ROTATION CROPS*

"ROTATION of crops" has become a byword in present-day systems of arable farming. The reasons are patent and need but little discussion here, save to point out certain factors which make varied cropping specially advisable under South African conditions.

It is obvious that on land where the same crop is grown continuously the soil will, in time, become denuded of those elements of which the crop requires most. This impoverishment of available constituents will take place more quickly than the working down of the dormant, non-assimilable material into a state suitable for absorption by plants. It is therefore well to crop land with species of varying requirements so that a "balanced" demand is made of the soil, adopting the principle that a crop requiring much phosphorus, for instance, be followed by one requiring less phosphorus, and more of the other ingredients, such as potash or calcium.

Crops with different types of root systems, shallow and deep, for example when used alternately will help maintain texture and fertility, functioning in varying layers of the soil and subsoil.

Rotation of crops is of importance in minimizing damage by pests, both of the root and aerial portions of the plant. A small black beetle (*Syagrus rugifrons*) has done serious damage to cotton crops in South Africa, working below ground level and practically destroying root systems, the only remedy being a change of cropping. Work at Barberton on insect pest control has shown that American Bollworm (*Heliothis obsoleta*) seems to prefer maize as a host plant to cotton; the pest does relatively little harm to the maize, and as this crop seems definitely attractive to one of the cotton-grower's worst enemies, there should be some incentive to him to include it in his cropping scheme if for no other reason than to act as a trap crop.

In a country of erratic rainfall and general climate, such as South Africa it is of importance to the farmer to have a range of useful crops. With constant liability to late rains, making the planting of long-period crops inadvisable, or to crops being wiped out by hail or wind early in the season, he does not want to have "all his eggs in one basket". With a long-period crop such as cotton (six to seven months) he may require something to plant on odd lands after his cotton-planting is finished; or should his cotton suffer irreparably from the elements, he may wish to replant his lands with some crop late in the season, say December or January. Bearing these factors particularly in mind, the aim at Barberton has been to pick out strains of various crops capable of maturing in a fairly short time (three to four months).

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* A discussion by W. L. Fielding, B.Sc., Dip. Agric., in *The Empire Cotton Growing Review*, Vol. X, No. 2. April 1933, based on work carried out at the Cotton Breeding Station, Barberton, South Africa, on the question of suitable rotation crops for inclusion in a cropping scheme having cotton as the main cash crop.

The provision of home-grown food for native labour and cattle rations is an incentive to the growing of certain leguminous and cereal crops on a farm where cotton is the main crop.

Apart from home-consumption, the selling of produce both on interior and export markets is one of the most difficult problems to be faced. Crops yielding produce adapted to market requirements are naturally being selected, but prevailing low prices make the introduction of these into a farming scheme very slow work. Owing to market prejudice some crops possessing desirable agricultural characteristics are debarred from extensive use by the farmer. For instance, a bean which is suited to conditions and is high yielding may be considered on the small side for native consumption or for the canning trade, whilst a rather larger relative fetching a high price on that market may be a poor proposition for the farmer owing to low yielding potentiality or susceptibility to insect pests. The beans may be of equal actual feeding value and of similar taste, there being no real rhyme or reason for the market preference save conservatism or the appeal of a larger, perhaps coloured, bean to the eye.

An extensive range of crops have been tried on the Corporation's South African stations, including maize, soya beans, sunflower, groundnuts, sorghums, and a miscellaneous range of legumes having possibilities. Following are brief notes on the agricultural and economic value of some of these crops, the selection of the most useful strains, and the fitting of them into a farming scheme having cotton as the main cash crop.

MAIZE *(ZEA MAYS)*

"Mealies" have long been a standby in South African cropping schemes. The Union's main crop is grown on the Highveld, and whilst much progress has been made in the breeding of suitable varieties for these areas, little attention has been given to maize problems on the Middleveld and Lowveld, in which areas the main cotton belt lies. On the Highveld, varieties of the white flat type (*indentata*) predominate. These are long-period maizes (140 to 150 days), and if put in late on the Lowveld often produce a poor crop. It is probable that in the Barberton area maize will be grown rather for purposes of food for native labour and cattle than for export. The need is then for a white-grained maize suitable for grinding into "mealie meal", the standard native foodstuff, the selected variety being capable of maturing a satisfactory crop in a comparatively short period. Out of a large variety of maizes tried, a White Flint strain, which has been under observation at Barberton over three seasons, has so far seemed best suited to requirements. Last season it definitely proved its yield capabilities in a variety trial. White Flint produces a round white grain which crushes into a meal apparently very acceptable to the native palate. It belongs to the *indurata* group, which are of a shorter maturation period and more drought-resistant than those of the *indentata* group.

White Flint grain is of a lesser market value than grain of the large white flat type, such as is produced by Hickory King or Potchefstroom Pearl; these latter would probably be grown by a man out to farm maize as the principal crop. The main question, however, being that of rotation crops for the cotton-grower, who will give prior attention to his cotton (and in some cases tobacco), White Flint has been selected as

probably the most suitable all-round type for a cotton-grower wishing to plant maize after his cotton, with a fair chance of obtaining a reasonable crop for feeding his native labour, even in an adverse season. About two tons of White Flint seed have been supplied to farmers in the Barberton area. It is also being grown on the Corporation's stations in Swaziland and Natal.

A maize of possible use, should export produce be required, is a small red-grained, Peruvian type. Points in its favour are early maturity, high resistance to the "streak" virus disease which causes serious reduction in yield in very late-planted maize in this area, and its production of a grain well suited to United Kingdom markets.

SOYA BEANS *(GLYCINE MAX)*

The produce from this crop has great possibilities in the commercial world. The uses to which soya beans can be put include the manufacture of soft soaps, paints, linoleum, water-proofing liquid, toilet powder, enamels and waterproof goods. The residual "soya cake", after oil extraction, forms valuable cattle cake. Several firms in England and on the Continent are now producing soya products for human consumption, the basic soya flour for these edibles being prepared by the Berzcellar process.

A very large number of soya bean varieties from different parts of the world have been tested on the Corporation's South African stations. Several have shown good yielding capabilities, but only one has proved of real use as a grain producer. This is the Barberton Y 1 strain, producing a fairly large, bright yellow bean, and owing its superiority to a high degree of resistance to shattering of grain when ripe. Oil content is in the region of 18 per cent. The beans make an attractive sample in appearance and are likely to prove generally acceptable from the market point of view. South African produce of this type has recently been reported on very favourably in comparison with the Manchurian soya beans customarily tendered on United Kingdom markets.

The soya bean has one big advantage in that it is the only bean crop which is not liable to serious damage by the large Cantharides beetle. This pest will often destroy the majority of the flowers on bean crops with exposed flowering systems; the flowers of the soya bean are borne in the axils of the branches and apparently owing to this obscurity within the foliage of the plant never suffer seriously.

Experiments at Barberton are giving useful information on the best spacing at which to grow soya beans, and on the best time to plant. Although South African soils as a whole are not considered deficient in nitrogen, there is always the need for keeping up nitrogen content on continuously cropped lands. It is this function which the leguminous crop in any rotation is expected to effect. In order that the soya bean shall fulfil this purpose, it is essential that the bacterium specific to the soya plant be present in the soil, so that it may infect the root systems and, working in "symbiosis" with the plant, fix nitrogen from the soil, air and moisture. The soya bean bacterium is not indigenous, and cultures have been imported with which to inoculate crops. A method of inoculating on a field scale with soil cultures of bacteria by means of a fertilizer attachment mounted on the planting machine is being tried out. The

question of the influence of lime on the effectiveness of the bacteria and on the general growth and yield of soya beans is being investigated. An acid soil condition is known to be unfavourable to the bacteria, and it is a question of whether more satisfactory inoculation and thence nitrogen fixation would justify a farmer liming his lands.

The soya bean seem suited to Barberton area conditions and may prove a useful crop when produce markets recover. During 1932 there has been a sale of twenty-seven tons of Y 1 soya from various growers to an oil-extracting company on the Rand. The price was naturally a low one, based on current London quotations, but such beginnings might later lead to the provision of a definite interior market for soya beans.

SUNFLOWERS

Some work has been done on spacing and the selection of an early maturing, good yielding strain of this crop. Sunflower seed is saleable in the interior for poultry food purposes, is exported in small consignments to Australia, and can be utilized on the home farm as crushed meal in the concentrate ration for dairy cattle. It is fairly drought-resistant, apparently immune from any serious pest or disease in this district, and is easily handled.

GROUNDNUTS

Suitable varieties have been selected, but the crop does not appear to have great possibilities for the cotton-farmer in this area. In order to obtain a good return, it seems probable that the crop should be planted in October or November, owing to the subsequent serious incidence of "rosette" (virus) disease. This question is being further investigated in time-of-planting experiments, but a crop which required to be planted at the same time as cotton would be less useful than crops capable of later planting.

MISCELLANEOUS LEGUMES

A range of leguminous crops of suitable growth duration for fitting into a rotation with cotton are under observation. Apart from rotational value, they have varying uses, such as providing dried beans for home consumption as cattle food and native labour rations; for sale on interior and possibly overseas markets for native or European consumption; or the provision of a mass of foliage to be cut as cattle fodder or ploughed in as a green manure.

A small white bean, tepary (*Phaseolus acutifolius*), has proved the most prolific yielder in this class, and is well suited to requirements, maturing in two and a half to three months. Tepary bean is a native of Texas and Arizona, where it is reported an important crop. In the crushed form it should prove a useful component of concentrate rations for cattle. In the cooked form it appears acceptable to the South African native's palate. A gold-mine in the Barberton area feeds tepary beans to its native labour. Where labour gangs include a proportion of natives belonging to a non-meat-eating tribe, the question of supplying proteins by feeding a bean ration becomes of importance. Good germination of this bean can be obtained under only moderate moisture conditions, the crop being quite an easy one to handle throughout.

Various kinds of *Phaseolus lunatus* (Lima, Madagascar, or butter beans) are being tried. They seem to have possibilities planted toward the end of the rains, and are worthy of extensive trial as they command a far higher market price than many beans, on United Kingdom markets, for European consumption.

Certain beans of the *Phaseolus vulgare* group (speckled sugar beans, large kidney beans, etc.,), command good market prices, but so far have shown little promise of being more than odd crops in this area.

It has not been possible to do any definite work at Barberton on the effects of green manuring on ensuing cotton or maize crops, but sunnhemp (*Crotalaria juncea*) is probably about the most useful crop, sown broadcast and ploughed in at 2 to 3 feet high. It has an added advantage in that a group of bacteria capable of infecting the roots of sunnhemp are indigenous in the Barberton soil, so that besides acting as a green manure, the crop may be beneficial from the nitrogen point of view.

Types of velvet bean (*Mucuna*) have been found to produce a good crop for hay and green-fodder purposes.

POSSIBLE ROTATIONS

Two experiments have been laid down at Barberton this year in which cotton will follow cotton, soya bean, tepary bean, maize, sunflower and fallow respectively. The experiments are laid out as random blocks. The strains of crops used are those which seem most likely to prove the best standard lots, and it is intended that the trials shall be more or less permanent, so that studies of the growth of cotton after cotton itself, after one year fallow, and after the various rotation crops may be made. The preliminary stages in the work of ascertaining what crops can be grown, the best spacing at which to grow them etc., having been done, it is now for these rotation experiments to demonstrate the merits of the various crops.

TOBACCO

Tobacco is an important crop in the area, "Barberton snuff" being in demand by natives throughout the Union. Those farmers having good tobacco lands and sufficient irrigation water will probably adopt a simple tobacco-cotton-tobacco rotation. This is a specialized side of farming, however, and the Corporation's work on rotations has therefore been directed towards the finding of crops for wider areas, and for lands where tobacco will not normally be grown.

SUMMARY NOTE

It appears probable that maize and soya beans will prove useful standard crops; maize as a feed for native labour, and soya bean as a cash crop either on interior markets or, with more settled world conditions, for export. Beans suitable for native and cattle feed, or for the European dried bean market, may have places in the farming scheme, as also oil-producing crops (apart from soya bean), such as sunflower and groundnut, the former with the further possibility of immediate use as a cattle or poultry food, the latter for sale to natives locally. Farmers having a dairying business will need to include a certain amount of green fodder in their cropping scheme, and for the ordinary arable farmer the provision of pit silage, made from a broadcast crop of sorghums or maize, will prove useful for draught oxen when the dry season is a long one.