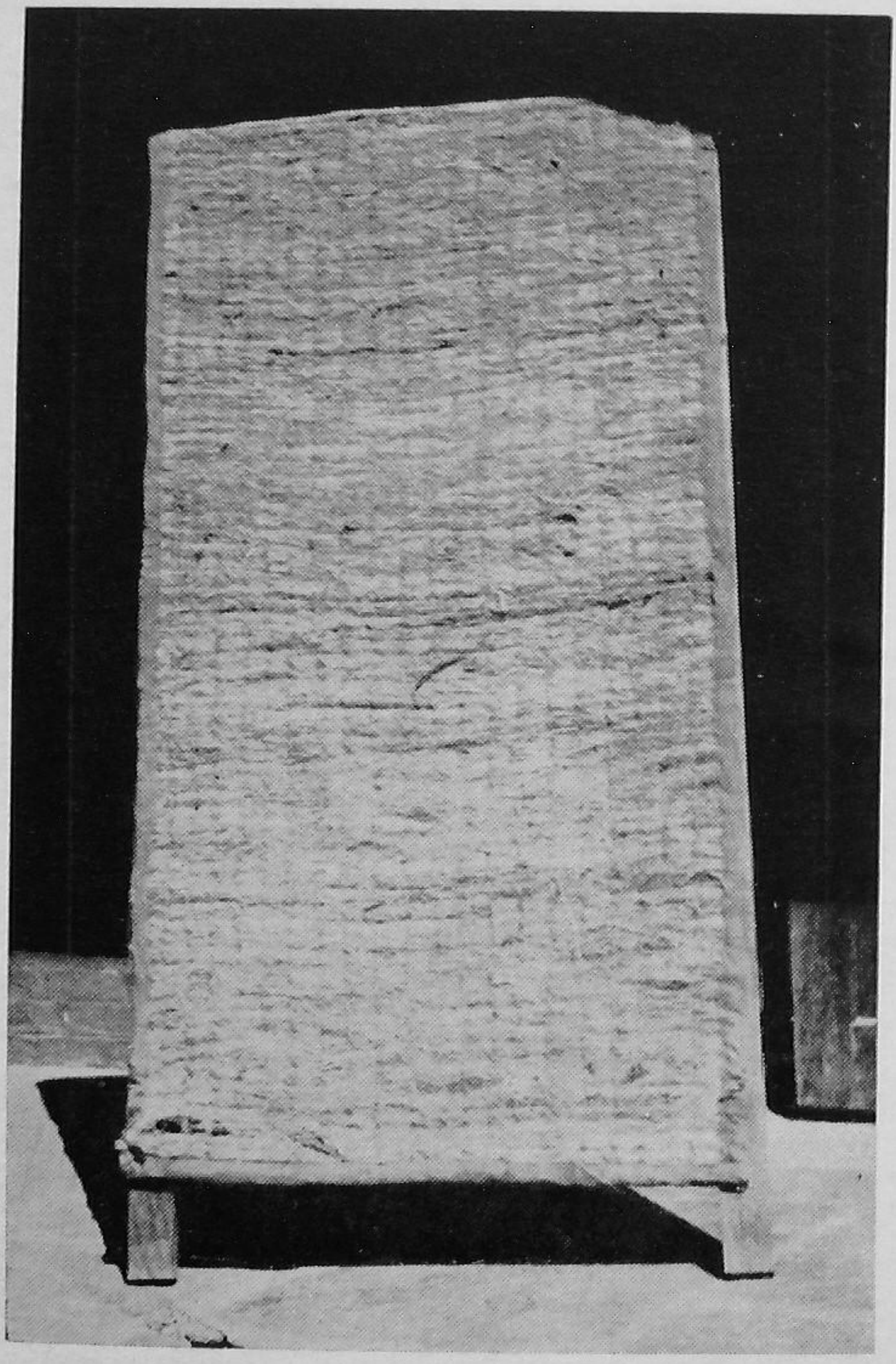
Farm Bulletin No. 18 (New Series)

THE VETIVER IN INDIA

INDIAN COUNCIL OF AGRICULTURAL RESEARCH NEW DELHI



A portable screen made of vetiver roots

THE VETIVER IN INDIA

Cultivation, uses, extraction of oil, etc.

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Farm Bulletin (New Series) No 18

ICAR Farm Bulletins are written in simple language and are intended for progressive farmers and the general public. These bulletins contain the latest and authoritative information on improved farming techniques for stepping up agricultural production. *The Vetiver in India* is the eighteenth bulletin in this series.

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GENERAL

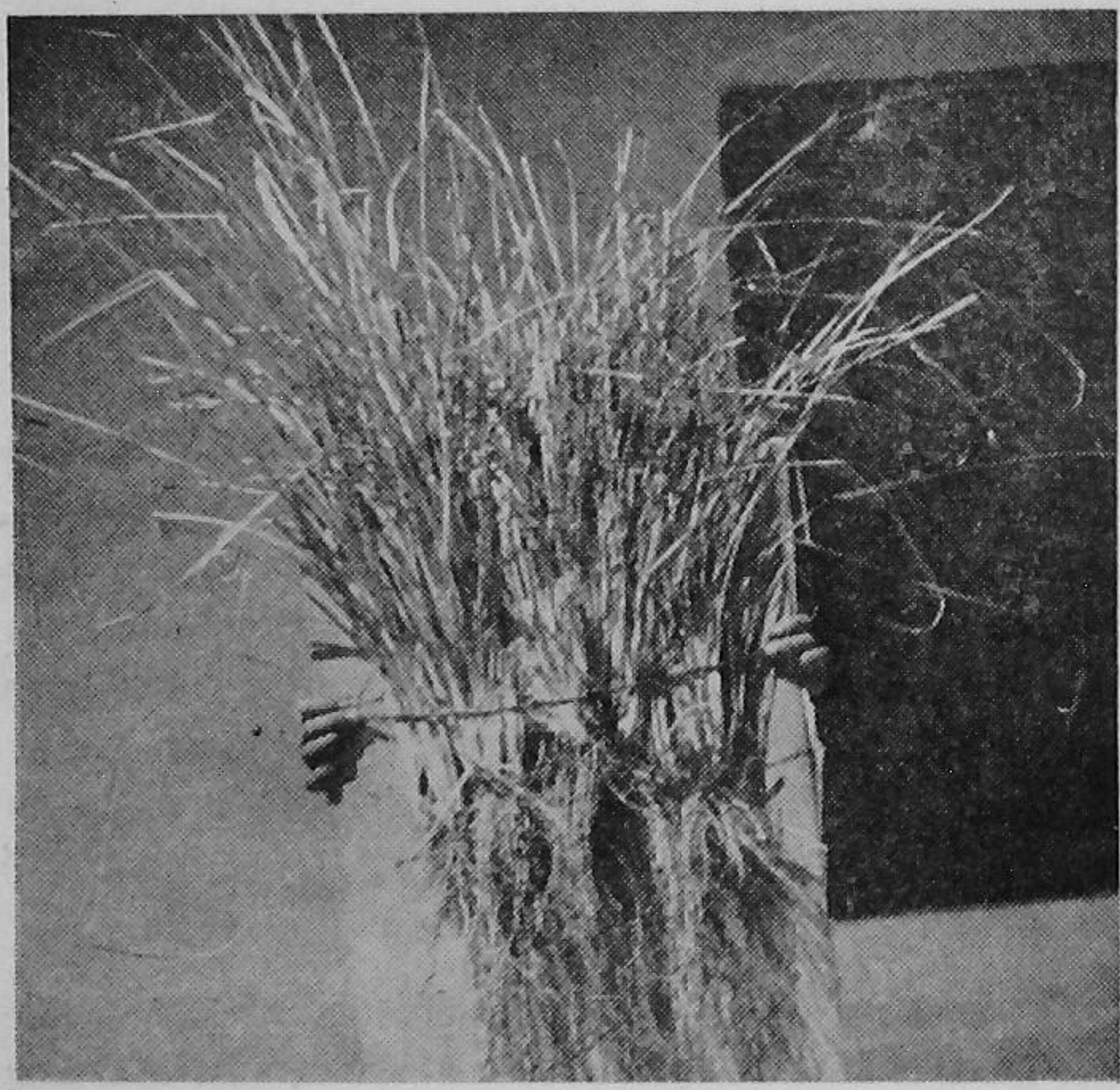
THE vetiver or *khus* is the source of the valuable aromatic vetiver oil which enjoys world-wide reputation as being one of the finest oriental perfumes.

An important essential-oil-yielding plant of India, vetiver has been grown and extensively used in the country for several centuries. Its medicinal and commercial importance was known even in the earliest days of Indian civilization. The vetiver has been referred to in various ancient works on *Ayurveda*, by Charaka, Vagbhadananda and others. The king of Kanauj in the 12th century had levied a duty on vetiver roots as evident from copper plate inscriptions dated 1103 and 1173 A.D., excavated from Etawah, near Agra in Uttar Pradesh.

At present, vetiver oil is widely used in making perfumes, medicine, soap and other toilet articles. Vetiver root is also used for several other purposes. Mats and screens made of vetiver roots known as *thattis* are a common sight in North India during the summer months. Besides, vetiver roots find a range of markets as fancy fans, ornamental baskets, brushes and the like.

Botanically, the vetiver grass is *Vetiveria zizanioides*, formerly called *Andropogon squarrosus*. The vetiver is known by different names in different languages. It is called *khus* in Hindi and Bengali, *vetiver or velamachamver*

in Tamil, *veltiveru* or *vattiveru* in Telugu, *ramacham* in Malayalam, *lavancha* in Kannada, *muddela* in Tulu, *vala* in Marathi and *ushira* in Sanskrit.



Vetiver plants with roots displayed

The vetiver belongs to the genus *Vetiveria*, which includes about seven species and is a member of the tribe Andropogoneae and natural order Gramineae—the common grass family.

The vetiver is a perennial grass, densely tufted, upright, often growing luxuriantly on rich, marshy soils attaining a height of 1 to 1.8 metre with the root portion branching

into spongy, aromatic and fine rootlets. It grows in large clumps, the leaves of which are long, errect, narrow, stiff with high margins and upto one metre in length. The grass puts forth a long terminal panicle carrying numerous slender racemes of spikelets. Many of the cultivated types rarely flower and the flowers that are seen on some other types never get seeds. The leaves of the plant are odourless and do not contain the essential oil. It is the root which gives the essential oil, and is strongly scented. The length of the root varies from 10 to 35.5 centimetres and sometimes even more.

2

DISTRIBUTION

THE vetiver grass is a native of India. It is found throughout the plains and lower hills (upto 1220 metres in altitude) of India, Burma and Ceylon. It grows very well under natural conditions in the lower hills and on the rich river-bank soils in a fairly hot (80°F) and damp environment. It is seen growing wild throughout the Punjab, and Uttar Pradesh, in the jungle tracts ascending into Kumaon hills upto 610 metres in elevation, on the banks of rivers and lakes and in the forests and elsewhere in the district of Bharatpur in Rajasthan. Very little of it is cultivated in these parts of India. In Central India, it is seen partly growing wild and partly cultivated. It is also found in Baroda, Chota Nagpur, Bihar and Assam. The plants also grow wild in parts of East and West Coasts of India,

on the waste lands of Cuttack, Andhra, Kerala, Mysore and Madras States.

The plant is cultivated systematically in certain places of Kerala, Madras, Mysore and Andhra Pradesh. The yield from the cultivated crop, however, meets only a very small share of the requirements of the country and bulk of the oil and roots is obtained from the wild formations.

The grass has been introduced into most parts of the wetter tropics, where it seems to thrive in a variety of environments on different soils. In many places it appears wild or semi-wild.

The grass is also cultivated in Indonesia, in the islands of Reunion, the West Indies, Malaysia, Fiji, Philippines and Louisiana in the United states.

In many parts of East and West Africa also the plant is growing wild. Because of its fibrous root system, it is also planted here on bounds and contours to prevent soil erosion.

3

VARIETIES

THERE are apparently two main types of this grass, one seeding and the other non-seeding. The one that grows wild in North India is mainly the seeding type while that of the South is non-seeding.

There are again two types found distinguishable by different stem and root characters. One type has a medium thick stem with more branching roots and the other a thick stem and less branching roots. The latter type is the one commonly found everywhere.

It is understood that there is also considerable difference between the North Indian and the South Indian strains with regard to the yield and aroma of the oil. It is said that the oil of the Bhartpur, Akila and Musanagar strains generally have an aroma superior to that of the oils derived from the South Indian grass. The yield of the South Indian types, however, is reported to be higher than that of the above mentioned strains though, experimental evidence in this regard is lacking. It can, therefore, be said that there is a wide field of selection among the types found in India in search for improved strains.

4

CULTIVATION

It is only in the South India that the crop is systematically cultivated. In Kerala State, the cultivation is mainly done in the villages of Kaipamangalam, Chentrapinni, Peringanam, Koolimuttam, Andathode and Punniyur in the Chowghat and Ponnani taluks of Trichur and Palghat districts, in Nilambur of Kozhikode district, a few villages like Neyyattinkara in Trivandrum district. Recently cultivation has also been taken up in Wynad and along its foot-hills.

In Madras State, the places where vetiver is cultivated are Tirunelveli, Srivilliputhur, Madurai, Thanjavur and Tiruchi. In recent years, the Madras Cinchona Department has taken up the cultivation of the crop in Cherangode and Moyar in the Nilgiri district and Anamallais in the Coimbatore district at the altitudes of 900 to 12,200 metres.

In Andhra Pradesh, cultivation is done to a certain extent in the Kurnool and East Godavari districts.

Propagation. The vetiver is propagated from seeds or slips. Seeding is found to be very profuse in the crop in the areas where it occurs wild, and regeneration takes place from self-sown seeds and by tillering during and after the rains.

In the south where the crop is cultivated on a large scale, the non-seeding type is grown. This is propagated from slips obtained from the uprooted clumps of the previous crop. Slips separated from the clumps with the rhizome portion intact, having 15 to 20 centimetres of the shoot portion, constitute the material for planting. If the clumps have been uprooted long before the planting and have been kept alive by watering, the rhizome portion will have developed small fibrous roots and the slips can be planted with the roots intact after trimming the roots, if necessary. In recent years, it is understood, that some of the seeding varieties of the North have been introduced in Nilambur in Kerala State and in Coimbatore and Nilgiri districts of Madras State. The seeds of the plant are sown in the nursery in early January and the seedlings so obtained transplanted on their permanent site in the field with the onset of the pre-monsoon showers in May.

Soils and Climate. Even though vetiver grows almost in every kind of soil, a rich and fairly well-drained sandy loam is considered the best. The grass grows luxuriantly in places with an annual rainfall of about 1020 to 2030 millimetres, temperature ranging from 70° F to 110° F and with a moderately humid climate. It thrives in rich marshy soils in a warm and damp climate, and grows sturdier with fine matty roots. In some parts of the Ponnani and Chowghat taluks adjoining the sea shore in Kerala, the grass is cultivated on sand and sandy loam, while it is grown on a light red loam with an admixture of fine gravel near about Trivandrum. In the foot-hills of Wynad the grass is grown on a fairly rich loamy soil. The heavy yield of roots and high oil content obtained in those places

are due to the good depth, texture and fertility of the soil. Vetiver can be successfully cultivated under rainfed conditions in most regions provided the soil is fairly rich and well-drained and the rainfall is not less than 1020 millimetres annually and is evenly distributed.

Trials at the Kerala Soap Institute, Kozhikode, have shown that the nature of the soil does play an important part in influencing the oil content. It has been found that red laterite loamy soils are preferable to soils of white sandy nature, as the roots in the former soil develop a higher oil content.

Preparation of Land. The jungle growth of the land intended for cultivation is first cut down and then heaped and burnt when sufficiently dry. After a few showers, a deep tilling is given to the land with *mamutties* and digging forks and ridges or beds and furrows made. On sloping land any stones or boulders found on the site are arranged along the contour as an anti-erosion measure. The ridges or beds are also made along the contour on such land.

There are three different systems of planting adopted by different growers. In one system, conical ridges, 30 to 38 centimetres high and 48 centimetres apart are made at the summit and the slips planted 23 centimetres apart on the summit. In another system, the land is laid out into beds 30 centimetres high, 68 centimetres wide and 45 centimetres apart edge to edge, and the slips are planted on these in two rows 22.5 centimetres apart, leaving 22.5 centimetres on either side. In the third system, the beds are made 45 centimetres high, 60 centimetres wide and 30 centimetres apart edge to edge, and two rows, 30 centimetres apart,

are planted on these leaving, 15 centimetres on either side. The spacing within the row is also 30 centimetres in this system.

Most of the cultivators prefer the second method. Trials in the Government Cinchona Plantations at Anamallais to determine the relative merits of the first and second mentioned systems of planting have indicated that the latter method gives a higher yield of roots. The cost of harvesting the roots is also lesser in this method.

Planting. Planting is usually done in the rainy season just before the outbreak of the monsoon. Best results are obtained if the planting is done in this period. In the West Coast of India this season falls in the second half of May. If facilities for irrigation are available, it is even preferable to do the planting in March-April as some growers do. In that case frequent irrigation will be necessary till the monsoon starts. The planting should be completed at the latest by the end of August as thereafter the monsoon trails off.

The slips obtained from the harvested clumps of the previous crops are used for planting. If there is likely to be a long interval between uprooting and re-planting, the clumps are collected and placed loosely packed on a well-forked plot of land, and frequent watering is given to keep them alive and growing.

The slips are planted in a pit five to eight centimetres deep, made with a pointed stick. Two to three slips are planted in each hole. This is done to provide for any casualties and to get a thick stand of plants. After inserting

the slips in the pit the soil around is pressed firmly and levelled. A coir rope is usually run along the proposed row to obtain a straight row of plants.

Casualties are replaced before the closing of the monsoon. Normally, about five to ten per cent of the points require refilling before the closing of the monsoon.

An acre requires usually 60,000 to 90,000 slips at two-to-three slips per pit in the commonly adopted system of planting (mentioned second above). From an average-sized clump, about 20-30 healthy and suitable slips can be obtained.

After-cultivation. After-cultivation consists of weeding the area and earthing up the plants. Three to four weedings are necessary in the first year and two to three in the second for a crop kept in the field for about 18 months. In the second year, one of the weedings is done just before harvest to facilitate the harvest operation and to avoid any roots of the weeds getting mixed up with the roots of the crop. In some places irrigation is also done as and when necessary.

Fertilising and Manuring. Timely manuring is essential for increased yield of roots and oil. The high fertility of the forest soils is perhaps a stimulating factor in producing a sturdy grass with profuse clusters under natural conditions.

In Kerala State, manures such as ash, compost, fish guano and sweepings from the fish curing yards on the coast are applied to the crop a month after planting. These are supposed to stimulate the growth and help to give a high stand of plants. Preliminary trials conducted under the

auspices of the Kerala Soap Institute, Kozhikode, have showed that manuring with ammonium sulphate, groundnut cake and brine manure (residue left in the brine in which fish is cured) would increase the yield of roots as well as the oil content.

Investigations on manuring with cattle manure, ash and bone-meal conducted by the Madras Agricultural Department on *modan* land under rainfed conditions at Pattambi, and Ambalavayal of Wynad showed that under Pattambi conditions:

(i) there was no significant difference between the different treatments, but the trends indicated that application of cattle manure, wood ash and bone-meal under 15 months' harvesting treatment had a beneficial effect on the yield of roots.

(ii) the different treatments adopted had no appreciable effect on the percentage of oil content of plants of 15 and 18 months age-group but in the 12 months age-group the application of bone-meal either singly or along with wood ash or in combination with cattle manure and wood ash seemed to improve the percentage of oil;

(iii) and the manurial treatment had no effect on improving the yield of oil.

The trials at Ambalavayal indicated that under 12 months' digging treatment, the application of wood ash had no effect in enhancing the yield. The application of cattle manure or bone-meal either singly or in combination seemed to have increased the yield of roots.

5

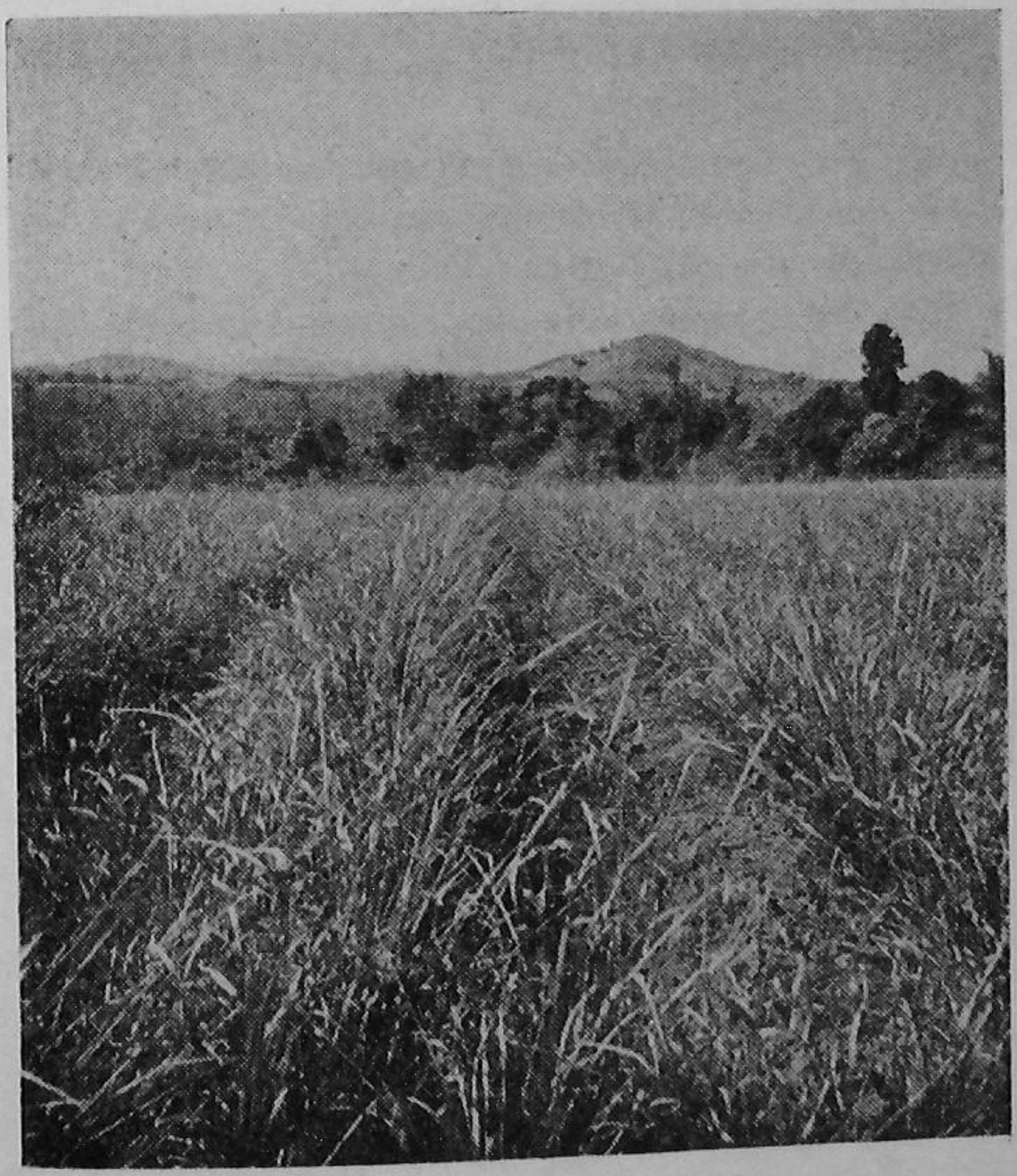
HARVEST OF ROOTS

It has been stated earlier that roots of vetiver are used either for making screens, fans and other articles or are distilled for the oil it contains.

In the northern parts of India where no systematic cultivation is done and only wild formations are exploited, there is no definite period for the harvest of roots. This is because it is difficult to assess the age of the crop in any block, and as natural regeneration takes place in profusion, any stand will be composed of plants of varying ages. But in general, it is the practice to harvest the roots both for the manufacture of articles and for distillation when the plants are 10 to 12 months old as far as it could be judged by the appearance of the plants and roots. In recent years, however, a system of rotational harvest of roots is reported to be followed in some places like Bharatpur. The Forest Department lets out on lease any particular block for extraction of roots once in fifteen months. This system ensures the harvest of mature blocks. The method is reported to have increased the yield of oil from about 0.3 per cent to 1 per cent and improved the quality also.

In areas where the crop is cultivated, the roots are harvested during the tenth to twelfth month if they are

intended for manufacture of articles. By this time the roots attain the required amount of length, thickness and roughness. If, however, the roots are intended for the extraction of oil, they will have to be retained longer, *i.e.*, 15 to 18 months.



A vetiver plantation nearing harvest (*Nilambur, Kerala*)

In the trials conducted under the auspices of the Kerala Soap Institute, Kozhikode, the optimum period of maturity

for the yield of oil, was found to be 15 to 18 months. Trials carried out by the Madras Agricultural Department at Pattambi and Ambalavayal have shown that under Pattambi conditions,

(i) the yield of roots per acre is maximum under 15 months' digging trials;
(ii) the oil content is the highest under the 18 months' digging trials;
(iii) the calculated yield of oil per acre is the highest under the 18 months' dug-out roots as under the Ambalavayal conditions;
(iv) the maximum yield of roots was obtained in the 12 months' digging and the least in the 18 months' digging; and
(v) the percentage of oil was the highest under the 15th month age-group.

In the Government Cinchona Plantations in the Anamallais and Nilgiris the roots are harvested from the 17th or 18th month onwards, and the harvest is completed before the end of the 20th month.

Some cultivators in South India harvest the roots from the 10th month onwards if the prevailing prices of the roots or the oil are high. But the yield of the roots as well as the oil will be low at this stage.

The oil obtained is also found to be of inferior quality and does not find discriminating markets.

Harvesting Season. The harvesting is done during the dry months of the year. It has been found that heavy and prolonged rains leach out the oil from the roots and a

large number of new roots that are produced during the rainy season further reduce the percentage of oil. Harvesting should, therefore, be avoided during the rainy months, and in the period immedicately following rains. The oil is also said to be induced during the very hot months due to evaporation. Harvest is also difficult during this period as the soil gets very hard rendering the operations difficult.

In the South, therefore, October to March can be regarded as the best months for harvesting. It can be seen that this period generally coincides with the period of maturity of the crop.

Method of Harvesting. The harvesting or uprooting is done with digging forks having prongs of 45 centimetres length. To start with, the stem portion is cut at a height of 15 to 20 centimetres and the clumps or stools are then uprooted. About 50 to 60 per cent of the roots come away with the clump leaving the rest in the soil. The clumps are beaten on a piece of log to remove stones and earth adhering to the roots and the roots are separated with a sharp-knife. As far as possible, the roots left in the soil are also collected. For an efficient collection of roots, it may be necessary to dig the soil at least three feet deep. The colour of roots ranges from light yellow or yellowish brown to slightly reddish.

The roots that possess the following characteristics have a good oil content. It should,

(i) expose a hard surface when the skin is peeled off;
(ii) be thick, hard, long and wiry; and
(iii) give a very bitter taste when chewed.

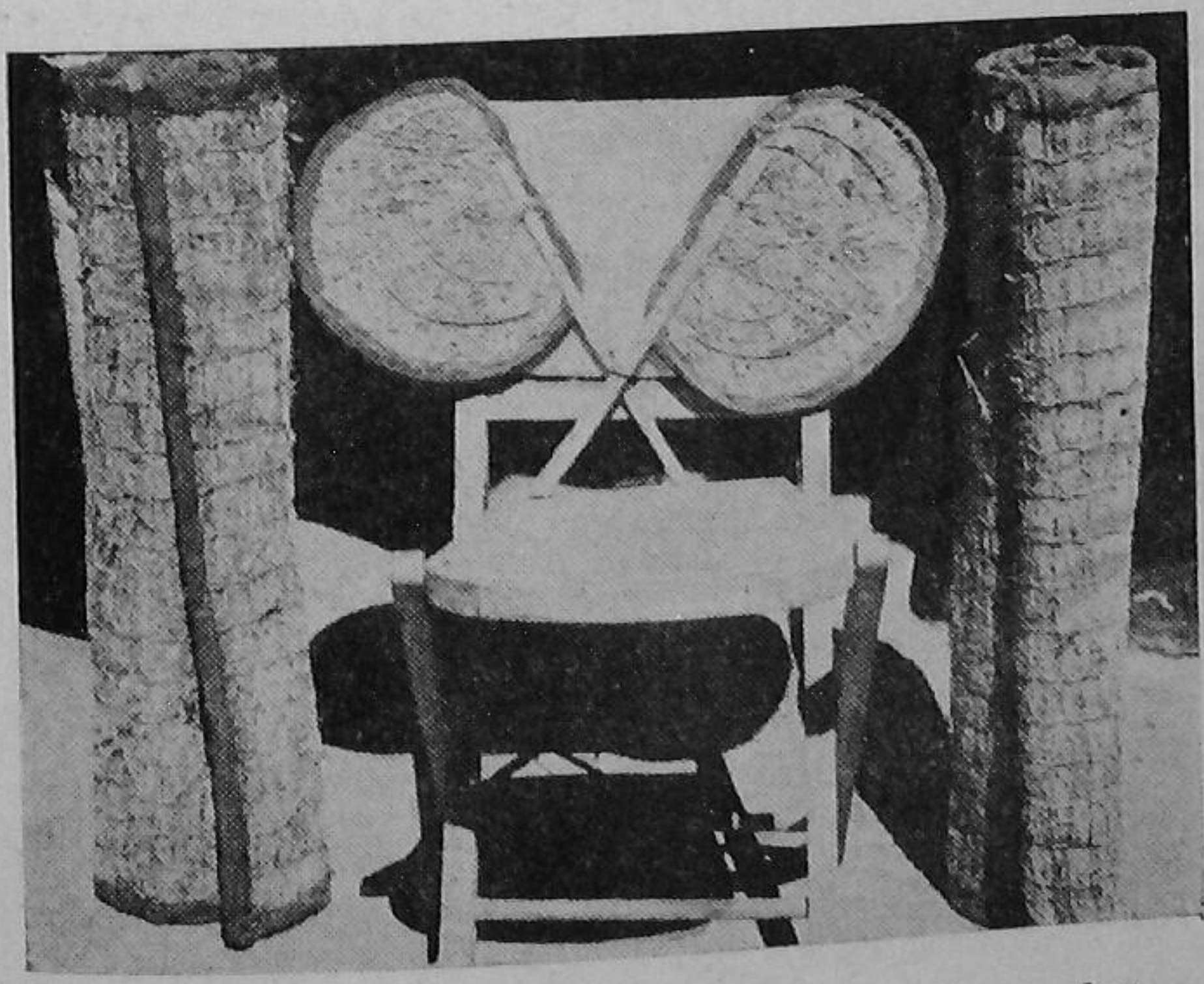
Yield

For the reasons mentioned already, it is difficult to arrive at the exact figure of yield of roots obtained from the wild formations. In the cultivated areas in the South, an average yield of 1,587 to 2,040 kilograms of fresh, washed roots per acre can be expected. An yield of 2,040 kilograms can be regarded as satisfactory. In the Government cinchona plantations, Anamallais, it is reported certain areas have given even 2,950 to 3,040 kilograms of fresh and washed roots while harvested at 16-18 months of age. Needless to say that besides the age, the soil and climatic conditions are important factors governing the better yield of roots. The yield also varies with various varieties.

6

USES

ROOTS of vetiver are used for a variety of purposes. Apart from extraction of oil, they are used to make aromatic mats and screens for doors, and windows and for shading verandahs. These screens are popularly known as *thatties* and are in great demand in summer months throughout India, especially in the North, for cooling



Mats and fans made of vetiver roots ready for market

or air-conditioning the rooms and for generating and spreading a fine and refreshing aroma. Artistic fans, fancy mats, ornamental baskets and brushes of different sizes are also made from the roots. The roots are also made into awnings, sun-shades, satchel bags and pillows. They are also knit along with bamboo splits and made into flat mattresses and used in Kerala as under-beds in summer months to give a cooling effect. Tied up in small bundles in bags, they are used for placing in wardrobes, boxes, etc., for the sake of their fragrance and for keeping away insects. In summer season a few bits of roots are commonly steeped in drinking water stored in goglets for imparting the aroma, particularly in the West Coast. This water is believed to cool the system during the sultry weather.

The roots of vetiver possess medicinal properties and are used for various medicinal and pharmaceutical prepartions both in the alopathic and *Ayurvedic* systems of medicine. The root, when made into a paste and applied to the head, cools the head, cures headache and acts as a soporific, or sleeping drug. It is used as a stimulant, refrigerant and stomachic and as a preventive against cholera. A paste of pulverised roots in water applied externally is beneficial in fever and heat strokes and is also reported to give relief from prickly heat, itches and ringworm. The roots are also used in combination with sandal and other fragrant woods as an ointment.

Vetiver roots contain a highly scented oil which finds wide use in the soap, perfumery and other toilet industries. The oil is not only a perfume by itself but is also an excellent fixative for the more volatile

types of oils. Because of the tenacity, intensity and remarkable persistency of the fragrance, the oil is also used in the blending and rounding off of various bouquets. The oil of lower quality is used in the manufacture of scented sticks or *agarbathies*. Medicinally the oil is regarded as a stimulant, diaphoretic to induce perspiration and a refrigerant. Taken internally it acts as a tonic. Its cool fragrance has a soothing effect on the system, particularly in tropical countries, where it is mixed with sandal paste and freely applied on the body during the hot months.

The grass is used for making brooms in parts of Uttar Pradesh. It is also used for thatching the house when old and tough. It is reported to be used for making paper in the Punjab. It has been found at the Forest Research Institute, Dehra Dun, that writing and printing paper can be made from the straw by mixing the pulp of vetiver root with the long fibre pulp of the *sabai* (*Eulaliopsis binata*) grass. It has also been found that a pulp suitable for making straw board can be prepared by dissolving it in lime. The mattry roots of the grass also make it valuable for binding the soil on field bunds and on contours to check soil erosion.

Consumption for Different Purposes

The largest consumption of the root is for making screens or *thatties* and miscellaneous articles for which about 60 per cent of the total output is used. The rest is used for extraction of oil. A major share of roots produced in South India, particularly along the West Coast, is consumed either for manufacturing medicines and toilet articles or for export to markets in north India. The quantity used for the former is estimated to be about 1,120 quintals.

Most of the oil produced in India is consumed for soap making; but some of it is used in pharmaceutical preparations. It is estimated that the present production of vetiver oil in India is only about 30 per cent of her irreducible minimum needs and the balance of requirements are met from imports from Indonesia, Reunion and other countries.

7

CENTRES OF PRODUCTION

THE total annual output of vetiver roots from all parts of India may be estimated at about 40,640 quintals and the area is computed at a little over 4,252 hectares.

CHIEF CENTRES OF VETIVER PRODUCTION

State	*Important Centres*	*Chief marketing centres*
Uttar Pradesh	Dehra Dun, Agra, Farukhabad, Biswan, Bareilly, Pilibhit, Kanpur, Kheri, Utripara, Sitapur, Gorakhpur, Gonda, etc.	Delhi, Lucknow, Kanpur
Rajasthan	Bharatpur, Rupbas, Kamether, Ajmer, Merwara.	Bombay, Ajmer, (Delhi)
Punjab	Hissar, Gurgaon, Rohtak, Karnal	Delhi

Kerala	Chowghat, Ponnani, Trivandrum, Nilambur, Wynad	Nilambur, Kozhikode, Cochin, Bombay, Calcutta
Madras	Tuticorin, Anamallais, Nilgiris	Bombay, Tirunelveli, Madras

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As stated earlier, vetiver is systematically cultivated only in South India. In the North, it is cultivated on a very limited scale and the roots that are produced and marketed or that are distilled are mostly those obtained from the natural growths. The tillering and seeding habit of the grass has resulted in its natural regeneration. As the grass grows wild and as it is exploited at all ages with scant regard to the fact whether it is sufficiently mature or not, the yield obtained is low and for the same reason it is also difficult to estimate it accurately.

The roots are collected from various parts and marketed in the trading centres where they are either sold as roots or distilled for oil and then sold. The roots from the Bharatpur district in Rajasthan are considered the best for extraction of oil.

In recent years there has been a steady increase in cultivation of the vetiver in Wynad and its foot-hills in Kerala State. A rough estimate of the area under cultivation is 200 hectares. The figures of yield of roots from these areas are not readily available.

8

EXTRACTION OF OIL

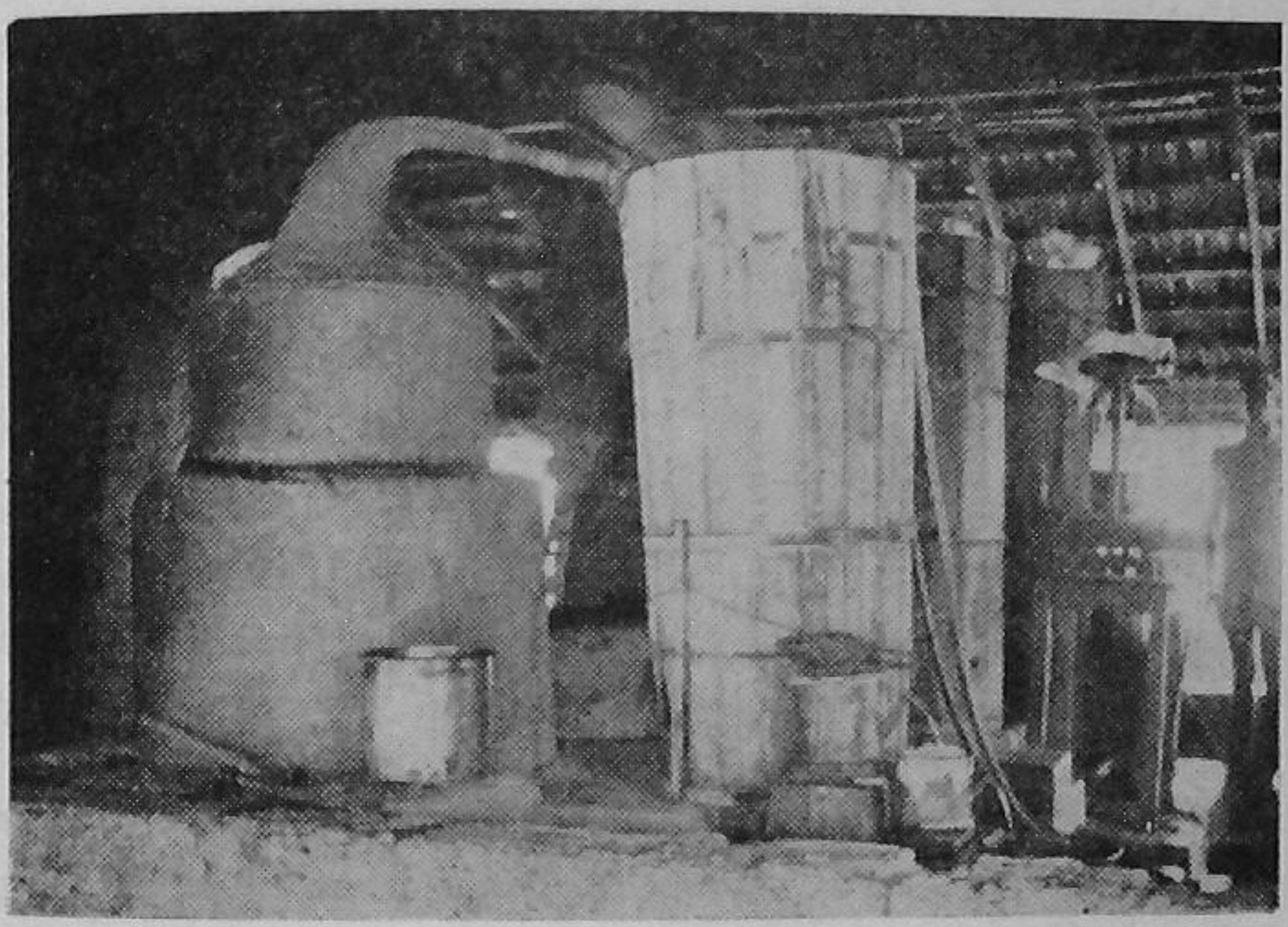
For extracting the oil, the roots are distilled. Briefly, the process of distillation consists of injecting hot water or steam into a still charged with roots. Under the influence of the boiling water or steam, the essential oil is liberated from the oil glands in the plant tissues and vaporises. The steam as well as the vapour of the essential oil is passed through the condenser attached where the oil is condensed. Then, both water and oil are drawn into a receiver where the oil separates automatically from water particles. Steam or water is continuously charged into the still until all the essential oil has vaporised. The oil is then collected in a separate chamber.

Distillation Equipment

The distillation unit is usually made of mild steel or stainless steel or copper or aluminium alloy. Copper stills are most commonly used as they are more durable, and would give quality oil.

The distillation unit consists essentially of the following parts as shown in the sketch.

(i) The body or cylindrical drum of required capacity;
(ii) a dome fitted on the top of the cylinder, usually with a water seal joint;



A distillation unit for the extraction of vetiver oil

(iii) a goose-neck which is connected to the dome;
(iv) a condenser coil which is connected to the goose-neck;
(v) a condensing chamber into which the condenser coil is placed; and
(vi) one to three receivers into which the distillate is received.

The body or cylindrical drum is provided with a perforated false bottom which is fitted above the true bottom. Both the dome and the drum are provided with manholes for charging and discharging the material respectively. The condensing chamber is provided with an inlet and an outlet by means of which, cold water is made to flow through the chamber to cool the condenser coil when the distillate flows through it. The still body is also provided

with a water inlet at the top and a water outlet below the false bottom. The material charged rests on the false bottom.

Roots are distilled as quickly after harvest as possible. Storage of roots results in loss of oil, particularly during the dry months of the year when the roots are usually harvested. Fresh roots are easier to distil. They release the oil more quickly than the stored roots. Another advantage of handling fresh roots is that a large quantity can be packed in a given still.

Certain markets such as London, however, it is understood, prefer oil distilled from stored roots, and such oil is said to fetch a very high price. But the demand for such high-priced oil is limited in our country at present.

Preparation of Roots for Distillation

The roots are washed gently after harvest to remove all the earth adhering and are chopped into bits of 4 to 5 centimetres length. Chopping makes release of oil easier and the recovery higher.

The root bits are then soaked in clean water for 15 to 18 hours and are charged into the still. It softens the roots and makes the release of oil easier.

Process of Distillation

The material is packed tight into the still leaving about 15 to 22.5 centimetres from the brim of the still on the top. The manholes are then closed and water is poured into the still to a height of 10 to 15 centimetres above the false bottom and the still is heated.

The water now begins to boil and the steam so generated extracts the oil from the roots, and the steam and the oil vapour rise to the still head and pass through the condensing coil. Here, the vapour condenses and the oil and water mixture drip down through the apouted end of the condenser coil.

The water in the still is kept boiling until no more oil comes out. The time required to reach this stage depends on the quantity of material under distillation and the size of the still. In vetiver, the thickest fraction of the oil comes out last and, therefore, the distillation is carried on continuously without break.

The water in the still is replenished in the course of distillation. Some stills have gauges fitted at the bottom which give an indication of the level of the water inside. The water level should never be allowed to fall below the level of the false bottom.

The distillate that finally runs out of the third receiver is collected and is used for replenishing the water in the still or for charging the still for a fresh distillation. This is done in order that any oil that has escaped with the water may be returned to the still.

During distillation the condenser should be kept warm by adjusting the rate of flow of water into and out of the condensing chamber in such a way that the distillate runs out warm at a temperature of about 30°-35° C. This is necessary because the oil of vetiver has almost the same specific gravity as water and, therefore, easily forms an emulsion with water. If, however, the distillate is warm,

the oil and water do not form an emulsion while passing through the coil, and what is collected on the muslin cloth in the receivers (referred to in the next para) will be oil with only traces of emulsion.

Collection of Oil

The distillate is collected in three receivers connected in series. As the oil that comes out at different stages varies slightly in density, a thin muslin cloth is allowed to float on the water in each receiver or tied to the mouth of the receivers to catch even those fractions of the oil that sink in water.

The oil that escapes through the three pieces of muslin cloth and collects in the water in the last receiver is of lighter fractions and is usually negligible in quantity.

The method of distillation described above is called water and steam distillation. Here the steam is produced by boiling the water contained in the still itself. Distillation can also be done by directly charging the material in the still with dry steam generated in a separate boiler. No water is poured into the still nor is any water allowed to collect in the still. This method gives a higher recovery of oil and is more economical. A cleaner oil also is said to be obtained in this method.

Refining the Oil

The oil thus collected is dark brown in colour and contains water and large quantities of suspended impurities. It has, therefore, to be refined thoroughly to render it suitable for marketing. The refining is done in the manner explained below.

The oil-water mixture is warmed slightly over a water bath and is transferred to a separating funnel. The warming breaks the oil-water emulsion and the oil separates out from the water and the water sinks to the bottom. As much of the water as possible is now drawn off.

From the separating funnel the mixture is again transferred to a metallic container, and clean powdered common salt, at about two teaspoonful per pound of oil is added to it and it is again warmed over a water bath and stirred vigorously. The salt now goes into solution in the water present in the mixture, thereby increasing the specific gravity of the water, and even the denser fractions of the oil now start separating and floating on the salt solution. Salt is added until no more of it goes into solution. The mixture is again transferred to the separating funnel, and the salt solution is drawn off as before.

The oil still contains traces of moisture and suspended impurities. To remove even the smallest traces of moisture from the oil, anhydrous sodium sulphate is added to the oil at about one tola per pound, and the oil is stirred vigorously. The sodium sulphate absorbs all the remaining moisture.

The oil is finally filtered through a filter paper mounted on a double-walled funnel. Hot water is made to circulate between the walls to keep the oil warm for easy filtration.

Specifications for Standard Oil

The genuine oil is of yellowish or golden yellow or sometimes dark brown viscous possessing a fine, intense and persistent, aromatic smell. The denser the oil, the

better and more persisting the aroma and this operates the fixatives property and value in perfumary.

The Indian Standards Institution, New Delhi, has laid down the following as the requirements for vetiver (khus) oil extracted from the roots of wild formations.

(i)	Colour and appearance	... Light brown to deep brown, sometimes greenish
(ii)	Odour	... Characteristic aroma and persistent odour of *khus* roots
(iii)	Specific gravity at 3°/30°C.	0.990 to 1.032
(iv)	Optical rotation	... 50° to 30°
(v)	Refractive index at 30°	... 1.512 to 1.523
(vi)	Acid value	... 25° to 80°
(viii)	Saponification value after acetylation	... 145 to 200
(ix)	Total alcohols as C15 H24° present by weight—Minimum	... 70
	Solubility in alcohol	... 1—2 vols.

The oil is best stored in coloured bottles with tight-fitting stoppers and with the minimum of air space.

Yield of Oil

The oil content of the roots varies considerably among the different types. The soil and climatic conditions and the age of the roots also have considerable effect on the oil content.

It is understood that in Java, Reunion and Brazil an average yield of 1.5 to 2.0 per cent of oil has been obtained in modern type of distillation stills. In Northern India as much as 1.12 per cent has been reported as the maximum yield. Air-dry root samples of 18 months' age collected in Pattambi are reported to have given yields ranging from 0.61 to 0.80 per cent and in Ambalavayal from 0.24 to 0.65 per cent. In the Government Cinchona Plantations on the Anamallais the average yield is said to range from 1.5 to 2.0 per cent on zero moisture basis.

Under the South Indian conditions an average acre-yield of 5 to 6 kilograms of oil can be expected, even though the yields as high as 8 to 9 kilograms are reported to be not uncommon.

9

ECONOMICS OF CULTIVATION AND OIL PRODUCTION

THE cost of labour is the principal item of expenditure involved in the cultivation of vetiver roots in South India. The following is a rough estimate of cost of production and income.

For the rainfed area of West Coast

(*According to the price of the oil and the cost of labour prevailed in 1960*)

		Per acre Rs. nP.
1.	*Preparation of land.*	
	Deep ploughing twice —2 pairs for two days at Rs. 5/- per pair per day.	20.00
	Ridge and row forming—3 pairs for two days at Rs. 5/- per pair per day.	30.00
	Labour for breaking clods and strengthening ridges, etc.—45 men at Rs. 1.50 per head per day.	69.00
2.	*Slips and planting.*	
	Preparing slips and planting—20 women at 75 nP. per head	15.00
	per day Cost of 75,000 slips.	25.00
3.	*After-cultivation.*	
	Five weedings—135 women at 75 nP. per head per day.	101.25
4.	*Harvesting* (including final weeding also).	
	Digging roots and shaking off the soil—45 men at Rs. 1.50 per head per day and 10 women at 75 nP. per head per day.	75.00
5.	*Distillation.*	
	Transporting, cleaning, and chopping the roots—100 women at Rs. 75 nP. per head per day and still attendants.	100.00
6.	Cost of fuel—81 quintals	225.00
7.	Interest on capital	15.00
	Total ...	675.25

Cost of 6.35 kilograms of oil at Rs. 132/- per kilogram as prevailing in yearly 1960	84000.
Net profit per acre	165.00

The profit that is obtained at the prevailing prices works out to be a mere one-half to one-thirds of what it used to be a few years back when the price of the oil used to range from Rs. 264 to Rs. 396 per kilogram. Restriction on the import of oils from foreign countries is sure to have a salutory effect on the price of the indigenous oil.

In the Bharatpur district approximately 10,000 maunds of vetiver roots are used for the extraction of oil every year. An estimate of the cost of production and income is given below.

Bharatpur area	Rs.
1. Cost of digging the roots from wild formations at Rs. 4/- per 37.33 kg. for 37,324 kilograms	40,000
2. Storing and chopping at Rs. 8/- per 37.32 kg.	80,000
3. Distillation (labour) at Rs. 3/- per 37.33 kg.	30,000
4. Distillation at Rs. 2/- per 37.33 kg. (fuel)	20,000
5. Cost of construction of *chappars*, ovens, etc.	5,000
6. Depreciation on the apparatus, repairs, and replacement.	2,000 3,000
7. Packing and transportation	5,000
8. Supervision charges ...	

9.	Royalty on vetiver roots ...	...	35,000
10.	Interest, insurance charges and other incidental charges on the capital.	...	5,000
	Total	...	2,25,000

Thus the cost of distillation of 37,324 kilograms of vetiver roots comes to approximately, Rs. 2,25,000. The 37,324 kilograms of roots produce 583.2 kilograms of *rooh khas*, *i.e.*, pure oil, at the average of 58.32 grams per 37.32 kilograms.

The selling price of *rooh khas* was reported at Rs. 6/- per 11.67 grams. The total approximate selling price thus comes to Rs. 3,00,000. The net profit works out to Rs. 75,000. (This is based on the price which was prevalent during 1956-57).

10

MARKETING

THE roots grown in South are marketed in Cochin, Kozhikode, Tirunelveli, Madras, Bombay and Calcutta. They are either sold as such or as manufactured articles like screens, fans etc. The oil distilled in the foot-hills of Wynad, Cochin etc. is sold in markets at Kozhikode, Cochin and Bombay.

In the North nearly 60 per cent of the roots extracted, almost all of which is from wild formations is based for

making *thatties*, fans etc. and the balance quantity is distilled for the oil.

Adulteration of Roots

Unscrupulous dealers often soak the dry roots in water and sprinkle sand and clay powder to increase the weight. Instances of adulteration of the vetiver roots with other roots of similar appearance but having no other value are also common. Similarly, once distilled roots or roots already used for *thatties* in a season are often brought into the market with a slight aroma being imparted to them by sprinkling a few drops of vetiver oil or admixing fresh vetiver roots with them. The oil is also adulterated with Copaiba balsam oil and sometimes with castor oil or sandal-wood oil. These malpractices should be guarded against.

11

PESTS AND DISEASES

THE grass is browsed by cattle and sheep particularly in the early stages of growth and, therefore, requires adequate protection against such damage.

It is understood that in the Government Cinchona Plantations on the Anamallais a root disease caused by *Fusarium* is said to take a heavy toll of plants in the field during the periods of heavy rainfall particularly on flat bits of land. Drenching the soil with one present Bordeaux mixture or 0.1 per cent wet Ceresan is said to reduce the incidence of the disease.

12

RESEARCH AND DEVELOPMENT

It is understood that at present India is producing only about 30 per cent of her requirements of the oil of vetiver and the balance of her requirements is met from imports from foreign countries such as Java, Reunion, Bourbon etc. In order to make the country self-sufficient in her requirements of the oil, it is necessary that the area under cultivation should be increased and the steps should be taken to rationalise the exploitation of wild formations. Research, aimed at reducing the cost of production and increasing the output of oil should also be taken up side by side with extension of cultivation.

The Council of Scientific and Industrial Research, New Delhi, has carried out a survey of the Indian *khus* and *khus* oil industry for the purpose of collecting factual data and devising ways and means of increasing and developing the cultivation of the plant. On the basis of the survey it has been recommended :

(i) to conduct field experiments to ascertain and establish optimum conditions relating to soil, climate, etc., for proper growth of the roots of selected quality;

(ii) to conduct cultural and manurial experiments;
(iii) to conduct field and laboratory experiments to determine the best time for lifting the roots, etc.
(iv) to study the characters of the oil obtained from roots produced in different centres and fix standards of grade and quality to facilitate the internal and export trade, and
(v) to conduct experiments to ascertain the best and cheapest methods of extracting the oil.

The Essential Oil Research Committee of the Council of Scientific and Industrial Research, New Delhi, has undertaken investigations about this crop (in addition to other essential-oil-bearing crops) through the National Chemical Laboratories, Poona, the Harcourt Butler Technological Institute, Kanpur, the Madras Cinchona Department and the Forest Research Laboratory, Bangalore. These centres, no doubt, will be carrying out systematic investigations on the lines suggested by the survey.

The use of medicinal devices for the preparatory cultivation operations and harvesting may help to bring down the cost of cultivation considerably and, therefore, it will be worthwhile taking up investigations in this line also.

It has been explained earlier that the main reason for the poor yields obtained from the wild formations is that they are exploited indiscriminately without ascertaining if they have attained the optimum maturity stage or not. Some states have, it is understood, introduced a system of rotational harvest, described already, which ensures that only mature areas are harvested. Other States in India where such wild formations occur should also introduce a

similar system for obtaining the maximum output of roots and oil.

It is understood that many of the types grown in Northern India yield oil of quality superior to that produced from the South Indian types. This oil is said to find a ready market and fetch high prices. Steps should, therefore, be taken to introduce these types in the South and determine if they can be successfully cultivated in all the localities. Some work in this direction seems to have been done already by the Madras Cinchona Department and some growers in Nilambur in Kerala. Some of the introduced types are already being successfully cultivated in Nilambur in Kerala and the Government Cinchona Plantations on the Anamallais and Nilgiris in Madras State. This line of work is sure to yield very fruitful and quick results.

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