RECENT PROGRESS IN THE CULTIVATION OF CAJANUS CAJAN AND THE METHODS OF PREPARING MARKETABLE DHAL IN CEYLON

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IN the first article on this subject which was contributed to *The Tropical Agriculturist* April, 1938, the author described in a general manner the culture and curing of dhal chiefly based on the practices followed in different parts of India. Possibilities of the introduction of (1) this crop in the rotational scheme of village agriculture in the Dry Zone of Ceylon and (2) a new village industry of dhal-curing were also indicated. In the present paper it is proposed to deal with the progress made in the early attempts to introduce the cultivation of this crop at the Experiment Stations in the Dry Zone of Ceylon and at the same time to discuss the experience gained in the successful solution of the local problems associated with the curing of the seed so as to produce a marketable dhal of high quality.

SUITABLE VARIETIES

Before the present experiments commenced, a crop of a small-seeded, local perennial variety of dhal was being grown at the Experiment Station, Anuradhapura, for some time chiefly with the object of improving the fertility of the soil. This perennial variety, though good enough to satisfy the primary object of improving the soil fertility, was not found to behave so satisfactorily in respect of its productivity of seed. The statement below summarizes some of the draw-backs observed in the economic cultivation of this perennial variety :—

(1) The figures of yield actually obtained during the course of its three years' trial clearly indicate that it is a very poor yielder. Its cultivation is not likely to prove an economic proposition from the actual yield point of view.

(2) Harvesting of the crop is a very costly affair. With a perennial variety, the only possible method of harvesting pods at any stage is by hand-picking. The experience gained till now indicates that hand-picking which is very costly makes the cultivation of this perennial variety an unremunerative business.

(3) The seed produced is of a very small size which, on curing, yields small-sized commercial dhal and as such would not realize the normal market value.
(4) As the perennial variety is bearing pods almost throughout the year, the quality of seed is relatively more liable to be damaged by rain.
(5) Being a perennial variety and thus occupying the land for quite a long time, it could not be conveniently fitted into a balanced scheme of rotational cropping.

It would, therefore, appear that, under our dry zone conditions, the most suitable varieties should necessarily be of annual type, particularly those that mature comparatively quickly and are heavy yielders of fairly large-sized seed. Gujarat, Western India, produces the finest quality of commercial dhal from an annual variety of creamy-white, medium-sized seed. The author procured from Mr. Manilal Damodardas Shah, Jambusar, Gujarat, a free sample of about three pounds of seed of this variety and it was sown at the Experiment Stations at Peradeniya and Anuradhapura in the *yala* season of 1938. The crop commenced to flower after about $2\frac{1}{2}$ months of sowing. The yield of seed from the first flowering was distinctly better than the one obtained from the perennial variety.

This small scale trial proved quite promising and, as a result, large scale trials were planned in the next season, *i.e.*, *maha* of 1938–39. A further supply of seed of the Gujarat variety was obtained from the Gujarat Seed Stores, Nadiad, Gujarat. It was decided at this stage to have some more varieties included in the comparative varietal trial. Seeds of two varieties, *viz.*, Pusa–69 and Rahar–15 were obtained from the Botanical Sub-Station, Pusa, India, for trial along with the Gujarat variety. Anuradhapura, Kotukachchiya, Tabbowa, Murunkan, and Minneriya were the centres where the trials with these three Indian varieties were carried out in the *maha* season of 1938–39.

PROPER TIME OF CULTIVATION

Normally, the dhal crop in India is sown at the commencement of the south-west monsoon (which is generally the chief monsoon in India) early in July. The seed-crop from the first flowering in this case is harvested in November or December by hand-picking of mature pods. An average woman labourer in India easily picks 50 lb. of mature pods in a working day.

Incidentally it may be of interest to note some of the profitable secondary uses of this crop. Wherever market demand (particularly in the vicinity of towns) exists, a substantial portion of the first crop is sold in the form of green pods for use as a vegetable. This practice helps the village farmer in realizing

relatively more profit. The immature seed from these green pods is as good a vegetable as the green garden peas. The use of this crop as a vegetable has been appreciated in countries outside India wherever this crop has been introduced. Once introduced and its real merits realized, it is bound to be a popular vegetable in Ceylon as well.

Soon after the harvest of the first crop of pods, second flowering commences and this yields the final crop of pods in March. The plants at this time are cut close to the land, allowed to dry and threshed. There is a great saving in the cost of harvesting of the second crop by this method.

In the dry zone of Ceylon, the north-east monsoon which commences early in October is the main season. Therefore, the proper time of sowing for this crop in the dry zone areas of Ceylon would be early in October. The first crop of mature pods would be available for picking by February or March which is a comparatively dry period. Second flowering would generally commence early in June and the crop in this case may be finally harvested in August. By adopting such a course of cultivation for this crop, it is quite possible to utilize for productive purposes the *yala* season which in many parts of the dry zone remains un-cropped at present on account of scarcity of water sufficient to start a new crop.

REVIEW OF THE EXPERIENCE IN THE CULTIVATION OF DHAL CROP AT THE DRY ZONE STATIONS IN THE MAHA SEASON OF 1938–39.

Anuradhapura.—At this station each of three varieties was planted on an acre of land. The sowing was done on January 10 to 15, 1939, by dibbling with a spacing of $3' \times 3'$.

The Gujarat variety flowered in the last week of March, but the flowers wilted and dropped on account of prolonged drought. With the subsequent rains in April, new flowers began to appear. However, again the crop received a serious set-back during the period of severe drought in May. Again with rain, a vigorous flowering commenced in June, 1939. This flowering resulted in successful fruiting and it was possible to harvest till August 9, 1939, 582 lb. seed of good quality from an acre of land. This can be taken as a very satisfactory yield only from one flowering particularly on such a light and gravelly type of soil under abnormal climatic conditions. Compared with the other two Pusa varieties, the growth of Gujarat variety has been much more vigorous with extensive side branching.

The two Pusa varieties have been found to be very late-maturing under our conditions. They commenced to flower late in June and, by the middle of August, the flowering had not substantially progressed or resulted in pods.

The crop of all three varieties has been remarkably free from the attack of wilt. The only damaging insect-pests that were observed were (1) pod-borer which belongs to *agromyza* species and (2) blister beetles. The attack of pod-borer has not been serious on this station and its incidence throughout the growing period of the Gujarat variety was below 5 per cent. Blister beetles appear with the commencement of flowering and continue throughout the subsequent growing period. It eats flowers, tender leaves and pods. These beetles were collected by hand and destroyed. The incidence of damage by this pest ranged from 5 to 10 per cent.

Had the Gujarat variety been sown early in October, 1938, it would have been ready for the first picking of pods in March, 1939. In that case it would have been possible to harvest the first crop in the much desired dry period of March and it would not have suffered, as it did in the present case during its flowering period, on account of drought.

Kotukachchiya.—At this place dhal is cultivated as an intercrop in the un-occupied space between the young cashew nut trees which are planted 20 feet apart on either side. The sowing of the whole crop was done very late, *viz.*, in November and December, 1938, as more attention was devoted to cashew nut during the earlier part of the season. The spacing of the crop with all the three varieties was $3' \times 2'$. The land was recently cleared and has not been stumped. It is not protected by the usual soil conservation measures. The whole area of about 51 acres had to be sown by dibbling. The Gujarat variety occupied 31 acres and each of the two Pusa varieties was grown on 10 acres. In spite of poor rainfall, the crop in its early stages appeared quite satisfactory.

The Gujarat variety flowered early in February and the picking of pods commenced in the last week of March. However, unusual rain of a fairly heavy character which commenced from March 29 (when the pods were in a stage of formation and active development), and continued till May 10, brought about practically a complete failure of the crop from the first flowering. To add to the trouble, the bund of a tank close to the farm burst and about half the area under this variety was flooded. The incidence of the attack of pod-borer during the days of continuous rain was very high. Second flowering started early in June and a crop of mature pods was harvested in August. Here also the late sowing had been greatly responsible for the loss of crop from the first flowering. Had the crop been planted early in October, mature pods from the first flowering would have normally been harvested by the end of March before the continuous rain started.

The two Pusa varieties have been found to be very late-maturing here as well. They commenced to flower from the first week of August.

The experience with regard to the relative growth of the three varieties of dhal at Tabbowa, Murunkan and Minneriya is of an identical character.

The experience at all the stations clearly indicates that under our dry zone conditions, both the Pusa varieties have proved very late-maturing. They have therefore to be discontinued from the present trials with effect from the next season. However, on account of their thick vegetative growth, there is a possibility of their being suitable for fodder purposes in Jaffna District where, at present, mostly the perennial variety of dhal is grown on a small scale. The leafy fodder of this crop appears to be as good as lucerne. The Pusa varieties may therefore be tried for fodder purposes in Jaffna District.

The Gujarat variety seems to be quite promising and its continuation along with a few more new quick-maturing varieties will form the basis of trial for the next season.

The cultural trials of dhal varieties may also be introduced with advantage in other parts of the dry zone such as the neighbourhood of Hambantota, Batticaloa and Trincomalee in the next season so that we might be able to judge the extent to which these parts of the dry zone will be suitable for the extension of dhal cultivation in future.

SUGGESTED CULTURAL PRACTICES FOR DRY ZONE STATIONS IN THE LIGHT OF RECENT EXPERIENCE

Keeping in view the local experience gained in the last season, the following suggestions are made for the cultivation of dhal as an entire crop (not a mixed crop) in the dry zone stations.

SOWING TIME

The most suitable time to sow this crop in the dry zone appears to be early October, the period of commencement of the north-east monsoon.

METHOD OF SOWING

The spacing should be $3' \times 2'$ with all the varieties. The seeds (3 to 4 per hill) will have to be dibbled to this spacing as we have not the appropriate kind of seed-drill and as sometimes the crop is to be planted on land from which stumps are not removed, *e.g.*, at Kotukachchiya.

CULTURAL METHOD

In the case of a land under regular cultivation, it is necessary that the land should be prepared for sowing in the usual manner by ploughing and harrowing. In the case of a newly-cleared

land where stumps have not been removed, the soil is expected to be in a better physical state and, therefore, preparatory cultivation may be dispensed with and only slight digging for making holes for dibbling would serve the purpose. After the germination is complete, filling of gaps and thinning wherever necessary allowing only two plants to remain in each hill, may be taken up as soon as possible. Only one weeding will normally be sufficient and the appropriate time for it will be any time after four weeks and before nine weeks of sowing. Second weeding may become necessary under certain conditions. The weeding times will have to be adjusted according to the season and the degree of weed growth under specific local conditions.

The first crop of pods is usually ready by February or March and will have to be harvested by hand-picking. The possibilities of utilization of green, tender pods as a vegetable might be explored. After the harvest of the first crop, second flowering would normally commence early in June. When most of the pods in the second flowering have reached maturity, the crop may be finally removed in August by cutting the plants close to the land.

TYPES OF COMMERCIAL DHAL AVAILABLE IN CEYLON MARKETS

At least five different kinds of products are available under the common name of dhal in the Colombo market. As there is a lot of misunderstanding about these different types of dhal, it would be useful, before we proceed further, to describe each of them so as to distinguish the one from the other.

The first is the oiled dhal which comes from Bombay. It is prepared entirely by the dry method (Refer pages 218 to 220 of *The Tropical Agriculturist*, April, 1938) from the seed of *Cajanus cajan* alone. A liberal amount of gingelly oil is used during the course of its curing and at the end of the curing process. It has all the desirable qualities of the best dhal, *viz.*, attractive appearance, absence of depression in the centre, golden yellow colour, ability to be quickly cooked to a softness and the best flavour. It sells in the Colombo market at about Rs. 6·25 per bushel. Unfortunately this dhal, being very costly, has not been able to find extensive local use and its merits have remained almost un-appreciated.

The second type of dhal is also made from *Cajanus cajan*. It is prepared either by the combined dry and wet method (which will be described at a later stage) or only by the dry method with very limited use of oil. It is of quite a good quality. Though not very oily in appearance, it looks attractive. It is free from depression in the centre but it takes a little more time to cook to a softness. It sells in the Colombo market at about Rs. 5·25

per bushel. This type of dhal, though not used in very large quantity, is certainly used to a much greater extent than the first one.

The third is the dhal from *Cajanus cajan* prepared by the wet method and it has its origin in South India. It is in fairly extensive use all over Ceylon. It has a well-marked depression in the centre ; takes a fairly long time to cook and even then does not get reduced to a homogeneous semi-liquid mass ; is not as attractive in appearance as the two varieties described in the foregoing paragraphs and, on cooking, does not have the characteristic flavour associated with those two types. It sells at about Rs. 4 to Rs. 4·25 per bushel in the Colombo market. Being cheap, it is used extensively and finds a ready sale.

The fourth type of dhal is a large-sized one without any depression in the centre, fairly attractive in appearance and is not treated with oil. This dhal cooks to a softness comparatively quickly but lacks badly in flavour. It sells in the Colombo market at about Rs. 3·50 per bushel. This dhal is not strictly prepared from the seed of *Cajanus cajan* but is a mixture of dhal from *Cajanus cajan*, field peas (*Pisum arvense*) and some other pulses. The percentage proportion of field peas is very high in this dhal. The seed of field peas realizes in the Indian market only 66 to 75 per cent. of the price realized by the seed of *Cajanus cajan*. Naturally, therefore, any commercial dhal which contains a high proportion of field peas is bound to be cheaper. This dhal is also in fairly extensive use. It is shipped to Colombo from Calcutta.

The fifth and the last type of dhal is entirely a different type and it has no relation or similarity to the dhal from *Cajanus cajan*. It is pinkish-red in colour, much smaller in size and cooks very quickly. It is wrongly known locally as *Mysore dhal*. In India it is known as *Masur dhal* and is chiefly cured from the seed of the common lentil (*Lens esculenta*) which is a small herb and is entirely different from *Cajanus cajan*. The pinkish-red colour of this dhal is its natural colour. This sells at about Rs. 4 per bushel and is extensively used all over Ceylon.

The object of the present experiments has been to produce a good type of marketable dhal from *Cajanus cajan* and our attention for the present will, therefore, be chiefly devoted to the problems of curing of dhal from *Cajanus cajan* alone.

SUITABLE METHODS OF CURING UNDER LOCAL CONDITIONS

There are two principal methods of curing dhal followed in different parts of India. Both of these methods have already been described in the author's first article. The advantages, disadvantages and the adaptability under local conditions of

each of these two methods were studied during the course of the preliminary curing trials. As a result of this study, it was realized that the wet method followed in South India is practically of no use under Ceylon conditions in spite of the advantage of slight cheapness in its favour.

The irregularity of weather conditions which is a common feature almost everywhere in this country, has a comparatively more deleterious effect on the wet method than on the dry method. For example, during the course of curing by the wet method, continuous rain or cloudy weather may occur for 4 or 5 days at a stage when the seed has been kept for drying after soaking it in water. The seed would not dry to the required extent under such conditions and would undergo unduly prolonged fermentation. This over-fermentation creates an undesirable odour in the final product and the quality of the whole lot is spoiled. This difficulty had actually been experienced during the course of the trial of the wet method on a former occasion at Anuradhapura. This method is, therefore, attended by the risk of damage or even absolute loss of all the seed in the event of any irregularity in the weather. The dry method, from this point of view, is quite safe. If there is rain at any stage of curing by this method, the seed can be stored indoors indefinitely without any detrimental effect. Besides this distinct advantage of safety, the dhal obtained by the dry method is quite free from the depression in the centre, has an attractive appearance, is superior in cooking quality and flavour and is capable of being stored without damage for a relatively longer period.

PROBLEMS ASSOCIATED WITH THE DRY METHOD OF CURING AND THE RESULTING MODIFICATIONS IN THE PROCESS TO SUIT LOCAL REQUIREMENTS

During the early trials of curing, it was realized that even the dry method of curing could not be adopted entirely in the form in which it is followed in India and that it required some important modifications to suit our local requirements.

The oil in general use in India for this purpose is gingelly oil because it appeals to the taste of the people and it is available in good quality at a reasonably low price in the Indian villages. The position in Ceylon is quite different in this respect. People in Ceylon generally like coconut oil better and it is available in the villages at a reasonably low price. Attempts were, therefore, made in the later trials to use coconut oil instead of gingelly oil. This has succeeded remarkably well with the modification in the technique of the dry method. In the modified dry method, the quantity of oil to be used during the curing process is greatly reduced and the application of oil at the end

of curing is entirely dispensed with. It is for this reason that the cured dhal does not continue to retain the characteristic flavour of coconut oil and therefore the possibility of the dhal cured with coconut oil acquiring rancidity during the storage period is entirely eliminated.

The second problem to be solved was to avoid as far as possible the oily appearance of the cured dhal as the people in Ceylon have not acquired the taste for the oily-looking dhal. With the modification in the method of dry curing, it has now been possible to reduce this oily appearance of cured dhal to a minimum, and it can be further reduced if necessary to a marked extent by the adoption of the combined dry and the wet methods of curing.

The next problem was to eliminate the minimum resting period of a fortnight which is necessary at an intermediate stage in the case of the formerly-described dry method. This step was desirable in view of the fact that the dhal-curing season available in Ceylon is of a shorter duration than in India. The observation of a fortnight's resting period would have the effect of further shortening the already short period of the curing season. This resting period is eliminated in the modified dry method of curing. The number of splittings have been increased from two to four to counteract the effect of elimination of the resting period.

This modified dry method has been found admirably to suit the local conditions and it yields a dhal of fine quality with the least possible oily appearance.

DESCRIPTION OF THE MODIFIED DRY METHOD OF CURING ADAPTED FOR LOCAL CONDITIONS

Before the actual curing process commences, it is desirable to grade the seed by means of appropriate sieves into three lots according to size. The three grades are : large, medium and small. This preliminary grading facilitates the splitting. If grading is not done, the splitting in the mill will not be of an even character on account of the variation in the size of seed, and there is a possibility of relatively more breakage of the dhal. From an average good crop, the percentage proportion of the three grades of seed is : first grade 80 per cent., second grade 17 per cent. and third grade 3 per cent. The curing of the first and the second grade seed is done in separate lots and the cured dhal may be marketed in separate grades or may be mixed together and marketed in the mixed form. The third grade seed which is very small-sized and imperfectly developed is not utilized for the curing as the resulting dhal is not likely to find a ready sale at a reasonable price. In India it is merely split and sold as a cattle food. In this form it realizes in the

Indian market a price of about two cents per pound. In this way the third grade seed which is otherwise useless for curing of dhal, is economically disposed of.

This process of curing can be conveniently divided into the following six stages :—

(1) *First splitting.*—Preliminary sun-drying before splitting is necessary only if the seed has not been sufficiently dried after threshing. The first splitting in the stone mill is very light and as a result only about 6 per cent. of the seed is split. The clearance between the two stones of the mill at the time of this splitting is the maximum and the seed is rapidly fed in large quantity at a time. The object of this light splitting is only to crack the seed coats. The partially-split seed with cracked seed coat is known as *dol.*

(2) *First application of oil and drying under sun.*—After the first splitting, the broken part of the dhal called *chuni* is separated with the help of a round sieve with small mesh (Fig. 1) If a fair amount of seed coats are separated they may be winnowed out, otherwise this is not necessary. The *dol* is then treated with coconut oil (Fig. 2) at the rate of one pound per 128 lb. *dol* in the morning and immediately exposed to the sun (Fig. 3) for drying. The duration of the drying period ranges from 1 to 3 days depending upon the intensity of heat of the sun and the thickness of the layer of *dol.* If the sun is mild or if the *dol* is spread in a thick layer, sun-drying for a longer period is necessary. While drying, it is essential frequently to disturb the *dol* so that the drying may be even.

(3) *Second splitting.*—After it is fully dry, the second splitting of *dol* commences. This splitting is also light and a further 13 per cent. of the seed gets split. This second splitting can be done in the evening after the *dol* has been dried during the day. The split material is then passed through a round, small-meshed sieve to separate the *chuni.* The seed coats may also be removed if necessary by winnowing.

(4) *Second application of oil and drying under sun.*—The *dol* at this stage is treated with coconut oil at the rate of one pound per 225 lb. *dol* in the morning and spread for drying under the sun for a day or two depending on the intensity of heat and the thickness of the layer of dol.

(5) *Third splitting.*—(The *dol* is now ready for the third splitting. This third splitting should be of a fairly heavy character. This is possible by slightly reducing the clearance between the two stones of the mill. A further 38 per cent. of the seed gets split at this time. After the splitting is over, the *chuni* and the seed coats are as usual separated from the

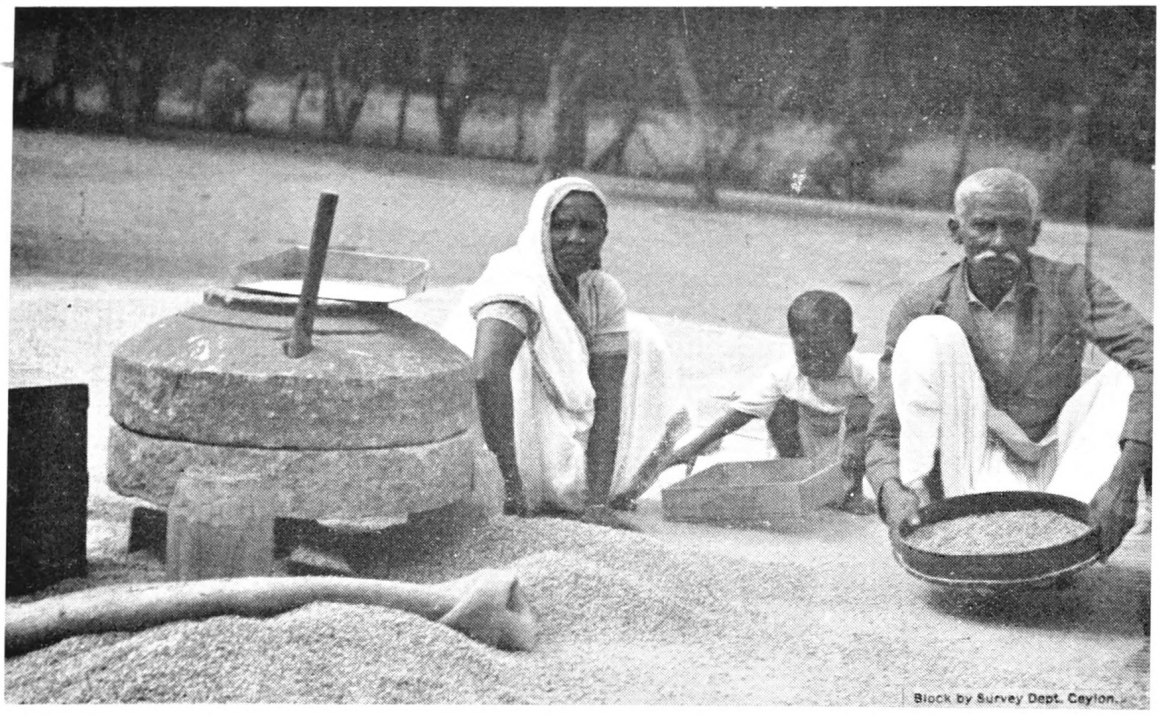

FIG. 1.—SIEVES AT WORK DURING THE PROCESS OF DHAL-CURING.

FIG. 2.—THE *Dol* BEING TREATED WITH COCONUT OIL.

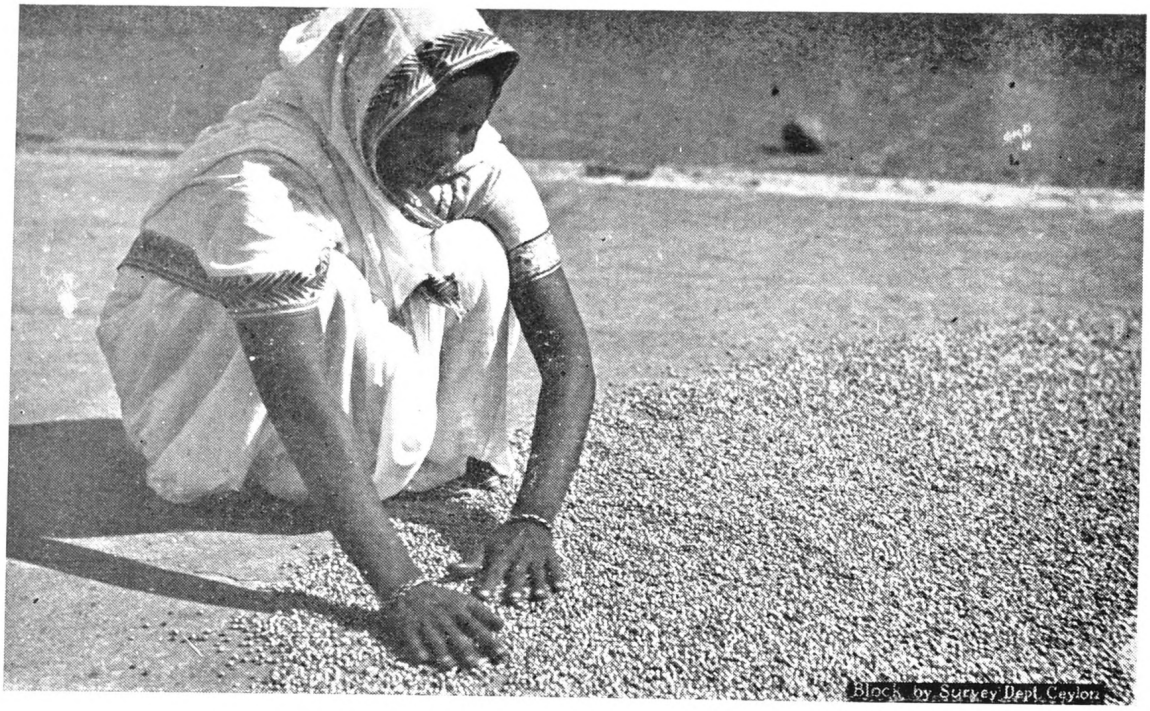

FIG. 3.—THE OIL-TREATED *Dol* BEING SPREAD FOR DRYING IN THE SUN.

FIG. 4.—WOODEN PARTS AND SIDE VIEW OF THE VILLAGE MODEL OF DHAL-SPLITTING MILL.

dol. The slightly broken dhal pieces may, if necessary, be separated by the appropriately meshed round sieve. Dhal is not to be separated from *dol* even at the end of the third splitting. No oil is to be applied at the end of the third splitting.

(6) *Sun-drying and fourth splitting.*—The material is kept for drying this time only for a day. It is then finally split for the fourth time. This splitting is also fairly heavy. Most of the *dol* is split at this time. The split material is passed through the rectangular steel sieve which separates the dhal. The *chuni*, broken dhal, and seed coats are separated in the usual manner described before. If the separated dhal has some proportion of seed coats still adhering, the seed coats can be separated from the dhal by lightly pounding it with the wooden mortar and pestle. About 3 per cent. of the *dol* remains unsplit even at the end of the fourth splitting. This can be finally split by immediately feeding it again in the mill without drying under sun or application of oil.

By this process dhal can be cured within a period of 7 to 8 days. The cured dhal does not look very oily and has all the desirable characteristics of good quality dhal. From the good seed of the first and second grade, the approximate percentage proportion of different dhal products as a result of satisfactory curing should be : 66 to 70 per cent. of good dhal saleable at full market value, 5 to 9 per cent. broken dhal saleable at about half the price of good dhal, 13 per cent. *chuni* or powdered dhal saleable in the Indian market at about $2\frac{1}{2}$ cents per pound, and 12 per cent. seed coats saleable in the Indian market at about $1\frac{1}{2}$ cents per pound. It may be of interest to note here that the results of the local curing trials from good seed have favourably compared with these Indian averages.

DESCRIPTION OF THE COMBINED DRY AND WET METHOD OF CURING DHAL ADAPTED FOR LOCAL CONDITIONS

Here also the seed requires to be graded as in the case of the dry method. The principal difference in this method is the use of a mixture of oil and water instead of oil alone. This process of curing can be conveniently divided into the following five stages :—

(1) *First splitting.*—The first splitting in the stone mill is fairly light and as a result about 20 per cent. of the seed is split. The *chuni* is separated out from the *dol.*

(2) *Application of a mixture of oil and water and drying under sun.*—The *dol* is treated with a mixture of oil and water in the evening. For 128 lb. seed, one pound of oil and five pounds of water are necessary. Coconut oil has been found to serve the purpose quite satisfactorily. The oil and water are first mixed in a bucket and gradually incorporated into the *dol.* When thoroughly mixed, it is heaped up and kept in that condition

for the whole night. The heap is disturbed in the morning and the material exposed in a thin layer to dry in the sun. The *dol* is allowed to dry for 3 to 4 days according to the intensity of heat of the sun.

(3) *Second splitting.*—When thoroughly dry, it is split for the second time fairly heavily, *i.e.*, with less clearance between the two stones of the mill. At this time a further 50 to 60 per cent. of the seed gets split. The dhal, broken dhal, *chuni* and the seed coats are separated from the unsplit *dol*. The dhal is finally cleaned and kept separately.

(4) *Second application of a mixture of oil and water and drying under sun.*—The unsplit *dol* is again treated with a mixture of oil and water in the same proportion and heaped up for the night. From the next morning for 3 to 4 days it is exposed to the sun for drying.

(5) *Third splitting.*—When thoroughly dry, the *dol* is split for the third time. Dhal is separated from the other by-products in the manner already described.

If the separated dhal has some proportion of seed coats still adhering, the seed coats can be separated by lightly pounding the dhal with the help of a wooden mortar and a pestle which are commonly seen in the villages.

Curing by this method yields almost the same proportion of dhal and other by-products. The dhal cured by this method looks less oily but is slightly difficult to cook.

STONE MILLS USED IN SPLITTING DHAL AND OTHER EQUIPMENT NECESSARY FOR DHAL CURING

The success of dhal-curing depends to a great extent upon the use of a right kind of splitting mill. Sometimes the distinction between the splitting and the grinding mill is not properly understood. Splitting mills are provided with devices for adjusting the clearance space between the lower and the upper stones enabling the degree of splitting of seed to be regulated. This makes the mill also adaptable for splitting a wide range of pulse seeds which appreciably vary in size. In the grinding mill, such a facility does not exist and, therefore, any material fed into such a mill is reduced to powder.

In Gujarat, Western India, two models of splitting mills are in general use. Both models were brought by the author from Gujarat and used during the course of the curing trials described in this paper. The one known as the village model is a relatively small-sized, handy, flat-shaped mill with an approximate weight of 150 lb. It costs about Rs. 15. It requires to be worked by two persons and it can split about 600 to 900 lb. of seed in a working day of 8 hours depending on the skill of the workers. Figs. 4, 5 and 6 illustrate the different parts, side view,

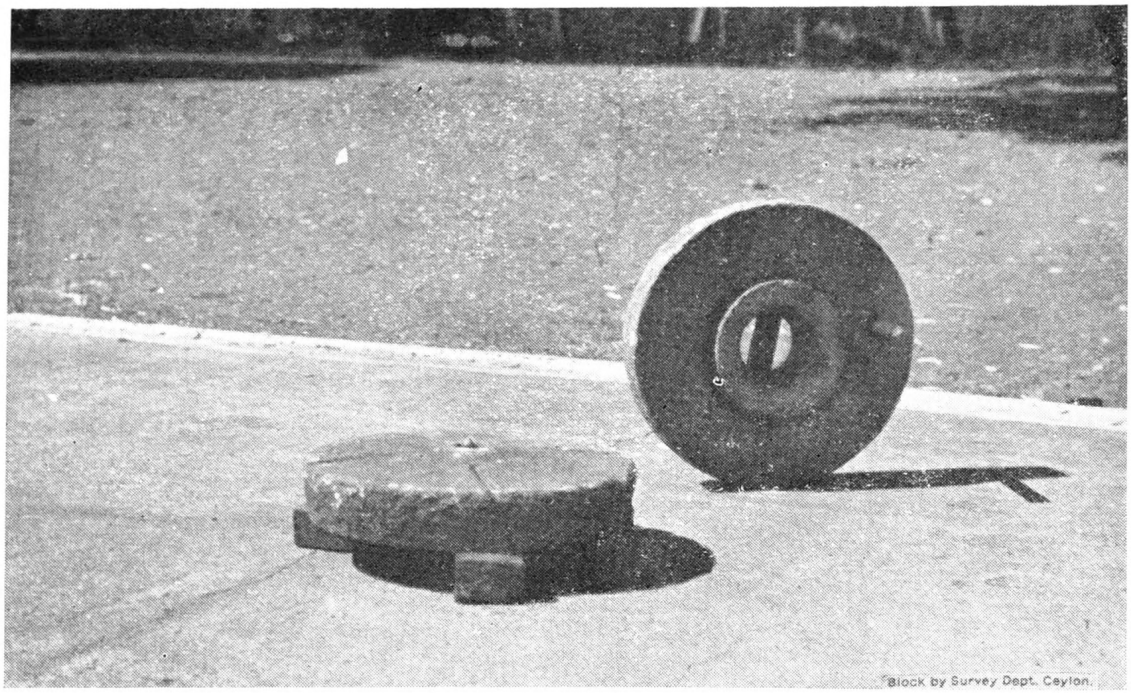

FIG. 5.—WOODEN PARTS AND SIDE VIEW OF THE VILLAGE MODEL OF DHAL-SPLITTING MILL.

FIG. 6.—DHAL-SPLITTING MILL : VILLAGE MODEL.

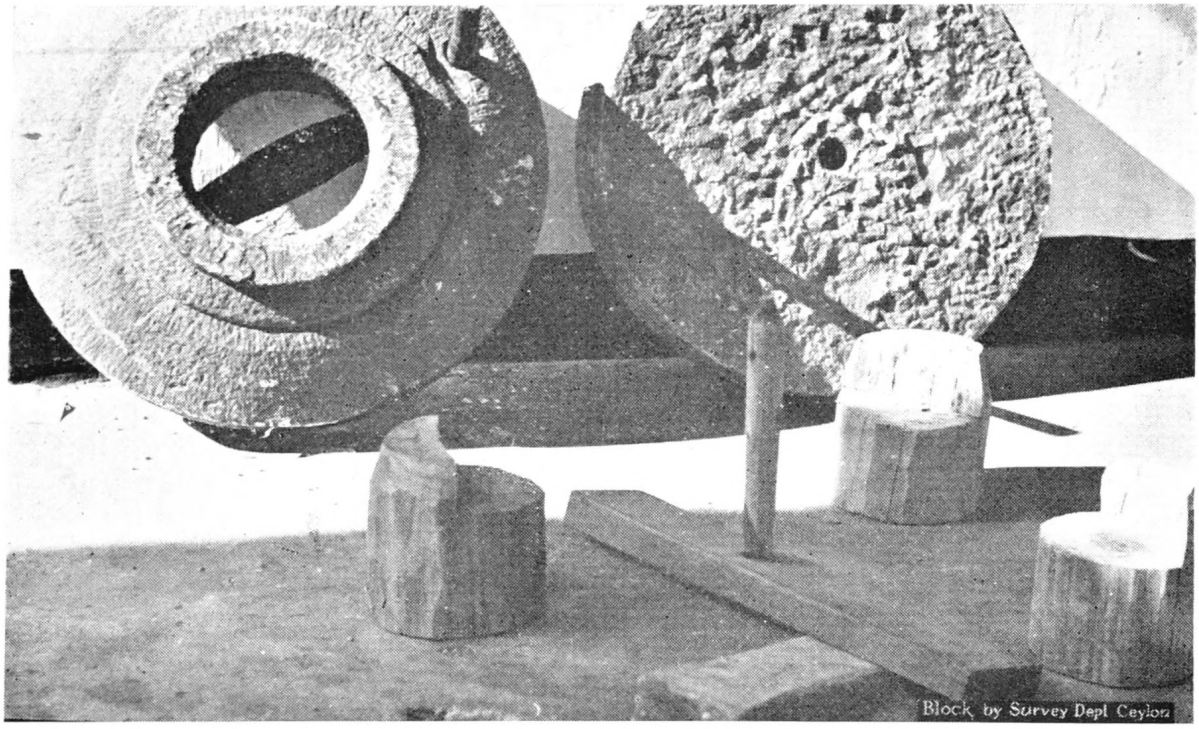

FIG. 7.—WOODEN PARTS AND SIDE VIEW OF THE COMMERCIAL MODEL OF DHAL-SPLITTING MILL.

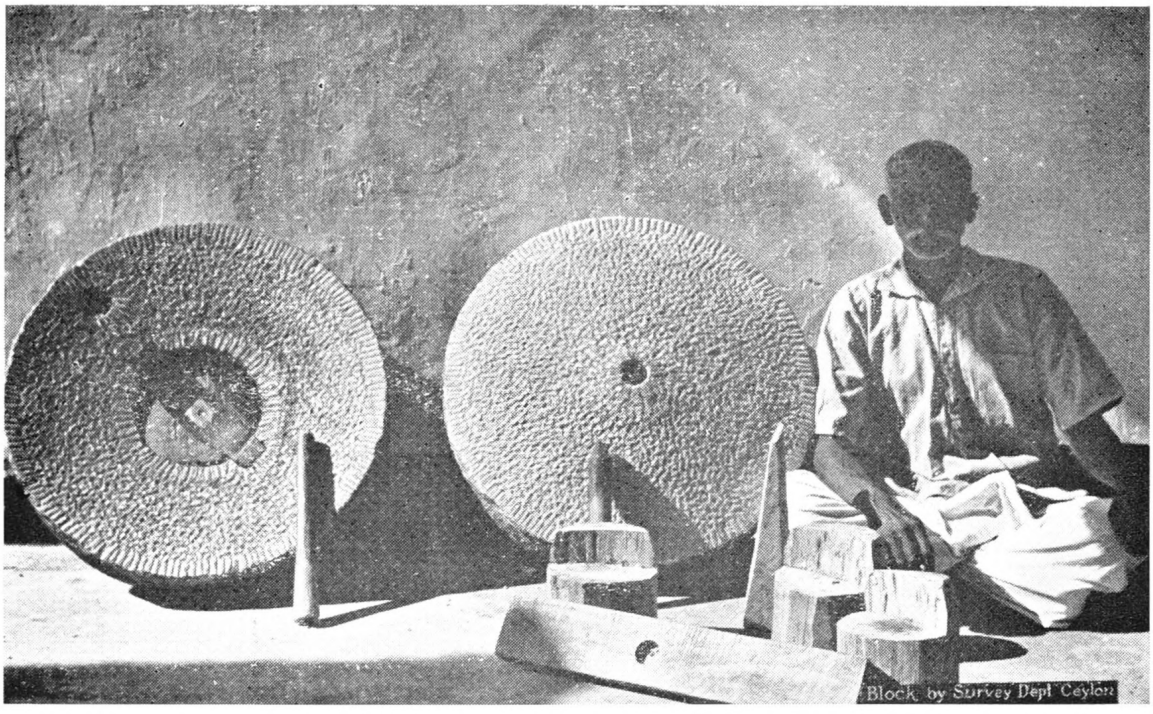

FIG. 8.—WOODEN PARTS AND SIDE VIEW OF THE COMMERCIAL MODEL OF DHAL SPLITTING MILL.

FIG. 9.—SIDE VIEW OF THE COMMERCIAL MODEL OF DHAL-SPLITTING MILL.

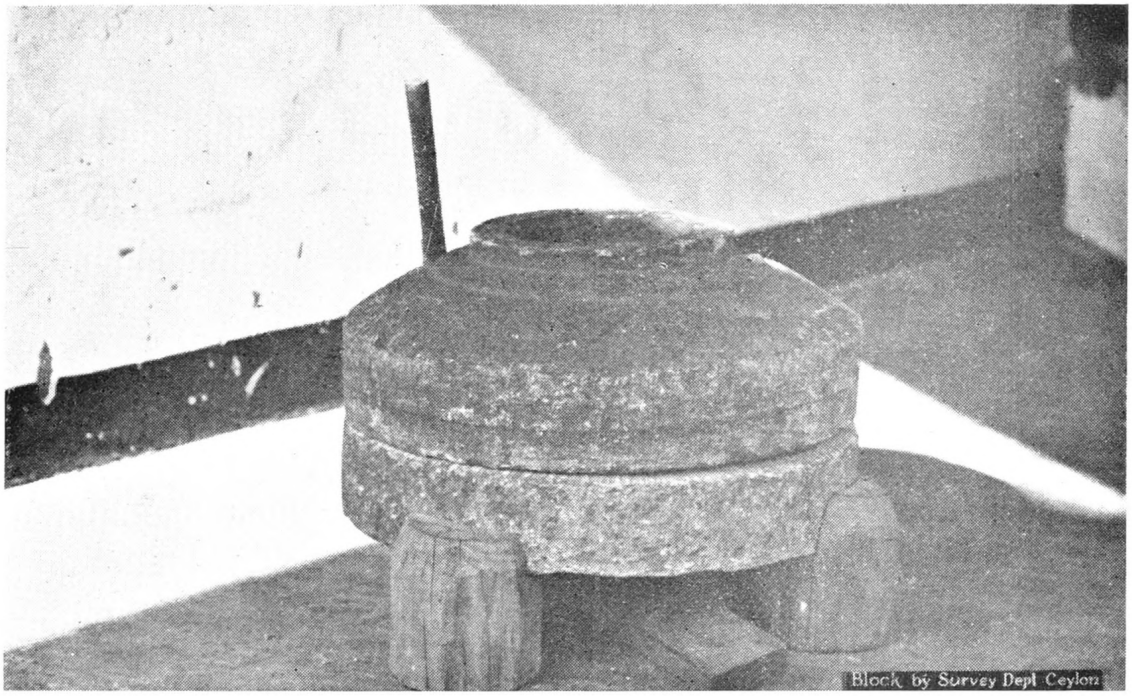

FIG. 10.—DHAL-SPLITTING MILL : COMMERCIAL MODEL.

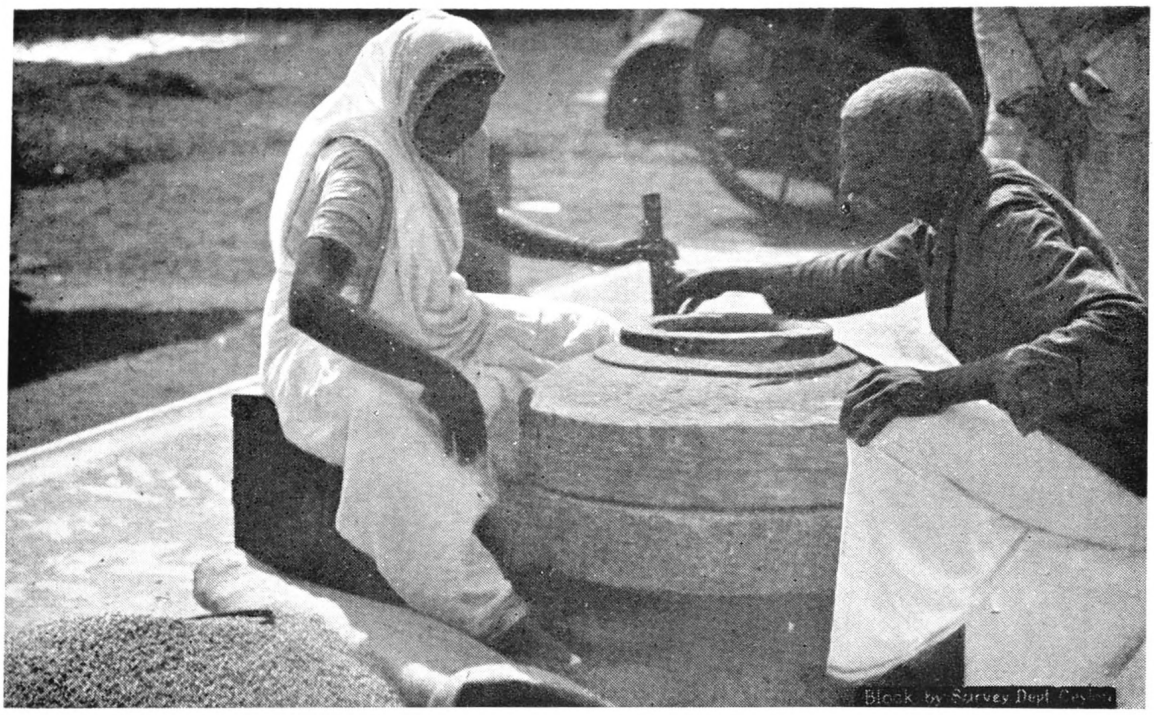

FIG. 11.—DHAL-SPLITTING MILL : COMMERCIAL MODEL AT WORK.

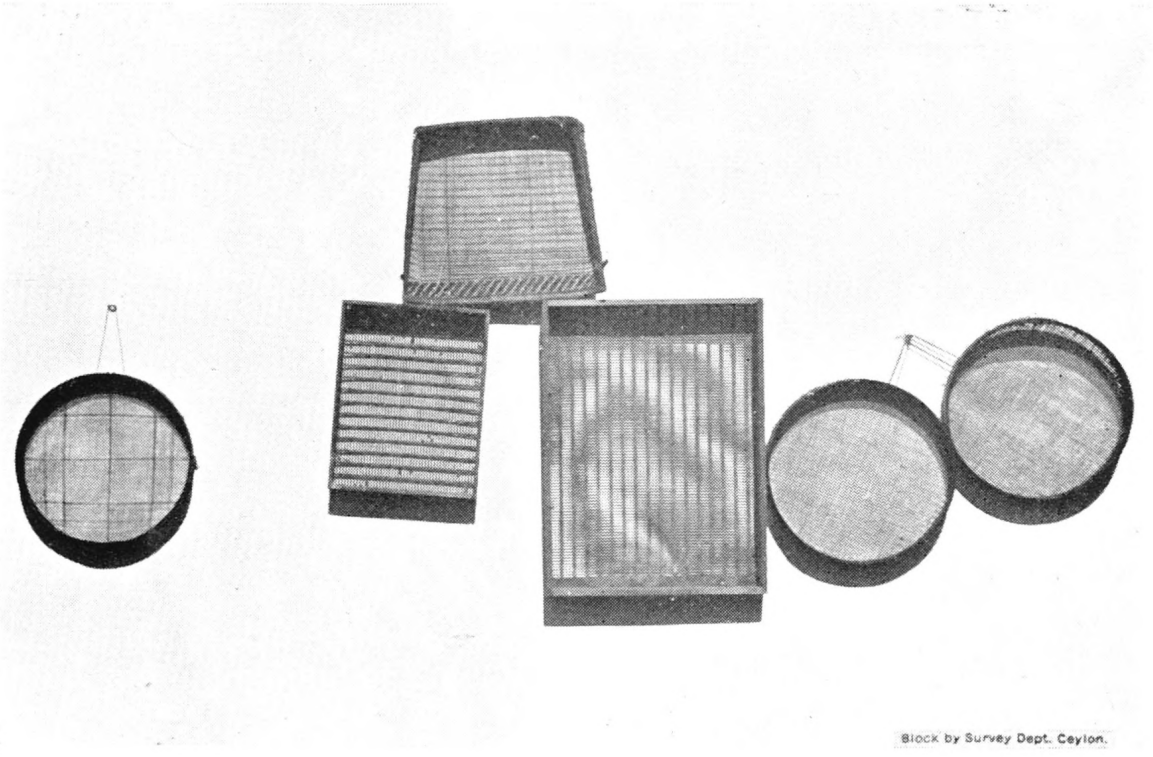

FIG. 12.—SIEVES AND WINNOWING FANS USED IN DHAL-CURING.

the actual working of this model and the relative position of the workers while working. This type of mill is generally used by the villagers who have to cure dhal on a small scale to meet the requirements of the village.

The other is the commercial model which is dome-shaped and quite heavy. This mill weighs about 500 lb. and its cost is Rs. 25. This is generally used in the towns by the professional dhal-curers known as *golas* who cure fairly large quantities of dhal. This model is also worked by two persons at a time and, though apparently very heavy looking, is quite light in actual working on account of the ease with which it is possible to adjust the clearance between the lower and the upper stones. It can split about 1,200 to 1,600 lb. of seed in a working day of 8 hours, depending on the experience of the operators. Figs. 7 to 11 illustrate the different parts and side views of the mill, the mill ready for work and in actual working showing the relative position of the operators.

Besides the splitting mills, sieves of different kinds and winnowing fan are required to separate the by-products from dhal at various stages of the curing. These are illustrated in Fig. 12. The round sieves are used according to the size of the mesh for grading seed, for separating powdered dhal and broken pieces of dhal. The rectangular steel sieves separate the dhal from the unsplit *dol*. The winnowing fan is used in separating the seed coats from *dol*, dhal and dhal pieces.

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