000,000
	➢ 6 big fans	200,000	1,200,000
➢ Sorting and grading green beans	➢ 2 Tables 2 x 10 m with conveyor belt	3,000,000	6,000,000
➢ Wilting the beans	➢ 2 packages wilting equipments; burners, big pan, wire basket, thermometer, LPG tubes.	1,000,000	2,000,000
	➢ 1 package oven (4 m x 4 m x 4 m) for wilting	20,000,000	20,000,000
	➢ LPG gas 80 big containers (tubes)	100,000	8,000,000
➢ Sweating	➢ 10 insulated sweating boxes (1 m x 0.8 m x 0.8 m)	300,000	3,000,000
➢ Drying	➢ 100 wooden trays (150 cm x 80 cm) for open field sun drying	20,000	2,000,000
	➢ 20 wooden racks (5 m x 0.8 m x 2.5 m)	300,000	6,000,000
	➢ 200 m black thick cloths	8,000	1,600,000
	➢ 1 package drying oven (4 m x 4m x 4m)	20,000,000	20,000,000
	➢ 5 trolleys with racks to carry 10-12 steel trays	1,500,000	7,500,000
➢ Conditioning	➢ 1 Conditioning room (8 m x 4 m x 4 m)	25,000,000	25,000,000
	➢ 25 roll Plastic films	20,000	500,000
	➢ 500 Carton boxes	6000	3,000,000
➢ Export preparation	➢ 500 strong corrugated carton boxes	9,000	4,500,000
	➢ 25 roll plastic films	20,000	500,000
TOTAL			**210,800,000**

** The cost of the land is not included. It is relative depend on location