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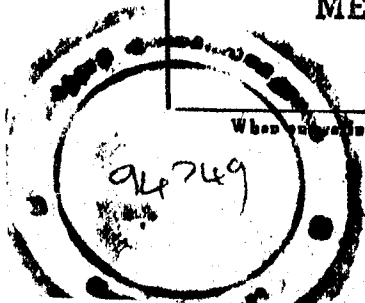
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Vol. XXXIII

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EDITORIAL

Need for Investigations on Tillage Questions of tillage have, from time to time, raised a large amount of controversy, as for example when Faulkner claimed that the traditional mouldboard plough is the least fitted implement for the production of crops. Dr. Keen has observed that "cultivation is the oldest section of the agricultural art, and the least understood branch of agricultural science". The numerous tillage implements and tillage practices that exist in the world have for the most part been evolved through generations of farmers by trial and error methods. For a long time even the agricultural scientist had taken these implements and methods without question with the result that compared to other branches of agricultural science data on tillage effects are meagre. There are still many agriculturists who feel that the deeper and more thorough the tillage, the greater is the benefit derived by the crop and the soil. The trend of results in modern scientific experiments is, however, to show that the benefits of cultivation have, in general, been over-emphasised.

Tillage experiments do not seem to have been undertaken very much prior to 1890. The first recorded are from America where rapid extension of farming to a wide range of soil and climatic conditions created a number of problems on soil cultivation. Sewell in 1919 reviewed the results thus far obtained, and concluded that shallow ploughing had given as great yields as deep ploughing, and that cultivation would be necessary only to kill weeds and to keep the soil in a receptive condition for the absorption of rainfall. He observed that the prevailing theories advocating deep ploughing and frequent cultivation were not based on experimental evidence. Tillage questions in America continued to receive a fair amount of attention, but for a considerable period the results obtained were ignored by workers in other countries where advanced agricultural investigations were in progress, for the reason that the soil and climatic conditions in these countries were different, and it was only about 1930 that a series of important investigations on soil cultivation and crop yields were started at Rothamsted in England. These investigations have corroborated the conclusions obtained by American workers. It has been shown at Rothamsted that deep ploughing had no more effect on yields than shallow ploughing, that double ploughings gave only an insignificant increase over single ploughing, and that the nature of the seed-bed itself had little influence on the final yields.

Experiments on the efficacy of soil mulches in conserving soil moisture have received early attention. The theory of capillary movement of moisture was supported by workers like King and Hilgard, and even in recent times, a few workers have reported the benefits of intercultivation in conserving soil moisture, as for example in the dry farming experiments in the Punjab. As early as 1915, however, Chilcott, Cole and Bur have, from a review of experiments, pointed out that provided vegetative growth is restricted, both mulched and unmulched surfaces lose the same amount of moisture. Numerous experiments on the intercultivation of crops conducted at Rothamsted show that cultivation above the minimum necessary to keep down the worst of the weeds give little improvement in crop yields and that a single hoeing done in the early stages of plant growth gave the maximum beneficial effect. Dr. Keen has shown that capillary movement in soils is operative only when the water table is within six feet of the soil surface and that most soils are capable of getting "self mulched". In an experiment on a well drained sandy loam at Surrey, England, Pareira in 1941 found that no moisture conservation was effected by a three inch soil mulch during dry weather when the water table lay within four feet from the surface.

There have not been many experiments on cultivation conducted on modern lines in India, apart perhaps from those relating to dry farming methods carried out during the last decade. Allen in 1935 reviewed the results of experiments on primary tillage made in several parts of this country and concluded that the inversion plough had no marked advantage over a good type of paring plough or over the country plough, except in the matter of eradicating perennial weeds or in the preparation of soil for garden crops. He observed that where soil is light, deep cultivation is rarely advisable, and that where it is heavy and in general unirrigated, increased depth and inversion showed little advantage. In the Madras Province experiments on the clayey soils at Koilpatti led to the conclusion that variations either in the depth of ploughing, time of ploughing or the kind of implement used failed to give significant differences in the final yields. In one set of trials in which ploughing was compared to no ploughing during four seasons, the ploughed plots did not yield more than the unploughed in any one of the years.

These evidences suggest that it may be possible to omit some, if not many of our traditional cultural operations without affecting crop yields or profits. Cultural expenses have risen to very high levels, and any reduction in the number of ploughings, depth of ploughing or the number of cultivations necessary for profitable crop production would materially benefit the cultivator. Research on tillage problems is still in its early stages and satisfactory generalisations that would apply to all soil and climatic conditions are not yet available. There is therefore an urgent need for extensive investigations in tillage practices, traditionally followed by the cultivator or actively advocated by the Department, in so far as they are not supported by facts and figures.

Observations on the Rainfall and Yield of Crops in the Dry Lands of the Hagari Research Station.

By P. KRISHNA RAO, L. Ag. Assoc. I. A. R. I.,

*Dry Farming Development Officer,
Agricultural Research Station, Hagari.*

The yields of crops are, in general, influenced by several factors like the fertility of the soil, the quantity of manure applied, the rainfall during the year, pests and diseases etc. Of these, the largest single factor that influences the yields of crops on the dry lands is the rainfall. In the black cotton soil tract of the Ceded Districts the limiting factor for crop production has always been the rainfall. The frequent failures of rains have resulted in frequent famines.

With a view to find out precisely the relation between the rainfall and the yield of the major crops of this tract sorghum (*jonna* or *cholam*) and cotton, an experiment has been laid out recently in 1943 in the Agricultural Research Station, Hagari, with a two course rotation of cotton and sorghum, making two treatments replicated four times. This is necessarily a long range experiment, which has to run for nearly 30 years to obtain precise data on the relationship of rainfall with crop yields. However, on a preliminary study of the rainfall, its distribution and the crop yields at the Station over the preceding 16 years, 1929 to 1944, a few interesting trends of sufficient definiteness and importance have been observed. Sixteen years is admittedly too short a period for precise statistical analysis, but as the trends were quite discernable they are described below:—

These black cotton soils are situated in a low rainfall area. The average rainfall at the Hagari Station is 20 inches. The variation in the total annual rainfall is very great ranging from 11.59 inches to 26.27 inches. The yields of crops have also varied considerably. The variations in the rainfall and in the yields of crops are given below:—

	Minimum.	Maximum.
Rainfall	11.59"	26.27"
Yield of Sorghum grain (in lbs) per acre	112	503
Yield of Sorghum straw (in lbs.) per acre	896	2021
Yield of cotton kapas (in lbs.) per acre	144	465

Actually, the maximum rainfall years have not given the maximum yields and all the low rainfall years have not given the lowest yields. The fact is that not only the total rainfall of the year but its distribution in the year is equally important. The rainfall during the 16 years, their distribution through the months, and the yields of crops of sorghum and cotton are chronologically given in Table I

From a study of the data it can be seen that certain rainfall distributions have been favourable for heavy crop yields while in other cases the yields have not been as high as expected even though the total rainfall for the year was high. With the object of finding out the best distribution of rainfall for producing good crops, the yields of crops have been classified into 3 groups (i) Yields above average, (ii) Average yields and (iii) Yields below average. The distributions of rainfall for each group are presented in Tables II and III for cotton and sorghum.

The soils are commonly known as "black cotton soils", 'black' from the colour of the soils and 'cotton' from the crop commonly raised on the soils. They are of the heavy type with a large clay content. Rain water does not soak into the soil quickly and so a great deal of rain water passes over the land without being absorbed. Under these conditions, only heavy and continuous rains can soak the soils to a sufficient depth, when they will be fit for sowing. It will be seen from the rainfall statements that continuous and heavy rains are received only during the short period of 4 months in the year, i. e., from July to October. This makes it impossible for crops to be sown in these lands earlier than September, and therefore these lands, the tract in which they are situated and the cropping are locally called *Hingari* (in Kanarese) or *Rabi* (in Hindusthani) which simply means late. Cotton is sown in September and sorghum in October. To suit the late rains and the heavy nature of the soils, the two main crops grown in this tract are also special to this tract. The cotton is known as "Westerns" cotton and the sorghum known as *bele jola* or *tella jonna* or white sorghum, one of a type that do not mature in the other parts of the presidency. From the two tables, the following trends are observable with regard to the relation between the distribution of rainfall and crop yields in the environment of this tract.

- (i) The rainfall in the period between the 4 months July to October has a great influence on the crop yields of cotton and sorghum.
- (ii) A total rainfall of about 10 to 12 inches in this period, the deficiency in any one month being made up in the other months, is sufficient to produce average crops, provided insect pests and diseases are not severe.
- (iii) Rainfall above this quantity during this period has given yields above average provided no pests and diseases damage the crops. Very good yields have been obtained, where the rainfall during this period is above 14 inches
- (iv) Cotton is sown in the month of September. If the rains are insufficient in September, or are delayed, the cotton yields become less than average, even though the total rain in the period July to October reaches up to 11 inches. Sorghum is sown in the month of October. Insufficient rains during October reduce crop yields

and if rains are prolonged into November and December they also reduce crop yields as in 1931-32, 1936-37 and 1941-42. Prolonged rainfall and cloudy weather in November and December, when the temperature is low, induce insect pests and diseases which lower the yields of *jonna*, while clear weather during these months checks diseases

- (v) By the middle of November in any year it will be possible to state what the yield of crops is likely to be during the year in conformity with the above indications. A famine year is easily seen at the middle of October itself, as in 1942-43.
- (vi) The variations in the yields of sorghum are greater than those of cotton, sorghum being more sensitive to rainfall conditions than cotton.
- (vii) The division of rainfall into S. W. monsoon rain and N. E. monsoon rain and fixing the definite period of these rains is not very helpful in the interpretation of rainfall data for this tract. Owing to its situation in the middle of the peninsula nearly equidistant from the east and west coasts, this tract received only the tail ends of both the monsoons which often merge into one another. It is difficult to keep separate account of the rain received from the two sources especially in the month of September, when often rains from both the directions are received on the same day. It has, therefore, been more convenient to take into consideration the month's rainfall as a unit and not to divide it to the South-west and North-east, as one monsoon runs into the other without apparent transition.

Summary. The black cotton soil tract of the Ceded Districts of Madras is situated in a low rainfall area (20 to 25 inches). The yields of the crops cotton and sorghum, are influenced much by the distribution of the rainfall in the year. The amount of rainfall received within the period of 4 months from July to October determines the nature of crop yields. 10 to 12 inches of rain during this period gives average crop yields, provided insect pests and diseases are not severe. They are higher or lower than the average according to the amount of total rainfall received during this period, irrespective of the total annual rainfall. By this standard it is possible to state during the middle of November in any year what the nature of crop yields would be, which will come to harvest only 4 or 5 months afterwards in March-April.

TABLE I.
Yields of Crops—Sorghum and Cotton and Rainfall data from 1929-30 to 1944-45.
At the Agricultural Research Station, Hagari—Madras.

S. No.	Season.	Yields of crops in pounds.				Rainfall in inches during												Total for the year January to December.
		Sorghum		Cotton	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Octo.	Nov.	Dec.		
		Grain lbs.	Straw lbs.	kapas lbs.														
1	1929-30	322	1318	270	-	0.36	-	2.18	2.09	0.04	0.06	0.17	11.91	2.91	1.23	0.31	21.26	
2.	1930-31	206	-	118	0.05	-	0.46	0.09	1.73	2.16	1.34	0.09	2.73	6.97	0.21	-	15.83	
3.	1931-32	112	1734	171	-	-	-	0.72	3.77	3.31	0.43	0.33	7.21	2.20	1.92	0.16	20.05	
4.	1932-33	273	1183	164	-	0.62	-	0.57	1.40	1.89	0.90	6.42	4.06	5.80	1.28	0.16	23.10	
5.	1933-34	265	896	233	-	0.18	0.07	0.43	2.22	0.34	2.18	10.48	5.85	2.67	1.08	0.77	26.27	
6.	1934-35	194	1120	164	-	-	-	1.81	1.19	2.20	5.21	0.36	0.17	2.27	1.62	-	14.83	
7.	1935-36	503	1240	272	0.16	-	0.02	1.41	0.21	5.03	4.21	3.58	3.06	4.08	0.29	-	22.05	
8.	1936-37	213	2021	166	-	0.90	0.73	0.03	2.75	1.38	0.79	1.01	7.50	3.27	6.20	-	24.56	
9.	1937-38	204	1234	174	-	0.48	0.57	2.66	0.58	0.23	1.05	0.62	7.14	2.35	0.05	-	15.73	
10.	1938-39	495	1035	465	-	0.37	0.41	0.40	2.64	0.64	1.30	9.28	7.72	0.11	-	-	22.87	
11.	1939-40	367	1580	223	-	-	-	0.35	0.26	1.97	2.14	5.82	2.77	7.62	0.37	-	21.30	
12.	1940-41	255	1561	144	-	-	-	2.14	7.32	1.31	0.99	1.78	2.41	4.99	0.91	0.19	22.04	
13.	1941-42	144	1436	194	-	0.23	-	0.84	1.46	0.94	0.52	1.98	6.53	2.37	-	1.36	16.23	
14.	1942-43	Famine year—No crop sown																
15.	1943-44	182	1125	190	0.37	-	0.29	-	1.80	0.35	5.24	0.23	1.43	0.87	0.31	1.06	0.01	
16.	1944-45	344	1266	298	-	-	0.17	0.37	1.90	3.70	1.87	0.67	5.16	8.13	1.46	-	23.43	

TABLE II.
Rainfall and yield of crops—Cotton.

S. No.	Season.	Yield of kapas per acre lbs.	Rainfall in inches during												Total for the year Jan. to Dec. inches.	Total rain in the period July-October (4 months) inches.
			Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Octo.	Nov.	Dec.		
I. Years in which the yields were above average.																
1.	1929-30	270	-	0.36	-	2.18	2.09	0.04	0.06	0.17	11.91	2.91	1.23	0.31	21.26	15.05
2.	1935-36	272	0.16	-	0.02	1.41	0.21	5.03	4.21	3.58	3.06	4.08	0.29	-	22.05	14.93
3.	1938-39	465	-	0.37	0.41	0.40	2.64	0.64	1.30	9.28	7.72	0.11	-	-	22.87	18.41
4.	1944-45	298	-	-	0.17	0.37	1.90	3.70	1.87	0.67	5.16	8.13	1.46	-	23.43	15.83
II. Years in which the yields were average (160 to 240 of lbs. Kapas per acre).																
1.	1931-32	171	-	-	-	0.72	3.77	3.31	0.43	0.33	7.21	2.20	1.92	0.16	20.05	10.17
2.	1932-33	164	-	0.62	-	0.57	1.40	1.89	0.90	6.42	4.06	5.80	1.28	0.16	23.10	17.18 *1
3.	1933-34	233	-	0.18	0.07	0.43	2.22	0.34	2.18	10.48	5.85	2.67	1.08	0.77	26.27	21.18 *2
4.	1934-35	164	-	-	-	1.81	1.19	2.20	5.21	0.36	3.17	2.27	1.62	-	14.83	11.01
5.	1936-37	166	-	0.90	0.73	0.03	2.75	1.38	0.79	1.01	7.50	3.27	6.20	-	24.56	12.57 *3
6.	1937-38	174	-	0.48	0.57	2.66	0.58	0.23	1.05	0.62	7.14	2.35	0.05	-	15.73	11.16
7.	1939-40	223	-	-	-	0.35	0.26	1.97	2.14	5.82	2.77	7.62	0.37	-	21.30	18.35
8.	1941-42	194	-	0.23	-	0.84	1.46	0.94	0.52	1.98	6.53	2.37	-	1.36	16.23	11.40
9.	1943-44	190	0.37	-	0.15	1.46	4.12	0.98	0.49	0.90	5.75	1.83	2.30	-	18.35	8.97
III. Years in which the yields were below average.																
1.	1930-31	118	0.05	-	0.46	0.09	1.73	2.16	1.34	0.09	2.73	6.97	0.21	-	15.83	11.13 *4
2.	1940-41	144	-	-	-	2.14	7.32	1.31	0.99	1.78	2.41	4.99	0.91	0.19	22.04	10.17 *5
3.	1942-43	No crop	-	0.29	-	1.80	0.35	5.24	0.23	1.43	0.87	0.31	1.06	0.01	11.59	2.84

REMARKS: *1. Crops affected by disease. *2. Crops affected by disease. *3. Heavy November rains seedling deaths.
*4. Rains too late for cotton. *5. Rains too late for cotton.

TABLE III.
Rainfall and yield of crops—Sorghum.

S. No.	Season.	Yield in lbs. per acre.		Rainfall in inches during												Total for the year (Jan. to Dec.).	Total rain during the period July to October (4 months).
		Grain.	Straw.	Jan.	Feb.	March	April	May	June	July	Aug.	Sep.	Octo.	Nov.	Dec.		
I. Years in which the yields were above average																	
1.	1929-30	322	1318	-	0.36	-	2.18	2.09	0.04	0.06	0.17	11.97	2.91	0.23	0.31	21.26	15.05
2.	1935-36	503	1240	0.16	-	0.02	1.41	0.21	5.03	4.21	3.58	3.06	4.08	0.29	-	22.45	14.93
3.	1938-39	495	1035	-	0.37	0.41	0.40	2.64	0.64	1.30	9.28	7.72	0.11	-	-	22.87	18.41
4.	1939-40	367	1580	-	-	-	0.35	0.26	1.97	2.14	5.82	2.77	7.62	0.37	-	21.30	18.35
5.	1944-45	344	1266	-	-	0.17	0.37	1.90	3.70	1.87	0.67	5.16	8.13	1.46	-	23.43	15.83
II. Years of average yields (200 to 300 lbs. of grain per acre).																	
1.	1930-31	206	-	0.05	-	0.46	0.09	1.73	2.16	1.34	6.09	2.73	6.97	0.21	-	15.83	11.13
2.	1932-33	273	1183	-	0.62	-	0.57	1.40	1.89	0.90	6.42	4.06	5.80	1.28	0.16	23.10	17.18 *1
3.	1933-34	265	896	-	0.18	0.07	0.43	2.22	0.34	2.18	10.48	5.85	2.65	1.08	0.77	26.27	21.18 *2
4.	1936-37	213	2021	-	0.90	0.73	0.03	2.75	1.38	0.79	1.01	7.50	3.27	6.20	-	24.56	12.57
5.	1937-38	204	1234	-	0.48	0.57	2.66	0.58	0.23	1.05	0.62	7.14	2.35	0.05	-	15.73	11.16
6.	1940-41	255	1561	-	-	-	2.14	7.32	1.31	0.99	1.78	2.41	4.99	0.91	0.19	22.04	10.17
III. Years in which the yields were below average.																	
1.	1931-32	112	1734	-	-	-	0.72	3.77	3.31	0.43	0.33	7.21	2.20	1.92	0.16	20.05	10.17 *3
2.	1934-35	194	1129	-	-	-	1.81	1.19	2.20	5.21	0.36	0.17	2.27	1.62	-	14.83	11.01
3.	1941-42	144	1436	-	0.23	-	0.84	1.46	0.94	0.52	1.98	6.53	2.37	-	1.36	16.23	11.40 *4
4.	1942-43	No crop	-	-	0.29	-	1.80	0.35	5.24	0.23	1.43	0.87	0.31	1.06	0.01	11.59	2.84
5.	1943-44	182	1125	0.37	-	0.15	1.46	4.12	0.98	0.49	0.90	5.75	1.83	2.30	-	18.35	8.97
REMARKS: *1. Crop affected by disease. *2. Crop affected by disease. *3. Insect attack. *4. Insect attack.																	

REMARKS: *1. Crop affected by disease. *2. Crop affected by disease. *3. Insect attack. *4. Insect attack.

Cattle Wealth of Mysore and its Development.

By M. KRISHNA SASURI, B.A., I.D.D., Assoc. I.D.R.I.,

Imperial Dairy Research Institute, Bangalore. 38

SYNOPSIS Background of livestock rearing—Grazing facilities and fodder resources—Review of livestock figures for the past fifty years—Veterinary and Animal Husbandry welfare work—whether Bullocks are sufficient for cultivation in Mysore—What number of cows would suffice to rear a pair of working bullocks—Estimate of the annual monetary value of cattle and its products—The production of milk and milk products and the *per capita* consumption in Mysore—the breeds of Mysore cattle and their improvement—Policy of breeding Mysore cattle in relation to higher milk production.

1. Background for Livestock rearing. (From the standpoint of economic and occupational means of living). It has been estimated that 76 per cent of the population of Mysore depend on the "exploitation of animals and vegetation". Pasture and Agriculture form the principal or subsidiary means of livelihood of large classes of population. According to the Census Report of Mysore, 1941, in Mysore there are 11,000 professional cattle breeders and 14,500 shepherds. Cattle and sheep rearing is an important subsidiary occupation for the efficient cultivation of land. Mysore has been an important source of supply of a large number of plough cattle to the neighbouring provinces of Madras, Bombay, Hyderabad and Coorg. Although there are no accurate statistics of cattle exported from the country, the number should be very considerable. Besides, over one hundred cattle fairs are annually held in the Mysore State, which are visited by purchasers from all over the State and outsiders. The density of livestock population is estimated to be 79 cattle and buffaloes and 75 sheep and goats per 100 acres of cultivated land, which indicates that Mysore is predominantly a country for rearing livestock. Mysore is also a wool-producing and manufacturing centre in India, the output of wool being about 27 lakhs of pounds of wool per annum or 3 per cent of India's total annual wool production. Mysore also contributes 11 per cent of total Indian export of skins of sheep and goats.

The climate is generally mild, without extremes, and is conducive to stock-breeding. The average rainfall is well distributed with an average of 25—30 inches in the *maidan* tracts and about 60 inches in the *semi-malnad* tracts. The whole state is benefitted by the south-west and north-east monsoons from May to November. The predominant type of soils in Mysore is red loam, deep and uniform in character, easy for good cultivation. The black cotton soils are met with in large stretches in certain parts of the State. All the soil types are generally low in nitrogen and phosphoric acid but rich in potash, lime and iron favourable to stock-raising.

2. Grazing facilities and fodder resources. The adequacy of fodder resources and pasture lands in relation to livestock numbers is essential for

economic stock breeding and agricultural development. The main fodder resources of cattle comprise of (1) straw from cultivated crops that is, cereals, pulses and green fodder crops which is estimated to be about 1.59 tons per head of cattle per annum, based on the normal standard crop in Mysore, which is insufficient, (2) natural grazing facilities to meet the deficit cultivated crops (i) forest grazing and pastures, (ii) current fallow lands, (iii) *Gomal* and *Hulbani* pastures.

Forest grazing has its natural limitations to meet the requirements of the vast numbers of cattle of Mysore and about 5.8 per cent of cattle have access to forest grazing of 1.82 lakhs of acres. Therefore forest grazing is comparatively unimportant in the matter of providing adequate fodder. Out of the Amrithmahal Kaval lands of 2.09 lakhs of acres, only 0.65 lakh acres used to be given for grazing under the *terige* system and the remaining is reserved for Government Amrithmahal herds. But recently, a large percentage of these Kaval lands was granted for cultivation purposes.

Out of this area of 78.6 lakhs acres of land under occupancy in Mysore, nearly 25 per cent, i. e., 15.4 lakhs of acres is fallow, which is a source of grazing to cattle, providing about 0.3 acre *per capita*. This land being under the control of the owners with restricted control provides somewhat better pasture than the common village *gomal*.

The *gomal* and *hulbani* pasture lands, to the extent of 35 lakhs of acres in the State, provide a poor type of general pasture of about 0.7 acre *per capita* of cattle population excluding sheep and goats. They are over-grazed and no grass is ever conserved. Being common property it is under no man's care and as such there is little inducement to improve the productive capacity of these lands. The improvement of the *gomal* land has been the subject of Government's anxious consideration, in connection with the fodder and grass problem. Concessions to grow Napier grass, sunflower, fodder *jola* and other crops have been offered. It has also been demonstrated by experiments at the Government farm, Hebbal, that pasture and fallow land could be improved by growing cultivated grasses like Dry Napier grass. The seedlings of this grass, once transplanted on ploughed land, continue to yield good grass for a number of years with little care. The Department of Agriculture can supply large quantity of seed. Progress can be expected if large number of people realise the advantages and follow the new methods with determination.

Briefly, the estimated output and requirements of fodder in Mysore are noted below:

1. Cattle and Buffalo population
(excluding sheep and goats) ... 50 lakhs.
2. Estimated annual output of cultivated fodder crops 78 lakhs tons.
3. Estimated annual requirement of fodder for
cattle and buffalo ... 140 lakhs tons.
4. Estimated annual deficit to be made up
from natural resources ... 62 lakhs tons.

The general cry for more pasture lands will not solve the problem of fodder. Let us have "Less of the free and uncertain yielding free-pasture land; and more of fodder crops' cultivation" which alone can remove fodder scarcity. It is not only the raising of fodder crops, but the proper conservation of the available fodders in the form of silage and hay during the seasons of plenty, for use as reserve in the seasons of drought or scarcity, that should be attended to.

3. Review of the livestock numbers in Mysore and their increase during half a century. According to the cattle census of 1940-41, there are 7.31 lakhs of cows and 4.70 lakhs of buffalo cows, over three years of age kept for breeding. The breeding bulls maintained, work out to one cow bull for every 50 cows and one buffalo bull for every 60 buffalo-cows. Out of 15,300 cow bulls at stud 14.5 per cent are approved bulls maintained by Government and local bodies. The increase of the standard type of stud bulls in large numbers under controlled breeding operations is the policy for improving and building up better strains of livestock.

The following table shows the increase of livestock in Mysore for a period of nearly fifty years from 1894-95 to 1940-41.

Year.	Cattle (Adults only).	Buffaloes (Adults only).	Sheep.	Goats.
1894-95	2,807,699	480,052	1,753,614	888,844
1940-41	3,057,877	594,899	3,056,813	1,724,810
Increase for 50 years	+8.6%	+23.9%	+42.6%	+193.8%
Average increase for Nine Quinquenniums	+0.96%	+2.66%	+4.73%	+21.53%

Reviewing the cattle censuses of the past fifty years (1890-1940) the following significant points may be noticed:—

Cattle. In 1920-21, the cattle strength of Mysore reached the peak, having increased by 17.9% as compared with the figures of 1894-95. But since 1920-21, the cattle strength has steadily gone down by 3.3%.

Buffaloes. In 1920-21, the number of buffaloes also reached the maximum, having increased by 39.1% as compared with the strength of 1894-95. Since 1920-21, the buffaloes have decreased by 15.2%.

Sheep. The strength of sheep in Mysore reached the top point in 1915-16 having increased by 43.2% from 1894-95. From 1920-21 up to 1935-36, it steadily decreased by 15.5%. But in 1940-41, it had slightly increased by 0.6% only.

Goats. The goat population of the State, however, more than doubled itself in 1915-16 having increased by 206.6% as compared with the figures of 1894-95. But since 1915-16, it has steadily decreased by 12.8%.

It is, however, noticed that during the last twenty years, there has been a continuous decline in all classes of livestock in Mysore. The increase in cattle by an average of only 0.96% per quinquennium is very slight. The

human population in Mysore during the last twenty years increased nearly by 75% while the cattle increased only by 8.6% and the cropping by 37%. The milch buffalo receives better care and treatment as is evident from the figures of increase. Buffaloes have increased thrice as compared with cattle during the past half a century. Goats, in spite of neglect, have multiplied rapidly in Mysore.

4. Veterinary and animal husbandry welfare in Mysore. The veterinary service in Mysore has developed rapidly, due to the keen and forward policy of the Government. At present there are ninety veterinary dispensaries, spread all over the State. Each dispensary renders veterinary aid to the tune of nearly 55,000 head of cattle and buffaloes; i. e. about 6.6% of bovines receive actual treatment; while in India as a whole there is one veterinary dispensary for every 1,80,000 head of cattle and buffaloes, i. e. about 3% of bovines receive veterinary aid.

India, on an average, spends 6.2 pies per head of cattle and buffaloes per annum on matters relating to animal husbandry and cattle welfare work. Mysore is spending 15 pies per head of cattle and buffaloes per annum while the Punjab spends 10 pies; Madras 1.8 pies and Bombay 4.7 pies.

5. Whether bullocks are sufficient for efficient cultivation in Mysore. What number of cows would suffice to rear a pair of working bullocks? In Mysore, there is about one pair of bullocks for every 12 acres of land under cultivation, which is insufficient for efficient agriculture. The cropped area in Mysore is 63 lakhs acres, and the culturable occupied fallow land is 15 lakhs acres, which has to be brought under cultivation of crops to meet the increased demand of deficit food crops; for food crop growing has not kept pace with the population growth, which has necessitated large imports of food grains. About 9.7 lakhs pairs of bullocks are needed for normal and efficient agricultural operations; the state is now short by 3.4 lakh pairs of bullocks, that is 35% of normal requirement of bullock power.

Then, what is the number of cows needed to rear a pair of working bullocks? This is not an easy problem, but it could be estimated for practical purposes. Considering the average working life of bullocks as ten years, and that they begin to work at the age of $3\frac{1}{2}$ to 4 years, about 17 are to be replaced annually; it should be remembered that there are barren cows and unproductive cows. The calving interval is about $2\frac{1}{2}$ —3 years. The heifers mature late. Among cows or females of breeding age, one in every four animals calves. On the basis of the cattle census figures of 1940 in Mysore, it can be approximately calculated that a pair of working bullocks is produced for every ten cows actually calved. Twenty-six female animals, over three years of age kept for breeding, produce a pair of working bullocks. Further, the number of female calves below three years of age, as compared with cows, is five times the number of cows. These features give a striking impression of the general unsatisfactory management, feeding and care of the young stock and the dry cows. For a larger number of

efficient bullocks to be produced, as well as for the improvement of milk yield of cows, the dry cows should be well fed so to reduce the dry period and induce frequency of calving and the young stock at all stages should be cared for and fed so as to induce early maturity and quick breeding. The unproductive period should be reduced to get a better economic return from cattle.

6. Estimate of annual monetary value of cattle and its products in Mysore. The approximate total monetary value of cattle and its products per annum may be assessed at Rs. 22.2 crores on the basis of pre-war rates:

	Rs.
1. Cattle labour in agriculture ...	1147.50 Lakhs.
2. Cattle labour for purposes other than agriculture ...	229.50 "
3. Milk and milk products ...	375.63 "
4. Value of young stock born and surviving ...	66.00 "
5. Manure ...	298.50 "
6. Other products ...	103.00 "

Total Rs. 2220.13 lakhs
(or 22.2 crores).

7. Production of milk and milk products in Mysore and per capita consumption. There are three milch cows for every milch buffalo in Mysore. But out of the total annual production of 80.8 lakhs maunds of milk, 52 per cent is produced by cows and 48 per cent by buffaloes. This indicates that the buffaloes are better fed and cared for than the cows, and the buffalo is three times more efficient as a milk producer. The cow really deserves more attention. The State also produces 7.53 lakhs maunds of goats' milk for consumption.

Out of 88.33 lakhs maunds of milk produced per annum 20.1 per cent is consumed as fluid milk, and 79.9 per cent is converted into products. Out of the products manufactured from milk, ghee constitutes 36.4 per cent, butter 21.6 per cent, curd 19.0 per cent and *khova* 2.9 per cent. The total value of milk and milk products produced and utilised per annum amounts to Rs. 375.63 lakhs.

The per capita consumption of milk and milk products expressed in terms of fluid milk works out to 4.4 ozs. per day, of which 0.9 ozs. is consumed as fluid milk and 3.5 ozs. in the form of products such as curd, ghee, butter and *khova*. The per capita consumption of milk and milk products in Mysore is below the average for India which is estimated at 6 ozs. which itself is only one-third of the normal nutritional standard advocated. To keep up the normal health of the population of Mysore, the consumption or production of milk should be increased four times.

8. The breeds of Mysore Cattle and their improvement. The Hallikar and Amrithmahal are the two basic breeds of cattle in Mysore.

They have same common features but are different in respect of breeding and certain other characteristics.

In 1572-1600 A. D., i.e. nearly 400 years ago, the Vijayanagar Viceroy at Seringapatam imported superior cattle from Vijayanagar and these cattle with the cattle of the Gollars or Hallikars who migrated from time to time from the north and settled down in Mysore, attracted by its salubrious climate and extensive rich pastures, formed the nucleus of Amrithmahal cattle establishment, which continued under the royal patronage of the rulers of Mysore. The Amrithmahal cattle remained the property of Government admitted as a separate department from 1627-1704 for army requirements. Since then it has undergone changes along with the political history of Mysore. But the Hallikar cattle was in a purer state, under different environment, and bred by certain private breeders in some parts of the State. Even now, the Hallikar breed is found well established and less intermixed, as a domestic and popular breed, with certain breeders who have carefully maintained the purity of the strain. The two breeds, Hallikar and Amrithmahal form the basis of all the improved types of cattle found throughout the State.

In the breeding policy adopted for the rearing of Amrithmahal cattle milk has never been the object. It is found that under proper care and feeding the Amrithmahal cows can rear their calves and give surplus milk for the use of the owner; but it is mainly a draught breed to produce excellent bullocks. It is distinct as a draught type, hardy in constitution and disease resistance. They are active and fiery and are fast walkers. They constitute a distinct species and it is stated that they possess the "same superiority over other bullocks in every valuable quality as Arabs do over other horses".

The Hallikar cows may be classed as the local milk breed of Mysore. They have been bred under domesticated conditions for a long time and are more amenable to handling than the Amrithmahals. The Hallikar cows have compact udders hard and well placed teats and the tendency for milk flow is greater than in the Amrithmahals. The milk is very rich in butterfat and is characteristically yellow in colour, indicating richness of carotene. The Hallikar Bullocks are as efficient workers as the Amrithmahals and they are very popular, commanding good prices in the cattle markets of Mysore. The highly prepotent characteristics of the Hallikar breed indicates its qualities of purity and superiority.

The Mysore Amrithmahal Department is probably the largest Government owned cattle-breeding establishment, maintained by any Government. (The history of Amrithmahal cattle reveals its fortunes in relation with the political history of Mysore.) The State is fortunate in owning the nucleus of this finest specimen of the best draught breeds of the world's cattle, famous in the military campaigns of Southern India and abroad.

Chikka Devaraja Wodeyar (1672-1704) reorganised the Amrithmahal cattle department under Government administration, selecting the typical

animals. He designated the cattle department as "Benne Chawadi" meaning a combined cattle breeding and dairy establishment to supply draught animals and also milk and butter. Vast and rich pasture lands, known as *Kavals*, were assigned to them in different parts of the State. Branding of animals was introduced to identify Government cattle, with the brand mark *De*. Several other progressive methods of cattle development were introduced.

Hyder Ali and Tippu Sultan (1704-1800) later on increased the strength of cattle and improved their qualities with the object of securing superior artillery and pack bullocks for their battles. Tippu Sultan, in particular developed the strength of the Amrithmahal herds and systematised the department with the title "Amrithmahal Department" for the first time. The system of management of Amrithmahal cattle introduced by Tippu Sultan more or less continues on similar lines to-day. Tippu Sultan was so interested in the breeding and development of Amrithmahal cattle that he attended personally the annual musters, to distribute the rewards for the best animals and well managed herds. The peak of progress of Amrithmahal cattle was reached at this time and it may be said that Tippu Sultan perfected the organisation of Amrithmahal Department that was previously inaugurated by Chikka Deva Raja Wodeyar and considerably developed by Hyder Ali.

After the fall of Seringapatam (1800) the British Government owned the Amrithmahal herds. In 1840, the Amrithmahal cattle herds and grazing lands were handed over to the Mysore Commission. But in 1860, the Amrithmahal establishment was broken up out of false sense of economy. The herds were sold and the best animals were taken away to Egypt. This step was very detrimental to the progress of the Amrithmahal breed and affected its valuable service to the people of Mysore.

His Highness Sri Mummadi Krishnaraja Wodeyar Bahadur re-established the Amrithmahal Department in 1866 to preserve this valuable breed. He collected all the available good animals in Mysore, to the extent of 4000 cows and 100 breeding bulls and they were again resumed by the Madras Government. In 1882 the Government of His Highness the Maharaja of Mysore purchased the Amrithmahal cattle numbering 12,500. Since that period regular stud bulls of herds, births, deaths and other records and arrangements to muster cattle by name and brand have been maintained under Government control.

The Amrithmahal Department was a quasi-military institution for some years, by virtue of its origin and purpose. As the Military transport services were greatly mechanised, the activities of the Amrithmahal Department decreased. Finally in 1920, the Department was affiliated to the Mysore Agricultural Department with the object of supplying good cattle to the needs of the ryots of Mysore. The Amrithmahal stock which survived declined in quality as a result of several changes and methods of handling.

The re-orientation in breeding practice is necessary to restore the breed to its original level of excellence and efficiency, combined with quick breeding qualities and general utility. The Government of Mysore are generously active in devising ways and means for improving the cattle wealth of Mysore.

Accordingly, several cattle breeding stations in the State have been opened to rear the Amrithmahal cattle on modern lines to facilitate the supply of suitable stud bulls for grading up the village cattle in the State.

As already stated, the Hallikar breed exists as a typical species of Mysore cattle in certain tracts. Even pedigree strains, i. e. those which breed true to type and as carefully maintained without admixture of foreign blood by certain classes of professional Hallikar breeders—are still available. Such tracts may be defined as unit areas for pedigree registration of Hallikar cattle on lines similar to the other important breeds of cattle in other parts of India. This would establish the breed and the breeders on better-founded status as well as by the foundation for rapid expansion and control of breeding operations on an intensive scale and also ensure equitable prices for valuable Hallikar stock.

9. Policy of breeding Mysore Cattle in relation to higher milk production. The Hallikar and Amrithmahal cattle are predominantly draught types. The Hallikar cows have shown better capacity to higher milk yields than the Amrithmahal cows, under conditions of good feeding, care and management. The quantity of milk produced by the cows kept by the average ryot is not sufficient to provide an adequate supply of milk for his household. This is because the natural milking qualities of these cattle have been neglected for a long time. They received too little attention in feeding, care or selective breeding to maintain the level of efficiency; and exhibit their natural or latent potentialities. It has been proved that Indian cattle, under conditions of good feeding and care, let alone breeding, can yield about 60 per cent more milk as compared with their present treatment under village conditions. More milk at lower prices is badly needed in our towns and villages. But the first need of the ryot is the bullock. In the policy of breeding Mysore cattle for draught purpose, more milk yield to the extent of a surplus of 1,500 pounds of milk in a lactation, after feeding the calf well, can be looked for, without any apprehension of the sacrifice of the draught qualities of our breeds. As far as the duality of purpose is concerned—i. e. the combination of the draught and milking qualities—it is within the natural limits of function in our cattle.

Since Mysore has a traditional good market for bullocks and our people need more milk and milk products, general utility animals of the above mentioned standard, from the standpoint of both draught and milk requirements, can be bred by our breeders out of the existing breeds of Mysore cattle, with improved practices of feeding and selective breeding.

The Vegetation of Ananthagiri.*

Ananthagiri, a hill of about 3,000 feet in height is a very useful and interesting place to a botanist. The several plants and species, as a whole the type of flora, is quite different from what we find round about Madras and further southwards.

Up to 500 feet the common plants are several Compositae, Umbelliferae, the prominent *Combretum* bushes etc. Along the road-side are seen the cultivated *Guizotia abyssinica*, the seeds of which are economically important for yielding a kind of oil, the economically important Solanaceous plant *Nicotiana* and several other crops.

From 500 feet upwards the flora has changed into the wild type. The striking feature is the huge bamboo trees with their gigantic inflorescences hanging up to the road thus troubling the travellers slightly. The common plants on the way are *Kydia*, *Bauhinia*, *Trema* and many Papilionaceous creepers.

On the way to Galikonda, a place 5 miles off from the bungalow, many interesting plants are seen. The vegetation is rather thick, but for a few open tracts of land here and there, which are characterised by dry grass and by the ornamental garden Compositae *Zinnia*, that has grown wild. The wild *Phyllanthus* and *Acacia* shrubs guard the roads while the *Naravella* bushes with their ripened fruits present a beautiful scene to look at.

Many Labiateae like *Pogostemon* and *Plectranthus*, Acanthaceae like *Strobilanthes*, Rubiaceae like *Oldenlandia*, Compositae like *Vicoa*, *Bidens*, *Vernonia* and *Anaphalis* formed both the herbaceous and shrubby vegetation of the place.

At places where a small stream may be running through steep rocks of the hills interesting ferns are collected besides *Spirogyra*, *Zygnema*, some Desmids, liverworts and mosses. At one particular place in the cool valley are seen the following ferns and bryophytes.

A big *Alsophila* tree, *Goniopteris* with its dimorphic leaves, *Nephrodium*, *Lastrea* of one variety and *Pteris aquilina*. In addition, beautiful green patches of mosses with capsules are found on the surfaces of the rocks. One kind of *Selaginella* and a big mass of liverworts are also collected.

From this place onwards the major portion of the hillside is covered over by a typical type of *Lastrea* with big well-marked sori, being protected by the bean-shaped indusium on the under surface of the leaf.

Most of the cool shady places greet any botanist with their beautiful ferns like *Davallia*, *Asplenium*, dimorphic type of *Lastrea* and *Alsophila*. Among the angiosperms the interesting plants are of the Ranunculaceae like *Naravella* and *Climatis* and the parasitic *Loranthus*, *Rubus*, *Mallotus*,

* From among the manuscripts with the late Prof. T. Ekambaram, M.A., Ph.D. Published at the instance of the Director of Agriculture, Madras, as the Department is now interested in the Araku Valley (Vizagapatam).

three or four species of *Desmodium*, *Menispermaceae* creepers and many *Acanthaceae* plants. The wild *Mangifera* with more than one terminal bud also attract the attention of the passer by.

On the way to Bora caves almost the same type of flora is seen except for a few additions like *Swertia* of *Gentianaceae*, *Ardisia* of *Myrsinaceae* and the sticky *Compositae* called *Siegesbeckia*. The remarkable plant that we collected here is the insect-like red fruits of *Zingiberaceae*. The same *Acanthaceae*, *Labiatae* and *Rubiaceae* plants are repeated. *Bauhinia* forms a beautiful creeper with some of the cut-ends of the stems hanging freely so that the anomalous nature of the stem is made out to a certain extent by examining the cut-ends. Some of the orange and other citrus trees with their fruits present a pleasant scene to the travellers, especially thirsty people. Here too, many cultivated crops like *Cajanus*, *Guizotia* are seen. Another interesting plant for which Ananthagiri is famous is the *Balanophora*—a root parasite. Near and round about the Bora caves the same kind of plants are seen. On the whole Ananthagiri is a good place for ferns as well as Angiosperms.

Flora of Mahendragiri.

The majority of plants are the same as those of Ananthagiri. The flora is varying from the foot of the hills to the bungalow at the top. At half way comes a definite change in the vegetation. The first part, i. e., up to 1,500 feet the flora resembles more that of the plains and is characterised by the creepers, shrubs and a few trees scattered here and there. Many barren lands are also seen with cultivated crops here and there.

Among the creepers the prominent are the *Dioscorea* species with big as well as small leaves and also some *Menispermaceae* plants, *Combretum* and one *Lythraceae* shrub with red flowers are also common. The trees are mostly *Semicarpus* and *Terminalia* species.

The second part of the hill is characterised by thick vegetation. The big trees *Kydia*, *Dillenia*, *Terminalia*, occasionally wild *Mangifera*, *Anacardium* and also some *Sterculiaceae* trees occupy the sides. At one place for about 50 yards *Kydia* trees are common.

Many *Acanthaceae*, *Labiatae*, *Compositae*, and to some extent *Rubiaceae* plants formed the shrubs of the place. Especially the undergrowth variety of *Strobilanthus* blocked the side paths. As we go higher up we find *Pittosporum*, *Meliaceae* trees *Celastrus*, *Gymnosporia*, *Clematis* with big white flowers and *Osyris* to be common. Still more higher up we find the big trees like *Garcinia* and wild *Mangifera*. From this height of 3,000 feet up to the bungalow, a small herbaceous plant with prominent yellow flowers presents a good sight and attracts the botanically interested person more.

The northern side of the bungalow is characterised by the same type of vegetation. But most of the parts are dry with a few cool, shady places formed by the big trees like *Garcinia*, *Mangifera*, *Pittosporum*, *Terminalia* *Flacourtia* and some thorny *Zizyphus* shrubs as well as *Dioscoriaceae*

shrubs *Polygonum*, *Thalictrum*, and *Triumfetta* along with some grasses occupied the dry parts and troubled the travellers to some extent. At one cool shady place *Gnetum*, a gymnosperm is found bearing the cones. At another such place, the leaves of all the small trees are covered with a sticky viscous material, the cause and source being not known. But it can be explained that some insects attract honey from some of the big trees and as the insects die, they drop the honey down. Most of the leaves are covered with abundant *Flacourtia* and *Terminalia* flowers.

At a height of about 2,500 feet on the hill there is a cultivated garden of peaches, wild roses and oranges. At a good distance from this spot, there is a big marshy place where some mosses, *Botrydium* and also algae are collected. Quite near to this place there is a cool place with a small pool of water where two ferns, *Polystichum* and *Lastrea* are collected. In this pool *Spirogyra* and *Zygnema* in conjugation stages are also collected.

On the whole Mahendragiri has not got many ferns except the common *Pteris aciculina* all over and also the dried up *Adiantum*. The above two *Lastrea* and *Polystichum* are very rare.

It is a very good place for angiosperms. With all its varieties of *Bauhinia*, *Terminalia*, and *Semicarpus* trees, the place looks very promising.

Ananthagiri Plants.

- | | |
|---------------------------------|--------------------------------|
| 1. <i>Compositae</i> | 8. <i>Caesalpiniaceae</i> |
| i) <i>Laggera alata</i> | i) <i>Bauhinia</i> . |
| ii) <i>Zinnia</i> | 9. <i>Urticaceae</i> |
| iii) <i>Bidens</i> | i) <i>Trema orientalis</i> . |
| iv) <i>Vernonia</i> | 10. <i>Meliaceae</i> |
| v) <i>Vicou</i> | i) <i>Cipadessa</i> . |
| vi) <i>Siegesbeckia</i> . | 11. <i>Euphorbiaceae</i> |
| 2. <i>Labiatae</i> | i) <i>Sarcococca trinervia</i> |
| i) <i>Pogostemon</i> | ii) <i>Malotus</i> . |
| ii) <i>Lavandula</i> | 12. <i>Bixineae</i> |
| iii) <i>Plectranthus</i> | i) <i>Flacourtia</i> . |
| iv) <i>Leucas</i> | 13. <i>Ebenaceae</i> |
| v) <i>Leonotis</i> . | i) <i>Dioscoria</i> . |
| 3. <i>Rubiaceae</i> | 14. <i>Sterculiaceae</i> |
| i) <i>Oldenlandia</i> | i) <i>Kydia calycina</i> . |
| ii) <i>Coffea</i> . | 15. <i>Hypericineae</i> |
| 4. <i>Ranunculaceae</i> | i) <i>Hypericum</i> . |
| i) <i>Naravalia</i> | |
| ii) <i>Clematis</i> . | |
| 5. <i>Rosaceae</i> | |
| i) <i>Rubus</i> . | |
| 6. <i>Papilionaceae</i> | |
| i) <i>Crotalaria albida</i> | |
| ii) <i>Flemingia Grahamiana</i> | |
| iii) <i>Dumasia</i> | |
| iv) <i>Desmodium</i> . | |
| 7. <i>Acanthaceae</i> | |
| i) <i>Acystasia</i> | |
| ii) <i>Strobilanthus</i> . | |

Ferns.

- | | |
|---------------------------------|-----------------------------|
| 1. <i>Lastrea</i> —two species. | 8. Walking fern. |
| 2. <i>Davallia</i> . | 9. <i>Pteris aquilina</i> . |
| 3. <i>Asplenium</i> . | 10. <i>Pteris</i> sp. |
| 4. <i>Adiantum</i> . | 11. <i>Blachnum</i> . |
| 5. <i>Nephrodium</i> . | 12. <i>Hemionites</i> . |
| 6. <i>Goniopteris</i> . | |
| 7. <i>Alsophila</i> | |

Gymnosperms.

1. *Gnetum*.

Mahendragiri Plants.

- | | |
|--|---|
| 1. Ranunculaceae | 2. Rubiaceae |
| i) <i>Clematis</i> | i) <i>Rubia cordifolia</i> |
| ii) <i>Thalictrum</i> . | ii) <i>Swertia</i> . |
| 1. <i>Polygonum</i> —Polygonaceae. | 9. <i>Embalia</i> —Myrsinaceae. |
| 2. <i>Gymnosporia</i> —Celastrinaceae. | 10. <i>Pittosporum</i> —Pittosporaceae. |
| 3. <i>Viola</i> —Violaceae. | 11. <i>Peperomia</i> —Piperaceae. |
| 4. <i>Osyris</i> —Santalaceae. | 12. <i>Rubus</i> —Rosaceae. |
| 5. <i>Anaphalis</i> —Compositae. | |
| 6. <i>Justicia</i> —Acanthaceae. | |
| 7. <i>Ardisia</i> —Myrsinaceae. | |
| 8. <i>Thunbergia</i> —Acanthaceae. | |
-
- | | |
|-------------------------|---------------------------|
| Ferns. | |
| 1. <i>Polystichum</i> . | 4. <i>Plasobellis</i> . |
| 2. <i>Lastrea</i> . | 5. <i>Pteris aquilina</i> |
| 3. <i>Adiantum</i> | |

SELECTED ARTICLE

Breeding Sorghums for Social Objectives.*

By JOHN H. MARTIN

Crop breeders are practical humanitarians, ever striving to improve the welfare of man and animal and to abolish poverty, want, famine and misery. Conscious of the fact that many famines of the past could have been prevented had suitable crop varieties been available, they endeavour to reduce the hazards of agriculture by breeding new varieties resistant to diseases, insects, drought and storms, cold and heat. In these endeavours, crop breeders are fully aware that their accomplishments have important social and economic aspects. By eliminating losses incident to pests and the weather, breeders help to stabilize yields and production, knowing that a well-balanced and diversified agriculture becomes established only where crops fed on the farm and those sold for cash both make uniformly good returns. The reduction in losses due to such "acts of God" as drought or root rot, by the growing of resistant varieties usually results in higher average yields per acre. If the apostles of an economy of scarcity view these increases with alarm, the breeder points out that such yields mean more efficient production and greater abundance, whereas crop failures bring poverty and want. Most crop breeders have long recognized that breeding merely for increased YIELDING CAPACITY is not only difficult but often unnecessary. Varieties long in existence have shown a maximum capacity to yield five to ten times the AVERAGE ACRE YIELDS for the particular crops in the United States. Consequently, the improvement of acre yields has occupied a minor place in sorghum breeding as is apparent from the record of achievements which follows.

Much of the work of crop breeders has been devoted to social and humane objectives. For example, the replacement of numerous bearded wheats and rough-awned barleys with new awnless or smooth-awned varieties, although adding little to productivity, has contributed greatly to the comfort of the men and beasts who have suffered from contacts with harsh awns. A few early experiences of the writer in extracting stiff, ever-burrowing, barbed barley awns from the swollen mouths of horses and from his own eyeballs and underwear left no doubt as to the need for material improvement in that respect. Also, stiff-stalked strains of hybrid corn and other cereal crops have helped mankind by facilitating machine harvesting, thus conserving the energies and back muscles of workers who heretofore had to stoop to the ground to gather lodged crops. The breeding of cereals for improved technical quality has for its

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ultimate objective greater human satisfactions in the form of better bread, beverages, and other cereal products that we consume.

Perhaps the greatest social achievement of the crop breeder has been the reduction of ravages by disease. Any understanding person who has seen widespread areas of a crop devastated by a disease, and is cognizant of the blasted hopes, of the fears, poverty, and human and animal privation accompanying a crop failure cannot but hope that something be done to prevent the recurrence of such a disaster. During the past 25 years the major efforts of crop breeders have been devoted to that objective, and scores of new disease-resistant varieties now on American farms attest the success attained. Also the growing of resistant varieties helps keep down the populations of parasitic insects and disease organisms. Unless the breeding for resistance to diseases and insects goes on continuously, new diseases and pests and new strains of the older parasites, soon multiply. These have more than once created havoc among varieties that were originally resistant to attack. Consequently, the sometimes maligned crop breeder is just as essential to maintain a vitalized, intensive agriculture as the farmer who grows the crop.

The humanitarian and social benefits resulting from the improvement, since World War I, of just one crop viz sorghum, are reviewed here. The items mentioned are accomplishments of the Federal and State sorghum breeders with whom the writer has been associated. The story of the improvement of many other crops would be similar.

Improved Sorghums Check Human and Animal Privation. In 1925, a new disease, now known as pythium root rot or "milo disease," was discovered in certain varieties of sorghum growing on two experiment stations. Later, this disease was found to be widespread on farms. It sometimes destroyed entire fields. However, the more common experience was a reduction of a third to a half in yield without the grower's being aware that a disease was the cause of his poor crop until he later tried a resistant strain. The breeding of resistant strains of all susceptible varieties has now been completed so that losses from this insidious disease are today nearly negligible. In this case the remedy was available before farmers knew that the disease existed. Livestock no longer need be under-nourished because of grain shortages caused by pythium root rot.

Chinch bugs have often damaged sorghums in a drastic fashion. Some varieties were found to be much more susceptible than others but no variety is fully immune from injury. The breeding of resistant strains of susceptible types thus far has been only partly successful. However, sufficient progress has been made so that by the proper choice of varieties and cultural practices the more severe losses from chinch bugs can be avoided. The contrast between susceptible and resistant varieties is often striking. Thus again crop research brought to the farmer and to the nation more milk, more meat, and more wealth.

During the unprecedented drought of the 1930's the corn in the Great Plains region failed with almost sickening regularity. Sorghum which resists drought much better than does maize, was already widely grown in the southern and central Great Plains, but the varieties grown for grain matured too late for the northern sections. Fortunately, sorghum breeders in the South had anticipated the need of their northern friends before many of the latter realized it themselves. Quick-maturing grain varieties, especially for the north, were being bred in Oklahoma, Kansas, and Colorado. These new varieties were soon made available to farmers of South Dakota and Nebraska. As a result, livestock starvation and human deprivation were held in check until the drought was over. The new sorghum varieties, Sooner, Colby, Coes, Early Kalo and Day will long

be remembered for their part in the salvation of drought sufferers. In one year the corn crop of South Dakota was so short that little was available for the decoration of the famed Corn Palace at Mitchell. However, sorghum was abundant despite the drought, and the exterior designs on the building were constructed of sorghum heads of four different colorful varieties. By that expedient, the cultural and social value of the annual Corn Palace fair was preserved, a curious symbol of a change in agricultural practice only possible because of foresighted scientific breeding.

Sorghums Bred for Machine Harvesting Save Toil. Harvesting grain sorghum by the older methods of hand topping and row binding requires extensive hand labor. Combines were never used for harvesting any crop in the southern Great Plains until 1918, and were not generally acceptable for harvesting even wheat for five or six years thereafter. It was fully recognized that the varieties of sorghum then available were too tall and weak-stalked, or had recurved heads that made them unadapted to efficient combine harvesting. Experiments were begun as early as 1919 to develop suitable varieties. Beaver, the first extra dwarf, stiff-stalked combine type grain sorghum variety for growing in the southern Great Plains was distributed in 1928. Other new short, erect-headed varieties—Wheatland, Day, and Colby followed in later years. The greatest progress was made only recently. No less than eight new improved disease-resistant combine varieties have been distributed since 1940. About seven million acres, or 80 per cent of the sorghum harvested for grain in 1944, consisted of these new varieties cut with combines. Thus, during one war-time year when labor was virtually unobtainable, some 120 million bushels of grain were harvested by a method requiring only one-eighth of the manpower necessary to harvest the varieties available 15 years earlier. In the light of current food shortages, the social gains resulting from an additional billion pounds of meat or two billion quarts of milk cannot be overlooked.

Better than Liniment. Bundles of sweet sorghum stalks cut for forage or silage are difficult to handle under the best of circumstances because of their weight and length. When the stalks fall down before harvest, difficulties are multiplied and the labor becomes back-breeding indeed. Sorghum breeders long ago felt the urge to ease the burdens of the harvesters. Their most striking achievement towards this end was the development of the Atlas variety. It has stronger stalks and is thus less likely to lodge than other sorghum varieties of similar height and growth. This characteristic, together with the palatable white seed, explains why Atlas sorgho, first distributed in 1928, soon became a leading silage and fodder crop in the area from central Kansas and Nebraska eastward. Early Kalo is a highly productive grain sorghum grown in western Kansas and Nebraska, but the stalks are so slender that they often topple over soon after the grain is ripe. The crop can be saved usually by cutting it promptly with a binder, a method entailing considerable hand labor. Sometimes, in the hope of saving labor, growers allow Early Kalo to stand until the grain is dry enough to harvest with a combine but in so doing they run a serious risk of having the crop fall down, after which the grain can be saved only by tedious hand heading of the prone stalks. In order to avoid this risk, a recently developed strain from the original Kalo variety, called Midland (Kalo 617), was distributed for growing on 20,000 acres in 1944. Midland has short sturdy stalks, making it well suited to combine harvesting. In widespread farm tests in Kansas in 1943 it was found that 99.5 per cent of the Midland stalks were still standing at the time of combine harvest. It is difficult to evaluate the social gain in terms of relief from strain and toil, as a result of the growing of stiff-stalked sorghums. Nevertheless, in total human benefits it probably excels any patented, pain-killing, snake-oil backache remedy yet devised. This is an addition to the more readily evaluated savings in man-hours during an urgent labour shortage.

Tapioca Food Industry Saved by Sorghum Breeders. Chemical tests of sorghum seeds ten years ago revealed that several American varieties had a type of endosperm described as "waxy". Later investigations by others showed that the characteristics of the starch from "waxy" cereals were similar to those of tapioca starch and that waxy sorghum starch could replace the imported tapioca starch for puddings, pie fillers, and adhesives. Many children and sick persons, especially those with sore throats, find tapioca pudding easy to take. Some years ago, Leoti, a waxy-seeded forage sorghum, was crossed with Club, a productive grain type with large, soft seeds. Some of the selections of the waxy type from this cross were productive and had grain characters that made them very satisfactory for processing. When imports of tapioca were cut off by the War, one of the strains from the breeding nursery was increased to furnish seed supplies for commercial production. The new variety named Cody, was increased from 20 pounds of seed from the 1941 crop to a supply for processing of 32 million pounds of grain in 1944. As a result of this one breeding activity, millions of Americans will be able to get their favorite puddings and pies while the principal tapioca-producing areas are still in Japanese hands. Here we have again a large intangible gain in avoiding dislocation of food-habits plus the dollars-and-cents and man-hours contribution of making possible the use of a food processing industry without reconversion.

New Varieties More Palatable to Animals. Like human beings, domestic birds and animals exhibit very definite preference in their food whenever choice is permitted. They distinctly prefer sorghum seeds that are white or yellow. Nearly all of the sweet sorghums and some of the grain sorghums have brown seeds with a bitter taste. Sorghum breeders have a sympathetic interest in their animal friends as well as in their fellow humans. Consequently, they began some 25 years ago to breed strains of sorghum with palatable white or yellow seeds that otherwise were equal or superior to the bitter brown-seeded varieties. Atlas and Norkan sorgho are the outstanding achievements in this respect. However, many strains of white and yellow-seeded Darso also have been developed and it is expected that one or more of these may replace the reddish-brown-seeded variety now widely grown. Whether or not livestock and poultry thrive any better on the palatable-seeded varieties has not been determined and, at present, the economic benefits seem somewhat doubtful. It seems safe to assume, however, that a tasty diet will make the animals more contented and it may well increase their food intake, assuring optimum development.

Breeders Bring Relief to Broomcorn Harvesters. Broomcorn is a specialized type of sorghum grown for the peculiar "brush", the fibrous mass of seed branches from one to two feet long. The gathering, threshing, curing, baling and handling of high-quality shed-cured standard broomcorn requires an average of 120 to 130 hours of man labor for every ton of cured brush produced. Any saving of this labor is important to the grower, particularly when help is scarce. The stalks of tall (standard) broomcorn must first be broken over or "tabled" to bring the brush within reach of the hand cutters. Dwarf broomcorn on the other hand, is short enough to be pulled or cut directly from the standing stalk. Until recently no dwarf broomcorn was adapted to sub-humid regions where much of the high quality broomcorn is produced, because that part of the brush enclosed in the boot usually became stained, since the boot harbors aphides and moisture. The new dwarf Fulltip variety, however, bears the brush so well exerted from the boot that little staining occurs, thus adapting it to humid conditions. Also, the improved sweeping quality of brooms made from Fulltip brush makes household tasks easier. Fulltip has been grown in central Oklahoma to a considerable extent for three years with an appreciable saving in harvest labor at a time when men are scarce. Merely eliminating the "tabling" operation saves about five

miles of walking backwards while breaking over 125,000 stalks, for every ton of cured brush produced. Some 20,000 acres of Fulltip will be grown in 1945. Total drudgery done away with by this rather minor exercise of the breeder's art is equivalent in the 1945 crop to one man's walking backward around the earth at the equator. The elimination of this rather uncomfortable procedure would seem to be a definite social gain.

The chaff enclosing broomcorn seeds bears numerous hairs that rub off readily while the brush is being harvested, hauled, and threshed. These plant hairs, which cloud the air around the thresher, are extremely irritating to the eyes and nostrils and to a perspiring skin. Scratching to relieve the so-called "broomcorn itch" often causes considerable areas of the skin to become infected. Then complications set in. "Broomcorn Johnnies," as itinerant broomcorn field hands often are called, regard the "itch" as the most objectionable feature of their job. To remedy this situation, broomcorn was crossed with a brushy-headed sorghum from China that had little fuzz on the chaff. Subsequent recrossing and selection produced a broomcorn that, if grown widely on a commercial scale, should largely eliminate irritation from the hairs. Then the "gripes and groans" of the "Johnnies" should likewise be largely eliminated. When such varieties have come into general use the alleviation of human misery will have been brought one step further.

Even "Plenty of Nothing". Not all crop improvement results in increased yields. Many disease-resistant varieties yield no more than the varieties they replaced, except when the disease is present. They merely stabilize yields at a satisfactory level. Some improved varieties having better quality, shorter or stiffer stalks, or other desirable characteristics yield even less than the varieties they replaced. Thus Atlas sorgho yields less forage than Kansas Orange, the variety it has almost entirely replaced. The new combine-type grain sorghum varieties all have a lower maximum potential capacity and some of them show lower average yields than the Dwarf Yellow Milo which they have replaced. All of the new quick-maturing varieties for the North have small plants and are inferior to the older standard varieties in their ability to produce under long-season, favorable growing conditions. Thus it becomes evident that some of the most important steps in sorghum improvement have come from the development of varieties with lower potential yielding ability. That, perhaps, is as it should be because the chief complaint regarding certain forage varieties is that they yield so much that they are hard to harvest. Sorghums introduced from the tropical regions all grow too large for harvesting with existing modern machinery, and thus are unacceptable here. The aim of maximum efficiency under given conditions of climate and other factors must not be lost sight of by the modern plant breeder, who tailors his varieties to order.

Breeding varieties merely for low yields has not been beyond the demands placed on the modern breeder. To meet a special situation a need arose for a sorghum that would yield nothing at all worth harvesting. When sorghum is planted on land to prevent soil blowing or to furnish a protective cover while grass is being established, it is desirable that the entire growth be left on the land. If the plants bear products that can be utilized as grain, as forage, as sirup or broomcorn brush, there is a strong urge to gather at least a part of the crop, especially when nobody is watching. The demand for such a specialized protective crop has been met by selection from a cross between Sudan grass and an inferior-quality cross-bred strain of broomcorn. The new "no-yield" sorghum removes the temptation to harvest because the stalks, although making a good growth, are too hard and dry for forage purposes and they contain no sweetness. Furthermore, the seed is too small and sparse to make it worth harvesting for grain, and the brushy heads are unsuitable for making brooms.

Neither is it safe to pasture the crop because of the possibility of "sorghum poisoning" from the presence of prussic acid. Such a variety that yields merely "plenty of nothing" cannot contribute to crop surpluses. However it is available when circumstances warrant its use.

Conclusions. The examples just cited show that some of the major accomplishments in crop breeding have been directed toward human betterment and humane achievements, without having contributed to crop surpluses. In stabilization of yield through elimination of crop failures they have made a very important contribution. Furthermore, the record of achievements and objectives demonstrates that, in large part, breeders have been fully conscious of their obligation to strive for the advancement of social welfare throughout the globe.

Abstracts.

The Water Buffalo of India. (By Ralph W. Phillips, *The Journal of Heredity*, Vol. 36, pp. 71--76, 1945). Next to cattle, the water buffalo is the most important animal in Indian agriculture. Primarily used for milk production, the animals are in certain localities utilized for draft purposes, but they are generally considered to be too slow compared to bullocks. The buffalo is however capable of utilizing coarse roughage and yielding a fair amount of milk with a high fat content. The chief breeds recognized in India are:

Murrah. These are also known as Delhi buffaloes and are native to southern Punjab and the Delhi Province. They are mainly bred for milk production in the north of India, particularly Punjab and Sind and have been introduced into many other parts of India for improving the local stock. The animals have massive deep bodies weighing from 1,000—1,800 lb. in the case of bulls and 800—1,600 lb. in cows. Legs are short and heavy, head relatively small and the horns short and tightly curled (*Murrah*=curled). The hips are broad, rump sloping and tail short. The animals are generally black in colour, but fawn grey is not uncommon and white markings are frequently seen on the face, legs or tail. Average yields of 4,000 lb. of milk during a lactation period of 280 days have been recorded for Murrah buffaloes bred at recognised farms in India.

Kundi. Found in the forest tracts along the Indus river and in the rice growing regions in northern Sind this breed closely resembles the Murrah from which it is probably an off-shoot. The animals are rather large, about 1,000—1,200 lb in weight. They are generally black in colour but light brown animals are also found. The forehead is somewhat prominent and the face more or less dishd. Horns are thick at base and incline backward and upward, ending in a moderately tight coil, thus resembling a fish-hook (*Kundi*).

Nili. These animals are found in the valley of the Sutlej river mainly in the Montgomery and Ferozepore districts of the Punjab. The body is medium in size, head somewhat elongated, slightly bulging at the top and depressed between the eyes. Horns are small with very tight coils and the neck is long and thin. The usual colour is black but brown is also seen. White markings on the forehead, face, muzzle and legs, and a white switch on the tail are considered to be desirable characters by the local breeders. The Imperial Council of Agricultural Research has published records on two purchased Nili buffaloes that averaged 4,959 lb of milk in 361 days.

Ravi. Known also as the Sandalbar, this breed is similar to the Murrah and is found in the valley of the Ravi river and particularly in Sandalbar. The horns are broad and thick with a tight coil. The forehead is flat, the nasal bone broad and there is a marked depth from the base of the horns to the angle of the jaw. There is a distinct "double chin" and the neck is rather long and

thick. Black is the usual colour but brown is not uncommon. Sometimes pink markings occur on the udder and brisket.

Mehisana. This breed is in appearance intermediate to the Murrah and the Surti and appears to have arisen from a mixture of these two bloods. The body is somewhat longer compared with the Murrah and the legs are longer and lighter. The horns are also longer and not so tightly curled and the head is rather heavy. The colour is black or fawn grey, usually with some white markings on the face, legs or tip of the tail but there is no fixed colour. This breed is found in Baroda state and neighbouring areas.

Jaffarbandi. This breed is found in its purest form in the Gir forest of Kathiawar. The animals are large and compared to the Murrah the body is longer and not so compact. The head and neck are more massive. The forehead is prominent and the horns heavy and inclined to droop on each side of the neck and then turn up at the points but not in such a tight curl as those of the Murrah. The usual colour of these animals is black. They require large quantities of fodder, but the milk yield and the butterfat percentage are said to be high.

Surti. These animals are found in the Gujarat area in Bombay province and Baroda state and also in some other parts of southern India. They are medium sized and compact animals with the head long and broad and rounded between the horns, and the horns flat and long and sickle-shaped. The colour is black or brown, sometimes, with white markings on the jaw, brisket and switch of the tail.

Nagpur (Ellichpur). This breed is found in Central and southern India and is quite distinct from the Murrah. It is said to represent an ancient indigenous type. The animals are used for milk as well as work but milk production is lower than that of the Murrah and similar breeds. The body is generally lighter and the legs finer and longer than those of the north Indian breeds. The neck is comparatively long and the face long and thin with a straight profile. The horns are long and flat, and pass back on either side of the neck with only a slight curl.

The water buffalo would appear an ugly and ungainly animal and there are some disadvantages to its use, particularly the need for an abundance of water. Its milk is quite white, apparently due to a lack of carotene but the fat content is usually higher than in cattle and the milk yield reasonable under the conditions in which it lives. It is capable of utilizing coarse roughage of the type usually found in the wetter tropical regions and it has been found to be well-adapted for working in rice fields and other wet areas such as those of Eastern India and Southern China. It is also used extensively in the hot, dry regions of north-western India, Iraq and similar areas. This animal is therefore worthy of consideration for introduction into similar areas where it has not been tried so far.

K. K. N.

Crop Improvement—A Weapon of War and An Instrument of Peace. M. A. McCall. (*Jour. Amer. Soc., Agronomy*. Vol. 36, page 717). In the words of President Roosevelt, "Food is as important as any other weapon in the successful prosecution of the war. It will be equally important in rehabilitation and relief in the liberated areas and in the shaping of the peace that is to come". The American farmer has done an outstanding job in meeting the challenge to produce food. His achievements have been phenomenal, considering the handicaps of labour shortage and insufficient equipment. The agronomists of our country, however must also be given substantial credit for having helped to make possible the farmers' achievement. It is of course impossible to cover all the contributions of field crop research to the war effort; for that reason only a few selected high lights are considered at present.

Hybrid corn. Corn contributes more to our total wartime food supply than any other crop. The 1942 corn crop totalling 3,175,000,000 bushels was the latest on record, grown from 89,484,000 acres. The 1943 crop is estimated at 3,085,000,000 bushels, the second largest of record. Such phenomenal yields are to a great extent due to the widespread use of hybrid corn. It has been estimated that for the period of 1938 to 1943 inclusive, 50% or more of the corn acreage in each of the five states of Iowa, Illinois, Ohio, Indiana and Minnesota was planted to hybrid corn in these five states during these six years. In 1943, the hybrid corn acreage of these same five states was 31,200,000 acres. On the basis of the six-year average increase per acre by growing hybrid seed, the total increased yield in 1943 was 564,720,000 bushels. Assuming only one-third as great an increase on the remaining 17,460,000 acres of hybrid-corn grown in the United States in 1943, we get an additional 104,760,000 bushels or a total increase from hybrid corn in 1943 of 669,480,000 bushels. While this is an astounding figure, it seems reasonable.

Disease resistant oats. Another important development playing a major role in the efficiency of war-time crop production has been the distribution of new smut-resistant and rust-resistant oat varieties. These varieties yield from 10 to 25 bushels or even more above the varieties they are replacing, when rust is a factor, and even in non-rust years they are as good or better.

Soybeans. The increase in the production of this oil crop, as a Wartime necessity has been remarkable. In 1941 the acreage under soybeans was only about 6 million acres but in 1942 this was 10,008,000 acres, in 1943, 10,820,000 acres, and in 1944 a target figure of more than 13 million acres has been aimed at. This has been possible only because of the new varieties which have been developed in the co-operative programme of the States and the Federal Department of Agriculture.

Rust-Resistant Wheat. A new stem-rust-resistant variety, Thatcher, was released to farmers in 1934 and quickly became very popular, replacing the susceptible varieties Marquis and Copes not only in the United States but also in Canada. It was estimated that 13.5 million acres were grown in 1939, which increased to 18 million acres by the next two years. However this variety proved susceptible to leaf rust and in 1941 and 1942 was seriously damaged by that disease. To remedy this defect—two new varieties Rival and Pilot, produced by co-operative research in North Dakota have been released. These are resistant not only to stem rust but also to leaf rust and they are now replacing Thatcher in those areas where leaf-rust is important.

T. R. N.

Utilization of Plant Residues for the Production of Artificial Manures. (James P. Martin and Yueh Wang. *Jour. Amer. Soc. Agronomy*. Vol. 36, (5) p. 373, 1944). The paper discusses the production of artificial manures from organic residues like oat straw, clover hay, peat, leaves, cornstalks, salt-grass, hay and woody refuse. The transformation of the residues during decomposition and the quality of the manure produced are described. The composts were built up in layers, on a foundation of wooden structure so arranged that most of the liquid escaping could be collected and returned to the pile. Eight different composts were made, each containing 1,000 pounds of the respective dry organic material and chemical substances as below:—

- (1) Oat straw plus inorganic salts (34 pounds of ammonium sulphate, 10 pounds of superphosphate, and 30 pounds calcium carbonate)
- (2) Oat straw (700 pounds) plus clover hay (300 pounds)
- (3) Lowmoor sedge and reed peat (700 pounds) plus timothy hay (300 pounds)
- (4) Cow manure with oat straw bedding
- (5) Corn stalks plus inorganic salts (34 pounds ammonium phosphate, 10 pounds superphosphate and 30 pounds CaCO₃)

- (6) Salt-grass hay plus inorganic-salts as in (5)
- (7) Leaves (500 pounds) plus woody residues (500 pounds) plus inorganic salts (17 pounds ammonium sulphate, 5 pounds superphosphate and 15 pounds calcium carbonate)

The heaps were built up in layers, inorganic salts if required and water being added after each layer had been laid. The grass, hay leaves and straw did not compact readily; they were therefore tramped down after each layer was completed. During the course of decomposition, additional water was added to the tops of the piles in order to maintain the moisture content at approximately 75%. After 30, 70 and 110 days the piles were turned, sampled and re-piled. The composting period was considered complete when the nitrogen approximated 2.3 to 3%. Composts 1 to 5 inclusive were completed by December. They were soaked with water and tramped down tightly in order to create anaerobic conditions and thereby reduce further decomposition to a minimum and also to prevent nitrate formation and consequent loss of nitrogen by leaching and biological action. They were left in this condition until March and May when they were used for plant growth tests. The completed composts were weighed to determine the total amount of artificial manure produced and the percentage decomposition of the original organic material.

Greenhouse and field tests showed that a high quality manure could be made from corn stalks, comparable to composted cow manure within a period of 3 months. Good quality products were prepared within 4 to 6 months from cereal straw also. Tree and shrub trimmings take much longer to decompose. The best results were obtained by the addition of 0.7 to 0.75 parts of nitrogen to every 100 parts of dry straw. The conditions essential for success are proper aeration and temperature, an adequate supply of soluble nitrogen and a neutral or slightly alkaline reaction. The residual effects of the composts produced from cow manure, corn stalks and cereal straw were much greater than that of inorganic fertilizers.

T. R. N.

Hybrid alfalfa. H. M. Tysdal and T. A. Kiesselbach (1944). (*Jour. Amer. Soc. Agronomy*, 36, P. 649-67). Maximum productivity in alfalfa is obtained in the first generation hybrid progeny of a cross between two genotypes with high combining ability. The phenomenon of hybrid vigour is thereby most effectively utilized. Through the use of highly self-sterile, cross-fertile parental clones of alfalfa, the resultant seed may rather closely approach a pure F_1 hybrid constitution. The progeny is known as hybrid alfalfa in distinction to the "synthetic" variety which may be developed by the use of pure line, selections methods. The co-operative breeding programme at the Nebraska Agricultural Experiment Station has both the F_1 hybrid and the synthetic variety as objectives but it is believed that the former has the greater possibilities. The use of hybrid vigour may find its expression in the form of either single or double crosses. The perfection and testing of parental stocks may require several years before release, but the necessary basic information is now available and foundation stocks and hybrid combinations are under test. Improvement in yield of seed, yield and quality of forage and resistance to certain diseases and insect pests seems assured. It is the purpose of this paper to report the available information and to describe the procedure of alfalfa improvement by the method of controlled hybridization involving known high-combining ability of the component genotypes.

Alfalfa is normally a cross-fertilized crop. As an average for three Nebraska tests during 1936 to 1939, 89% of the seed resulted from cross fertilization. Commercial seed production in alfalfa is dependent upon 'tripping' of the flowers by insects. Seed yields may vary heritably and with the environment, variations in which influence the physiology of the plant, and with the prevalence of both

beneficial and harmful insects. **Evidence of hybrid vigour:** Hand-pollinated crosses between inbred lines have shown in many cases considerable hybrid vigour, depending apparently on the combining ability of the parents. The hybrids from single crosses yielded from 60 to 139% more than the parents, with an average increase of 86% over the controls in 28 trials. Upon inbreeding, the forage yield of alfalfa is reduced by 32% in the first generation, with additional decreases in subsequent generations until a level of 26 to 30% of the original yield remains at the seventh or eighth generations. The reduction in seed production upon inbreeding is similar, but even more drastic. Great differences occur in the amount of reduction of yield, between individual lines. The best five hybrids in order of yield were those built up from three, four, two, five and eight lines respectively. The average yield of these five hybrids exceeded that of the highest yielding commercial variety in the test by 23%. Evidence is accumulating in a number of crops as to the differences in combining ability of various lines to such an extent that it seems unnecessary to draw further attention to this important factor. Evidence is also accumulating that in alfalfa breeding at any rate, the plant breeder should select highly self-sterile plants for building up high-yielding hybrid seed. Male sterility as such has not been identified in alfalfa, but its possible occurrence and use should not be ignored.

A well-defined method for the isolation of desirable parental stocks and for subsequent selection procedure is essential for any breeding programme. To this end, the programme that was developed for alfalfa breeding at the Nebraska Experiment Station based on the principles enumerated above is described in some detail below.

Much has been said regarding the value of selfing in eliminating undesirable characters and for fixing desirable characters, but in a perennial crop like alfalfa clonal propagation is not difficult and a given genotype can be maintained indefinitely eliminating the need of self-fertilization for its continuance. This elimination of selfing procedure by-passes several years of inbreeding and makes it possible to select within larger populations with the same expenditure of time.

The desirability of large populations in any improvement programme cannot be over-emphasized. Observations made so far indicate that it is desirable to select for self-sterility, but selection for self-sterility makes it difficult to secure sufficient selfed seed to carry on the programme successfully, unless large populations are grown.

In selecting parental stocks, the characters that are considered most desirable from the commercial standpoint are: High yield of both seed and forage, fine stems, leafiness, superior seedling vigour, favourable protein and vitamin content, cold endurance and resistance to bacterial wilt, leafspot virus and other diseases and to leafhopper damage and nematodes. Selection for adaptation to unfavourable soil conditions may be possible. Self-sterility and cross-fertility are important characters. Since no variety is uniformly possessed of only desirable characters, the main objective must be to eliminate as many undesirable plants as possible in such a manner that the greatest number are eliminated with the least expenditure of time and labour. Thus, in most cases the first step would be the elimination of susceptible plants by disease. To accomplish this the original seedling can be inoculated with the bacterial wilt organism and the plants grown in an "epidemic nursery". The healthy survivors from this are transplanted into a special breeding nursery where the individual plants are examined for other desirable characters. A high percentage of plants would be eliminated on the basis of all these characters. From the survivors, those that are high in seed and forage production are advanced to the "polycross" nursery preliminary to testing for combining ability where each clone is subject to random pollination by insects. The progenies resulting from these clones that

were exposed to outcrossing are known as *polycrosses*. A number of clones in these polycrosses are eliminated on the basis of observation, and the selected clones are grown in randomized replicated plots seed from the replicate plots of performance of the polycross. To ensure that each promising clone would be maintained indefinitely, a few plants of each selected clone are planted in a permanent nursery.

Those clones with favourable prepotency as measured through the performance of their polycrosses are arranged in groups of ten or more for making all possible single cross combinations. The resultant single crosses are tested for performance in well-replicated plots. Once these tests are completed, the subsequent commercial production for hybrid alfalfa seed is a comparatively simple undertaking. Four predetermined clonal lines are involved in the commercial double cross. They are propagated as cuttings rather than by seed. Two crossing fields are required for producing the two single-cross parental stocks. In each of these fields, the two needed clones are space-planted into two alternate rows, to bring about the maximum amount of hybridization, seed of the two resultant single-crosses is planted in alternating rows, in a field to produce the double cross. The seed crop is harvested in composite and constitutes the commercial hybrid seed. The field may be continued for hybrid seed production so long as the stand remains satisfactory.

T. R. N.

Estimation of crop yields. (By V. G. Panse and R. J. Kalamkar, *Current Science* 1944, Vol. 13, P. 223-5) In a previous article the authors had described an experiment carried out in Akola district in Berar to estimate the yield of cotton in that district in 1942-43 and secure information on which to plan future surveys more efficiently. The results indicated that it was sufficient to harvest only one plot of one-tenth of an acre area per field, but that a larger number of fields per village improved the accuracy of the yield estimate without any increase in cost or labour. Based upon this information the experiment was repeated in 1943-44 in two adjoining districts, Akola and Buldana, with four instead of two fields per village. Ten random villages were chosen in each of the five tahsils in the districts of Buldana. The fifty villages selected for the survey formed a 3.7 per cent sample of all villages in the district. The districts Akola and Buldana together extend 7857 square miles out of which cotton was grown in 11 lakhs of acres. The total cost of the scheme was Rs. 18,000. It was noted that the predominant portion of the total variation in yield was due to the differences between fields in the same village. While the absolute magnitude of variation from different sources may differ rather widely from season to season and from district to district, its relative magnitude appears to remain approximately of the same order. This fact makes it possible to devise an efficient sampling technique sufficiently flexible for general application over all the rainfed cotton tracts of Peninsular India.

The average yield of seed cotton (Kapas) was estimated at 282 lb. per acre in Akola and 299 lb. in Buldana in 1943-44 subject to standard errors of 4.7 and 6.7 per cent respectively. The standard error in Akola was 6.3 per cent in 1942-43, the increase in precision being entirely due to the improvement made in the sampling technique this year. The official estimate of yield was 248 lb. per acre for Akola and 253 lb. for Buldana. These figures are 10 and 17 per cent lower than the corresponding experimental estimates. The district revenue and agricultural staff who were asked to inspect the crop in the fields selected for survey also under-estimated the yield. In 1942-43 when the crop was poor (136 lb. per acre) it was grossly over-estimated by the same agencies. Yields are thus over-estimated when they are poor and underestimated when they are really good in consequence of the natural tendency not to deviate too widely from the normal yield, the thirteen-anna complex as it is often called.

The degree of accuracy to be aimed at in future surveys also needs some consideration. The trade is interested in accurate production estimates over areas comprising several districts rather than of individual districts. The past two seasons' surveys were limited to one or two districts and had a standard error of the order of 5 per cent. Estimates of yield with a standard error of only 1 per cent may be demanded but such a standard of accuracy, though it can be attained would entail a very elaborate sampling with a corresponding increase in cost. With four fields to be sample harvested in each village, crop cutting will have to be done in more than 1,200 villages in each block where the production is required to be estimated with a standard error of 1 per cent the cost of such a survey would be necessarily high. On the other hand, slightly lower standards of accuracy of 2 or 3 per cent would seem to be sufficient for all practical purposes and this can be attained by sampling 383 villages and 170 villages respectively.

In irrigated areas and with crops like cereals that are less variable than cotton the position is probably better and it may be possible to secure an estimate of yield with less than 2 or 3 per cent standard error by sampling about 300 villages only.

It is proposed to carry out a crop-cutting experiment for estimating the average yield and total production over the whole cotton area in the Central Provinces and Berar at an estimated cost of Rs. 35,627. This survey will extend over 29,829 square miles and cover 3 million acres under cotton, representing over 99 per cent of the total provincial area under this crop and form the first step in estimating by a reliable technique, the production of the most important commercial crop in the country. It is to be hoped that this method will also be useful for estimating the yield of other principal crops.

The Cashewnut Industry. (*Eastern Economist* June 8, 1945, page 768). Introduced into India as far back as the sixteenth century the Cashew tree was in the beginning planted to check erosion on the coastal lands. It thrives on the West Coast, with a rainfall of 120-150 inches and also in tracts of the East Coast with a rainfall of 35 inches. Recently it has been successfully planted in the forests of Mysore.

The commercial importance of the cashew kernels is a development during the last two decades. The kernels are a concentrated food with attractive flavour and a high nutritive value. The U. S. A. and Canada have popularized its consumption and are now the biggest buyers in the world market. The exports of cashew kernels to the U. S. A. has risen from 50 tons in 1925 to 18,000 tons in 1941. India supplies 95 % of the international demand and the rest comes from Brazil. Africa also grows cashew trees but most of the output is sent on to India, for processing and re-export as kernels to America and other countries.

Reliable statistics of areas under Cashew cultivation are not available and are difficult to compile owing to the fact that the trees are grown over scattered areas and are in many cases mixed with other crops. There is again very little relation between area and production in different tracts, as the number of trees planted per acre, and the yield per acre vary widely from region to region. Areas planted essentially for fuel, where a tall growth is aimed at, may hold about 1000 to 1500 trees per acre. But in other parts of India, where cashew planting is intended for kernels, the number of trees per acre ranges only from 50 to 250. It is estimated that a hundred trees per acre may be taken as a fair average. The yield of kernels varies from 30 lbs. on the West Coast to 40 lbs. in Orissa. Fruiting begins in the 3rd. year but the tree attains its full bearing only by the 10th year and continues so till its 30th year and then begins to decline. A hot and protracted summer brings the best produce both in quantity and quality. The crop is collected between the month of February and May. The

annual production from British India and the Indian States average about 44,000 tons. More than 70 per cent of the total crop comes from the West Coast including Ratnagiri and North Kanara in Bombay, South Kanara and Malabar in Madras and Cochin and Travancore states. Other areas of lesser importance are the Midnapore District in Bengal and the districts of Puri, Gangam and Balasore in Orissa. Local consumption varies from 1 per cent in Cochin and Travancore to 15 per cent in Mysore and Orissa. Imports from Africa into India have increased from 572,000 maunds in 1937 to 883,000 maunds in 1941-42. African nuts are processed in India and re-exported as kernels abroad. About 95 per cent of these imports are treated on the West Coast out of which the Quilon area alone consumes 75 per cent.

The methods adopted for assembling the crop and transporting it to the factories are slow and costly. The petty cultivator is only too eager to receive some ready cash and is reluctant to go all the distance direct to the wholesale dealer and consequently a class of itinerant merchants have grown up, who go from place to place and buy the crop for resale to the wholesale dealers. The existence of this class of middlemen entails a loss of 10 to 15 per cent to the growers on the value of the produce. The quantity passing direct from the larger planters of Cashew trees to the wholesale dealer is only about 7 per cent of the total turnover. There are about 20 firms in Bombay with branches in East African ports for the import of nuts. These firms distribute their stocks to the chief processing centres at Mangalore, Calicut, Quilon, Malvan and Vengurla. No customs duty is levied on the import of raw cashew nuts into India. The pre-war cost of transport from Africa to Bombay was about Rs. 20 per maund.

The export trade which consumes nearly three-fourths of the total production consist entirely of peeled kernels. Before the kernels can be put on the market they have to be processed in factories by roasting, shelling, peeling and sweating. The traditional method were for women to roast the nuts in open earthen pan over twig fires. The wages paid in such cases were 3 annas per bag of 2 maunds, about 15 maunds being roasted in one day. The defects of this method are low output, almost complete loss of shell-oil and injurious effects on the health of the workers. An efficient and hygienic method is by the rotary cylinder—where 50 maunds of nuts could be roasted per day by six men. The rate of wages is 8 annas per head. Even the rotary cylinder has the drawback of being unable to avoid the loss of a large proportion of the valuable shell oil. A much more efficient method is to process the nuts in oil baths, for which a patent has been taken by an English Firm "Messrs. Pierce Leslie & Co" in 1936. This machine can treat 300 to 350 maunds of nuts in 24 hours and combines the advantage of large output with maximum extraction of shell oil. After the nuts are roasted they are shelled by hand generally by women and children. The cost of shelling is about 4 pies per pound. Mechanical crackers were tried but proved unsuccessful as a higher proportion was lost in breakage. After the kernels are extracted from the shells they still retain a thin brownish skin which is to be removed before the kernels are fit for eating. They are dried in the sun or in hot chambers and peeled off by women and children. The ivory white kernels so recovered are kept in sweating chambers for 2 or 3 hours. The annual turnover of an average factory is 10,000 maunds. Such a factory employs about 200 workers a day—more than 90 per cent of whom are women and children. Excepting two foreign firms which employ the oil bath system, no factory uses power.

Cashew kernels are graded for export, according to specified "American Standards", based on counts of the number of kernels per pound. Graded kernels must be full-grown, ivory-white and free from stain or insect attack. There

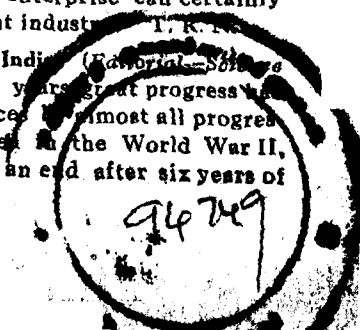
are separate grades of whole kernels and broken. Kernels for foreign markets are vacuum packed in cans of four gallons each. Some firms inject carbon dioxide into the cans after exhausting the air. Kernels in vacuum-packed tins keep well for one year while those in carbondioxide last for two years. Kernels for inland consumption are handled very carelessly; no fine grades are fixed and packing is done in old kerosene tins and broken and low-grade wholes sent in gunny bags. These seldom last longer than 3-4 months and in the monsoon get badly damaged by insects.

No customs duty is levied on the export of kernels but an agricultural cess of $\frac{1}{2}$ per cent is levied, for the funds of the Imperial Council of Agricultural Research. The trade is controlled by representatives of processing factories of foreign countries functioning through common offices. A few merchants in Bombay handle a small portion of the trade. The prices are generally influenced by the demand in the U. S. A. and fluctuate in sympathy with those of other commodities. It is interesting to note that in spite of shipping and other war-time difficulties there is an upward demand for kernels, the rise in price being 150 shillings per cwt in 1941-42. Inland prices vary from market to market and season to season. In the biggest consuming centres of Delhi and Nagpur the prices in 1941-42 were Rs. 52 and 63-12-0 per maund.

The chief by-products of this industry are the cashew apples, peels and shell oil. The average out-turn of cashew apples per tree is estimated to be 75 lbs. and the total production about 5 million maunds. The juice is rich in sugar and jams can be prepared from it, although more than 85% of the produce is only wasted at present. Shells form 70-72 per cent of the weight of nuts of which about 60 to 65 per cent is actually recovered. Shells are sometimes used as fuel in factories. Peels form about 12 per cent of the weight of kernels and nearly 75,000 maunds of peel are said to be obtained every year. At present they are merely mixed with cowdung to make bratties which is obviously a misuse as they are a very nutritive food for poultry. But the most valuable by-product of the cashewnut industry is the shell oil. Within the last 6 or 7 years, intensive research in the U. S. A. has revealed that shell oil is extremely valuable in certain industries connected with the making of varnishes, inks, moulding compositions and insulating coatings. It has also been found to be of immense value in the production of munitions. The oil content of shells is about 25 to 30 per cent by weight. Roasting in rotary cylinders leaves about 2 per cent of the oil, whereas oil bath processing yield 15 per cent. The export of this oil rose from 1073 tons in the first three years of the war to 1910 tons in 1942-43. The price in the U. S. A. was 475 dollars per ton of 235 gallons each. At present the oil is processed only by two foreign firms and all essential information is withheld as trade secrets.

With a practical monopoly of this industry at the moment, India should make intensive efforts to increase production by planting the cashew tree in forests and wasteland areas. The experiment in Mysore should prove encouraging. Co-operation has a fruitful field here. If cashew nuts are marketed on a co-operative basis with direct dealings with the factory owner or wholesale dealer and specific standards adopted, the small cultivator can obtain 15 to 20 per cent more for his produce than at present. The immense value of shell oil, should also stimulate great interest in the industry and indigenous enterprise can certainly expect a profitable field of investment in the cashew nut industry. T. R. K.

A plea for the reorganization of Botanical survey of India (Editorial—*Science and Culture*, September 1945, Vol. XI, p. 105.) In recent years great progress has been made in the investigation of the vegetable resources of almost all progressive countries of the world, particularly those involved in the World War II, which fortunately for mankind has at last come to an end after six years of



terrible bloodshed. The need of fully utilizing plants and plant products for food, medicine and industrial purposes was never before felt so much in the history of the world. Different nations are vying with each other in the campaign of *Growing More Food*, betterment of its nutritive value and storage by modern methods including dehydration. Increase in food production is based on the results of intensive researches in pure and applied sciences carried on in the different agricultural, botanical and horticultural institutions. In some countries, particularly in Russia, Government officials, University workers and non-official scientists all put their head and heart together as members of one family in order to raise the standard of food production, even in the midst of their life and death struggle against Hitlerism, to preserve the freedom and integrity of their nation. Even in war-torn China, very important botanical explorations and investigations have been carried out. In the United States of America intensive research is proceeding on tropical plants including a large number of Indian plants for manufacturing insecticides and insect repellants. On the purely systematic side, which has important bearings on the applied aspects of agricultural investigations, extensive surveys and collections have been made of botanical materials, both dried and living from all over the world, including India and Burma, to enrich the Universities and botanical gardens in the United States of America.

In the "New Systematics of Cultivated Plants" the late Vavilov draws attention to the need for a critical survey of the diversity of varieties of important crops on a world scale. Wheat and potatoes are good examples to show how complicated the position is. Crosses made within the same morphological groups revealed large genetic differences. Cyclic crosses made between Indian and European types of soft wheat showed the presence of many lethal factors. "The need of practical plant breeding have brought us to the elaboration of a new agro-ecological classification of intraspecific diversity on a world scale." In these days of scientific advancement therefore, no one can deny the value and necessity of intensive botanical survey of unknown and little-known regions of the world. Botanists are on the look out to discover new species varieties or forms of plants for crossing purposes with a view to improve field crops, fruits, timbers, pastures, fibres, gums, oil-yielding plants and medicinal plants.

A comparison of the activities towards the expansion of botanical institutions in Russia and the United States of America with those in India shows how deplorably stagnant the state of affairs is in our country. Whereas in Russia and elsewhere, the close co-operation of the herbaria and laboratories with the garden and field for a proper study of all aspects of plant life is considered indispensable, in India certain quarters even suggest the suicidal policy of separating the Herbarium from the Royal Botanic Garden at Sibpur. This garden which was founded in 1787, through the exertions of Col. Robert Kyd, with the primary object of introducing and acclimatizing new economic plants to Indian conditions has been a recognised centre of botanical activity for over a century and a half. The tea industry in India was established through the efforts of the Sibpur botanists. Sir Joseph Banks in 1788 suggested to Warren Hastings that tea cultivation might be experimented with in Bengal. In 1826 it was discovered that tea grew well in the forests of Assam and in 1835 three officers of the Sibpur Botanic Garden were deputed by Lord William Bentinck to visit Assam and as a result of their efforts and recommendations the tea industry was established in India. The expense of the Indian tea commission and another mission to China to study the cultivation there cost the Government of India about Rs. 2,70,000.

The history of the introduction of rubber into India is similar and quite interesting. In 1876, H. A. Wickham smuggled a quantity of the seeds of *Hevea brasiliensis* from the Amazon basin and brought them over to Sir Joseph Hooker

at Kew. These were grown in the Orchid Houses at Kew and seeds supplied to India to the Sibpur gardens, Ceylon and Singapore also.

Sir Clements Markham pushed into the forests of Peru and Ecuador and at great personal risk brought back the seeds and seedlings of cinchona trees. These were raised at Kew and distributed. After the Dutch had naturalised cinchona in Java, Lady Canning deputed Dr. Thomas Anderson of the Sibpur Botanic Garden to Java, who brought back a consignment of plants and acclimatized them in the Sikkim Himalayas. Later, through the exertions of Sir George King cinchona cultivation and the manufacture of quinine were made a commercial success. It was again the Sibpur botanists who were responsible for the introduction of some of the best varieties of sugarcane from the West Indies which resulted in improving the yield and quality of Indian varieties. In the introduction of Jute to the markets of Europe the Sibpur garden authorities worked hand in hand with the Agri-Horticultural Society of India. The variety known as the Dacca Cotton (a variety of *Gossypium herbaceum*) was the basic material for the once famous Dacca muslins and at one time were extensively grown on the high banks of the Ganges and its branches. Roxburgh in 1832 has drawn attention to the points of difference between the ordinary Bengal and this special Dacca cotton and the MS plate is in the herbarium of the Royal Botanic Garden at Sibpur. No attempt has so far been made to re-discover this Dacca variety of Bengal cotton, which seems to have disappeared and Bengal which once supplied the world with cotton fabrics is now declared to be unsuitable for the growth of cotton plants. It is clear that attempts should be made for the re-discovery of this type. The Sibpur botanists have also taken a leading part in the introduction of exotic trees for the Forest Department.

There is no denying the fact that the vast resources of this country are not yet properly explored and to carry on this investigation on proper lines it is imperative that the botanical survey of India should be reorganised and placed on a proper footing. Definite proposals were drawn up as far back as 1910 by the special sub-committee of the Board of Scientific Advice of the Government of India, but these were shelved on the plea of financial stringency. In 1938, a committee of the Botany section of the Indian Science Congress made the following recommendations with the approval of the late Sir Arthur Hill, Director of Kew Gardens:—

1. The industrial section of the Indian Museum should be maintained as a separate department and its scope expanded so as to illustrate the vegetation of the Indian Empire and its chief economic vegetable products in particular. The herbarium of this section should be developed as a special herbarium for economic botany.
2. The headquarters of the Botanical Survey should be located at the Royal Botanic garden and the Sibpur Herbarium should be developed as the National Herbarium for India.
3. The scientific staff of the Botanical Survey should be strengthened.
4. The co-operation of the staff of Indian Universities is to be enlisted in working out collections and in conducting botanical surveys of the unexplored parts of the country.
5. An Advisory committee to be constituted, to determine the policy of the Botanical Survey to allocate the exploration grant and select the personnel for the purpose.
6. The personnel of the survey to be expanded so as to include specialists to deal adequately with various branches of botany and the Botanic Garden at Sibpur so organized as to render the study of experimental taxonomy possible.

The Universities in India are now producing promising young botanists and there would be no dearth of suitable personnel if opportunities are offered to them.

T. R. N.

Rotenone in the Root of *Derris elliptica*. Rotenone exists *in situ* in the form of whole derris resin (extractives) which occurs as discrete particles (globules) in certain cells in the xylem rays, xylem parenchyma, phloem parenchyma, and pericycle, and it does not occur in the vessels or in the fibres. Cells containing rotenone, in the resin form, are most numerous in the parenchyma of the phloem and of the xylem rays, being most dense in two concentric rings in the xylem.

Starch is also present in great quantities in rings in the xylem and phloem parenchyma, apparently alternating with rings of rotenone-containing parenchyma. No starch occurs in fibres or in vessels, and starch and whole derris resin are not contained in the same cells.

These particles (globules) or whole derris resin are in partial solution in an ethereal oil *in situ*. When the cell wall is broken the globules of resin and oil are suspended probably by means of slowly hemolyzing saponins which were shown to be present, in the sap of the plant.

The milky sap exuding from freshly cut roots of *Derris elliptica*, and the milky aqueous extracts of either living or air-dried roots, are acidic suspensions (pH 5.5 to 6.0) containing these particles (globules) of whole resin, ranging from 0.8μ to 3.9μ in diameter, and particles (granules) of starch, ranging from 7μ to 38μ in diameter. The former particles exhibit Brownian movement, but both types of particles may be removed quantitatively from the aqueous suspension by passing it through a filter of low porosity.

Although aqueous extracts of derris root contain saccharose, which readily hydrolyzes to fructose and glucose, experimental evidence indicated that the rotenoids do not occur, *in situ*, in glycosidic combination. (*Jour. of Agri. Res.* Vol. 71, No. 2)

A comparison of certain plant-growth substances with other herbicides. (G. E. Blackman, *Nature* Vol. 155, No. 3939, April 28, 1945.) The problem of weed eradication by chemical methods is engaging the attention of a research team at the Imperial College of Science and Technology, in England. Special attention has been given to the control of annual weeds in cereal crops. The substances studied are in particular 4-chloro-2-methyl-phenoxyacetic acid and 2:4-dichlorophenoxyacetic acid compared with copper chloride sulphuric acid and either a suspension of dinitro orthocresol or a solution of the ammonium salt. A feature of the results obtained is the specific action of the several herbicides on different species when spray concentrations (at the standard rate of 100 gallons per acre) are kept within the limits at which each herbicide is 'selective' in its action. It is however found that for some weeds several herbicides are capable of giving a high degree of control while for other species one compound alone is effective. Copper chloride and sodium 4:chloro 2:methyl phenoxyacetate are more specific than dinitro-orthocresol.

With the suppression of weeds increases in yield up to 90% have been obtained. The injury to the crops was found to be comparatively small, if any. Copper chloride and sulphuric acid gave smaller increases in yield and 2:4 dichlorophenoxyacetic acid was less selective in its action than 4-chloro-2-methyl phenoxyacetic acid. The phenoxy acid derivatives are outstanding in that they operate through absorption by both the root and the shoot. Therefore they may be applied before or after germination. Suppression of germination was obtained with amounts of 0.5-1.0 lb per acre while the quantity needed for killing susceptible weeds after they have emerged through the soil is even less—about 4 oz. per acre of the sodium salt. In addition to the investigation of cereal crops work is being done on the control of annual weeds on grasses, clovers etc., for seed production, flax and linseed, peas, onions, leeks and perennial weeds in grass-land. In these investigations it has been found that the

phenoxyacetic acids are again exceptional; in their capacity to control some perennial weeds. K. K. N.

Plant growth substances as selective weed killers. (R. E. Slade, W. G. Templeman and W. A. Sexton *Nature*, Vol. 155, April 28, 1945) It has been found that certain substances that promote plant growth when applied in small concentrations have a selective phytocidal action when used in larger concentrations. Thus, 3-indolyl-acetic acid and α -naphthalene-acetic acid have been found to be capable of killing some major weeds in cereals without harming the cereals themselves viz oats, wheat and barley. Out of a large number of substances tried, substituted phenoxyacetic acids and naphthoxyacetic acids were outstandingly effective and certain of them were fifty times as effective as α -naphthylacetic acid. 4-chloro-2-methyl-phenoxyacetic acid was one of the most active compounds tested. It readily eradicated weeds such as corn, butter cup (*Ranunculus arvensis* L.), fat hen (*Chenopodium album* L.), corn spurrey (*Spergula arvensis* L.) and field poppy (*Papaver Rhoeas* L.) at concentrations which were without effect on cereals. Germinations of yellow charlock (*Brassica Sinapis Visiani*) was suppressed and plants at any stage from seedling to flowering were readily killed by spraying with solutions of sodium 4-chloro-2-methyl-phenoxy-acetate supplying about 1 lb. per acre of the active principle. The substance appears to persist in the soil for several weeks. Considering the very low concentrations of these substances which bring about such marked differences, it is to be expected that such materials either present or produced in soils may influence considerably the nature and composition of the plant association growing upon them. K. K. N.

Gleanings.

Leaf-curl disease of tobacco in India *Ind. Fmg.* 1944, 5:220-3, bibl. 6. Five types of leaf-curl can be distinguished by their symptoms in northern India, and are designated as A, B, C, D, X. In an extensive investigation carried out at the Imperial Agricultural Research Institute, New Delhi, it was proved that the white fly, *Bemisia tabaci*, is the chief vector and that the virus can be transmitted from 12 alternate hosts which are listed. There is at least one alternate host for every type of leaf-curl. Sunn hemp and zinnia and the weeds *Ageratum conyzoides* and *Euphorbia hirta* appear to be the most important sources of infection. The seasonal histories of tobacco and the various alternate hosts are diagrammatically shown in a chart. The eradication of all alternate hosts, a control measure recommended in Java and Africa, seems impracticable in India where the white fly will thrive on over 100 hosts apart from the dozen more important ones mentioned in the article. However, preliminary experiments with rosin compound conducted at Pusa tend to show that satisfactory control may be expected if spraying or dusting is started in the seed bed and carried out for two months at 10-day intervals. Further tests on a field scale and in various parts of the country are necessary. (*Horticultural Abstracts* Vol. XV, March 1945).

Sweet potato: an emergency crop *Ind. Fmg.* 1944, 5:218-9. The significance of sweet potatoes as an emergency crop in India is stressed and it is pointed out that on an acre to acre and bulk to bulk basis sweet potatoes will outyield every other food crop within a comparatively short period of time. It is thought that yields in South India averaging at present 4-5 tons per acre could be doubled with careful cultivation and good manuring. (*Horticultural Abstracts*, Vol. XV, March 1945)

Increasing quinine production. *Crown Colonist*, 1943, 13:457. New methods of increasing the production of quinine are being tried in East and West Africa and in Ceylon. The Russian method of growing the cinchona as a short-term crop, harvesting the entire plant when it is 12 to 18 months old, the alkaloids being

extracted from the whole plant, is one of these. In Ceylon also forest regulations prohibiting the collection of wild cinchona bark have been annulled following a report by Dr. S. N. Ganguly, the Quinine Technologist of the Department of Science and Industries, that suitable cinchona bark could be collected from the wild and semi-wild trees found in some parts of Ceylon. The Ceylon Department of Agriculture have earmarked certain areas as suitable for cinchona growing and from 300 to 500 acres are to be so cultivated for a start.

(Horticultural Abstracts, Vol. XIII, September 1943)

Bed bugs and bean leaves by J. C. M. Gardner—*The Indian Forester*, LXX, 12: 409. It is the practice in the Balkan countries to trap bed bugs by spreading common bean leaves (*Phaseolus vulgaris*) on floors. One investigator records the collection of 2.25 lb. of bugs in this way from one room alone; the bugs appeared to be dazed and reluctant to move from the leaves. An interesting account is given by Richardson (1943, *J. Econ. Ent.* 36:543) of his investigation of this effect. He finds that the leaves are neither attractant or stupefying; the explanation is that the legs of the insect become entangled in the small hooked hairs present on both sides of the leaves. Leaves of several species without hooked hairs gave negative results; the seed pod, with hooked hairs, of another species successfully trapped the bugs.

This suggests a profitable line of enquiry in India (a new one here as far as I know) perhaps applicable to certain other pests.

Formative effects of environmental factors as exemplified in the development of the onion plant. (By Dr. O. V. S. Heuth, *Research Institute of Plant Physiology, Imperial College of Science and Technology*, S. W. 7. *Nature* 155, May 26, 1945, p. 623) During the last two decades, discoveries of great importance have been made in the field of plant morphogenesis and the predominant part played by the internal factors of day length and temperature has been established. Application of this knowledge to the control of plant growth in agricultural and horticultural practice have led to important results, for example in the forcing of bulbs and the development of vernalisation as a practical technique. In both these cases temperature effects are concerned; with regard to length of day effects the practical results so far have been less than anticipated. The present article brings to a focus, these lines of research in an attempt to elucidate the behaviour of the onion plant. The investigation was begun five years ago with the primary object of discovering the cause of "bolting" (flowering in onions grown from sets) and the most satisfactory methods of control. As the work progressed investigations on the mode of production, storage and use of onion sets have been carried out. The present account is concerned with the physiological effect and interactions of the factors of day-length and temperature in controlling the developmental morphology of the onion plant, especially the processes of bulb formation and flower initiation and development. A fairly comprehensive picture has been obtained on the control of development by the external factors of day length and temperature.

The effects on flowering may be summarised as follows:—First a direct effect of high temperature (ranging from 21 to 30°C) whereby inflorescence initiation and emergence are inhibited partially or completely by exposure of the plants to temperatures above 21°C either during the whole period of growth from seed to set during the whole storage period October—March or the earlier part, or throughout the second season of growth from replanted set to mature onion. When high temperature is applied during the last part of the storage period it delays but may not ultimately reduce flowering. The effects of high storage temperature are not due to the drying of the sets.

Very low temperatures (0°C) throughout the storage period or for the first part only, reduces flowering; but low temperature for the last part only results in a sudden flush of inflorescence initiation on return to normal temperature and

appears actually to increase flowering. Medium temperatures (10–15°C) at any time during the life-history are apparently the most favourable to flowering except for the accelerating effect of cold storage.

On flowering, the length of day has an indirect effect associated with bulbing as well as a direct effect. At temperatures high enough to induce rapid bulbing in plants grown from sets, long days suppress inflorescence emergence; at temperatures low enough to prevent or delay bulb-formation, long days accelerate the emergence of inflorescences by increasing the rate of scape elongation. Day length is apparently without effect on flower initiation, and affects only the further development and emergence of the initials.

The more important effects on bulbing and ripening are these: The onset of bulbing is a response to the stimulus of long days and there is an interaction with temperature, such that at lower temperatures longer days are needed. Seedlings apparently need a longer photo-period for bulbing than do plants grown from sets. At high temperatures bulb development is rapid and the emergence of new leaves ceases abruptly with its onset; at lower temperatures one or occasionally several more leaves may emerge. With a return to short days and (or) low temperature, bulbing may be arrested and leaf emergence recommence without the usual dormant period. Long days and high growth temperatures not only stimulate rapid bulbing onset and development but also expedite ripening. Bulbing onset and ripening are delayed in plants grown from sets stored at high temperature, either throughout the winter (October—March) or for the part only; heat treatment for the first part only of the storage period has little or no such effect. Such delay is increased if drying of the sets in store is prevented by high humidity.

Further work is now being directed towards a more rigorous analysis of the internal factors involved in bulb development and initiation of the inflorescence. The importance of such internal factors is indicated by the striking effect of size of set; large size is the chief characteristic leading to bolting and the experimental fact that artificial reduction in size by the removal of swollen leaf bases prevents or delays bolting points the way to further progress in the analysis.

T. R. N.

Departmental Notifications.

Gazetted Service.

Sri T. Ramanujam Naidu, A. D., Bapatla to act as special D. A. O., for work in connection with Bapatla college, vice Sri M. Satyanarayana transferred as D. A. O., Crop Cutting Experiments; Sri S. Dharmalinga Mudaliar on the expiry of his leave is reposted as D. A. O., Salem vice Muhamad Ali Sahib transferred as D. A. O., Saidapet relieving Sri M. Gopala Chettiar posted to Nellore; Sri M. Sanyasi Raju asst. in Chemistry to officiate as Agricultural Bacteriologist vice Sri P. D. Karunakar on other duty; Sri N. S. Rajagopala Ayyar personal Asst. to the D. A. O., Salem is considered to have acted temporarily as D. A. O., Salem from 23-5-45 to 30-6-45 vice Sri S. Dharmalinga Mudaliar granted leave.

Subordinate Service.

Sri K. Ramanujachari, retired A. D., is re-employed for a period of one year and posted as A. D., Atmakur vice Sri K. Sanyasi Rao transferred as A. D., Madakasira, relieving Sri G. Narasimha Rao posted as F. M., A. R. S., Samalkota; Sri K. V. Thyagaram, Asst. in cotton, Coimbatore to be Asst. in Cotton, A. R. S., Siruguppa; Sri K. B. Vaideeswaran, F. M., Special Vegetable Scheme, Coimbatore to be F. M., A. R. S., Nanjanad; Sri K. Ramaswami Ayyar on the expiry of his leave to be, A. D., under the Special Officer for Vegetable Scheme, Coimbatore vice Sri K. Sundararajan posted as A. D., Sugar Factory, Podanur. Sri M. Gopala Rao, Assistant in Pulses, Anakapalli and Sri N. K. Thomas, A. D., Avanshi to be

marketing Assts. for the supply of jaggery to Defence Services with headquarters at Anakapalli and Kodumudi respectively; Sri A. K. Nagarathnam, Asst. in Entomology to be Asst. in Pulses; Sri K. V. Natesa Ayyar A. D., Gudiyatham to be A. D., Tiruppur; Sri Gopala Unnithan on the expiry of his leave to be Personal Asst. to the D. A. O., Vellore vice Sri K. L. Ramakrishna Rao transferred as Personal Asst. to the D. A. O., Tanjore; Sri M. K. Padmanabhan, A. D., Wyand Colonisation Scheme to be Asst. in Paddy, Coimbatore; Sri A. K. Ramasubba Ayyar, A. D. Coimbatore to be Personal Asst. to the D. A. O., Coimbatore vice Sri T. Gopalan Nair transferred as A. D., Palghat; Sri C. Venkatachalam A. D., Rajahmundry to be Personal Asst. to the D. A. O., Bezwada; Sri A. S. Krishnan, F. M., A. R. S., Aduthurai to be A. D., Dindigal vice, Sri E. R. Chellam Vincent posted as A. D., Coimbatore; Sri A. Subba Raju, A. D. Nuzvid to be A. D., Narasapur; Sri J. Navaneethakrishnan, F. M., Central Farm Coimbatore to be A. D., Avanashi; Sri V. K. Appaji on the expiry of his leave is reposted as A. D., Erode; Sri B. Appala Naidu Asst. Lecturer in Botany, Govt. College, Coimbatore is posted as Asst. in Botany, Agricultural College, Bapatla; Sri Uchil Ananda, A. D., Kotagiri is transferred to Ootacamund for 6 months for district work training; Sri P. Lakasam, Asst. in Rubber, Bannur to be Mycology Asst., Bezwada; Sri C. P. Thiruvengadam, A. D., Arni to be A. D., Gudiyatham, vice, Sri K. V. Natesa Ayyar transferred as A. D., Tiruppur; Sri R. Shanmugasundaram, A. D. (under training) Gudiyatham to be A. D., Tirupattur vice Sri T. K. Ramachandran posted to Chengam; Sri W. R. Nargunam, A. D., Tirupattur and Sri P. Gopalakrishnan, A. D., Nanganeri are posted for the scheme of the multiplication and distribution of Kurunganni cotton with centres at Aruppukottai and Koilpatti respectively; Sri L. K. Narayana Ayyar, A. A. D., Papanasam to be Agricultural Instructor, Central Jail, Trichinopoly, vice Sri P. Subramania Ayyar transferred as F. M., A. R. S., Pattukottai relieving Sri K. Ramanathan posted as F. M., A. R. S., Palur; Sri G. Kameswara Rao, A. D., Losarigutlapadu and Mutyalapadu Land Colonisation Co-operative Societies is posted as A. D., Bapatla; Sri S. Venkataraman A. A. D., Nannilam to be A. A. D., Omalur.

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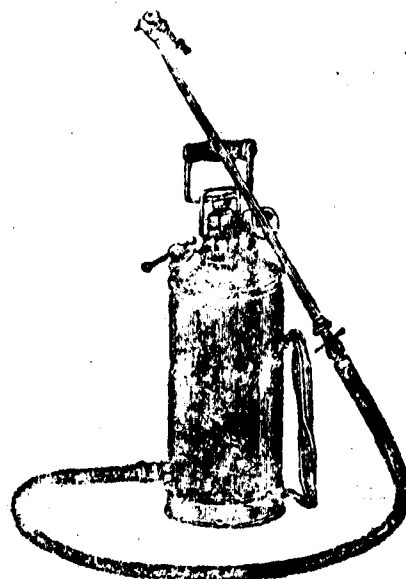
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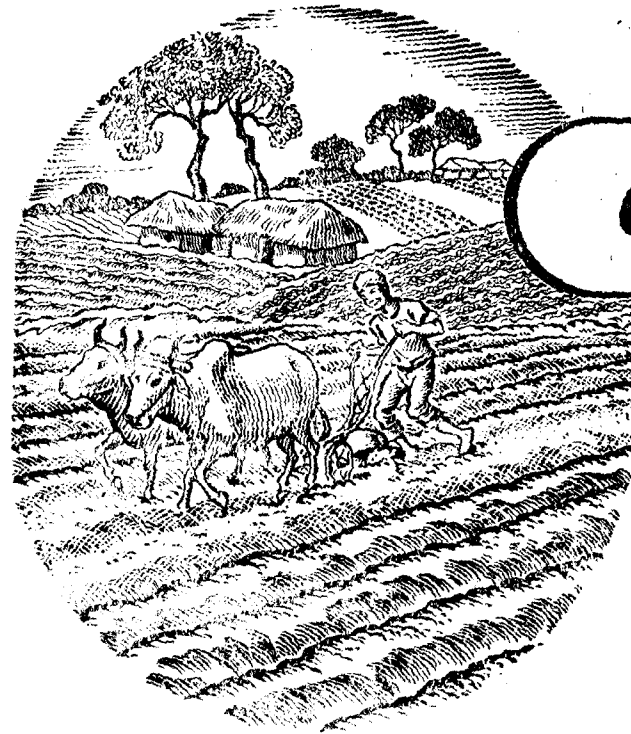
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