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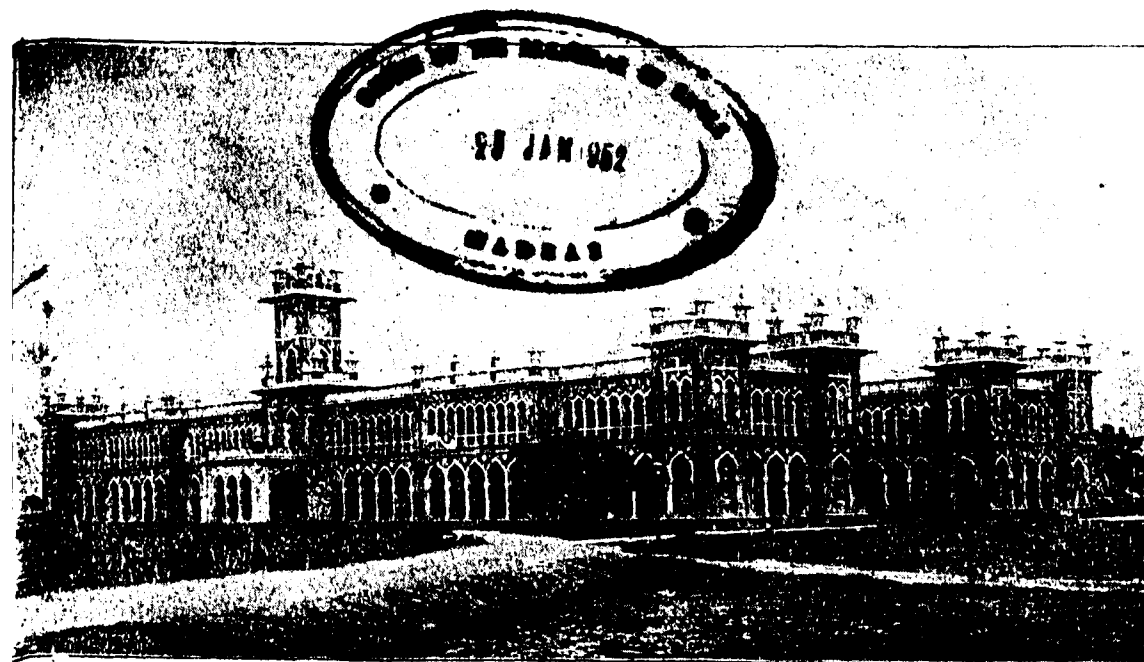
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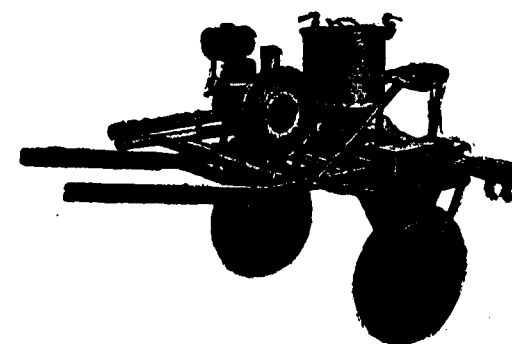
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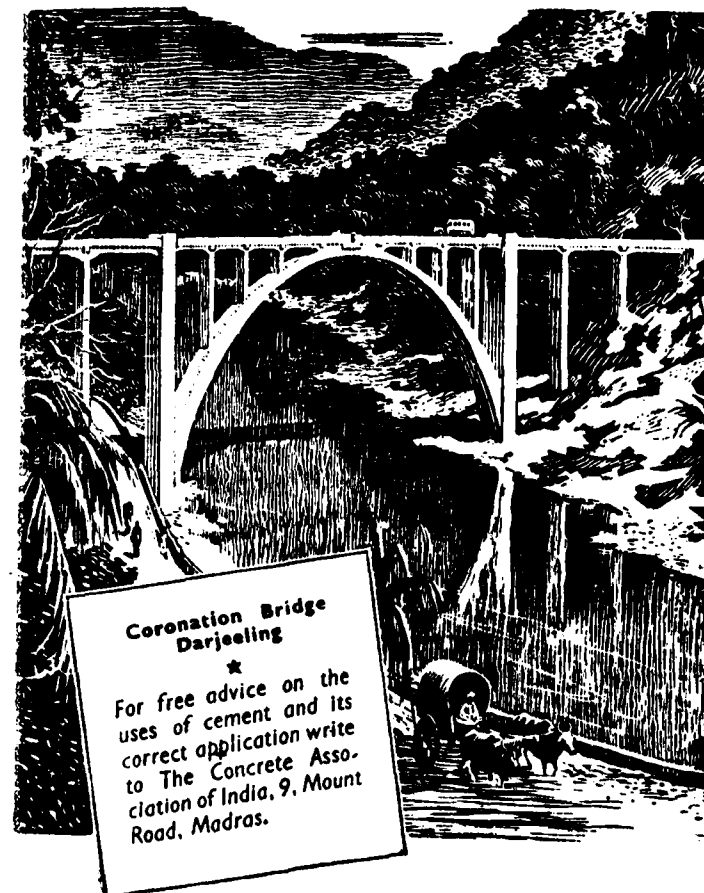
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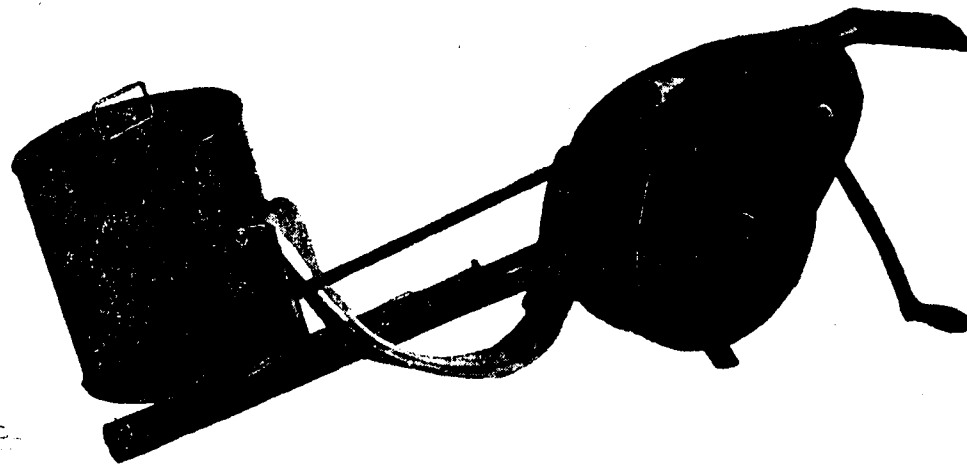
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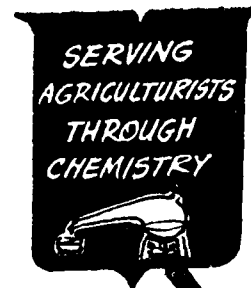
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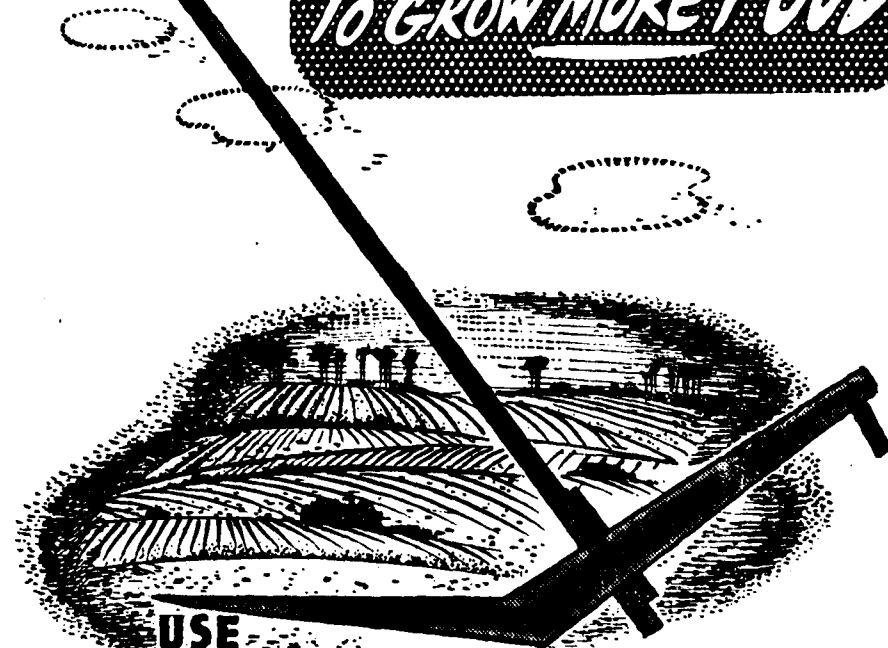
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and the average yields of the same crops under Indian conditions. For instance, the average yield for paddy is reckoned only at 907 lb. per acre; the average yield for wheat at 800 lb. and the average for potatoes is only 14,800 lb. per acre, all pitifully low when compared with the average yields reported from other countries of the world. In fact, it is quite a familiar feature to find India relegated to the last place, bringing up the tail-end with a ridiculously low figure, in all the graphic representations of the commercial products of the world. Thus the average yield of milk per cow is 20.5 lb. in Holland, 15 lb. in England and 14 lb. in New Zealand, while the average yield of an Indian cow is just over 2 lb. of milk per day. In spite of the fact that we possess nearly one-third of the world's cattle population, we produce only 12 per cent of the world's milk. The same is the tale in the case of nearly every other product. In rice, the average yields in other countries are: Italy 3,000 pounds per acre, Japan 2,300 lb., Egypt 2,000 lb. U. S. A. 1,450 lb., China 1,400 lb., while India comes last with 907 lb. per acre. In fairness it should be said, however, that about 17 per cent of our cultivated area gives two crops in a year, which fact is not allowed for in these statistics and we have also to allow for the common practice (as for example in the Tanjore area), of reporting paddy yields only after deducting a number of other items, such as for seed, for "mahimai" and for the tenants' quotas. To that extent our actual yields may not be quite so poor as they look on paper, but the fact remains that a very wide margin of improvement is both possible and necessary in the direction of improving our average yields in all crops. What our country needs at present is not so much a mere extension of food-growing areas as an all-round intensification of cultivation methods and improvement in the efficiency of crop production.

Water Requirements of Crops, with Special Reference to Rice

By

SRI M. B. V. NARASINGA RAO,
Paddy Specialist, Coimbatore.

Since all agriculture is dependent on water, it is not surprising that centres of ancient civilization have all been close to perennial river systems. Later on, people have constructed dams and storage reservoirs, to spread out the water supply from these rivers more uniformly and control the risk of periodical floods and inundations. Tank systems are also similar in their aim and execution. In any system of irrigation however, one has to take into account the quantity of water available and the quantity needed by different crops at different stages of their life cycle.

The present paper is a review of the work done so far in India, on the water requirements of different crops, with special emphasis upon Rice, as it is the most important amongst all our food crops. The material has been culled out from various Annual Reports of different State Departments of Agriculture and Schemes financed by the Indian Council of Agricultural Research (1).

The chief factors influencing loss of water from cropped fields are (1) field evaporation, (2) transpiration by growing plants, (3) seepage losses and (4) the preparatory treatments that the land had undergone, such as flooding etc. These factors are in turn influenced by climatic conditions, the nature of the soil and sub-soil, the depth of ground water table, the length of the irrigation season and the agronomic practices in vogue in the particular tract in question. It is also to be kept in mind that not only do different crops require different amounts of water but that even the same crop needs different amounts of water at different stages of its growth-period.

Amongst the factors that influence water losses, the nature of the soil, the distributing channels and the distance of lead are important, as they determine the "transmission losses" as distinct from loss by evaporation. At Maruteru in the Godavari delta, the daily loss of water due to transpiration was nearly 0.02 inch. At Aduthurai in the Tanjore delta, the loss by seepage amounted to 0.02 to 0.03 inch per day, that from evaporation to another 0.02 to 0.03 inch, while the loss from actual transpiration of the rice crop varied from .01 to .06 inch per day in different seasons and years. Thus the aggregate loss of water was nearly 0.1 inch per day.

An estimate of similar "evaporo-transpiration" figures is given below for other crops, as reported by McKenzie Taylor (1) in an investigation on the rise of water table in the Punjab in the Upper Chenab Canal area.

Crop.			Water consumed (evaporo-transpiration in inches)
Millet	...	...	8
Maize	...	...	9
Cotton	...	...	12
Fodder	...	...	14
Sugarcane	...	...	38
Rice	...	...	22
Rice (In Madras)	...	...	26 to 29 inches
			(over a period of 135 days' duration).

It would be clear from these data that rice is a crop that needs large quantities of water, although it can adapt itself to some extent to insufficient water supplies.

Singh and his co-workers in the Banaras University (2) observed that there were three distinct periods of high water requirement in paddy, the first during the seedling stage extending over a period of 10 days, the second during the pre-flowering stage covering about 25 days and the third during the time when the grains are formed, covering a period of 5 or 7 days.

Bihar : Experiments (2) were conducted to find out the growth of rice plants under varied conditions of water supply, viz.,

- (1) Paddy soil with standing water
- (2) Paddy soil under puddled conditions
- (3) Paddy soil under a cracked condition

and it was found that paddy thrived best under puddled conditions. The water requirements of late or long duration varieties were (as would be expected) definitely higher than that of early or medium duration varieties.

It was also observed that the water requirements of drought-resistant and flood-resistant types of paddy were lower than that for ordinary varieties of the same duration group, the drought-resistant types being the lowest in their water requirements.

Both in late and in early varieties there was a gradual rise in water requirements from the early stages upto the flowering stage, the maximum being attained just before flowering. The actual water requirement just prior to flowering was about two or three times the quantity required 10 to 15 days before flowering or the quantity required after flowering was over. Soon after flowering, there was a decrease in the water requirement.

Manuring was helpful not only in enhancing yields but also in lowering the water requirement. It was further noted that plants receiving farm-yard manure showed a lower water requirement than those receiving artificials like ammonium sulphate.

Once the rice plants had got well established they did not need standing water, but only a moist soil surface for optimum growth and yield. In pot-cultures water-logging was found to retard growth and tillering, but this aspect needs confirmation from field trials.

Assam : Experiments (2) carried out at the Karimganj Farm, to find out the water requirements of rice under varied conditions, showed that (1) the water requirement was somewhat higher in loams than in clayey soils and (2) the water requirement was found to be the least in unmanured plots and the highest in plots treated with Ammophos.

In Bengal, the minimum amount of water for a successful crop of rice was found to be 40 inches of total depth. A certain reduction in the transpiration rate was observed in the case of rice plants manured with phosphates and it was also noted that in years of deficit rainfall, phosphates were definitely helpful in maturing a crop that would otherwise suffer from insufficient moisture.

It was also noted that excessive watering in the early stages of growth was detrimental to tillering in the case of *aus* or autumn paddy, but during the flowering stage frequent watering was necessary.

Similar investigations by Sen (4) in the Calcutta University, have shown that plant height increased with the height of water standing in the field but standing water suppressed tiller formation in rice, the number of tillers decreasing progressively with an increase in the depth of standing water allowed. When the field was allowed to crack by drying out, flowering was delayed in *aus* paddy. Flooding the field after transplanting for a period of three weeks for *aus* varieties and somewhat longer for *aman* or winter varieties that have a longer duration, followed by subsequent de-watering, was beneficial to crop growth but during the later stages of growth, drainage was essential for proper aeration.

The optimum water supply for maximum yields was found to vary with different varieties of rice.

Hector (5) showed that the transpiration rate was a varietal characteristic which remains fairly constant for any given variety over a wide range of moisture levels. The rate of transpiration per unit area of leaf surface was markedly different between two varieties—one early and the other late, that were studied. The transpiration rate was higher in the early type. In the early type, the ratio of leaf to root was much larger than in the late type and further the stomata, though nearly the same in number per unit leaf area, were also demonstrably larger in size.

Experiments at Cuttack in Orissa (2) indicated that where irrigations were given in addition to rainfall, the paddy yields were improved. Thus, two three and four inches of water per acre were supplied to broadcast winter rice, in addition to the usual rainfall that was received during the growth period and it was found that 2 inches of "extra water" gave the best yields.

In Madhya Pradesh (3), experiments were carried by Bal (6) with medium and long duration varieties, growing under three conditions namely, (1) with standing water, (2) watered when needed and (3) no irrigation, and in two types of soils "Dorsa" clay loams and in "Matasi" sandy loams. The best yields were obtained from the late variety growing in standing water, both in the clay loams and sandy loams. In very heavy soils however, the rice crop showed better growth under well-drained conditions rather than when grown in standing water.

In Bombay, the water lost by transpiration during the life cycle of the paddy plant was found to be equivalent to nearly 25 inches of rainfall, whereas Singh and his co-workers at Banaras calculated that the quantity used up in transpiration and evaporation amounted to 27.4 inches of rainfall. In Assam, the experiments indicated that transpiration rate was closely following the fluctuations in daily temperature.

This type of evidence does not however clarify the question as to why a wet-puddled and submerged condition are necessary for good growth in rice. It has been suggested that such submerged condition provides certain constituents that are not available in semi-dry or "merely moist" conditions, one such constituent being silicon.

In Madras, irrigation experiments have been carried out by the Agricultural Department in this State, first to ascertain the quantity of water required by crops and then to find out the details of time and quantity of water needed, to secure the maximum yields. In the case of rice the total quantity of rice was determined in the first stage and in the second epoch the best method of distributing a definite quantity of water over the life-time of the rice crop was sought to be determined.

Some of the early experiments were conducted in ryots' fields; some were with flow irrigation from canals, while others were carried out with irrigation from wells. The aim of these early experiments was to find out how much water was needed and at what intervals it should be supplied for different crops like paddy, cholam, ragi, cotton, cumbu, groundnut and sugarcane. Later on, the experiments were confined to Agricultural Research Stations with larger areas and a more detailed set of treatments.

The table below gives the duty of water for different crops at different stations in the Madras State (3), representing different tracts and regions. The duty of water is the irrigation work which a given

quantity of water can perform and is usually shown as the number of acres on which a crop can be irrigated by a continuous flow of water at the rate of 1 cubic foot per second.

TABLE I
Duty of water for various crops

Agricultural Research Station	Region	Soil	Crop	Period of growth	Average duty of water
Maruteru	Godavari and Krishna deltas	Heavy, black clayey soil	Sugarcane	Mar-Jan.	107
			Banana.	do. do.	136
			Rice first crop.	June-Dec.	81
			Rice second crop.	Feb-Mar.	54
Aduthurai	Cauvery (old delta)	Light clay (alluvial loam)	Rice-Kuruvai	July-Oct.	68
			" Samba	Aug-Jan.	76
			" Thaladi	Oct-Feb.	80
Pattukottai	Cauvery (New Delta)	Sandy loam	Rice-Kuruvai	July-Oct.	37
			" Samba	Aug-Jan.	47
			" Thaladi	Oct-Feb.	67
Coimbatore	Canal fed, supplemented by wells	Black cotton soils—of a lighter type	Rice	Aug-Feb.	51
			Ragi	May-Sep.	130
			Sorghum	May-Sep.	120
			Cotton	Oct-April	190
Lower Bhavani Project area		Loose, gravelly soils.	Rice	Aug-Feb.	40
Siruguppa	Tungabhadra Project area	Heavy, black cotton soils	Rice	July-Dec.	60
			Sugarcane	Mar-Feb.	99
			Bajra	June-Dec.	103
			Ragi	July-Oct.	126
			Groundnut	July-Oct.	156
			Sorghum	June-Sep.	163
			Wheat	Nov.-Mar.	235
			Cotton	Aug-Mar.	265

The quantity of water needed for rice varies according to the nature of the soil and locality, the state of the land prior to and at the time of planting the crop, and the quantity and distribution of the rainfall that is received during the life time of the crop. In certain special tracts as in the sandy loams of the Pattukottai area, the duty of water for the *Kuruvai* crop between July and October is as low as 37, whereas in the deltaic areas of Maruteru, where there is an assured supply of irrigation water and also good rains between June to October, the duty of the first crop of paddy may be as high as 81. Even at Pattukottai, and at Aduthirai too, the *samba* and *thaladi* crops have generally a higher duty of water than the *Kuruvai* crops.

At Coimbatore, where a long duration *samba* type of rice is grown under tank-fed irrigation, an average of 51 inches of water is required per acre in addition to the rainfall that is received during the growth of this crop.

The duty of water in the heavy black soils of the Tungabhadra Project area works out to 60, whereas in the loose gravelly soils of the Lower Bhavani Project area, the duty is only 49 for rice.

The next series of experiments, which were continued from 1938 to 1942 are summarised in Table II. The results of these experiments, though they are not very consistent, still serve to indicate the following conclusions:—

At Maruteru Agricultural Research Station (West Godavari System) the results were not significant for the first crop in any year but in the second crop season, it was noted that the yields were in proportion to the quantity and frequency of water supplied. The control plots which received the largest quantity of water nearly always gave the highest yields. A similar result was noticeable in the sandy loams of Pattukottai in the Cauvery Mettur Project area, though here too, the results were not significant in all the seasons. At Aduthurai, due to the fact that the plots where the experiments were laid out were all more or less at the same level, water that was let into any one plot, got distributed by mere seepage to practically all plots, so that no conclusions are possible from the experiments at this Station.

At Coimbatore, where the water supply for the rice crop is from tank-fed channels, supplemented by well irrigation, the differences were not significant in three out of five years, i. e., when the rainfall was normal or above normal. In years of deficient rainfall however, treatment A i. e., 2" irrigation given at 3-day intervals, gave the best yield and equalled the yield from plots that had standing water throughout. Other treatments, receiving water at wider intervals recorded lower yields.

TABLE II
First set of experiments

Treatments

A — 2" in 3 days	E — 4" in 12 days
B — 2" in 6 days	F — 4" in 18 days
C — 2" in 9 days	G — Normal for 4 weeks and
D — 4" in 6 days	4" in 12 days
	H — Normal — standing water

Results

Yield of grain — Single crop
Paddy Breeding Station, Coimbatore.

Year	A	B	C	D	E	F	G	H	Z test P—0.05	C.D. P—0.05
1938—39	2786	2458	2228	3094	2425	2259	3016	2915	Yes	558.8
1939—40	2840	2663	2319	2819	2566	2394	2719	1300	No	
1940—41	2106	1750	1806	2119	1925	1663	1806	1950	No	
1941—42	4320	3976	3117	4357	3121	2940	3714	4222	No	

Agricultural Research Station
Maruteru—First Crop

Year	A	B	C	D	E	F	G	H	Z test P—0.05	C.D. P—0.05
1938—39	3100	3025	3016	2981	3190	2975	3086	3152		
1939—40	2352	2481	2410	2291	2349	2057	2412	2463	Yes	47.3
1940—41	2863	2844	2370	2710	2653	2233	2612	3025	Yes	88.8
1941—42	2370	3124	2743	3383	3227	2712	3161	3434	Yes	370.3

In a second series of experiments, from 1943 to 1947, (at the Agricultural Research Station, Aduthurai on *Samba* paddy), the treatments were slightly modified, as indicated in Table III.

TABLE III
II. Second set of experiments—Treatments

A 1" minus rainfall	...	Once in 3½ days
B 1" ignoring "	...	" 3½ "
C 2" minus "	...	" 3½ "
D 2" ignoring "	...	" 7 "
E 2" minus "	...	" 7 "
F 3" minus "	...	" 7 "
G 4" minus "	...	" 7 "
H 3" of water at all times (Control).		

Yield of grain

Year	A	B	C	D	E	F	G	H	Z test P—0.05	C.D. P—0.05
Paddy Breeding Station, Coimbatore.										
1943—44	1763	1825	1616	1928	1734	1481	1913	2047	No	
1944—45	2467	2755	2717	1713	2656	2725	2931	2825	No	
1945—46	2949	3107	3107	3012	3201	2918	2969	2069	No	
Agricultural Research Station, Aduthurai (<i>Samba</i>)										
1943—44	2320	2350	2250	2360	2350	2350	2390	2370	No	
1944—45	2539	2627	2506	2612	2400	2450	2353	2533	No	
1945—46	3806	4130	4250	3865	3900	4030	4940	4100	No	
Agricultural Research Station, Maruteru.										
1943—44										
I crop	3118	3004	3133	3091	3245	2678	3004	3311	No	
II crop	2451	2486	2474	2325	2302	2429	2354	2599	No	
1944—45										
I crop	3211	3289	3276	3070	3063	3298	3131	3189	No	
II crop	2289	2320	2381	2238	2333	2054	2327	2522	No	
1945—46										
I crop	2200	2336	2328	2314	2340	2445	2395	2476	No	
II crop	1670	1697	1932	1464	1472	1692	1562	2035	Yes	258
1946—47										
I crop	2914	2911	3053	2914	2900	2992	3262	2982	No	
II crop	1568	1587	1372	1430	1352	1381	1442	1783	Yes	265

These trials were carried out at Coimbatore, Aduthurai and Maruteru. The Coimbatore trials were inconclusive on account of the failure of monsoons. At Maruteru, the control i. e., "depth of water kept standing at all times", gave the highest yields in two first-crop seasons and was on a par with the treatments receiving water at $3\frac{1}{2}$ days intervals. All the treatments where water was supplied at 7-day intervals, recorded poorer yields. At Aduthurai, the results of this series of experiments too, were inconclusive in all the three years of trial.

In a third set of experiments commenced in 1948, the time of planting was varied and the water allowed was given to different depths, this quantity being further split up into different phases of crop-growth. The main indications from this series were that the yields were more dependent on the time of planting, than on the quantity of water supplied. The inter-actions between different planting periods and different quantities of water supplied were also not significant.

Another set of experiment was carried out for 2 seasons (1946 and 1949) to find out how far drying out of paddy fields would affect the ultimate yields as compared to the ryots' practice of keeping a film of water standing throughout the season. This intermittent drying out was suggested as an anti-malarial measure to aid in destroying mosquito larvae that are usually found in the standing water in rice fields. The results indicated that yields were the highest in plots where water was always kept standing. In the 1949 season, keeping the fields 'dry' for two days appeared actually to improve the grain and straw yields. Keeping the field dry for three days before letting in water, had no adverse effect on yields, but drying for 4 days was slightly harmful, while drying for 5 days was definitely so, lowering the yields by nearly 20% from controls. A similar trend was noticeable in the straw yields also and it may be concluded therefore, that paddy fields should not be kept without standing water for more than three days at a stretch.

Irrigation experiments on rice have also been conducted at the Siruguppa Agricultural Research Station in the Tungabhadra Project Area. These showed that irrigating the heavy, black, clayey soils of the Tungabhadra Project area did not lead, as apprehended at the outset, to any rise of deleterious salts from the sub-soil to the surface as a result of irrigation. It was also noted that a single crop of long duration rice could be grown to better advantage in the Tungabhadra Project area, than a double crop of two short-duration varieties. Where sugarcane was grown in rotation with rice, both the crops were seen to be benefited on account of the fallow period that intervenes once in two years, between September to June.

Another observation was that better yields could be secured when rice was grown in the well-drained, shallower soils in the Tungabhadra Project area, than on the stiff, black clayey soils where drainage was

more difficult. In order to bring the land into proper condition, any system of cropping and particularly so for rice, must include deep ploughing and drying out of the soil during the fallow period. To this end it is necessary to devise an integrated system of co-operative planning in the Tungabhadra Project area, according to a zonal pattern, so that soil moisture could be maintained at optimum levels at the right time, in the various places to be served by the Tungabhadra Project. And for this, sufficient experimental data and basic knowledge regarding the water requirements of different crop plants are essential, since wastage of water would only add to the sub-soil reservoir and lead to water-logging and eventually reduce the usefulness of the irrigation system itself.

Discussion: It would be noted from the above summary of work that the experiments so far conducted have all been more or less on empirical lines. Numerous factors that are concerned in the water requirement of crops have been omitted from consideration. The main results from all the experiments reviewed so far are only that (1) rice needs more water than any other agricultural crop, (2) that more water is needed by a rice of longer duration than a short duration type, and (3) that the quantity of water needed depends to a large extent on the type of soil as well. An integrated picture of the behaviour of the rice plant in regard to its water requirement is still lacking and a good deal of further study is still needed to attain this end. The main lines along which studies may be carried out are indicated below.

Three aspects are involved in any study of the water requirements of crops, namely the soil, plant and the atmosphere and none of them may be ignored in any scheme of investigation on this subject, particularly when paddy is the crop plant that is proposed to be investigated. The rice plant is in several respects rather peculiar and differs from other crops in requiring a special set of soil-water conditions before it can thrive.

In spite of the fact that it is one of the oldest and best studied among crop plants, a number of problems remain still unsolved, such as:—

- (1) how far puddled conditions are essential or advantageous for rice growth,
- (2) how far the presence of an algal film is necessary for good growth of rice
- (3) the inter-relations of these with the water requirement of rice plants at different stages of the life cycle.
- (4) Basic knowledge regarding the water requirements of all the different varieties (or at least the most important types) under a standard set of soil, moisture and atmospheric

conditions (i. e., temperature, light and humidity) should be gathered first, before any attempt is made to extend the study to the variations in water requirements brought about by a different set of soil and moisture conditions, and also the effect of different manurial treatments.

In view of the fact that no amount of care can duplicate in pot cultures the same conditions that exist in the field, the findings from pot culture studies have necessarily to be verified and confirmed by field tests. However pot-culture studies may be made to approximate to field conditions by making use of lysimeters of large surface and soil capacity. A further advantage in these will be that they can be kept under controlled conditions of light, temperature and humidity so that the experiments of one season can be repeated in other seasons with a greater expectation of reproducible results. Under such controlled conditions, observations on the micro-climate in and around the crop can be recorded and conclusions drawn therefrom, within a shorter period of years than under field conditions.

It is therefore suggested that this line of investigation is one that merits serious attention if the problem of utilising the available water supply to the best advantage in crop production in general and rice production in particular, is to be solved in a satisfactory manner.

Acknowledgement: Thanks are due to Sri T. R. Narayanan, Plant Physiologist, for his helpful criticisms in preparing this paper.

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Rainfall at Coimbatore as Influenced by Other Meteorological Factors

By

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Introduction: No aspect of climate has greater economic significance than rainfall. It is a recognised fact that success in crop production is mainly due to the receipt of timely rains in required quantities. So the importance of precipitation to agriculture hardly needs to be emphasized.

Material and Methods: The meteorological data collected in the observatory attached to the Agricultural College and Research Institute, Coimbatore, for a period of 37 years were taken up to assess the relative influence of the various meteorological factors like relative humidity, maximum and minimum temperatures and wind velocity on the rains received in the locality where the Institute is situated.

At first simple correlations between various factors were worked out for different months of the year. Then the mean co-efficients of correlation were worked out between rainfall and other factors, for all possible combinations of the variables taken in pairs, after which the partial correlations were worked out to assess the relationship between rainfall and relative humidity by removing the interference due to other meteorological factors.

Results and Discussion: The results of analysis of the weather data are furnished in tables I, II and III. They reveal the following features:—

Of all the possible combinations of the five elements of climate studied, a high degree of positive correlation exists between rainfall and relative humidity and a significant negative correlation between rainfall and maximum temperature.

The partial correlation between rainfall and relative humidity after eliminating the other three factors, namely, maximum temperature, minimum temperature and wind velocity is + 0.3959, while the total correlation without the elimination of these three factors is + 0.5321. This proves the importance of these three elements of climate as influencing precipitation. Further, it becomes evident that no one climatic factor acts alone.

There exists a significant total negative correlation between relative humidity and maximum temperature. Eliminating the effects of minimum temperature and wind velocity, either singly or in combination, the degree of negative correlation between relative humidity and

maximum temperature is enhanced and the coefficient of correlation becomes highly significant. High wind velocity, especially when accompanied by low atmospheric humidity, reduces chances of precipitation.

There is a positive significant total correlation between relative humidity and minimum temperature and there is an apparent increase in the value of the coefficient of correlation, when the effects of maximum temperature and wind velocity are removed, but it is not significant. Low wind velocity seems to form conditions favourable for condensation of clouds.

Conclusion: Rainfall is a vital factor which goes a long way in accentuating crop production. The other factor of climate like relative humidity, air temperature and wind velocity are important in influencing the precipitation.

Acknowledgment: The authors are highly grateful to Sri M. B. Venkatanarasinga Rao, Paddy Specialist, for his valuable guidance in the preparation of this note. Their thanks are also due to all those who have been responsible for the collection of the data, forming the basic material for this paper.

TABLE I
Total and Partial Correlations of all possible combinations of Factors Taken in Pairs.

1 = Rainfall, 2 = Relative Humidity
3 = Maximum Temperature, 4 = Minimum Temperature.
5 = Wind Velocity,

S. No.	Factors between which correlation has been worked out	Total Correlation.	Partial Correlation
1.	Rainfall and Relative Humidity	+ 0.5321**	r12.345 + 0.3959*
2.	Rainfall and Maximum Temperature	- 0.4652**	r113.245 - 0.3378*
3.	Rainfall and Minimum Temperature	+ 0.1405*	r14.235 + 0.1047
4.	Rainfall and Wind Velocity	- 0.0182	r15.234 + 0.0356
5.	Relative Humidity and Maximum Temperature	- 0.4005*	r23.145 - 0.2453
6.	Relative Humidity and Minimum Temperature	+ 0.2000*	r24.135 + 0.1923
7.	Relative Humidity and Wind Velocity	- 0.1259*	r25.134 - 0.1621
8.	Maximum Temperature and Minimum Temperature	+ 0.0809	r34.125 + 0.2012
9.	Maximum Temperature and Wind Velocity	- 0.0303	r35.124 + 0.0010
10.	Minimum Temperature and Wind Velocity	- 0.0844	r45.123 - 0.0606

Note: — * Significant.

** Highly Significant.

Rainfall at Coimbatore

551

157.35-12

TABLE II.
Correlation Between Rainfall and Relative Humidity showing the Successive Values of Partial Correlation after the Elimination of other Factors.

S. No.	Particulars of the factors correlated	Total Correlation	After eliminating one factor	After eliminating two factors	After eliminating three factors
1.	Rainfall and Relative Humidity	r12 + 0.5321†	r12.5 + 0.5343 †	r12.45 + 0.5222 †	r12.345 + 0.3959*
			r12.4 + 0.5194 †	r12.43 + 0.3953 *	
			r12.3 + 0.4204 †	r12.35 + 0.4248 †	
2.	Rainfall and Maximum Temperature	r13 - 0.4652 †	r13.5 - 0.4670 †	r13.45 - 0.4839 †	r13.245 - 0.3378*
			r13.4 - 0.4831 †	r13.42 - 0.3378 *	
			r13.2 - 0.3250	r13.25 - 0.3210	
3.	Rainfall and Minimum Temperature	r14 + 0.1405*	r14.5 + 0.1395	r14.35 + 0.1990	r14.235 + 0.1047
			r14.3 + 0.2018	r14.23 + 0.1036	
			r14.2 + 0.0373	r14.25 + 0.0409	
4.	Rainfall and Wind Velocity	r15 - 0.0182	r15.4 - 0.0064	r15.53 - 0.0315	r15.234 + 0.0356
			r15.3 - 0.0470	r15.23 + 0.0236	
			r15.2 + 0.0581	r15.24 + 0.0605	

† Highly Significant.

Note: — * Significant.

TABLE III
Correlation Between Relative Humidity and Maximum Temperature Showing the Successive Values of Partial Correlation after the Elimination of Certain Factors.

S. No.	Particulars of factors correlated	Total Correlation.	After eliminating one factor	After eliminating two factors	After eliminating three factors
1.	Relative Humidity and Maximum Temperature	$r_{23} = 0.4003^*$	$r_{23.1} = 0.2040$ $r_{23.4} = 0.4278 \dagger$ $r_{23.5} = 0.4107^*$	$r_{23.45} = 0.4358 \dagger$	$r_{23.145} = 0.2453$
2.	Relative Humidity and Minimum Temperature	$r_{24} = 0.2060^*$	$r_{24.1} = 0.1565$ $r_{24.3} = 0.2611$ $r_{24.5} = 0.1977$	$r_{24.35} = 0.2523$	$r_{24.135} = 0.1923$
3.	Relative Humidity and Wind Velocity	$r_{25} = 0.1259^*$	$r_{25.1} = 0.1373$ $r_{25.3} = 0.1586$ $r_{25.4} = 0.1260$	$r_{25.34} = 0.1613$	$r_{25.134} = 0.1621$

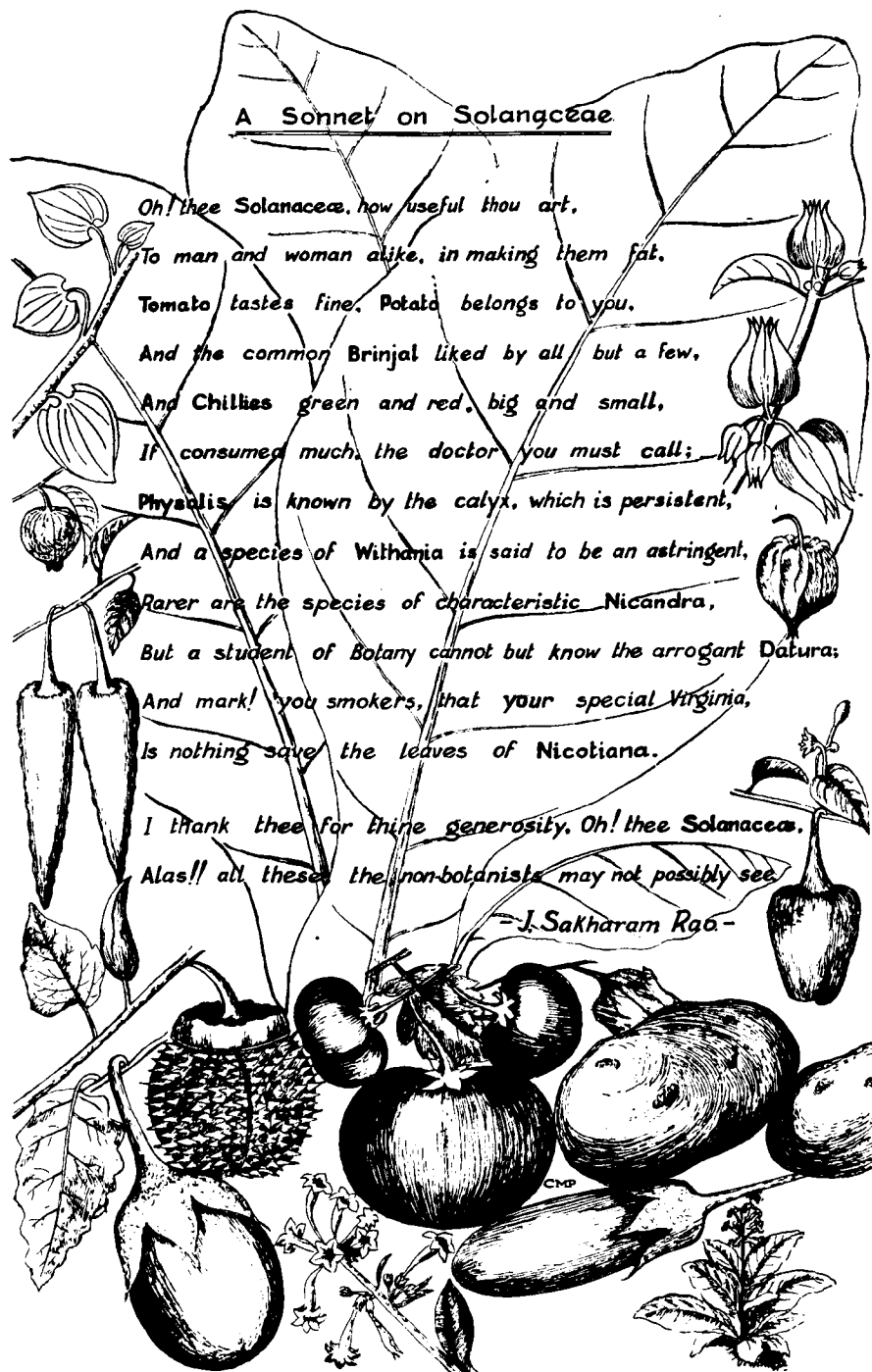
Note:— * Significant.

† Highly Significant.

A Sonnet on Solanaceae

Oh! thee Solanaceae, how useful thou art,
To man and woman alike, in making them fat.
Tomato tastes fine, Potato belongs to you,
And the common Brinjal liked by all but a few,
And Chillies green and red, big and small,
If consumed much, the doctor you must call;
Physalis is known by the calyx, which is persistent,
And a species of Withania is said to be an astringent,
Rarer are the species of characteristic Nicandra,
But a student of Botany cannot but know the arrogant Datura;
And mark! you smokers, that your special Virginia,
Is nothing save the leaves of Nicotiana.
I thank thee for thine generosity, Oh! thee Solanaceae.
Alas!! all these the non-botanists may not possibly see.

-J. Saktharam Rao-



Two New Berry Fruits — Blackberry and Raspberry (Rubus spp.) for the Hill Ranges of South India

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and

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Among the better-known bush fruits, Cape gooseberry and strawberry are at present grown on a more or less field scale in hill regions of South India between elevations of 5,000 and 7,000 feet. Blackberry and raspberry were introduced for trial at Coonoor in 1946. In the first two or three years, the plants made very slow growth. Their later performance, however, proved to be promising, and they can now be deemed as two valuable additions to the bush fruits suitable for cultivation on the hill ranges of South India. These should prove of particular appeal since their cultural requirements are far less fastidious than other crops like the strawberry.

Description: Both blackberry and raspberry are low, straggling and prickly shrubs popularly known as brambles. The former bears small, globular and irregularly-shaped, soft fruits which become purplish dark when fully ripe, each fleshy carpel of the fruit (botanically the fruit is an aggregate of drupelets) containing a small stone inside. The juicy fruits have a mild and pleasant, sub-acid flavour. Raspberry, on the other hand, bears much softer fruits than the blackberry with characteristic cone-shaped fruits with a hollow centre and are bright pink in colour when fully ripe. Raspberries have a somewhat woolly flesh, and possess a more agreeable taste than blackberries, being less acidic. The fruits, in either case, are about $\frac{1}{4}$ " to $\frac{1}{2}$ " in diameter and are borne either on sides of long, straggling branches known as "canes" or on their tips.

Climatic and Soil Requirements: Both blackberry and raspberry are suited for growing under temperate or subtropical conditions of climate as exist at elevations of 5,000 to 7,000 feet. Climatic conditions which favour the growth of fruits such as apple, pear and plum, may be considered as congenial to them also. They are not fastidious as to the soil, but grow best on well-drained loams supplied with plenty of organic matter. Lighter soils with adequate manuring and proper attention are also suitable. Judged by their growth and cropping at Coonoor (5,800 feet) on the Nilgiris, most of the hill regions of our State characterised by similar climatic features may be expected to prove suitable for the cultivation of the blackberry and raspberry.

Culture: The simplest method of planting is in rows five feet apart with two feet from plant to plant. The plants (root suckers or tip-layers) are set out in pits dug in well-prepared and manured land. Planting in moderately rainy weather aids in quicker establishment of the plants. When once the plants are well established and begin to produce "canes" which form the main fruiting branches later, no elaborate inter-cultural operations are necessary, except periodical removal of weeds and an occasional hoeing.

The plants usually produce a number of root suckers which should be periodically thinned, till the plants attain the bearing age. Otherwise they are likely to weaken the main plant and make it too straggling in growth. As the plant grows, a number of branches or 'canes' are produced, which should be tied to wires, trellises or stakes, keeping the shape open. Just before spring, the canes are cut back to firm wood to induce the formation of side branches that will yield sprays of fruit later on. The canes of one season produce fruit in the following season, after which they are cut down. Thus three to five new canes are allowed to form for the following season, and when harvest is over, these are removed and others allowed to emerge for subsequent fruiting. The process is thus repeated annually for producing new canes year after year. Excessive shortening of the fruiting canes should be avoided, particularly in the raspberry, which carries its crop near the tips of branches. In blackberry too, which bears most of its crop laterally on either side of long canes a severe cutting back appears unnecessary; only really old wood need be removed, tipping the other growths to the minimum extent necessary.

The plants, soon after the harvest is over may be manured with about 5 to 10 lb. of cattle manure and one-fourth to half a pound of oil-cake or other organic manure per plant. By such systematic attention to pruning, manuring and other cultural operations it is possible to obtain uniformly good yields over prolonged periods.

No major pest or disease has been observed on the crops at Coonoor.

Cropping: Blackberries usually begin to bear from the second year after planting, while raspberries come to yield about a year later. The former are available for harvest from May onwards and the crop lasts for about a month after that, while raspberry fruits a little later in the season and continues to yield till about the end of June, or middle of July.

Under Coonoor conditions, the yield of raspberry has averaged about 50 to 100 fruits per plant, while that of blackberry has been appreciably larger with a mean yield ranging from 200 to 300 berries per

plant, of which nearly 120 to 150 fruits of the former and 90 of the latter go to a pound. On the above basis an acre yield up to nearly 3,000 lb. from raspberry and about 6,000 to 10,000 lb. from blackberry may be expected.

Propagation: Both the fruits can be propagated either through root-suckers which are abundantly produced around each plant from the time the plants are established or from "tip-layers". The latter gives better results, and high-yielding canes are best perpetuated in this manner.

The method of tip-layering is briefly described below:—

Small holes are made in the ground near the parent plant about three to four inches in depth. A small quantity of manure is placed at the bottom of each hole and the tips of selected canes buried into the holes about an inch deep, covered by soil and trodden down firmly. It may be necessary to peg down each layered cane in order to keep it in position. Care should be taken to see that the canes are not unduly bent while layering. The tip-layers are ready for separation in about two to three months' time. It is better to leave them as they are in the ground for sufficient development of roots and sever them only at the time of planting, as this would ensure better and quicker establishment of the plants after final planting in the field. The best period for tip-layering at Coonoor has been found to be September—October.

Uses: The fruits of both blackberry and raspberry can either be eaten out of hand or made into preserves, as jams, jellies or other forms to suit different tastes. The fresh fruits when eaten with cream make a fine table dessert. They are sometimes mixed with strawberry while serving with cream, which makes a delightful combination. It is also reported that raspberry leaves contain a valuable principle "fragarine", which has high medicinal properties. During World War II, raspberry "leaf-tea" is reported to have been largely used in welfare clinics and obstetric medicine. Blackberry and strawberry leaves also have similar medicinal properties.

Correspondence

Dear Editor,

I have read with interest your latest editorial on the subject of practical training in Agricultural education, and have also taken note of the consensus of opinion on the subject, from a perusal of the relevant proceedings of the Conference of Research Officers of the Madras Agricultural Department held in May 1951 at Coimbatore. While it will be generally conceded that a more intensive practical training in farming methods should be imparted to Agricultural graduates, I believe there is an enlightened, though yet unvoiced, body of opinion against the idea of extending the Agricultural degree course by six more months, over and above the present curriculum of three years, to achieve the above objective.

A distinction has already been recognised between (1) extending the Agricultural degree course by six more months to cover the period of training and (2) imparting practical training for six months on an Agricultural Research Station to graduates entering service in the Agricultural Department. The latter may be considered as a matter of administrative convenience determined by the needs of the Department, while the former is of greater academic importance. The proposal for the extension of the B. Sc., degree course in Agriculture, to cover a total period of 3½ years leads one to seriously consider, whether any alternative suggestions for imparting the necessary intensified practical training within the present three-year period, by a suitable adjustment of the syllabuses, have been examined and with what result.

Recently, it is increasingly pronounced in responsible quarters, that the present Agricultural education is inadequate to meet the specialised needs in the various branches of research or extension work. Hence it is suggested, that any scheme for the reorganisation of Agricultural education should now recognise the need to produce graduates distinctly trained for research or extension work. The bifurcation of the degree course at the end of two years and provision for specialised training in extension or research divisions in the third year would obviate the necessity to extend the period of the degree course. The necessary practical training, which is proposed to be given in the extended period of six months can as well be given in the third year of the B. Sc. degree course, to such of those graduates who are to make their future as agricultural advisers to the farming public. The students choosing a research career may be trained in the individual branches of science during this period. This bifurcation and specialised training will result in properly equipped scientific personnel in the different branches of agricultural science.

Lawley Road P. O.,

Dated, 7th Dec. 1951.

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Assistant in Cotton.

Agriculture News Letter, Madras

The Expansion of Rice Growing. Although a comparative newcomer among Australian grain crops, rice is now a well-established and flourishing primary product. It has been responsible for much of the development of the Murrumbidgee Irrigation Area of New South Wales, and in the future may lead to a fuller utilization of parts of Northern Australia. From a commercial beginning of 157 acres in 1924, the area under rice in the Murrumbidgee Irrigation Area expanded to 20,000 acres by 1930, but a limited water supply and fears of over-production kept the acreage to between 23,000 and 25,000 acres in the pre-war years. There are probably 100,000 acres of suitable land for rice in the Murrumbidgee Irrigation Area, but a good rotation is essential to maintain high yields. Most farmers follow a three or four-year crop rotation with wheat, oats and other cereals. The improved condition of the soil after growing rice has resulted in higher yields from other cereal crops and, in addition, the sowing of temporary pastures has led to an extension of fat lamb raising throughout the area.

During the war, extension of the acreage under rice was encouraged to meet military requirements, and a new area at Wakool, irrigated from the Murray River, was brought into production. After the war water supply problems dictated a reduction in acreage and only in the last two years have acreages approached the peak of 1943-44. The crop is acquired by the Rice Marketing Board which allocates agreed quotas to the various millers who sell both locally and overseas through private traders subject to government commitments. Since early in the war, export commitments by the Government had absorbed all but minimum quotas for

RICE PRODUCTION

	Area sown to rice	Production	Yield
	'000 acres	Million bushels	bushels per acre
1943/44	41	4.0	98.67
1948/49	33	2.7	83.79
1949/50	38	3.8	100.78
1950/51	41*	4.5*	112*

Estimates only. One bushel rice "paddy" is 42 lbs.

resident Asiatics and persons on special diet. Rice became generally available on the local market only late last year.

The harvest of 76,000 tons of "paddy" rice completed in June, should, when processed, provide 25,000 tons of polished rice for local requirements and a further 25,000 tons will be available for export, mostly to Malaya, Papua, New Guinea, New Zealand, and Pacific islands. The export demand for Australian rice has been very strong since the war, for production in the rice-exporting countries of Burma and Indo-China has been interrupted by political instability and civil war, and expanded output in Siam and elsewhere has not been able to match the rapid increase in population in Asia. The Australian Government has therefore been called on to supply as much as possible to rice-eating peoples of the British Commonwealth who would normally draw supplies from the world market. Expanded demand for rice has therefore prompted examination of some of the vast areas of Northern Australia which experts claim to be suitable for rice-growing. The extensive flooding of many of these areas in the monsoon seasons has led many to believe that rice could be cultivated with very little effort over wide areas particularly in the Northern Territory and Kimberley district of Western Australia. A survey by a New South Wales Department of Agriculture specialist in 1949 confirmed the potentialities of such

areas as the Fitzroy and Ord River plains of Western Australia, and the Adelaide, Marrakai and Daly River plains in the Northern Territory, but pointed out the impracticability of commencing operations until detailed statistics of flood levels and durations were obtained and unless a suitable variety of rice seed was available for use.

The Old River plains have long been under consideration as an irrigation project, and their use for rice-growing has been considered in relation to this larger scheme. The other areas of the Northern Territory could possibly be used with a less expensive system of levee banks to give some flood control. Quarantine restrictions on the importation of tropical varieties of rice known to be suitable to these climatic conditions are a big handicap, but it has been suggested that one of the research stations in the Northern Territory be used as a plant quarantine station to assist in this work. In the meantime, a private organization has already begun experimental sowings on the Liveringa Plains, on the Fitzroy River, south-east of Derby, Western Australia, and although using a "temperate" variety of rice, hopes to gain sufficient experience to be able to enlarge its activities within a few years. If these experiments are successful, the value to Australia of an agricultural industry in a hitherto purely pastoral area will be considerable. Provided tropical rice has the same beneficial effects on soil as other varieties have had in the Murrumbidgee Irrigation Area, it may be possible to introduce other crops in a new rotational system.

The 1951-52 Wheat Harvest. Despite reasonably satisfactory seasonal conditions throughout the growing period, except in Queensland, the coming wheat harvest is likely to be smaller than in any year since 1945/47. Yields are expected to be good from most areas, but the reduction in acreage sown has been so great that production will probably not exceed 155m. bushels. The acreage has fallen more in New South Wales than in any other State the area sown being estimated at only 29m. acres, a drop of 13% from last year. Acreages in Victoria and South Australia have been reduced by slightly smaller amounts, while Western Australia and Queensland much the same areas as last year were sown. The total acreage under wheat in Australia is estimated at 105m. acres, a fall of 11.5% from last year's 1186m. acres and 19% less than the pre-war average.

The Australian Wheat Board will have great difficulty in meeting its commitments for the coming year. The amount of wheat retained on the farms for seed will reduce the total quantity available to the Board to 145m. bushels, whereas minimum requirements for local use and export commitments are 170m. bushels. Unless carry-over stocks are sufficient to meet this deficit of 25m. bushels, Australia will have no option but to request a reduction in her International Wheat Agreement quotas, which now stand at 89m. bushels. In any case, there will be no "free market" wheat available from the 1951/52 harvest. This will reduce returns to Australian wheat-growers, which are an average of returns from low-priced locally-consumed wheat sold under the International Wheat Agreement at 18s.1d. per bushel, and "free" wheat which sold last year at about 18s. per bushel. Wheat growers are guaranteed a return equal to the cost of production assessed by the Commonwealth Bureau of Agricultural Economics, and this has determined the home consumption price. Yet even with substantial quantities sold overseas at higher prices, average returns to farmers have been insufficient to keep up the acreage sown to wheat when more profitable alternative uses of land are available, such as woolgrowing and, in some cases, other grains which do not come under government control.

Crop and Trade Reports

Cotton: The sowings of cotton crop are reported to have been delayed in the districts of Krishna, Anantapur, Cuddapah, Nellore, North Arcot, Coimbatore, Tiruchirapalli, Ramanathapuram and Tirunelveli due generally to delayed rains. The area under the crop is expected to be above normal in the districts of Krishna, Kurnool, South Arcot, Chittoor, Madurai and Malabar due partly to intensive propaganda for extension of cotton cultivation and partly to attractive prices prevailing of cotton. The condition of the standing crop is reported to be generally satisfactory in all the districts except Krishna, Anantapur, Chittoor, North Arcot and Ramanathapuram where the crop is reported to have been generally affected by inadequate water supply. The crop in West Godavari district is also reported to be not satisfactory. In Ramanathapuram district the crop is reported to have been affected by pests. The wholesale price of cotton lint per imperial maund of 82 2/7 lb. (equivalent to 3,200 tolas) as reported from important markets on the 3rd November, 1951 was Rs. 80-14-0 for Cocanadas, Rs. 93-10-0 for White Northern, Rs. 94-13-0 for Red Northern, Rs. 82-14-0 for Westerns (Mungari), Rs. 87-1-0 for Westerns (Hingari), Rs. 105-13-0 for Coimbatore Cambodia, Rs. 95-8-0 for Coimbatore Karunganni, Rs. 15-9-0 for Tinnevelly and Rs. 63-0-0 for Nadam Cotton. Compared with the prices published in the last report (i.e.) those which prevailed on 13th October, 1951 these prices reveal a rise of approximately 0.1 per cent in the case of Cocanadas, 1.3 per cent in the case of Westerns (Mungari) and 1.2 per cent in the case of Westerns (Hingari), a fall of approximately 0.6 per cent in the case of Tinnevelly, the prices remaining stationary in the case of other varieties.

Gingelly: The gingelly crop is reported to have been affected by heavy rains in July 1951 in West Godavari and Krishna districts. In the districts of Kurnool, Anantapur, Cuddapah, Chittoor, Salem, Coimbatore, Mathurai, and Ramanathapuram the crop was affected due to inadequate rains during the period of its growth. The yield per acre is expected to be normal in the districts of Sriakulam, Visakhapatnam, East Godavari, Guntur, Bellary, South Arcot, Tanjore, Malabar and South Kanara and below the normal in the other regions of the State. The wholesale price of gingelly seed per imperial maund of 82 2/7 lb. as reported from important market centres on 3-11-1951 was Rs. 33-7-0 in Cuddalore, Rs. 32-15-0 in Tirunelveli, Rs. 32-4-0 in Rajahmundry, Rs. 31-2-0 in Visakhapatnam, Rs. 30-12-0 in Eluru, Rs. 30-9-0 in Tuticorin, Rs. 30-6-0 in Salem, Rs. 29-10-5 in Tiruchirapalli, Rs. 29-2-0 in Kakinada and Rs. 28-14-0 in Vizianagaram. Compared with the prices published in the last report i.e., those which prevailed on 6-10-1951 these prices reveal an increase of 3 per cent in Tirunelveli and a decrease of 6 per cent in Tuticorin and 5 per cent in Eluru, the prices remaining stationary in Cuddalore, Tiruchirapalli, Kakinada and Vizianagaram.

Sugarcane: The condition of the standing crop is reported to be generally satisfactory in all the districts except Kurnool, South Arcot, Chittoor, North Arcot and Coimbatore where crop is reported to have been affected by inadequate water supply and the yield is expected to be reduced considerably in consequence. In West Godavari district, the standing crop, though affected by heavy rains in the early stages, is reported to have rallied as a result of heavy manuring. The wholesale price of jaggery per imperial maund of 82 2/7 lb. at important markets on the 3rd November 1951 was Rs. 20-9-0 in Mangalore, Rs. 18-12-0 in Rajahmundry, Rs. 18-1-0 in Visakhapatnam and Vijayanagaram, Rs. 18-0-0 in Bellary, Vellore and Salem, Rs. 17-10-0 in Tiruchirapalli, Rs. 16-7-0 in Kakinada, Rs. 16-0-0 in Coimbatore, and Rs. 15-8-0 in Chittoor. Compared with the prices published in the last report i.e., those which prevailed on the 13th

October 1951 these prices reveal a fall of approximately 3.1 per cent in Chittoor, a rise of approximately 3.6 per cent in Coimbatore the prices remaining stationary in the other markets.

Groundnut: The winter crop of groundnut is reported to have been affected by heavy rains in July 1951 in West Godavari District and by drought and delayed rains in the districts of Guntur, Kurnool, Anantapur, Cuddapah, Nellore, North Arcot, Coimbatore and Mahuraj. The crop was affected in Guntur district by plant lice which was effectively checked in time. It was affected by insect pests in Bellary and Salem districts. It was affected by insect pests in Bellary and Salem districts. The condition of the crop is generally satisfactory in the other regions of the State. The wholesale price of groundnut (machine shelled) per Imperial Maund of 82-2/7 lb. as reported from important market centres, on 3rd November 1951 was Rs. 31-3-0 in Cuddapah, Rs. 31-2-0 in Guntur, Rs. 31-0-0 in Adoni, Rs. 30-11-0 in Tadpatri, Rs. 30-4-0 in Nandyal, Rs. 30-2-0 in Erode, Rs. 29-12-0 in Salem, Rs. 29-9-0 in Vellore, Rs. 29-7-0 in Coimbatore, Rs. 29-5-0 in Cuddalore, Rs. 29-2-0 in Vizianagaram, Rs. 28-13-0 in Bellary. Compared with the prices published in the last report i. e. those which prevailed on 6th October 1951 these prices show an increase of 9% in Vellore, 8% in Erode, 7% in Salem, 6% in Nandyal, 5% in Coimbatore, 3% in Bellary, and one per cent in Guntur and a decrease of 3% in Vizianagaram, the prices remaining stationary in Cuddalore.

Cotton Raw in the Madras State: The receipts of loose cotton at presses and spinning mills in the Madras State from 1st February 1951 to 2-11-1951 amounted to 2,48,890 of 392 lb. lint. The receipts in the corresponding period of the previous year were 2,90,569 bales. 3,70,536 bales mainly of pressed cotton were received at spinning mills and 10,353 bales were exported by sea while 1,03,553 bales were imported by sea mainly from Karachi and Bombay.

[Public (Economics and Statistics) Department.]

Gleanings

Poultry Meat Tainted by BHC—Treated Grain: Tests carried out by the Poultry Branch of the Department of Agriculture and Stock have shown that the flesh of fowls fed on grain treated with the commercial grade of the insecticide benzene hexachloride (BHC) may have a musty flavour when the birds are slaughtered.

BHC has proved to be very effective in protecting wheat, maize and other grains against insect damage. It is compulsory to use it on hybrid maize, grain sorghum and French bean seed submitted for certification, and in view of the current shortage of carbon bisulphide some other grains are also being treated with this insecticide. While it in no way harms grain intended for sowing, it should not be used on grains which are to be fed to poultry, as in addition to its flesh-tainting properties it may also give eggs a musty flavour.

There is some evidence that milk may be tainted, and so it is tentatively recommended that BHC-treated grain be not fed to milch cows.

Deodorised BHC is marketed by the trade, but its use as an insecticide in stored grain appears to be too costly where a large quantity of grain is concerned. (Queensland Agricultural Journal, (September 1951. Vol. 73. Part 3).

M. A. S.

Review

Cytogenetic Studies in Yeasts. A considerable amount of work has been done on the cytology and genetics of yeasts in the Indian Institute of Science, Bangalore. We are in receipt of six reprints of publications on this subject as listed below, being pages 1 to 128 of Vol. 32, Part A of the Journal of the Indian Institute of Science, 1950. Four of the papers deal with mutation processes, two with mutation, one with cytoplasmic inheritance in yeasts. The papers are by Dr. M. K. Subrahmaniam and his associates.

The subject studied is of great interest and is a modern development, an extension of cytogenetics to micro-organisms. Owing to the great economic importance of yeasts, the study has also practical possibilities.

The papers on mutations discuss the present knowledge on the subject comprehensively and suggest new interpretations based on the work done at Bangalore. A peculiar feature found in yeasts is their great plasticity in vegetative cell form and the apparent frequency with which mutations take place. The three papers on chromosome constitution and cytoplasmic inheritance are a review and discussion and do not include new experimental work. There is a good deal of controversy on this aspect and some workers in other countries do not accept the Bangalore work on chromosome constitution in yeasts. These papers give the most reasonable interpretation of yeast cytogenetics, providing the basic observations are accepted. These important contributions to cytogenetics would be more generally acceptable if accurate experiments are carried out on sporulation, single spore cultures and the biochemistry of mutant forms. Fresh observations on chromosomes in yeasts in different cultures are also highly desirable, as all the conclusions are now derived from observations on "giant colonies".

1. Krishnamurthy, S. N. and Subrahmaniam, M. K. (1950) Further observations on Reverse Mutations in Yeasts; Jour., Ind. Inst. Sci. Vol. 32 A. p. 1-28.
2. Subrahmaniam, M. K., (1950) The problem of haploidy in Yeasts; Ibid pp. 29-40.
3. " " Haploidy and the Species Concept in Yeasts; Ibid. pp. 41-50.
4. Ranganathan, B. and Subrahmaniam, M. K., " Studies on the mutagenic action of chemical and physical agencies on Yeasts; Ibid. pp. 51-72.
5. Subrahmaniam, M. K., " A critical evaluation of the question of cytoplasmic inheritance in Yeasts; Ibid. pp. 73-90.
6. Ranganathan, B., " Studies on the mutagenic action of chemical and physical agencies on Yeasts: Part II. Mutations induced in Yeasts by temperature shocks; Ibid. pp. 91-111.
7. Mitra, K. K., and Subrahmaniam, M. K., " Studies on the Mutagenic action of chemical and physical agencies on Yeasts: Part III, Further Observations on the general effects of Chrysene on Yeasts; Ibid. pp. 113-128.

C. G.

Weather Review for November 1951

Weather Review — For November 1951

RAINFALL DATA

Division	Station	Total rain-fall for the month	Departure from normal in inches	Total since 1st January in inches	Division	Station	Total rain-fall for the month	Departure from normal in inches	Total since 1st January in inches
Orissa & Circars	Gopalpur	2.2	-1.7	49.6	Central Contd.	Coimbatore	7.0	+3.0	24.1
	Calinga-patnam	5.2	+1.8	40.0		Tiruchirappalli	7.2	+0.2	32.0
	Visakha-patnam	3.1	-1.6	42.4		Naga-pattinam	11.9	-5.6	32.7
	Araku Valley*	4.1	+2.1	67.1		Aduturai*	7.6	-2.8	28.3
	Anakapalle*	3.1	-0.1	47.1		Pattukottai*	8.9	+0.6	25.6
	Samalkot*	1.7	-1.8	36.6		Madhurai	4.3	-1.4	37.2
	Kakinada	4.7	-0.2	45.2		Pamban	14.8	+3.1	33.5
	Maruteru*	2.1	-1.5	52.8		Koilpatti*	8.8	+2.8	26.0
	Masulipatnam	0.6	-5.2	34.1		Palayam-cotta	9.7	+2.3	25.4
	Guntur*	0.1	+1.9	28.3		Amba-samudram*	11.8	+1.8	37.0
	Bapatla*								
	Agri. College, College Farm	0.3	-3.7	26.6					
	Bapatla*	0.8	X	29.1					
	Rentachintala	1.0	-0.9	18.6					
Ceded Districts	Kurnool	0.0	-1.2	27.2	West Coast	Trivandrum	15.9	+8.9	73.9
	Nandyal*	0.0	-1.5	23.1		Fort Cochin	10.0	+3.3	101.0
	Hagari*	0.2	-1.5	21.1		Kozhikode	6.6	-0.8	101.3
	Siruguppa*	0.3	-1.0	19.0		Patnambi*	9.0	+4.1	87.0
	Bellary	0.5	-1.5	23.9		Taliparamba*	5.6	+0.6	117.0
	Cuddapah	1.7	-1.8	20.2		Nileshwar*	6.0	+0.4	118.2
	Kodur*	4.4	-3.4	22.1		Pilicode*	4.2	-1.0@	114.5
						Mangalore	3.3	-0.6	119.7
						Kankanadi*	2.1	-1.0	115.6
Carnatic	Nellore	7.3	-4.4	22.6	Mysore & Coorg.	Chitaldrug	0.5	-1.9	25.9
	Buchireddipalem*	7.4	-4.9	20.4		Bangalore	2.2	-0.5	35.6
	Madras (Meenam-bakkam)	10.4	-3.6	20.5		Mysore	1.0	-1.7	31.5
	Tirurkuppam*	6.1	-5.5@	27.1		Mercara	4.5	+1.5	121.7
	Palur*	20.4	+8.6	45.2					
	Tindivanam*	8.7	+1.4	27.7					
	Cuddalore	36.3	+20.8	54.5					
					Hills	Kodaikanal	9.4	-0.8	72.7
						Coonoor*	17.9	+3.5	66.0
						Ootacamund*	2.5	-3.4	44.1
						Nanjanad*	2.8	-2.3	62.5
Central	Vellore	6.5	-1.2	31.4					
	Gudiyatham*	7.1	+2.7	25.5					
	Salem	3.9	+0.1	29.9					
	Coimbatore* (A. M. O.)	6.0	+1.3	19.1					

- Note:—
- * Meteorological Stations of the Madras Agricultural Department.
 - @ Average of nine year's data for Pilicode, and eight year's data for Tirurkuppam, and seven years' data for Arakuvalley is given as normal.
 - Average of ten years' data is taken as normal.
 - X The farm was started only this year.

The low pressure area that existed over the West Central Bay of Bengal on 31—10—51 shifted slightly southward on 1—11—51 and persisted as a shallow closed low till 6—11—51. Another trough of low existed in the South East Arabian sea over the Comorin area and along and off the Malabar Coast on 7—11—51, passed westwards and became unimportant on the next day. The North-East Monsoon slightly strengthened along the Coromandal coast on 7—11—51 causing widespread rains in coastal Tamil Nad and local rain in the rest of the region, and weakened on 13—11—51. During this period on 12—11—51 unsettled conditions existed in the neighbourhood of Latitude 9° North and longitude 60° East in the South-East Arabian Sea, intensified into a cyclonic storm on 14—11—51 while moving northwards, became severe on 16—11—51 near about latitude 18½° North and Longitude 66½° East, weakened rapidly on the very next day to a shallow depression which got filled up on the 19th.

In the meanwhile 17—11—51 conditions were markedly unsettled in the South-West Bay off Ceylon, tried to strengthen, but passed as a low pressure wave across the Cormandel Coast. Under its influence the North-East Monsoon has been active in the North Tamil Nad and the adjoining parts of coastal Andhradesa causing widespread and locally heavy rains. Cuddalore recorded a rainfall of 10.5" on the 18th. On the 18th itself a trough of low appeared over the South-East Arabian Sea off the Malabar Coast, persisted till 22—11—51 and became less marked on 23—11—51. A low pressure wave moved westwards across the South-East Bay on 21—11—51, causing unsettled conditions in the South-East Bay of Bengal, which concentrated into a depression with its centre near about latitude 12½° North and longitude 85½° East on 24—11—51. This moved towards North, North West and weakened into a trough and became unimportant on 27—11—51. This caused widespread rains in Tamil Nad and coastal Andhradesa as it moved from South to North.

Again a shallow trough appeared off the Malabar Coast on 27—11—51 which became less marked on the very next day but persisted upto the end of the month, as a low pressure wave moved over the Maldives region on the 29th November.

Three western disturbances passed over North-West India during this period.

Night temperatures were generally above normal over the region.

The particulars regarding the noteworthy falls and the zonal rainfall have been furnished below.

ZONAL RAINFALL

S. No.	Name of zone	Actual rainfall	Departure from normal	Remarks.
1.	Orissa & Circars	2.3	- 1.1	Below normal.
2.	Ceded Districts	1.0	- 1.7	Far below normal.
3.	(a) Carnatic	7.8	- 4.6	Far below normal.
4.	(b) South Arcot Districts	21.8	+ 0.3	Far above normal.
5.	Central	6.3	+ 1.0	Just above normal.
6.	South	9.7	Nil	Just normal.
7.	West Coast	7.1	+ 1.7	Just above normal.
8.	Mysore & Coorg	2.1	- 0.7	Just below normal.
9.	Hills	8.2	- 0.8	Just below normal.

Note-worthy Falls during the month

S. No.	Date	Place	Rainfall in inches for past 24 hours.
1.	6—11—51	Kakinad	2.3"
2.	8—11—51	Kallakurichi	2.6"
3.	10—11—51	Pamban	2.6"
4.	"	Nagapattinam	2.3"
5.	11—11—51	Fort Cochin	2.4"
6.	13—11—51	Trivandrum	2.9"
7.	18—11—51	Cuddalore	10.5"
8.	19—11—51	Madras (Nungambakkam)	3.5"
9.	"	Vellore	2.7"
10.	"	Nellore	3.3"
11.	"	Meenambakkam	2.7"
12.	24—11—51	Nagercoil	3.4"
13.	25—11—51	Calingapatam	3.1"
14.	"	Vizagapatnam	2.1"

Agricultural Meteorology Section,
Lawley Road Post, Coimbatore.

M. B. V. N., C. B. M. & M. V. J.

Departmental Notifications

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„ Narasimhamurthi, B. L.	Asst. in Millet, Coimbatore,	Asst. Millet Specialist, Coimbatore

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„ Raman, N. V.	Horticultural Trainee,	Entomology Asst., Coffee Borer scheme, Oota- camund
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Names	To
Balakrishnamurthi, S.	Asst., in Chemistry, Coimbatore.
Meenakshisundaram, K.	Inspector, Cotton Certification Scheme.
Shiva Rao, Y.	Assistant in Chemistry, Coimbatore.

The following promotion of Lower Subordinates as Upper Subordinates is ordered with effect from 1—4—1951 in the following order of seniority:—

Names	To
Sri Alagiriswami, M.	Asst., A. D., Nilakottai.
„ Achuthan Nair, E.	„ Badagara.
„ Samu Iyer, P. V.	„ Manures, Trichy.
„ Pappaiah, B. P.	„ Polavaram.
„ Ratnavelu, M.	Sub-Asst., in Paddy, Coimbatore.

THE MADRAS AGRICULTURAL JOURNAL

Hints to Contributors

The pages of the Madras Agricultural Journal shall be open ordinarily only to the members of the Madras Agricultural Students' Union.

All articles for publication should be addressed to the Editor, Madras Agricultural Journal, Lawley Road P.O., Coimbatore.

In view of the high cost of printing contributions should be as concise as possible and should conform to the best usage in the leading Journals published in India and abroad.

Manuscripts should be typed with double spacing on one side of the paper only and with wide margin. They should not ordinarily exceed 5,000 words or 12 pages of printed matter including tables and illustrations in the Journal. Manuscripts should be carefully revised; numerical data and calculation checked. Main headings in the text should be typed in capitals with paragraph indentations and followed by a period and two hyphens. Sub-heads should be lower case and be underlined to indicate italics. Latin nomenclature and local terms etc., should be in italics. Original papers must conclude with summary of not more than 300 words drawing attention to the main facts and conclusions.

Tables: The number of tables should be restricted to those absolutely necessary, as numerous tables detract from the readability of the article. Each table should be numbered consecutively from 1 up and must have a heading stating its contents clearly and concisely. The tables are to be typed on separate sheets with their positions marked in the text.

Illustrations: Wherever possible illustrations should be made with pen and Indian ink for reproduction as line blocks. The name of the author, title of the article and figure number should be written on the back of each figure in blacklead pencil. Each figure should have a legend typed on a separate sheet.

Photographs: Photographs and wash drawings are more expensive as half-tone blocks are necessary. The cost of blocks is chargeable to the author of the article. Photographs submitted as illustrations should be unmounted, glossy prints of good quality, with strong contrasts, trimmed so as to include only the essential features to be illustrated. They should preferably be of the same size as desired in the printed paper. Photographs should always be packed flat, never rolled or folded.

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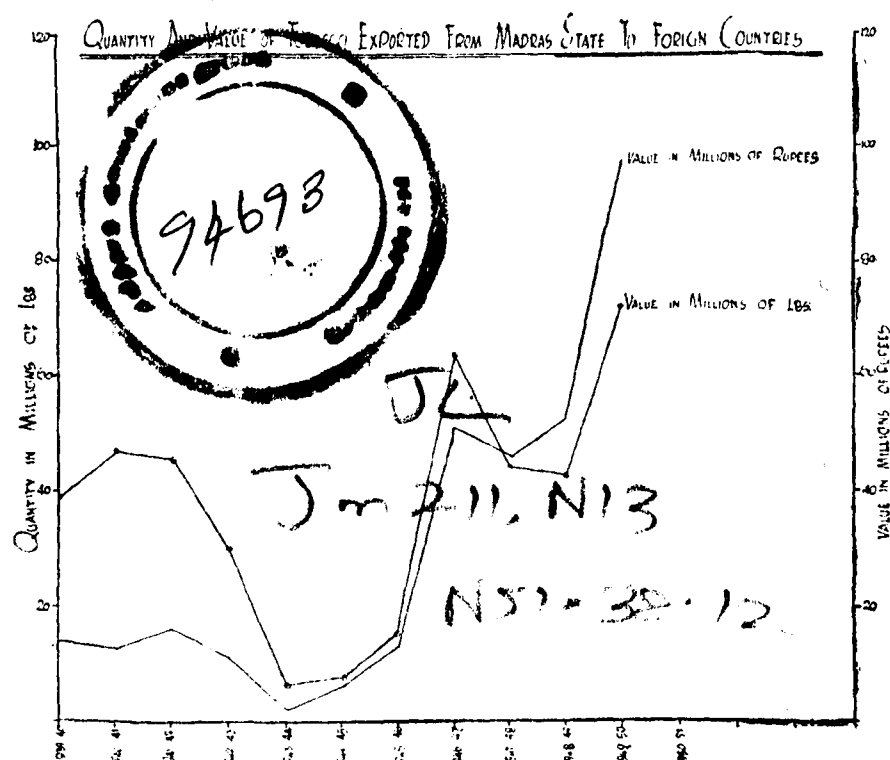
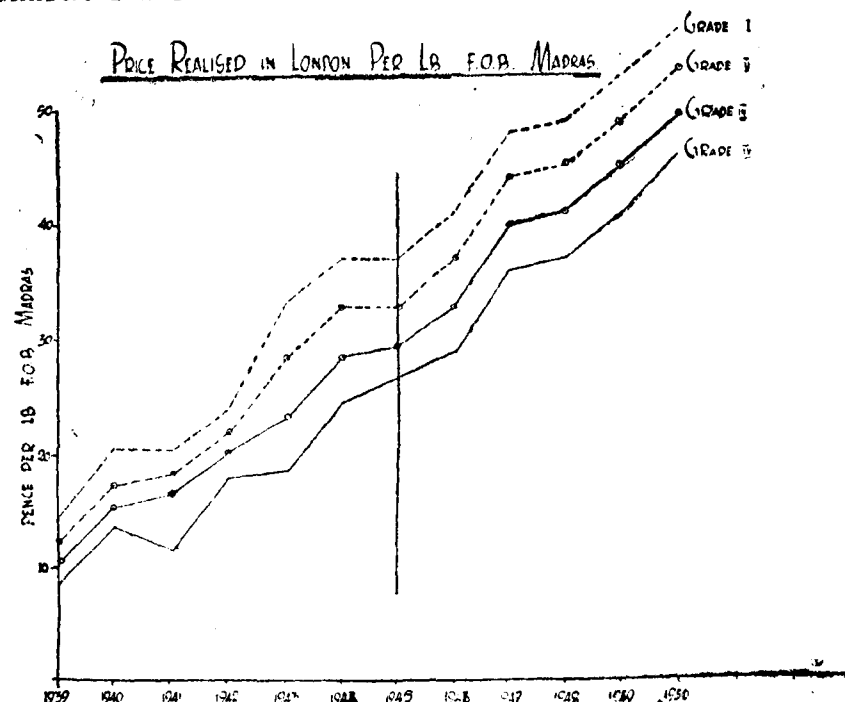
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The responsibility for statements, whether of fact or opinion, rests entirely with the author of the article and not with the Editorial Board of the Madras Agricultural Journal.

Virginia Tobacco in Madras State
(By T. K. Viswanathan, M. A. J., Vol. XXXVIII, No. 11, p. 510)

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