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M. M. Krishna Marar and C. A. Kunhiraman

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INTRODUCTION

NEARLY three-fourths of the total acreage under coconuts in India lies on the West Coast between the Arabian Sea and the Western Ghats in a narrow belt stretching from Bombay in the north to Cape Comorin in the south. The palms here are being grown purely with the help of rains and the soil and climatic conditions obtaining in this region are not quite conducive for getting maximum production from the crop under natural conditions. The following are among the more important limiting factors:-

(i) The soils are mostly of the lateritic, loamy or sandy type, very poor in organic matter and manurial ingredients.

(ii) The soils are excessively drained with the result that their capacity to absorb and retain moisture for the use of the crop throughout the year is very poor. Being a perennial tree which continues to bear all the year round, there is a continuing demand from the palm for moisture and nutrients present in the soil.

(iii) The rainfall is not well distributed. Though the average annual rainfall is well over 100 inches, most of it is received during a short period of three months (June to August) of the south-west monsoon. The rainfall is poor or undependable in the other months with the result that there is a continuous period of drought for 5 to 6 months in the year, from December to May. The pattern of rainfall distribution at Central Coconut Research Station, Kasaragod is given in Fig. 1.

The combined effect of poor retentivity of soil, absence of rains, high temperature and low atmospheric humidity during

summer months is to accelerate the loss of moisture from the soil. During this period the moisture content rapidly goes down to about 5 per cent in laterite soil, 2 per cent in loamy soil and to as low as 0.1 per cent in sandy soil. This is really a very trying time for the coconut palm and it is no wonder that they exhibit acute symptoms of moisture stress. The foliage turns yellow and shedding of buttons and immature nuts increases. The importance of adequate soil moisture during this period in relation to yield has been well brought out by the positive correlation obtained between the yield of a particular year and the rainfall received during January to April of that year as well as the rains received during the same period, in two years previous to it (Patel, 1938).

It is clear from what is stated above that among the factors limiting production at present, inadequate soil moisture during summer months is an important one. Any attempt at improving the productive capacity of the coconut palms on the West Coast should, therefore, give top priority for measures designed to increase the moisture availability in the soil. Addition of silt or clay and augmenting the organic matter content of the soil will to some extent improve the moisture retaining capacity of the soil. Provision of irrigation facilities in summer is, however, the one step that will help to relieve moisture stress most. These measures are strictly of local importance or of limited applicability. It has, however, been demonstrated that burial of coconut husks is an effective method of improving coconut gardens raised under unirrigated conditions. It is the purpose of this article to collect and collate all the information available on the subject for the benefit of the coconut growers.

PROPERTIES OF HUSKS

Husk which forms the outer covering of the coconut is an important raw material for the coir fibre industry. In India, green husks are being utilised on a large scale, particularly in the Travancore and Cochin areas of the Kerala State, for retting and conversion into fibre. In the other coconut areas, husk is mostly burnt as fuel and nowhere is the disposal of husk a problem. On the other hand, in other important coconut growing countries like Ceylon where coir fibre industry has not developed much, husks get accumulated into huge heaps and their proper disposal is a serious problem for the growers to face.

The husk has many useful properties. One is its manurial value. It contains potash in a very easily soluble condition. The potash is present in the husk to the extent of 1 to 3 per cent (on dry basis) and in husk ash to as much as 20 to 35 per cent. In Ceylon (Leaflet No. 5, Coconut Research Institute, Ceylon), about a lakh of husks on an average are estimated to contain potash equivalent to one ton of muriate of potash. The amounts

of nitrogen and phosphoric acid present in the husk are relatively small.

A second property of the husk is its spongy and fibrous nature which enables it to absorb large quantities of water and retain it. A fully soaked husk is able to absorb 6 to 8 times its weight of water. The properties of husks enunciated above suggested that they might, if buried in coconut plantations, prove beneficial to the palms in the following ways:-

The husk may make available to the coconut, potash - the most important manurial requirement of the palm. And the water it absorbs and retains during the rainy season may keep the soil cool and help the coconut trees to tide over drought in summer months. The buried husk does not decompose quickly or become compact and it may prevent hardening of the soil and allow water to percolate freely into lower layers. The spongy structure of the husk may also provide a good medium for extensive root development. These benefits have largely been realised in practice under field conditions.

HUSK BURIAL PRACTICES IN VOGUE IN CEYLON

It was in Ceylon where the disposal of husk is a problem that large scale burial of husks in coconut gardens was first tried and its beneficial effects observed. Different methods of burying husks are now found practised there. Thus the husks are buried in small pits 4′ × 4′ × 3′ or in circular basins with a diameter of 6′ and 1′ deep called 'saucer pits'. Again husks are buried in-between rows of palms in trenches 8′ to 10′ broad and running along the whole length of the row. In still another method husks are buried in trenches along rows of palms.

RESULTS OF EXPERIMENTS IN INDIA

Before husk burying is recommended to coconut growers in India, it was considered necessary to gather definite experimental data on the feasibility and economics of the practice and also on certain other matters arising from or relating to it in the different soil types on which coconut is being grown. The experiments were accordingly carried out in three Agricultural Experimental Stations on the West Coast, *viz.*, Kasaragod (now Central Coconut Research Station, Kasaragod), Nileshwar I (Pilicode) and Nileshwar III. They are briefly discussed hereunder.

(I) **Effect of husk burial.** An experiment to study the response of husk burial was first initiated at the Agricultural Research Station, Kasaragod (now Central Coconut Research Station, Kasaragod) in 1937, in a block of 2.20 acres in extent. The soil is red loam and very deep. It has poor water holding capacity and fertility. The coconut palms growing in the block are of the ordinary tall variety of the West Coast. They were at that time about 40 to 50 years old and had not been receiving irrigation at any time. Dry coconut husks and leaves were

buried in an area of 1.50 acres of the block in trenches 6' wide and 12 to 15 inches deep and running in-between the rows of trees in both lengthwise and crosswise directions. It took about three years to complete the operation and the number of husks buried worked out on an average to about 1000 husks per tree. The rest of the area (0.70 acre) was left to serve as control. The block was given regular intercultivations as usual, but no manuring was done to the trees.

Observations were regularly made on the condition of the trees and data in respect of female flower production, yield of ripe nuts, setting percentage and number of functioning leaves in the crown gathered. The first visible effect was a general improvement in the condition of the trees, particularly in the colour of the foliage which took on a dark green hue. This was then followed by an increase in the number of functioning leaves in the crown. Later on there was favourable effect on the yield of the palms for a few years, as can be seen from the data furnished below.

Mean yield of nuts per tree per year

Year	Husk buried plot (A)	Control plot (B)	Difference (A—B)
1937	38	47	-9
1938	48	55	-7
1939	40	46	-6
1940	63	47	16
1941	70	48	22
1942	54	46	8
1943	65	58	7
1944	45	43	2
1945	72	63	9
1946	27	31	-4
1947	45	50	-5
1948	53	65	-12

The changes produced in the relative position of the 'husk buried' and 'control' plots consequent on husk burying have also been graphically represented in Fig. 2.

The husk-buried plot started at a disadvantage. During 1937-39 the mean yield per tree in the treated plot was 7 nuts less than that of the control. In spite of this, because of the favourable effect of husk burial there was a complete reversal in their relative positions. Not only was the initial difference made up but substantial gains were also made by the treated plot, when compared with the control. The maximum beneficial effect was felt in 1941. Then there was a decline and the plots reverted to their original relative position from 1946 onwards. Thus it appeared to show that the beneficial effects of burying husk once may last for about 6 years. During this period the average increase in yield over control was 11 nuts, per tree per year, but considering the fact that the control plot had at the beginning a lead of about 7 nuts, the actual increase recorded should be taken to be 18 nuts per tree per year. The evidence is thus conclusive that husk burial does improve the coconut gardens raised under rain-fed conditions.

Since the husk buried plot was found to rapidly deteriorate, husks were again buried for a second time in the Block during 1948-50. The results were more or less similar to those observed in the first instance.

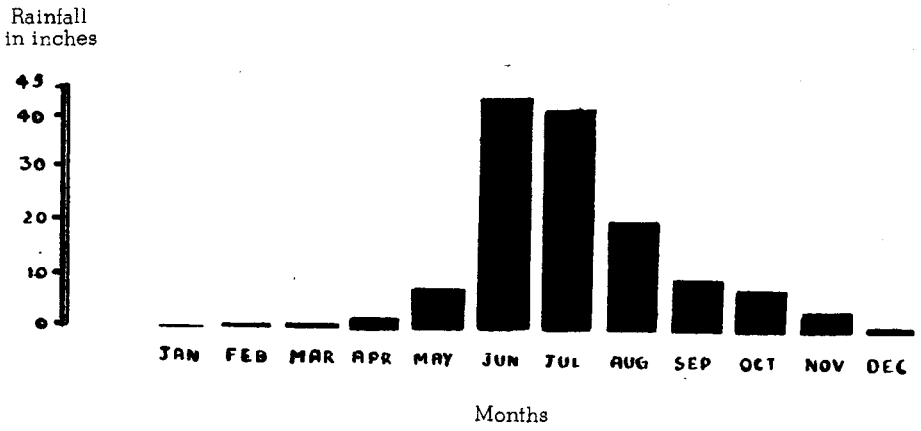

Fig. 1. Pattern of rainfall distribution at the Central Coconut Research Station, Kasaragod.

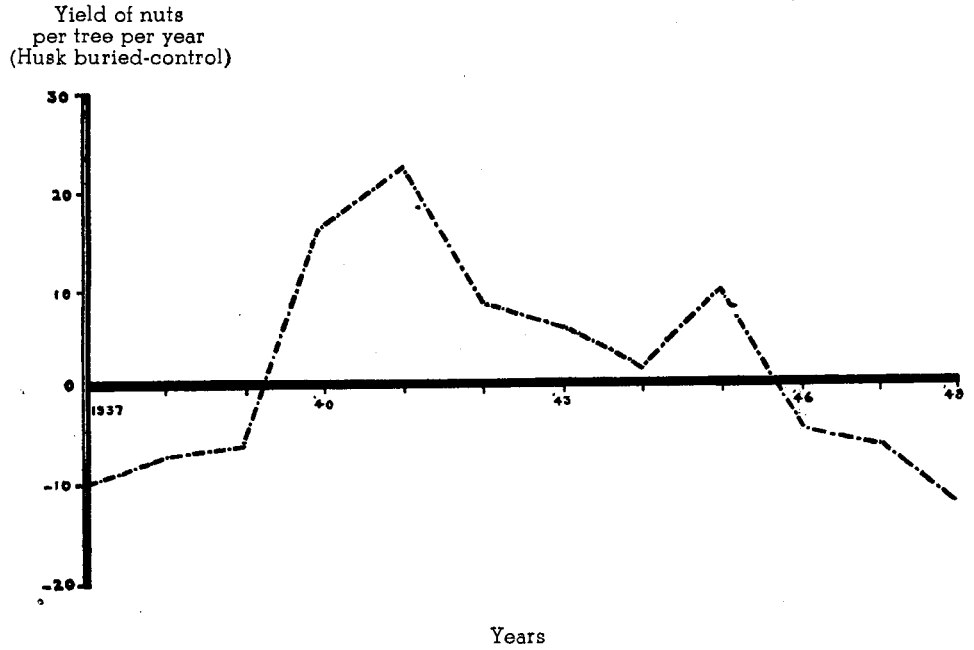

Fig 2. Graph showing the changes in the relative position of husk-burial and control plots.

Fig. 3. Buried husks become compact and brittle in course of time.

a) Husk which was lying buried in the soil for about 8 years.

b) Fresh husk.

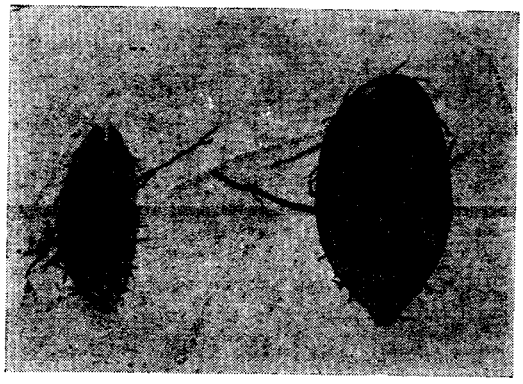

Fig. 4. Ramification of coconut roots in buried husks.

In the laterite gravelly soil of the Agricultural Research Station, Pilicode also response to husk burial was obtained.

(2) Husk burial vs. general dose of manure. At the Agricultural Research Station, Pilicode (laterite gravelly soil) an experiment was carried out to compare the effect of husk burial with that of the application of a general dose of manure consisting of 3 lb. of ammonium sulphate, 2 lb. of bonemeal and $1\frac{1}{2}$ lb. of potassium sulphate. It was concluded from the results that in soils such as the one in question suffering from deficiencies of all the important plant nutrients it might be necessary to supplement husk burial with the application of nitrogenous and phosphatic manures also to obtain maximum benefits. This is only to be expected as husks can supply only potash in appreciable quantities and not the other nutrients.

(3) Depth of burying husks. Another matter which was investigated at the Agricultural Research Station, Pilicode was the proper depth at which the husks have to be buried. Two depths of burying viz., 15" and 36" were under comparison. The improvement in yields due to husk burial was again in evidence, but there was no marked difference in response between the two depths under comparison. It was, therefore, concluded that from the economic point of view, 15" deep trenches would normally be sufficient for burying husks in coconut plantations. The advantages of the use of deeper trenches are not commensurate with the extra expenditure involved.

ECONOMICS

Any practice to receive acceptance at the hands of the coconut growers, should first be able to convince them regarding its economic feasibility. An attempt is made hereunder to work out roughly the economics of husk burial based on the results obtained at Central Coconut Research Station, Kasaragod.

Cost of burying husks in an acre of coconut plantation containing about 70 trees

Cost of excavating trenches 6′ wide & 15″ deep both lengthwise and crosswise in-between rows of trees	Rs. 100
Cost of arranging husks in trenches and closing them	Rs. 200
Cost of 70,000 husks @ Rs. 3 per 1000 husks	Rs. 210
Interest on money invested initially for 7 years (approx.)	Rs. 90
Total	Rs. 600

Gross Income

Average increase in yield during the six-year period @ 108 nuts per tree, for 70 trees	7,560 nuts
Value at Rs. 150 per 1000 nuts	Rs. 1,134
Increased income per acre for 7 years	Rs. 1,134–Rs. 600 = 534
Increased income per acre per year	= Rs. $\frac{534}{7}$ = Rs. 76

Note:- **Cost may vary according to local conditions of soil, wages of labour, cost of husks, etc., while income will depend upon the prevailing market rate for nuts.**

It is seen from the results that husk burial is a definitely profitable way of improving coconut gardens, in places where husks and labour are available readily and cheaply.

DISCUSSION

There is sufficient evidence in the experimental results given above to show that husk burial in coconut gardens raised under unirrigated conditions and subject to drought does improve the coconut palms. They also appear to show that where the soil is deficient in all the important plant nutrients, husk burying may have to be supplemented by the addition of nitrogenous and phosphatic fertilizers also, if better results have to be obtained. The trend of response has followed the same pattern as is observed in manurial and cultural experiments, *viz.*, the increased yield is obtained only a couple of years after the commencement of the operation. The improvement is not also found maintained at high level for any length of time; it reaches a peak and then begins to decline steadily. From the results it appears that 5 to 6 years after the initial husk burial, the operation may have to be repeated again in order to prevent the yield from going down. The fact that in Ceylon some planters repeat husk burial once in every 6 years or so, gives additional support to the above conclusion.

The beneficial effects of husk burial already referred to previously, may be due to the potash content of the husk and to its moisture retaining capacity. The individual effect of each of these cannot, however, be assessed separately from the data available. The potash present in the husk is in a very soluble form and can be expected to be lost almost completely in the first one or two years after burying. The moisture holding capacity may also suffer some set-back as the husks get compacted and become brittle. A sample of buried husks taken out after a period of about 8 years (Fig. 3) is found to break down into pieces with slight pressure and did not appear to possess any appreciable water holding capacity at that stage. It is probably this deterioration taking place in the quality of husks that is reflected in the declining yields. That the husks do absorb water and that this water is made use of by the trees is clear from the fact that a large number of root-lets have been observed to penetrate the husks (Fig. 4). Main roots have not been, or only rarely, seen to grow into or through the husk, but they throw out laterals to make use of the water retained in the husks.

These studies do not throw any light or permit any conclusions to be drawn on one aspect, *viz.*, the effect of trenching alone as distinct from that of the husks buried. In the process of opening out trenches soils get disturbed on a large scale and large number of roots also get severely

pruned. These themselves cannot but have some effect. In fact, there is evidence to show that even trenches of much smaller size (2′ wide and 2′ deep) dug in-between rows of trees have benefited coconut palms (Memoirs of the Department of Agriculture, Madras). Recently some more evidence for the beneficial effect of root pruning has been obtained at Kasaragod (unpublished). There is, therefore, need for fresh experiments to determine the contribution of each factor to the sum total benefits observed as a result of husk burial.

LIMITATIONS

Though husk burial has been demonstrated to be a useful practice, it has certain disabilities which stand in the way of its becoming popular in the entire coconut tracts of India. The first and foremost is the wide-spread use of husk in the coir industry. In tracts where this industry is well established, husks fetch very high prices, even Rs. 30 to 40 per 1000 husks, and cannot be expected to get diverted for any other purpose. Secondly no grower can get sufficient number of husks from his own garden to meet his requirement and if he has to purchase husks from outside, the cost will go up. Of course this difficulty can be solved by taking up only a few trees every year and completing the operation in the entire garden in the course of a few years. The high initial outlay required to take up husk burial at one stretch may also be beyond the means of a large majority of coconut growers. Here also, spreading out the operation over a few years is the only way of making it possible for many to take this up. There is also another consideration. By burying husks the growers lose fuel which they largely use. But a thrifty coconut grower can satisfy his requirements of fuel by conserving all the dry spathes, flower bunches and leaves that may be available in a coconut garden.

POINTS TO BE CONSIDERED

It has already been shown that the benefits of husk burial may, in part, be due to the potash content of the husk, but the value of husk as a source of potash varies depending upon the source of husk and how it is stored. According to Salgado (1936) the potash content of husk is correlated with the potash status of the soil. Thus in one case he has estimated the amount of potash contained in husks from trees growing on gravelly soil to be about 9 lb. per 1000 husks as against 15 lb. in husks from loamy soil. This difference in potash content between the two lots of husks is by itself of sufficient magnitude to cause differential responses.

Proper storage of husks is also essential. They should not be exposed to rains prior to burying in the soil. The potash is present in the husk in the readily soluble forms of chloride and carbonate and will be lost by leaching if it is allowed to get soaked in water. Salgado (*loc. cit.*), for instance,

found that husks kept immersed in water had lost as much as 50 per cent of potash present in them in a period of about two months.

Though husk burial has given beneficial results in coconut plantations under dry system of cultivation, the practice cannot be recommended in gardens situated in low lying areas subject to water stagnation. The conditions which are already bad in such regions are likely to get worsened.

DIRECTIONS FOR HUSK BURYING

Now that husk burying has proved its usefulness for the coconut gardens on the West Coast, the following directions are offered for the benefit of the coconut growers:–

At the beginning of the monsoon rains, linear trenches 5′ to 6′ wide and 15″ deep may be dug in the centre of the interspace between two adjacent rows of coconut trees. Coconut husks which have not been previously exposed to rains may then be spread at the bottom of the trenches in a single layer with the concave spongy inner side facing upwards. Over the layer of husks soil is lightly spread to cover up the concavity. The above process, i. e., alternating layers of husk and soil may be repeated till the last layer comes upto about 9 inches below ground level. The trench may then be finally closed with the soil dug out. The accompanying sketch (Fig. 5) will show how the cross-section of a filled up trench will look like.

It is not advisable to fill the trenches with the husks right upto the ground level as there is the chance of the husk being disturbed by ploughing or digging operations. The effect of cultivation alone on the coconut palm in this area is very marked and nothing should be done which will prevent it being done satisfactorily.

There is no hard and fast rule regarding the number of husks to be buried. The number will vary with the size of the husk. Usually about 1000 husks per tree will be sufficient. Husk burial need not be completed in one year itself. In the first year husk burying may be done in lengthwise trenches in the alternate rows of palms. In the second year it may be continued in the rows left undone in the first year. In the third year the operations can be completed in the crosswise trenches. This is diagramatically illustrated in Fig. 6.

SUMMARY

The feasibility of husk burial for the improvement of coconut plantations has been discussed in its various aspects in the light of experimental results available. The following is a summary:

(1) Husk burial in coconut plantations under dry system of cultivation has been found to increase the yield of the coconut palms. The improvement resulting from one operation will last for about 6 years.

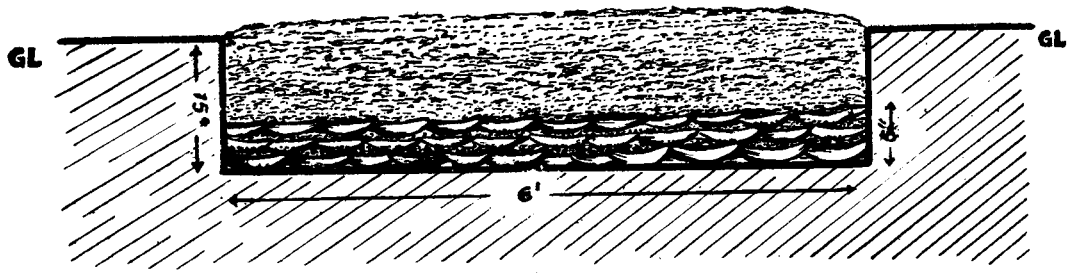

Fig. 5. A sectional view of a husk buried trench.

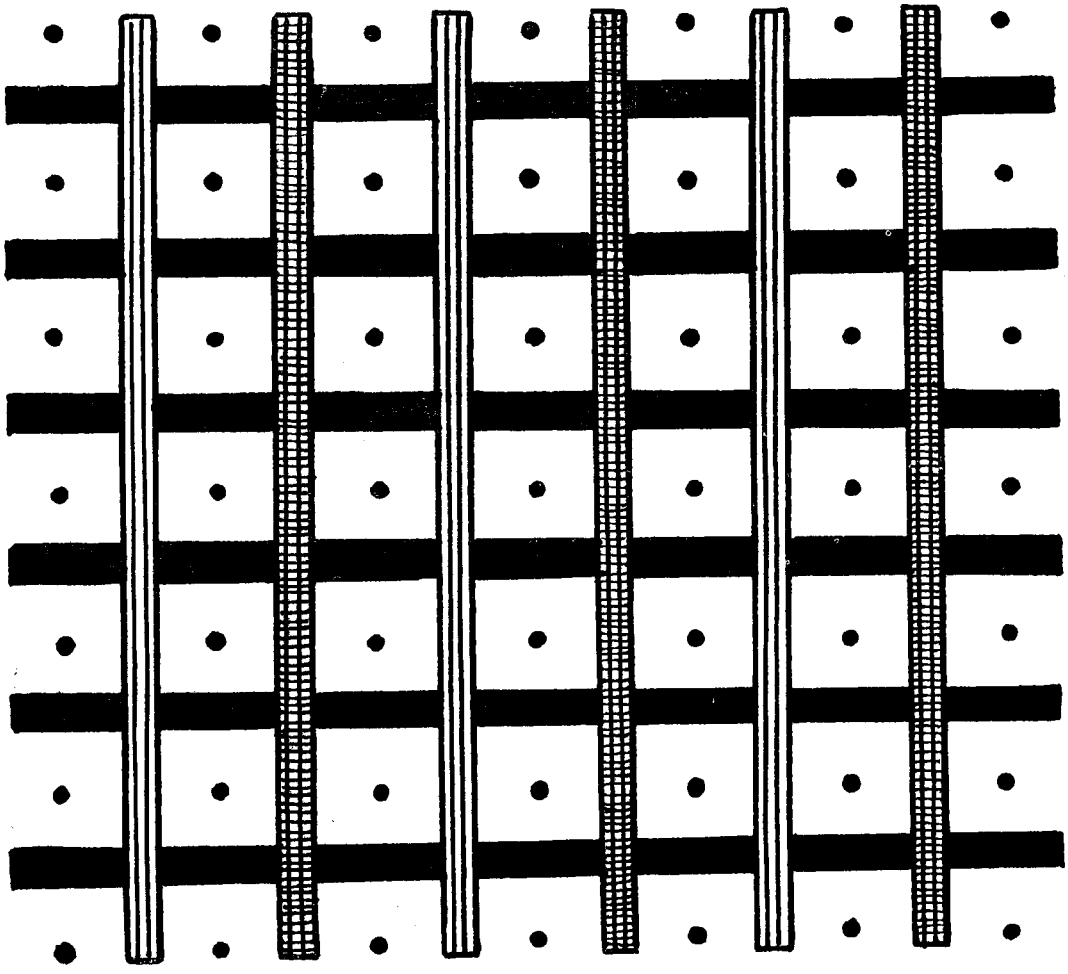

Fig. 6. Husk burying spread over a three-year period.
Each type of shading represents one year's operation.

(2) Where the soil is deficient in the important plant nutrients, husk burial may have to be supplemented with the application of nitrogenous and phosphatic fertilizers also if maximum benefit is to be obtained.

(3) Trenches for burying husks need be only about 15" deep. The advantages of the use of deeper trenches are not commensurate with the extra expense involved.

(4) A few questions for which the information already available does not provide answers have been indicated.

(5) The need to give proper consideration to certain aspects in husk burial has been stressed.

(6) Detailed directions for burying husks are given.

ACKNOWLEDGEMENT

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