An essay on the culture and manufacture of indigo : to which was awarded the prize of eight hundred rupees by the Madras Government, 1860 / by John Shortt.

"*Every art is improved by emulation.*"

AN ESSAY

ON THE

CULTURE AND MANUFACTURE

OF

INDIGO,

TO WHICH WAS AWARDED THE PRIZE OF EIGHT HUNDRED RUPEES
BY THE MADRAS GOVERNMENT, 1860.

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INDIGO.

THE consideration of this subject may be divided into two parts, viz. :—

I.—*The cultivation of the plant.*

II.—*The manufacture of the dye.*

It may not, however, be out of place, before entering minutely into these divisions, to give a very brief general history of Indigo, as also a short account of the plants from which the dye may be obtained.

History.

Indigo, as a blue dye, was long known in India. It was first imported into Europe by the Dutch in the year 1660, and subsequently by Portuguese, French and British traders. Notwithstanding the many objections against its introduction into Europe, it became in course of time an article of extensive commercial value; so much so, as to interfere seriously with the Home trade in Woad.

The export of Indigo from India declined considerably at the commencement of the 18th century; but, under the patronage of the late East India Company it has since increased. The quantity at present exported from the Madras Presidency alone, is about seven thousand chests annually: the quality of such Indigo being considered second only to that produced in Java.

Indigo-yielding plants, may be classed under three genera, viz., 1, *Indigofera;* 2, *Isatis;* and 3, *Nerium.*

1.—INDIGOFERA.

Of this genus there are several varieties, viz. :—

Genus Indigofera.

1. *Indigofera Tinctoria.*—This is the cultivated species of this Presidency and of Bengal, and furnishes the chief article of commerce in the Madras Presidency. It is also to be found in Madagascar, the Isle of France and St. Domingo.

2. *Indigofera Anil.*—This is a wild species, commonly found at Phillips's Island in Spain and in the West Indies; as also along the

Gambia in Africa. It is characterized by an erect, under shrubby stem, deflexed, curved, with both sutures thickened and prominent—ten to twelve-seeded. The Spaniards were the first who seem to have manufactured Indigo from this species in Mexico and other parts of America, and the Portuguese in Brazil. It is cultivated in some of the Provinces of the Punjaub for the purpose of manufacturing the dye. It is doubtful whether this belongs to the same species as the *Indigofera Tinctoria* or to a distinct one.

3. *Indigofera Argentea* is the wild, or silvery-leafed Indigo: its growth in India, while admitted by some, is disputed by others. It is shrubby, with round branches of a silky whiteness, from oppressed pubescence; leaves pinnate, eight to twelve-paired, leaflets opposite, obovate, silky, pubescent; racemes shorter than the leaf; legumes pendulous, much compressed, knotted, canescent, two to four-seeded. It is the species cultivated in Africa and America for the sake of its dye, which it yields in small quantities, but of superior quality.

4. *Indigofera Cœrulea.*—This species is known as the Karoo-eti, or Black Indigo, of the natives of India. It is an erect shrub, growing in dry, barren, uncultivated ground, to the height of three feet; and higher when cultivated in good garden soil. It flowers during the wet and cold seasons; the leaves are pinnate, four-paired, obovate, emarginate; racemes rather shorter than the leaves; legumes deflexed, curved, contracted between the seeds, being from three to four-seeded. From the leaves of this plant, Indigo of a light color has been obtained by Dr. Roxbough; lighter, it would appear, than that obtained from Indigofera Tinctoria, or Wrightia Tinctoria, and in larger proportion. The Indigo from this species is obtained by the scalding process.

"Karoo-eti," or Black Indigo.

5. *Indigofera Disperma* is the plant cultivated in Spain, America, and in some parts of the East Indies. The stem is herbaceous, weak; branches, round; leaves, pinnate, four to six-paired; leaflets, elliptico-oblong, smooth; racemes, slender, larger than the leaf; legumes, round, subtorulose, mucronate, two-seeded. It furnishes a superior dye stuff. The Guatemala Indigo comes from this species.

6. *Indigofera Glauca* is the Egyptian and Arabian species.

7. *Indigofera Pseudo-Tinctoria.*—This species is cultivated in some parts of the East Indies, and is said to furnish the best kind of Indigo.

8. *Baptisia Tinctoria* is the wild Indigo of the United States, and furnishes a blue dye.

9. *Cinerea* and *Erecta.*—The latter is a native of Guinea.

There are several other varieties common to the coast of Guinea, such as Indigofera Hirsuta, and Indigofera Glabra.

10. *Tephrosia Apollinea* and *Toxicaria* are plants which yield a species of Indigo; the former is found in Nubia, and the latter on the banks of the Nile.

2.—Isatis.

Genus Isatis.

1. *Isatis Tinctoria,* or *Woad,* is the species cultivated in Europe and China. It may perhaps with advantage be introduced into India.

2. *Isatis Indigotica* is found in Shanghae and Chusan, and is largely cultivated in the Re-Wang-Meon district.

(These two varieties belong to the natural order Crucifera.)

3. *Polygomen Tinctorium* is a native of China. It has recently been introduced into Belgium for the manufacture of Indigo. It belongs to the natural order Polygonacea, or Buck-wheat family.

4. *Ruellia Indigotica* belongs to the natural order Acanthaceæ. In Assam this plant is known under the name "Room," and is there largely cultivated. It is also cultivated in India and at Che-king in China. The dye from this plant does not appear to be known to commerce, though the plant is easily cultivated, grows most luxuriantly, and is believed to be productive. The dye is obtained from the leaves of the plant much in the same way as that manufactured by the natives of this Presidency from Indigofera Tinctoria, viz., by steeping the plant, beating the liquor and precipitating the fecula by lime-water. It is known to the Chinese by the name "Tien-ching." The odour it emits during preparation renders it very offensive.

5. *Gymnema Tingens,* or *Asclepias Tingens,* has been made to yield Indigo in the East of an excellent quality. It is a climbing plant, and belongs to the natural order Asclepiadacæa, or Milk-weed family.

6. *Marsdenia Tinctoria* (of the same order as the preceding).—This also supplies a blue dye resembling Indigo.

3.—Nerium.

Genus Nerium.

1. *Wrightia Tinctoria* (named after Dr. Wright) belongs to the natural order Apocynacæa, or Dog-bane family. Characters of this order—calyx, five-parted; corolla, salver-shaped, having at its throat ten divided scales, with the stamens exserted and attached to the same part; anthers, sagital,

cohering by their middle to the stigma; ovaries, two, cohering; style single, filiform, dilated at the top; scales five to ten, situated at the base of the calyx, outside the corolla; follicles distinct or combined, with adnate placentæ. It is a large wild tree, with pale green, soft leaves, which are deciduous in the cold weather, and on being bruised yield a kind of Indigo. It flowers in March and April, with white follicles in pairs, from twelve to eighteen inches long, the lower extremities of which unite as they ripen. It is a tree common in the low jung'es of Coimbatore, Salem and Orissa, where it attains considerable size. Its wood is white and close-grained, somewhat resembling ivory, whence it receives the common Indian name of "Paulay Murrum," or "Vep-paulay," from its milk-white appearance. From this plant, Indigo has been manufactured in this Presidency. Dr. Roxburgh first drew attention to the Indigo-yielding properties of this plant, and from its leaves he extracted Indigo by a shorter process than that in use: it is termed the "scalding process," or "European method;" but the method when applied to this plant does not seem to have been carried out with the same amount of success by subsequent manufacturers.

"Paulay."

A few other plants with which we are not sufficiently acquainted, are known to yield a blue dye, or coarse sort of Indigo—such as Galega Tinctoria, Spilanthes Tinctoria, Scabiosa Succisa, Cheiranthus Fenestralis, Bigmonia, and Tabernæmontana; and on the African coast, Amorpha Fruticosa, and Saphora Tinctoria.

I.–CULTIVATION OF THE PLANT.

INDIGOFERA TINCTORIA (Tamil, அவரி *Avarie;* Hindoostanee, نيل *Neel;* Teloogoo, నీలి *Neelie)* is very extensively cultivated in this Presidency as well as in other parts of India. It belongs to the natural order Leguminosæ, or Pea-tribe, which is indigenous to the tropical parts of Asia, Africa and America. All the varieties of this order are small, herbaceous, shrubby plants, having pinnate leaves, small and papilionaceous flowers, appearing in axillary clusters of a purple hue; the calyx is cleft; segments, acute; standard, roundish and notched at the upper extremity; keel furnished with a sub-acute spur on both sides; stamens, arranged in two distinct bundles—nine and one; legume, continuous, one or more seeded; seeds, truncated, separated by spurious cellular partitions.

Natural order of plant. Characters of the order.

Indigofera Tinctoria is an under shrub belonging to the sub-order Papilionacæa, or Pulse section, and has the butterfly form of corolla. It has an erect, branched stem with stipulated pinnate leaves, the leaflets being in pairs of five and six, long, obovate, scarcely pubescent. The inflorescence is a raceme, with axillary flowers shorter than the leaves; the legumes are approximated towards the base of the rachis, being nearly cylindrical, and presenting rounded swellings, which are successively bent downwards and upwards in continuous curves; the sutures thickened, seeds about ten, cylindrical and truncated at both ends. The plant is a biennial, as it passes through all the phases of its existence in two years. It is cultivated to some extent in India by native Ryots on their own account, as also for a few leading mercantile firms, which have large factories for manufacturing the dye. Some of these may be seen at North and South Arcot, Cuddapah, Nellore, Rajahmundry, Salem, Tinnevelly, Trippasore, Vellore, &c.

Characters of the Indigofera plant.

Natives cultivate on their own account to a small extent.

The Natives have small factories of their own in the various districts in which Indigo is cultivated. In general, the dye has hitherto been manufactured by them in a rude and indifferent manner; and they have not paid that attention to the culture of this valuable dye which its importance demands. It requires much care and attention in the cultivation of the plant to increase the quantity and improve the quality of the dye.

Native Factories.

The mode of culture followed by the native cultivator is that of freely ploughing up dry or garden land, and manuring the ground in one or other of the following methods :—

The mode of cultivation by Natives.

A flock of sheep or goats is sometimes enclosed on the ground intended to be sown with Indigo for a few nights previously, at an average of 200 head per cawnie. At other times the ground is lightly scattered with wood-ashes, cow-dung, &c.; and at others, the refuse of the Indigo plant from the steeping vat, or its ashes, is scattered over the fields. The first method is no doubt the best, for both the dung and urine of the animals are secured ; but the advantage thus gained is partly lost by the subsequent exposure to the heat of the sun, which dissipates the most essential or volatile ingredients contained in them, leaving nothing but the undecomposable rubbish on the fields.

Ploughing and manuring.

As a general rule Indigo fields are not irrigated—the Native cultivator depending for the success of his crop upon the periodical rains.

Irrigation not practised.

The seed is generally broad cast, and when the seedlings attain the height of two or three inches, the fields are weeded ; this is sometimes done a second and a third time. The sickle is brought into play at the end of the third month after sowing, when the plants bloom. It is soon made up into bundles about seven feet in girth and sold to the manufacturer, usually at the rate of seven bundles per rupee.

Sowing.
Weeding.
Cutting.
Gathering.
Market value of plant.

On the arrival of the bundles at the factory, which by previous arrangement take place about 10 a.m., they are stacked into what is termed the " steeping vat," and pressed down by large beams which are firmly bolted to upright iron rods or stone posts, buried partly in the ground. Water is then let into the vat so as to stand a couple of inches above the plant. In this manner it is allowed to macerate from eighteen to twenty hours, by which time a kind of mucous fermentation will have taken place : the fluid is then let out by the removal of certain plugs into the beating vat, where it is beaten with oars or paddles for a couple of hours. Lime-water in proportionate quantity is then thrown in, and the fluid allowed to settle for a couple of hours. During this time the fecula precipitates to the bottom of the vat ; the plugs are now

Stacking.

Steeping.

Beating.

Collection of fecula.

opened and the supernatant fluid let out. The fecula is then taken up with flat copper pans and strained through a layer of coarse cloth. It is next placed in a copper boiler with a sufficient quantity of fresh water, and boiled till ebullition freely occurs. The fire is then put out and the contents allowed to cool.

Boiling.

The pulpy mass is next collected in bags made of dungary cloth; these are placed in a wooden box having a till, in which it is submitted to pressure by means of a screw in order to expel the whole of the fluid contained in the mass. This is repeated for two or three days; and when the mass has been completely drained, it is cut into square cakes and placed in the shade, and the moisture allowed gradually to evaporate

Pressing.

Cutting.

In about a month the cakes are cleaned or brushed to remove a whitish efflorescence which forms on their surface, and also to give them a glossy appearance. The article is now ready for the market and is styled *fresh-leaf Indigo*, and is considered superior to that manufactured from the dry leaf.

Cleaning.

The dry-leaf process is carried out in the same way, except that the plant is cut, dried and threshed to collect the leaves, which are sold to the manufacturer by weight, at 90 seers; or by measure, at 350 cubic feet per rupee. The dry leaf is submitted to the action of water in the vat to undergo the process already described as the fresh-leaf process. The fresh-leaf process is that by which the Native at present manufactures his Indigo; and the plant chiefly used is the Indigofera Tinctoria; but at some of the large factories under European superintendence, this process is somewhat modified: more care is taken in the several steps of the manufacture, and greater importance attached to cleanliness.

Only slight variation between fresh and dry-leaf processes.

We shall now consider the cost of cultivating one cawnie of dry Poonjay land with Indigo by the native cultivator who does not irrigate:—

	RS.	A.	P.
Ploughing (at 8 annas a time for) eight times.....	4	0	0
For Eight measures of seed.....	1	4	0
Sowing and covering, weeding &c.....	4	4	0
Cutting and cost of carriage to factory.....	5	0	0
Land tax to the Collector.....	2	0	0
Total...	16	8	0

The average quantity of plant obtained in three crops from the one cawnie of land is 250 bundles, each having a girth of seven feet, and at the market rate of seven such bundles per rupee, returns, as the whole produce of one cawnie, rupees 35-12-0, from which deduct the cost of culture &c., viz., rupees 16-8-0; a clear profit of rupees 19-4-0 is thus shown to accrue to the cultivator. We shall see the further profits in the *manufacture* of Indigo as cultivated above.

Cost of manufacture.

Cost of manufacturing Indigo from the produce of one cawnie of land, the manufacturer himself being the cultivator :—

	RS.	A.	P.
Cost of 250 bundles (each 7 feet girth) of plant grown by Ryot on his own account (as already exhibited),.....	16	8	0
Wages of six men at 2 annas 8 pie each per day for five days for stacking, beating, &c.....	5	0	0
Wages of four men for boiling, pressing, drying, &c., for three days at the above rate.....	2	0	0
Wages of plug maistry for eight days, at 4 annas per day.	2	0	0
Contingent expenses.....	5	4	0
Total cost...	30	12	0

Proportion of Indigo obtained.

The average quantity of Indigo obtained from 250 bundles of the plant is 2½ maunds, and the average market price of such Indigo is Rupees 35-0-0 per maund of 25 lbs.

Value of the Indigo.

	RS.	A.	P.
Thus 2½ maunds of Indigo at 35 rupees per maund.....	87	8	0
Deduct cost as above.....	30	12	0

Profits.

Net profit... 56 12 0

Cost of outlay not considered.

The cost of outlay for setting up the factory with the necessary apparatus has not been taken into account; nor yet the losses in case of failure of the periodical rains, or of want of success in the manufacture.

Profits less where manufacturer buys his plant.

In cases where the manufacturer *buys* his plant, we have to deduct from the

Net profit (as before shown) of Rupees.....	56	12	0
The cultivator's profit (as shown above) Rupees.....	19	4	0
The balance shows the *actual* profit to the manufacturer who buys his plant.....	37	8	0

In the latter system, although the profit is less, there are less risks. Nearly all the Native manufacturers pursue this plan as the safer one.

Having detailed the native mode of the cultivation and manufacture of Indigo, as well as shown the cost of each, and their attendant profits, we shall now proceed to suggest improvements by which, if adopted, a superior quality of Indigo will be obtained, and in quantity sufficient to remunerate both cultivator and manufacturer; and the growth of Indigo, instead of being the precarious enterprise it is at present considered, will prove a very remunerative investment of labor and capital.

In pursuance of the plan originally proposed, we shall consider, first, the improvements necessary in the cultivation of the plant, such as selection of soil, ploughing, kinds of manure, choice of seed, sowing and mode of irrigation, weeding, cutting and gathering. As these points are of importance, we will give to each a separate consideration.

Selection of soil.

Care should be observed in the selection of the soil for cultivating Indigo, and to carry this out more effectually, the chemical elements necessary for the nourishment of the plant, and the manner in which the roots strike the ground, should be kept in view. As the Indigo plant has branched roots, which enter more or less vertically into the soil, well drained land, neither too dry and sandy, nor too stiff and clayey, should be selected. A sandy light soil with a subsoil of clayey loam, will answer well; but in land that is rather moist and has a light free subsoil, or good loam, the Indigo plant grows very luxuriantly. When, however, the plant grows *too* rapidly, the quantity of dye yielded by a given quantity of leaf is comparatively small.

Too rapid growth of plant not desirable.

In selecting lands, open or garden lands are preferable as they allow free evaporation. At some places where wet land has been tried, it has proved a failure from excess of moisture and its liability to swamp, more especially during the rains. When the soil, however, is light and loose, it facilitates the descent of the root. A fair crop may be grown on lands formed of a dark clay loam if facilities exist for draining such lands.

Open lands preferable.

In choosing ground, advantage should be taken of localities where water abounds. It is a very good plan to select the site of factories in the neighbourhood of ground

Site of Factories.

where the culture of Indigo may be carried on, and the wells of the factory brought into play for irrigating the plant, and whence it may be conveyed to the factory, with ease, in time, and with considerable diminution of expense.

The ground having been chosen, especial care should be paid to the ploughing. The ground should be ploughed so that at least a foot of the soil be turned up. The weeds, &c., found on the ground might with advantage be collected and burned for manure. After the earth has been repeatedly turned up, so as to expose every part of it to the action of the sun and air, it should be manured.

Ploughing.

Weeds used as manure.

In this country, sufficient attention has not been paid to agricultural improvements, and consequently the same rude process of manuring which has been in existence for centuries continues to be carried out to the present day. In the use of manure it is not the quantity, but the quality, which should receive attention. The native method of enclosing sheep on the ground has been alluded to, and the reason why it is not as effectual as it might be, has been noticed; so also where dung-heaps are used as manure, the essential ingredients having been already volatilized by exposure to atmospherical influence, the undecomposed rubbish, or refuse, is all that remains: the Ryot is satisfied with this because he perceives no great loss in the quantity.

Kinds of manure.

It is now an ascertained fact that certain plants thrive only in soils where the necessary minerals required for their structural formation are found; and such are usually contained in the ashes of the plant. Indigo belonging to the Leguminous family, requires the phosphates of Magnesia, Lime, Potash, Soda, &c.; it is incumbent, therefore, on the agriculturist to supply these to the soil, with a view to enrich it; and if carefully attended to, almost any soil may be rendered suitable and productive. The necessary minerals can be readily obtained with little or no additional expense, simply by substituting a dung-pit for a dung-heap. Adjoining the byre, or other convenient place, a large pit of from three to six feet in depth with a proportionate width should be excavated, and it ought to be so constructed that all the urine and dung of horses, cattle, goats, pigs, fowls, &c., and other refuse matter, might be conveyed to it. For this purpose the bottom and sides of the pit should be faced with stone or metal. Brushwood or refuse straw, &c., with which every village abounds, should be placed to the thickness of a foot

Construction of dung-pit in substitution of the usual dung-heap.

at the bottom and sides of the pit, and into it be thrown, besides what has been already mentioned, the washings of meat, fish, rice, &c., dead animals, as dogs, cats, and other carrion, generally found lying in the neighbourhood of villages, and to which may also be added, human urine and excrement.

Uses of lime.

To deodorize the pit and prevent it from becoming offensive, as well as to facilitate the decomposition of animal and vegetable matter, and to supply an element in the fabric of the plant, a small quantity of fresh lime should be occasionally thrown in, so that in a few months a valuable quantity of manure may be obtained, rich in its fertilizing properties and containing the necessary ingredients, not only for the Indigo plant, but for all other Leguminosæ and Gramina, as well as other plants. The manure thus obtained, will nearly equal American guano, and eventually become a marketable article, The pit should have a covering of thatch, so as to protect it from the sun and rain. There is no reason to doubt that when this subject is thoroughly understood in its practical application it will be adopted by the Ryots, who will thus realize an increase of double or treble the usual crops. This is the kind of manure required for the cultivation of Indigo, and by which a luxuriant crop, rich with the dye, will be produced, as it is evident that the dye depends on the healthiness and luxuriance of the plant.

Manure prepared as suggested, when fit for use.

Manure prepared after the manner just described, will, in twelve months, be sufficiently disengaged by putrefaction, to be ready for distribution in the ground. It should then be carted away to the field in the cool of the afternoon, and on its being laid on the field, the ground should be ploughed, so that it may at once become mixed with the soil, and thus prevent any of its volatile ingredients being dissipated by exposure to the atmosphere. The ground should next be levelled and laid out in square beds of a convenient size. Beds eight by twelve feet each are easier irrigated than those of a larger size.

Choice of seed.

In the choice of seed, it is necessary to satisfy ourselves from its weight and appearance that the seed is sound; and, if possible, to ascertain the crop from which it has been collected. That from the first and second crops is the best; but, from a mistaken notion of economy, the seed from the third crop, though inferior, is that generally used by the native cultivator. The seed from the second is superior to that collected from the first crop, because at the time the second crop is gathered, the plants have arrived at matu-

rity ; and, from being in full vigour, the seed then produced, will abound in the nourishment requisite for the plant in the first stage of its growth. In fact, seeds should be chosen from the finest specimens that can be procured. Unfortunately, however, it too frequently happens that when the cultivator is obliged to resort to the market for his seed, he has no means of correctly ascertaining from which crop the seed has been collected, except by external appearances: that from the second crop looks more sound and is larger in size, has a glossy appearance, and a light-brown color; whilst that from the third crop, is of smaller grain, with the husk more or less wrinkled, and of a dark brown color.

It is necessary to be aware that several impositions are practised upon purchasers of seed, exposed for sale in the market. Old and new seed are mixed in equal proportions, but this can be detected by their difference in color. It sometimes occurs that this pulse, like the cereals, is attacked by weevil, and then, although the grain appears entire, the embryo is destroyed. To deceive the purchaser, seed of this description is soaked in a thick mixture of clay for an hour or two, in order to close up the orifices made by the insect in the grain: but this trick may be exposed by steeping the seed in pure water, which when renewed several times, will make the orifices distinctly visible. Lastly, old seed, as well as those first described, is submitted to a process of oiling, with the view of giving it the glossy appearance of new seed. This imposition can be detected by washing the seed with soap and water, and drying it in the sun, for it thus loses its glossy appearance and becomes of a dark-brown color.

Sowing.

The cultivation of Indigo in this Presidency is generally made dependent on the rains, and seed is, therefore, sown according to the different seasons; but when facilities exist for irrigating the field, the seed should be sown early in October, or immediately after the first shower of rain. The ancient method termed "broad-cast" is still carried out, and answers very well when the cultivation is entirely dependent on the rains; it, however, entails considerable waste of seed. The more economical and successful method of sowing by drills is feasible, for it may be practised from bed to bed, and from field to field; the best instrument for the purpose being a hand-drill. The short-cast method may also be carried out by scattering the seed from bed to bed in regular succession, the seed being carried in a cloth round the waist of the sower. Care, however, should be taken that the seed be not sown too closely, as the young plants are likely to be choked in their growth. The plants should be about eighteen inches apart, and

never nearer than twelve inches. We should, on the whole, prefer the usual broad-cast method prior to squaring the fields into beds; and after the seed has been cast, the ground should be twice ploughed over for the purpose of covering in the seed, and afterwards formed into beds to facilitate irrigation.

Precaution in sowing during dry seasons.

In the dry season, after the ground has been prepared, as already pointed out, it is necessary to irrigate it, in order to supply the necessary amount of moisture to the seed. On the third or fourth day after watering, it should again be ploughed to break up the incrustation formed by the evaporation of the water: the seed is now cast; the ground harrowed and afterwards squared into beds, so as to facilitate subsequent irrigation. Should this precaution of irrigating *before* sowing be not adopted, the seed will not germinate for want of moisture; as a thick impermeable crust results from the evaporation of the water, and which effectually prevents the young plants from shooting up; unless, indeed, there is such a quantity of water supplied as will prevent incrustation. The evil effect of an over-supply of moisture, as already explained, is the rotting of the seed and consequent loss to the cultivator.

Consequences of neglecting to irrigate previous to sowing.

The seedlings will show themselves on the third or fourth day, sometimes not until the sixth day, and when they attain the height of about six inches, the field should be carefully weeded. It is now time to see that the plants are at a proper distance from each other: those growing too closely should be transplanted to parts where they are too far apart, or they might be removed altogether. It is a great mistake to have the plants too near each other, as it interferes with their growth and prevents their branching out laterally; they, in consequence, grow up straight with but few side branches, and these have but few scattered leaves. Moreover, when plants are crowded, it interferes with the free circulation of air between them and deprives them of vigour, as well as checks their growth; and as the quantity of dye depends upon the amount of foliage, it is desirable to increase the quantity of leaves by encouraging free branching.

Treatment of seedlings.

Evils of over-crowding the plants.

When the plants are five or six weeks old, they attain the height of six or eight inches and begin to throw out branches. It is now necessary to loosen the earth around each plant with a hand-hoe, and at the

same time to remove the weeds which may have sprung up since the first weeding. This work can be done well by women or boys.

When about two months old, they should be weeded for the third time, and care should be taken not to bruise or otherwise injure the plants. The circulation of air through the crop, which now becomes more than ever necessary, will thus be facilitated.

Irrigation.

The irrigation of land growing Indigo does not appear to be generally adopted, the cultivation of the plant having hitherto been made dependent on the rains; and this accounts for the frequent failure of crops. The irrigation of land enables the plant to throw out a larger quantity of foliage and consequently increases the quantity of dye. It has been already noticed, that factory wells should be so situated that advantage may be taken of them when the plants require water; when the factory wells cannot be so employed, as will sometimes happen, wells may be sunk in the neighbourhood of Indigo fields for the purpose of irrigating them. To flood the lands is in many instances a means of fertilization, water being absolutely essential to the successful cultivation of Indigo, inasmuch as it secures moisture, and affords the necessary sort of nourishment to the roots, and prevents the bad effects that frequently arise from want of moisture in the soil; it also acts beneficially, by causing the more equable diffusion of nutritive matter which already exists in the ground. Excess of moisture will, however, rot the plant; hence the objection to cultivate wet land. On the other hand, it is necessary to recollect that too much dryness stints the growth or altogether destroys the plant. Great care and attention, with a certain amount of local practical experience, are essentially necessary to guard against both these evils.

Excess of moisture, as well as over-much dryness, inimical to the growth of the plant.

Indigo fields require to be watered on the eighth day after sowing, and once a week during dry weather, and fortnightly if the season be fair.

The usual means by which land is irrigated in this Presidency, is either the *Picota* or *Cavalay*.

Picota, or Yethum—cost.

A Picota requires three men to work it, and a boy to distribute the water on the ground. These will water about *one* cawnie of ground daily, and on an average, cost 10 rupees per month. The cost of erecting a picota is about 16 rupees.

The Cavalay requires a pair of bullocks, with a driver and a

Cavalay—cost.

boy; these will water about *three* cawnies of ground daily, and will cost about 13 rupees per month. The cost for erecting a cavalay and purchasing bullocks will be 64 rupees.

One or other of these appliances will be necessary for supplying the vats, &c., of the factory with water, so that if land adjoining the factory is cultivated, it may be turned to account either way. The cavalay should be preferred, as the bullocks will be of service in furnishing and carting manure, ploughing the ground, conveying the plants from the fields to the vats, &c. When the cavalay is not worked in watering the fields or filling the vats, the driver and boy may be employed in keeping from three to five cawnies of ground free of weeds.

Ravages by insects, how prevented.

Indigo plants are liable to be attacked by caterpillars, which sometimes devour the greater part of the leaves; they should, therefore, be sought out and destroyed. When they are numerous in the neighbourhood, dusting the fields with powdered quicklime early in the morning, before the dew evaporates from the leaves, is a very successful mode of keeping out caterpillars and other insects.

Signs of maturity.

The appearance of the blossoms indicates the period at which the plants are mature, and they may then be gathered for the purpose of extracting the dye. This period may sometimes be ascertained by the leaves breaking between the fingers with more or less brittleness. When the root leaves begin to ripen and drop—which generally happens when the plants are about three months old—it is an indication that the plants are ready for the sickle.

In cutting the plant, care should be taken not to leave too short a stem in the ground, but to cut immediately above the ripe or yellow leaves, so as to leave from six to eight inches of the stalk above ground. The leaves, as is well known, are the respiratory organs of the plant, and in order that the stalks may rapidly throw out buds and shoots, the more lower or yellow leaves are left the better; and the larger the stalks, the greater the subsequent branching. Still greater attention should be paid to this matter in a second and third cutting.

A day or two after the first crop has been gathered, the fields should be thoroughly weeded, and the ground loosened with a plough or hand-hoe; all clods should be broken, the fields manured and the ground levelled. The fields should then be irrigated, and the irrigation be carried on as before stated, viz., once a fortnight in fair, and twice

in dry weather. In about a week or ten days, the stumps will begin to throw out shoots. It is at the second sprouting that the plants attain the greatest amount of vigor, and thus yield a large amount of dark-colored foliage. Each plant will throw out as many as ten and twelve branches if sufficient lateral space has been allowed them. In the third week, and again in the sixth week, after the first cutting, the fields should be weeded; on each occasion of weeding, the earth around each plant should be loosened and the plants watered, and they should be carefully attended to, to prevent the ravages of caterpillars and other insects. In about three months, the fields will be ready a second time for the sickle.

Greatest vigour when attained.

In a day or two after the second crop has been gathered, the fields should be again weeded, and the earth loosened and manured, and immediately afterwards irrigated. The same attention should be paid to weeding, watering, &c., as for the first and second crops. In three months after the second cutting, the fields will be ready a third time for the sickle. Instead, however, of being gathered, the plants are now frequently allowed to run to seed; and in about a month or six weeks, the plants will be laden with small pods, of about two inches in length, each containing from three to ten seeds. The seeds will be known to have become mature by the plant itself becoming more or less yellow, and by the pods becoming of a dark brown color. The plants are now cut down and dried in the sun for a few days, and the pods gathered, either by threshing or by the hand. The pods are now submitted to a wooden mortar and pestle to be husked; the seeds are further dried in the sun for a week or ten days, and after they have been winnowed to free them from chaff, they are collected and preserved in closed earthen vessels. The seed will be of a light yellow color, and will be full-grained if the plants have been properly irrigated. The seed from the second crop is the best, and only from this crop should seed be procured; the second crop, moreover, yields nearly double the quantity of seed yielded by a third crop. The market value of seed is about eight measures per Rupee.

Period of second cutting.

Collection of seed.

Preservation of seed.

Best seed from second crop.

Market value of seed.

After each cutting, the plants are gathered and made up into bundles, usually of 7 feet girth each, for the purpose of being conveyed to the Factory, to be stacked into the steeping vat. In making or tying up bundles the

Gathering.

cuttings should not be roughly handled, nor should they, either then or subsequently, be subjected to any great pressure, as they are thereby likely to get contused. The secret of success consists in having the plants up to the vat as fresh as possible--they should be removed to the factory as rapidly as they are gathered. The cutting should invariably take place between 6 and 10 A. M., and it is always best to avoid cutting later, as exposure to the sun scorches the plants, and this materially interferes with the success of future operations.

Proportion of dye from the three crops.

It is necessary here to state, that the proportion of dye obtained from every hundred bundles of the plant from the three crops, is as follows :—

From the 1st crop. ..... 1 maund.
From the 2nd crop..... $1\frac{1}{4}$ maunds.
From the 3rd crop..... 1 maund.

II.—MANUFACTURE OF THE DYE.

Division of subject of Part II.

We are now able to enter on the consideration of the suggestions for the improvement of the manufacture of Indigo, and as the various processes are of importance, a separate consideration shall be given to each of the following heads: boiling, beating, collection of fecula, pressing, cutting, cleaning and packing.

Boiling.

On the arrival of the plants at the factory no time should be lost in stacking them into large boilers filled with water for the purpose of being boiled. The boiling should be continued until the leaf yields its coloring matter to the water; in the mean time, each boiler should have an attendant with a large prong with which the plants should be constantly kept under water, and who should be careful to see that the heat of the fire is reduced the moment ebullition occurs, for if the boiling is carried on longer than necessary, the coloring matter will be destroyed. This requires a great amount of practical knowledge, and no rule can be laid down which alone will be sufficient for the guidance of the inexperienced. By opening the cocks occasionally, and observing the color of the decoction (which should be somewhat oily in appearance, and have a reddish color with a peculiar musty odour), we may judge that the period for discontinuing the boiling has arrived.

Beating.

At this stage the liquid should be drawn off into the beating vat and there beaten with oars or paddles. Hitherto this has been done by cooly labor, but in some places an apparatus with paddles reaching to within a couple of inches to the bottom of the vat is used, and worked by animal power.

Proposition for a steam engine.

Cost of a steam engine.

The consideration of capitalists should be turned to the question—Whether a steam engine of 10 horse-power with an apparatus for pumping attached, might not be employed so as to facilitate labor of every kind in the factory, such as pumping up water for the boilers, working the paddles in the beating vat, &c.? When not thus employed, it might be brought into play for general irrigating purposes. An engine of 10 horse-power will cost about 8,000 rupees, and would irrigate from eight to twelve cawnies of land. The cost

of fuel would be trifling, inasmuch as wood might be substituted for coal, and the refuse of the Indigo plant also be used to effect still further economy of fuel. Bratties, or cow-dung cakes, also might furnish cheap fuel for an engine.

The beating, if properly carried out, will not require above an hour; possibly less when machinery is used. After the liquid in the vat assumes a black color, and the froth which first formed has subsided, fresh froth is thrown up; but the air-bubbles will be found smaller and of a more uniform size, and will give to the fluid a white dazzling appearance. It will now be necessary to test it: with this view, if some of the liquid be taken on a white plate (China-ware), the fecula will be seen settling into dark colored flakes, and the supernatant fluid will be of a yellowish color; a second examination will be necessary some twenty minutes after the first examination; the sediment or fecula will then be found to be coarsely granular, moving along the plate, or inclining it to either side, and the water will have become of a bright yellowish color, and sometimes even brown.

Testing.

The change in color, though sudden, is readily detected by watching the liquor; the mode of detection by the plate process, however, is quite sufficient to those who have had a little experience.

It is important to know that if the beating is not sufficiently carried out, it occasions a great loss of the dye, for instead of the dye becoming oxidized and precipitated, it remains suspended in the fluid and may be let off with it. On the other hand, excessive agitation breaks up the grains into a fine powder, and the deposition of the dye is thus retarded. No rules, however correctly and clearly expressed, can supply the place of a little practical knowledge, and the process when once seen practically carried out, is not readily forgotten. The moment the beating ceases, the froth in the liquid should disappear, leaving a clear surface of a chocolate-brown color intermixed with shades of blue; the absence of this latter tint will at once indicate that something has gone wrong.

Evils of insufficient as well as excessive beating.

Appearance of fluid after beating is completed.

All precipitants are not only utterly useless, but even injurious to the dye, as they deteriorate its quality. The essentials necessary to ensure a profitable yield, are that the plants should be fresh, healthy and of vigorous growth, the water clean and pure, and the different processes of boil-

Precipitants useless and even injurious.

ing and beating carefully attended to. The best precipitant is a thorough beating, which is necessary to give the liquid abundance of fresh air, so that the dye should become fully oxidized by combination with oxygen from the air—then, its own weight will precipitate it to the bottom of the vat. The apparent gain said to be obtained from the use of lime-water or ash-water is nothing beyond the additional weight of earthy matter and other impurities which interfere with the quality of the dye and thus reduce its market value.

Chemical changes.

It is necessary here to briefly describe the chemical changes which are supposed to take place, and to state the objects kept in view in the different processes necessary in the manufacture of the dye. Opinions of chemists are divided on this subject, and the chemistry of the process has not as yet been correctly ascertained: one set of chemists believe that in the Indigo plant the dye exists in combination with either an acid or an alkali which keeps it colorless until it has been separated from this combination; another set assert that Indigo does not exist in the plant, but that it is formed during the manufacture by a peculiar process while fermenting.

Varieties of opinion on the subject.

Supposed chemical changes.

The generally received opinion, however, is that boiling reduces the plant into its primary simple constituents, prior to the changes which attend their final resolution into water, carbonic acid and ammonia. The usual process of fermentation operates much in the same way as boiling, but it is not quite so manageable. These changes are as follows: the water, assisted by heat, penetrates the immediate particles of the plant and dissolves the gum as well as the gum-resinous sap; at the same time the alkali and oil, aided by heat, unite and form soap; this mixes with the gum solution natural to the plant, and renders the fluid saponaceous and opalescent; it is then sufficiently consistent to hold the resin or dye in suspension in the form of innumerable spherical globules.

It is well known that the sap of the Indigo plant contains, besides salts, oil and resin, gum and other substances which are of a mucilaginous nature; and though the dye or resin itself is insoluble in water, the ebullition favors its formation into a mucilaginous and saponaceous fluid sufficiently thick to enable it to retain the resinous dye in solution. The formation of the soap assists, no doubt, in the separation of the resinous dye from the salts and oil contained in the plant, which unite to render the fluid saponaceous. The union of the dye resin with the

liquid is mechanical; the decoction obtained being not a chemical, but a mechanical mixture. It is now the object of the manufacturer so to treat this fluid as to cause a precipitation of the dye, and for this purpose he practises what is termed agitation, or beating. This brings every part of the fluid in contact with the atmosphere, and as the Indigo contains a small portion of iron, it readily attracts oxygen from the air, and by becoming oxidized, gains weight sufficiently to render it heavier than the menstrum in which it has hitherto been suspended. From the friction of the Indigo globules against each other, caused by the agitation, they unite into grains, as well by their mutual affinity as by their viscid quality; they thus become sufficiently large to be precipitated by their own proper weight. The vat should now be allowed to stand for a couple of hours, when the supernatant fluid should be drawn off by two sets of plugs, which, without the loss of time attending the use of a small aperture, prevents also the rush of water and loss of dye consequent on the use of one large opening. The water should at first have a dark brown madeira color, and as it continues to run out it may vary slightly in color from the above. A brownish scum which rises to the surface should be carefully removed with a bamboo, which by extension across the vat, allows the scum to collect around it, while the liquor escapes through the plug-hole.

Agitation.

The water having escaped the fecula should be washed down with fresh clean water, so as to collect it at one end of the vat. There should be a drain here for conveying the water from the fecula through a flannel strainer into a reservoir, from whence it should be passed a second time through a flannel strainer into the boiler. The object of these strainings is to free the Indigo of sand and other impurities. Cotton cloth is generally used as a strainer, but flannel or serge would be better, because their loose down will more readily arrest foreign bodies. The best kind of strainer is a freely perforated box with a tightly fitting frame within, to which the flannel should be fastened. The box thus prepared, should be slung to the mouth of the drain. The filtering is a slow and tedious process; attention should therefore be paid while constructing the box, to have it sufficiently large, so as to facilitate this process as much as possible.

The various processes in the manufacture of Indigo should be carried out expeditiously, more particularly that of boiling; for if after agitation the fluid is not submitted to the boiler almost immediately, fermentation commences, which will in a great measure deteriorate the

quality of the dye. After the boiler has received the strained fluid, no time should be lost in bringing it up to the boiling point, and the liquid be carefully attended to while boiling. There should be an attendant at each boiler with a large perforated ladle, who should, the moment ebullition takes place, keep the liquid agitated in order to prevent the fecula from settling, or becoming attached to the sides of the boiler. If this is not attended to, the fecula gets burnt, and this damages the quality of the dye.

To avoid delay, manufacturers are in the habit of having water boiling in the boiler before the fecula or dye-fluid reaches it, which is an excellent plan as it saves much time. The object of boiling the agitated fluid at this stage is to concentrate the active principles of the dye, by causing the evaporation of the watery elements and volatile ingredients it contains. It also favors the further oxidation of the dye by bringing it into contact with the oxygen of the atmosphere. The dye by boiling attracts oxygen, and the heat facilitates the combination with it; and when this takes place, it gives out a strong sugary smell in place of the musty odour it had at first.

The fluid should now be turned out into what are called the "tables" by opening the stopcocks of the boilers. The liquid should be made to pass through another flannel filter while boiling-hot, as it will then hold in complete suspension the active vegetable principles; whereas, if the fluid in the boilers be allowed to cool, the principles become precipitated, and consequently will not pass with the fluid through the filter. The "table" alluded to, consists of a vat built in proportion to the cubic contents of the boiler. This should have within it on either side of the floor a walling of masonry or wood of about two feet in height. On this should be placed a strong wooden frame, and on the frame should be laid a stout sheet of cloth having its ends drawn up and fastened to the walls of the vat by means of iron rings; within this sheet, the decoction rich with the fecula should flow. After a while, the fluid percolates through the sheet into the vat below, where it is allowed to stand for a time till any remnants of the dye it may have held in suspension and carried with it below the sheet, are precipitated. This is ascertained by the color which the fluid has when the plugs are removed and it finds its way out of the vat.

Any fecula found on the floor of the vat, is now collected and conveyed to the reservoir vat to be returned to the boiler with the fresh decoction. As the water percolates through the sheet, the ends are gradually raised and tied together so as to collect the whole of the

fecula on its surface, when weights are placed on the cloth to express as much of the fluid as possible: for this purpose it may be allowed to stand for several hours, sometimes for a whole night. When the weights are removed, the dye will be found to have attained the consistency of a stiff paste, when it is transferred to the press-box.

Press-box.

The press-box consists of four pieces of well-seasoned tough wood, perforated on all sides and kept together in the form of a box (without top or bottom) by means of iron screw rods fastened with nuts, so as to be able to sustain considerable lateral pressure, when the moveable top and bottom approximate in screwing the press. The box should measure inside $3 \times 2\frac{1}{2}$ feet, and have a depth of 1 foot; the bottom of the box, which is moveable, should also be freely perforated. The box is to be lined with a coarse cloth of length and breadth sufficient to cover in the dye with which it has been filled from the tables, the bottom having been previously placed on the platform of the press exactly between its screws. The top of the box, which should be about 7 or 8 inches thick, and made so as to pass easily down into the box, is now put on, and the whole placed immediately under the press-beam.

The press-beam should then be let down and when the water ceases readily to escape through the holes, the beams should be screwed down by degrees until the top disappears within the frame of the box. When still more pressure is required, a couple of wooden blocks may be placed between the top of the box and the under part of the press-beam moved by the screw. Care should be taken to have the frames freely perforated, and the holes should be kept open by occasionally driving a stout iron wire through them. The perforations, by facilitating the escape of the water, permit of the more uniform pressure on the cake, and this prevents the fracturing of the formed slab. The time allowed for pressing should never exceed eight or ten hours. The force thus excited will reduce the Indigo from 10 or 12 inches in height, to 3 or $3\frac{1}{2}$ inches. When the beam has been removed and the frame opened, a slab of well-pressed Indigo will be found at the bottom of the press-box. The cloth should now be removed and the slab cut up into 3-inch cubes.

Great care is necessary in the use of the press, for if the pressure be unequally distributed, or too rapidly communicated by screwing down one end more than the other, the slab is likely to get injured.

Cutting.

For cutting the Indigo, a wooden frame having a number of partitions each of 3 inches square with one edge of the partitions sharpened, can be used

with advantage as it facilitates the process. The top of the frame is to have a board let in containing the factory mark, so that while the cakes are being cut into squares, a little additional force will also mark them, and both the operations of cutting and stamping might go on at one and the same time. Some breakage will of course occur, but if a cake break it should be slightly wetted and the pieces brought together by a little force, which will cause the fragments to adhere. The practice often resorted to of breaking up the cakes to have them submitted to the press-box a second time, is objectionable as it deteriorates the dye.

Drying.

The cakes having been cut and stamped, should now be placed on a tray with a double layer of stout coarse cloth having a layer of good bibulous paper between. The common unsized country paper answers the purpose very well. On the frame thus prepared the cakes should be gently and carefully laid, about 3 inches apart. The tray should then be removed to the drying house, and there be placed in a loft where it should remain for some three or four days, after which the cakes should be as carefully removed on to the stages in the drying house, observing the same interval of space as was given when they were placed on the tray. The stages may be formed of wood or bamboo. The cakes will retain their sugary smell for some days, unless something has gone wrong in the manufacture, such as excess or insufficiency in boiling. The cakes when drying, should never on any account be turned, for this drives the moisture from the surface to the centre. The drying house should be capacious, airy, and well lighted, for if not so, the white coat which the cakes of Indigo acquire from the growth of fungi upon them, will not occur ; as it is well known that light is essentially necessary for the growth of these fungi ; and it being desirable that the cakes should be as sound as possible, their growth should be encouraged by the free admission of light and air.

Cleaning.

When the Indigo is dry, each day's manufacture is taken up and cleaned with a very soft brush. Soft brushes are best, because hard brushes remove the white fungus covering the cakes, and thus take away from their appearance and value.

Packing.

The cakes are now carefully compared and arranged, after breaking off the edge of one side of a cake for the purpose of exhibiting its inner surface. They are then packed, and in doing so, a sample cake is generally kept,

which should be one of the worst in the box. Natives, however, frequently exhibit the best as a specimen.

It will take nearly a month before the cakes are thoroughly dry for packing into boxes; and in packing them they ought to be arranged so closely to each other as not to be displaced on moving the boxes. There is always a quantity of broken Indigo which should be packed separately. In packing the cakes it is a good plan to put down a layer of soft cotton at the bottom of the box, and a second layer about the centre, and on the top there should be a third layer of cotton before the lid of the box is put on. This, if properly done, is sufficient to keep the cakes firmly in their places, and consequently no friction or displacement can occur. Simple as the operation may seem, it requires some practical skill to pack the cakes neatly and correctly.

A short description may now be given of the apparatus required for the manufacture of Indigo as proposed, and which has been termed the "European method." Of the apparatus already alluded to, the following are the most important, viz., Boilers, Beating Vat, Tables, Press-box and Press.

Boilers.

Boilers should be of copper, two, three or four in number, according to the quantity of plant to be boiled. Each boiler should have a diameter of 5½ feet at top and 4 feet at bottom, and have on a level with its lower part a stopcock at each side, one to lead to the agitating vat and the other to the tables. The drains leading to these parts should have a filter suspended at their mouths where they open into the agitating vat and tables. The filter is usually a wooden frame, of 1½ feet square, the bottom being formed of a layer of flannel, through which the decoction filters in passing to the vat and tables.

Agitating Vat.

The Agitating Vat, built either of stone or wood, should be 18 × 14 feet, with a depth of 3½ feet. On a level with the floor of the vat, there should be two circular holes of 1½ inches each in diameter, and 1 foot apart; these holes should lead into a reservoir. One foot higher than the above, there should be two other holes of the same size leading into another reservoir. The floor of the vat should be made to slope towards these openings. The openings should be furnished with a tubing of copper, or they should be cut through a solid slab of granite and be nicely fitted with wooden plugs, wrapped over with flannel and made air-

tight. The upper plugs are to be opened when the, supernatant liquor is required to be left off; and from the reservoir where these open there should be a drain to convey the fluid to the adjoining fields. The fecula is washed down with clear fresh water, and passes through the lower openings (each of which openings has a filter similar to those already described) into the reservoir with which they are connected, and from whence the fecula is conveyed by buckets to the boiler, passing through another filter before entering. To save time, the boilers should be cleaned out and refilled with water, and brought up to the boiling point during the time occupied in the agitating process. After the necessary time in re-boiling, the second set of stopcocks (already alluded to) in the boiler should be opened, and the fecula be allowed to pass on to the tables. Instead of employing men to agitate the fluid in the vat by means of oars, an agitating punkah or paddle might be so constructed as to supersede this common and laborious mode of agitating, and for this purpose, a wooden shaft 16 feet long and 6 inches in width and thickness, should be placed across the centre of agitating vat. It should rest on the wooden blocks, having semicirular notches to receive the ends of the shaft which is let into the vat walls One end of the shaft, external to the vat, should have a moveable crank handle to work it, and the other end should be furnished with a fixed pulley. Into the portion of shaft within the vat should be fixed, at equal distances, three sets of paddles or fans, each set having four arms; the arms should each be 3 feet long, 2 feet broad and 1 inch thick; each set of paddles should be encircled with quarter-inch iron tires at the ends (*i. e.*, two tires to each paddle), for the purpose of fixing the arms of the paddle firm on to the shaft.

The crank end can be worked by human power, and the pulley end by animal power. This is done by attaching it to a wooden frame-work 8 feet high, and 12 feet wide, with a perpendicular shaft, 8 feet long, having a fixed drum at its upper third, and a lever arm at its centre. The two ends of the perpendicular shaft should be made so as to evolve in the frame like a pivot. A circular strap or rope should encircle the pulley at the end of the shaft across the vat, and be made to pass round the drum of the perpendicular shaft in the frame-work. By yoking a pair of bullocks to the free end of the lever of the perpendicular shaft, the shaft is made to turn on its own axis, which causes the vat shaft, with its attached paddles, to revolve also, and thereby uniformly to agitate the liquid in the vat.

By having an apparatus of this kind, either animal or human power

may be employed, at the pleasure of the manufacturer, for the purpose for which it is recommended.

Tables.

The Table is a cistern 12×4 feet, with a depth of 3½ feet; about two feet from the bottom of the tables there projects a ledge 6 inches wide, and on this ledge should rest a stout wooden frame, crossed with 2-inch rails, and on which a stout sheet rests. The fecula, on escaping from the boiler and passing the filter already mentioned, falls on the sheet for the purpose of being drained. The water passing to the bottom of the table is allowed to stand for two or three hours, so that any fecula carried through the sheet may become precipitated. At the floor of the table there should be a couple of holes with plugs, through which the drained liquid may pass into the adjoining fields. The fecula found at the bottom is collected next day and taken to the boiler, together with that which is brought from the agitating vat. The ends of the sheet may now be raised, the fecula collected in the centre, and the folds laid over so as to cover in the fecula, and weights placed over it to express more of the fluid; it is thus kept draining for about four hours, when the weights are removed and the fecula (now brought to the consistence of a stiff paste) is transferred to the press-box.

Press-box.

The Press-box recommended, has been already fully described under this head (*vide* page 21).

Press.

The Press consists of two upright beams of wood 4 feet in height and about 4 inches thick, each having a groove on the centre of its inner surface, so as to allow a play of two feet to a cross beam 5 feet long, which screws up and down between the uprights. The uprights are mortised to a platform formed of two beams, each 5 feet long, 6 inches wide, and 4 inches thick: these are connected by a couple of cross pieces of same breadth and thickness which serve to keep the beams about two feet apart; and it is to these cross pieces at each end of the platform that the uprights of the press are fixed. On the cross pieces within the uprights of the press, are placed two boxes, each furnished with a female screw. There should also be two male screw-rods, 3 feet in height with a diameter of 2½ inches, placed so as to work into the female screws; the upper ends of these screw rods should be made so as to receive handles for working the screws with.

The cross beam of the press has a simple box let into it through which the rods pass to enter the female screw on the platform; the ends of the cross beam, as already stated, play into the grooves of the

uprights, and which when worked down, leaves a space of one foot between itself and the platform. The press-box being placed on the platform, the cross beam is let down, and when the water ceases to escape, several blocks, about 4 inches thick and of the same length and breadth as the top of the press-box, are placed in it to give a depth of 8 or 10 inches, as found necessary, so that when the screws are worked, the top (with the blocks) is driven well into the box, reducing the mass of fecula from 12 inches to a slab of 3 inches of Indigo. In working the press it is necessary to observe that both screws are carefully and evenly worked, for which purpose there should be an attendant at each screw to watch that the force be exerted gradually together. Unequal pressure injures the Indigo, and causes it to fracture subsequently. After an interval of eight or twelve hours the beam is raised by unscrewing it, the press-box opened and the cloth unfolded, when a well-pressed slab of Indigo is seen at the bottom.

Cutting and Stamping.

For the purpose of cutting and stamping a square 36-inch frame is required, and which should be divided into twelve partitions, each 3 inches square. If at the top of such frame a board be let in with the factory mark, the cakes may be stamped at the same time that they are being cut, thereby facilitating the processes of cutting and stamping.

Before concluding, I beg to acknowledge having derived considerable assistance in the preparation of this Essay by consulting the following works:—

Balfour's Cyclopædia of India.
Calcutta Review, No. 59, March 1858.
Ure's Dictionary of Arts, Manufactures and Sciences.
Peddington's Paper on the Manufacture of Indigo, dated 10th June 1829.

Plate A.

Explanatory of the Ground Plan of the Indigo Factory.

A. Verandah of Factory.
B. Drying Room.
C. C. C. Drying Lofts.
D. D. D. Boilers.
E. E. E. E. E. E. Stopcocks on both sides of Boilers.
F. Channel leading to Agitating Vat.
G. G. G. Fans in Agitating Vat.
H. Crank for working Agitating Vat.
H. H. Agitating Vat.
I. Well.
K. K. K. Drain leading to Water Reservoir.
L. Water Reservoir.
M. Fecula Reservoir.
N. Reservoir for passing water out, after fecula has been precipitated a second time.
O. Drain leading to Tables.
P. P. Tables with frames.
Q. Ground plan of Press.
R. Press.
S. Press-box walling.
T. Top board of Press-box.
U. Bottom board of do.
V. Section of Oven and Boiler.
W. Section of Draining Table.
X. Frame of Draining Table.
Y. Section of Water Reservoir.
Z. Section of Fecula Reservoir.
a. Section of Agitating Punkah.
b. Frame for working Agitating Punkah by animal power.
c. Drum of Frame.
d. Yoke and Pole.
e. Section of Drum.
f. Section of Pulley.
g. Endless Strap.
h. Cutting Machine, with stamping board drawn out.
i. Section of do. do.

Plate B.

Explanatory of Factory Buildings.

A. Longitudinal section of Buildings.
B. Verandah.
C. C. Windows.
D. Agitating Vat.
E. Transverse section of Buildings.
F. Door leading to Drying Room.
G. Main door of the Building.
H. Old-style of Native Paddle for Agitation.
I. Copper Cup.
K. Spoon.
L. Knife used by Natives for cutting the slab into cakes.

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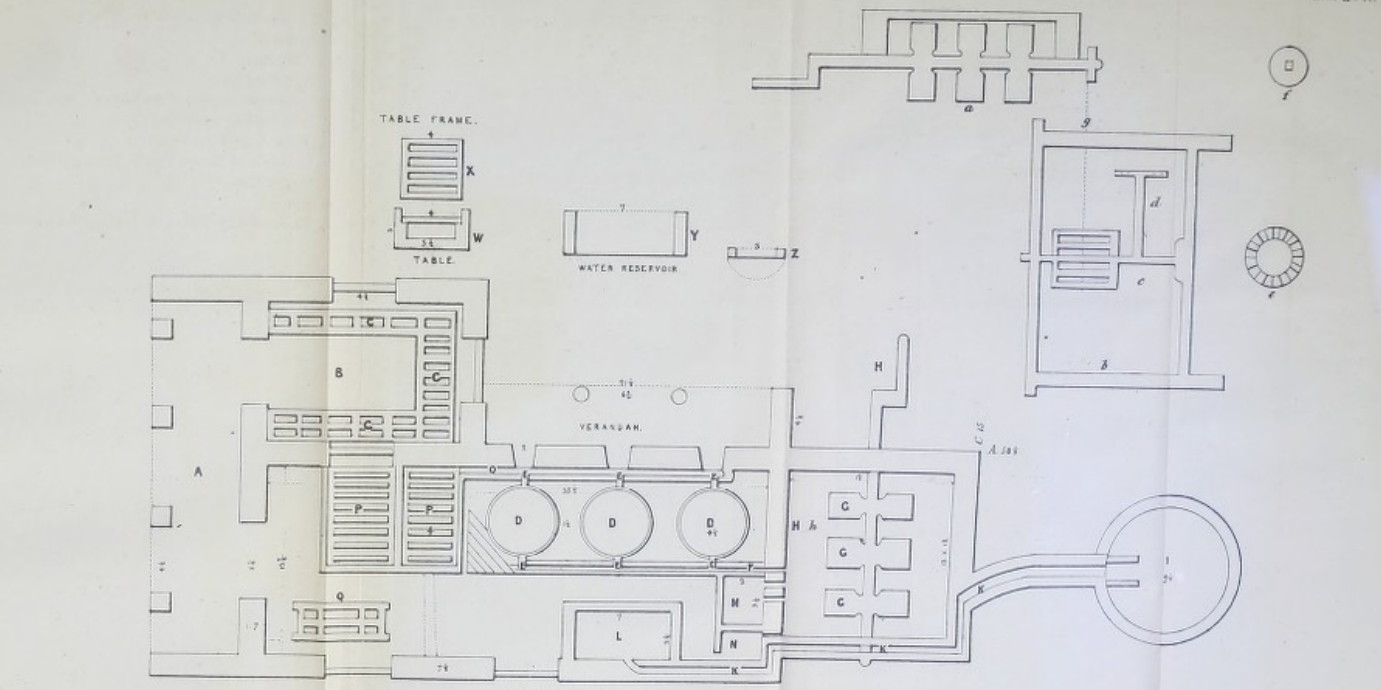
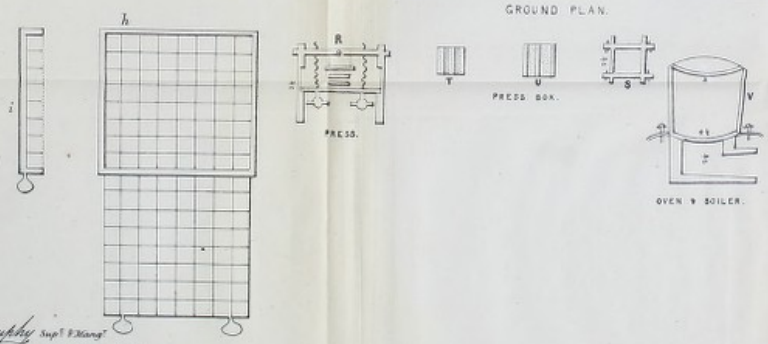
PLATE A.



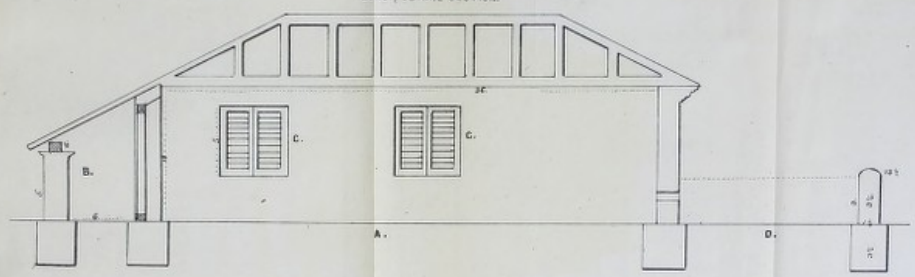


True Copy.

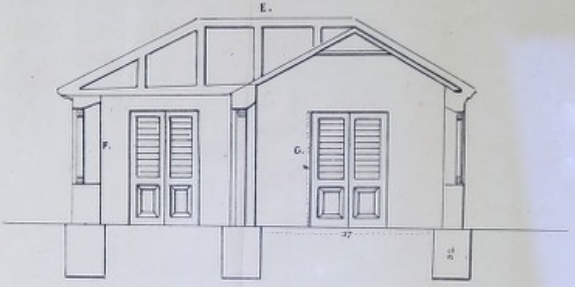
J. H. Lee Colonel
Chief Engineer, D.P.W.

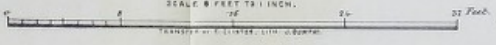
Draughy Supt. Draughtsman
Govt. Lith. Press, Central Office of P.W.

LONGITUDINAL SECTION.



TRANSVERSE SECTION.





KNIFE

SPOON.

PADDLE.

Dunphy Supt & Manag.
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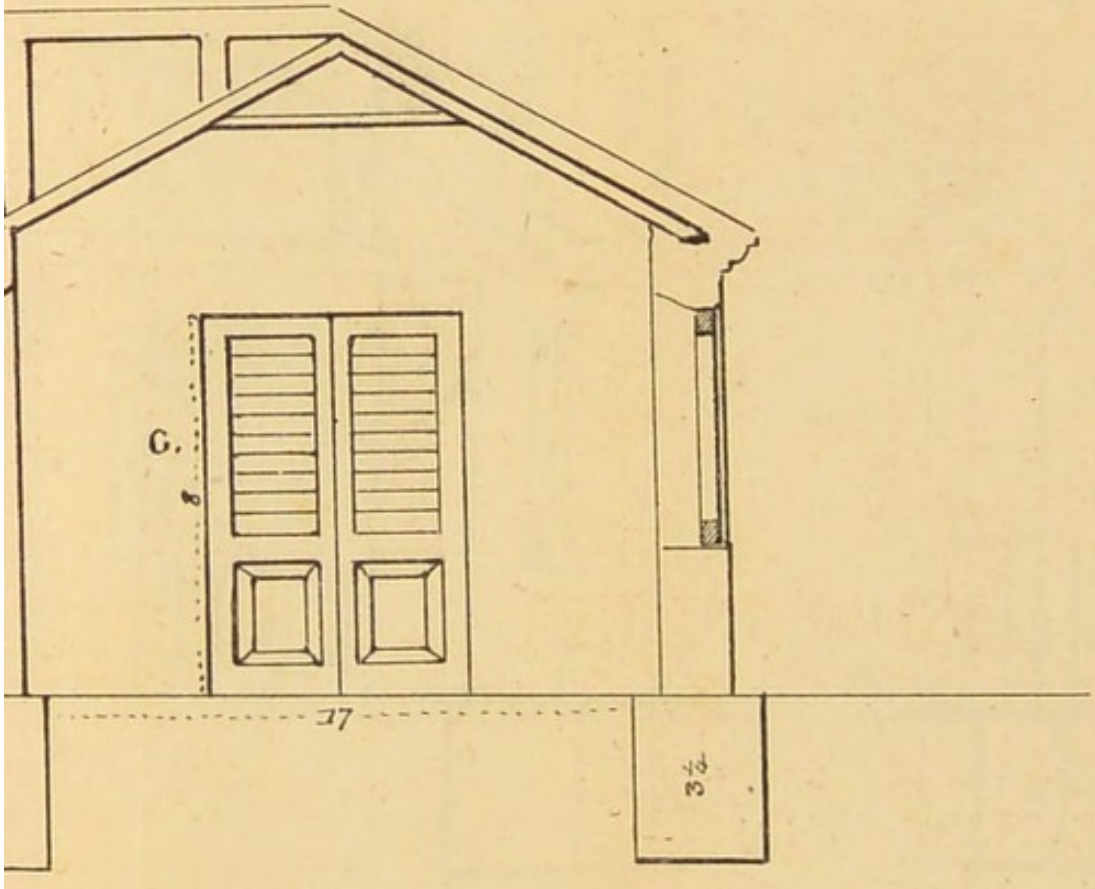
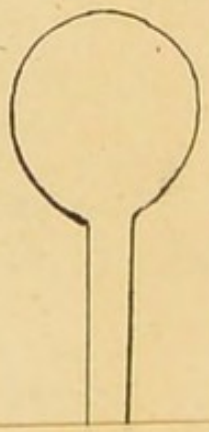
True Copy.

J. H. Bell Colonel.
Chief Engineer D.P.W.

RSE SECTION.

E.





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