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Some Aspects of the Regional Geography of Tamilnad

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(Continued from Vol. XXIV, No. 2, April—June 1949, Page 41).

AGRICULTURE

General

In Tamilnad as in the rest of India, Agriculture forms the foremost industry of the people and the agriculturist has been held in great esteem from the days of yore.

வேதநூன் முதலாகி விளங்குகின்ற கலையனைத்தும்
ஓதுவாரெல்லாம் உழுவார் தந்தலைக்கடைக்கே
கோதைவேன் மன்னவர் தங்குடைவளமுங் கொழுவளமே
ஆதலால் இவர் பெருமை யார் உரைக்க வல்லாரே ?

Vedanun mudalahi vilanguhinra kalaiyanaithum
Voduvarellam vuzhuvar tamtalai kadaikke
Kodaiven mannavan tamkudai valamum kozhuvalame'
Adalal ivar perumai yar uraikka vallare

—*(Kambar).*

"Even students of the Vedas and other branches of knowledge must wait at the door of the husbandman. The prosperity of the subjects of powerful kings depends on the ploughshare. So, who can describe the importance of the agriculturist?".

உழுவாருலகத்தார்க் காணியாஞ் தாற்று
தெழுவாரை யெல்லாம் பொறுத்து.

Vuzhuvarulagattark kaniah datra
Dezhuvarai yellam poruthu

—*(Tiruvalluvar).*

"The ploughers are the linch-pin of the world; they bear
Them up who other works perform, too weak its toils to share."

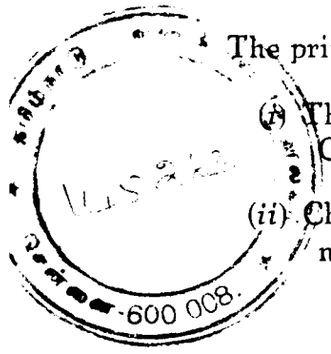
—*(Pope's translation).*

In the tropical land of Tamilnad rainfall and facilities for irrigation are the most important factors governing agricultural distributions. The other factors like soil and temperature are of minor account. All these factors have been considered in detail in the previous chapters.

The total cropped area is about 16 million acres. Of this, rice occupies 38%, Cholam 11%, Kambu 9%, Ragi 5%, Varagu 4% and the commercial crops, groundnut 9% and cotton 4%.

Cereals.

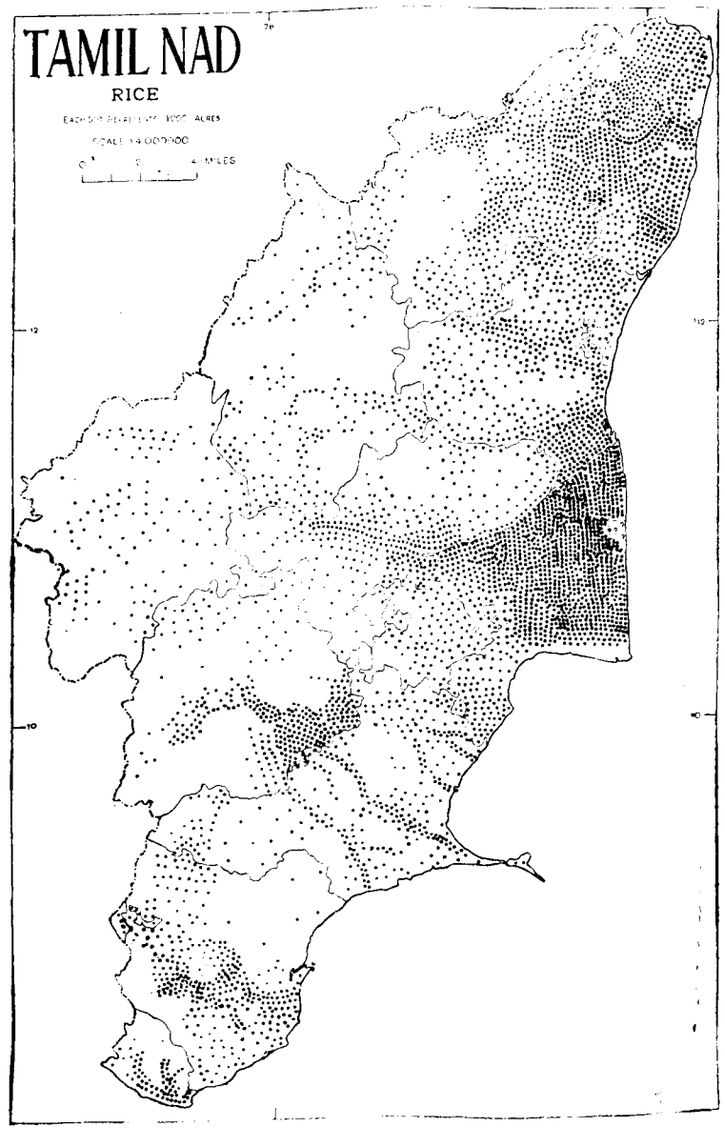
Rice:—Rice is the principal staple food of Tamilnad and is also universally grown all over the region, wherever the requisite water supply is available. As the crop requires an almost continuous supply of water, it is not cultivated in dry areas where there is little rainfall and where there is no scope for irrigation, as far example, in the black cotton soil region of Sattur and Koilpatti. The extent of cultivation in other areas depends upon the irrigation facilities available.



The principal rice growing areas in Tamilnad are

(*i*) The Cauvery valley and delta including the Chidambaram taluk.

(*ii*) Chingleput, eastern half of North Arcot and northern margins of South Arcot.



MAP 10.

(*iii*) The Pennaiyar valley especially under the Tirukkoilur Anicut.

(*iv*) The Periyar tract and the Vaigai valley.

(*v*) The Tambraparni valley and the southern Sub-Ghat Zone and

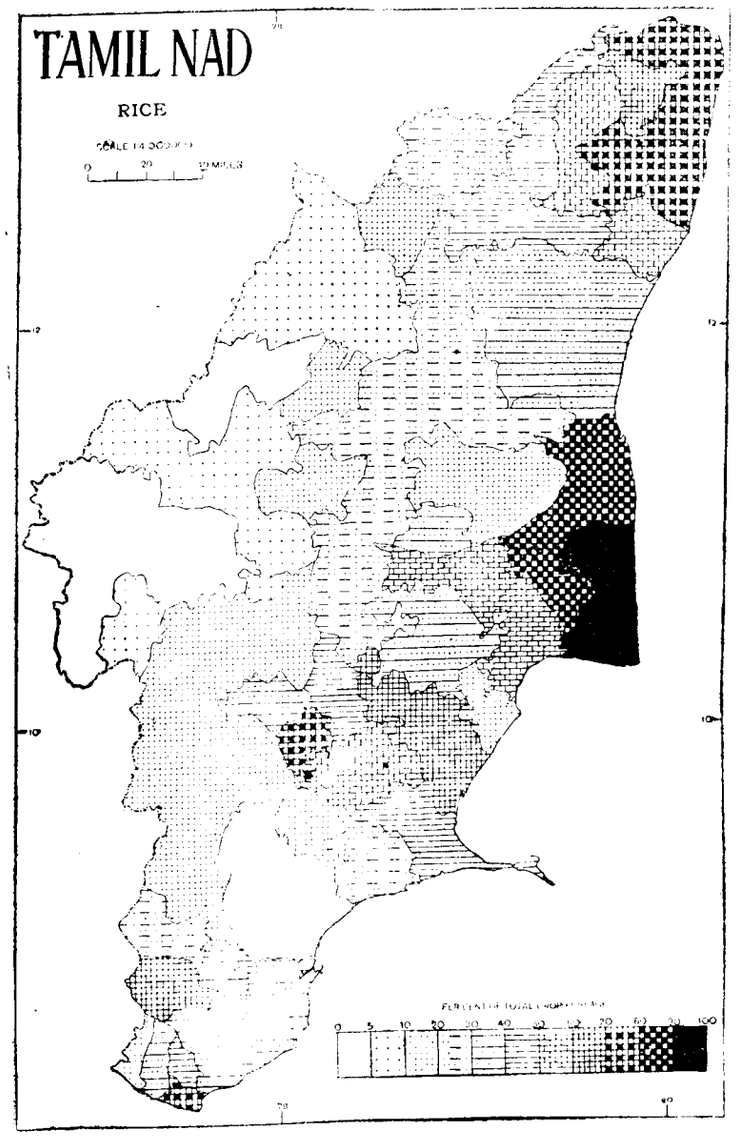
(*vi*) The Nanjanad area of the Travancore State.

Elsewhere also rice is grown to some extent in the narrow strips of land bordering the rivers, and under wells as in the Coimbatore district.

The proportion of the area under rice to the total cropped area is highest (over 90%) in the taluks Nannilam, Nagapattinam and Tirutturaipundi. This tract comprises the lower reaches of the delta (exclusive of the northern taluk of Shiyali) where there is too much water brought in by drainage channels of the upper and the middle reaches, added to the heavy rainfall of the retreating monsoon. The drainage is absolutely inadequate and rice alone is suitable to an such area and hence the highest percentage of cultivated area of the taluks under rice is found in this tract. This does not mean that the cultivation of rice here is very intensive. Much of the cultivation is of a primitive and cheap character on account of the risk involved in the flooding of land. It consists in scratching the ground, scattering the seeds of a very coarse paddy and leaving it to survive or not as it may. This is especially true of Tirutturaipundi taluk.[133]

The next highest percentage (80% to 90%) occurs in Chidambaram taluk and those in the middle reaches of the delta viz. Kumbakonam, Papanasam and Mannargudi. It is interesting to note that the taluks of Tiruchirapplli and Tanjore in the upper reaches of the delta further west have under rice only 50% to 60% of their total cropped area. The proportion of rice acreage to total cropped area is greatest in

133. Settlement Report of the Tanjore district, p. 81.



MAP 11

the southeast of the delta and decreases towards the west and north. This is because, proceeding from the coast to the interior there is less retreating monsoon rainfall, less amount of water logging and greater facility for drainage, but there is a longer duration of water supply. Hence the more valuable crops like betel, plantains and sugar-cane which require longer duration of water supply and good drainage facilities are grown side by side with paddy. As we go still higher up in the Cauvery valley, the concentration on rice decreases still further with better drainage facilities and land values also increase.

70% to 80% rice area is found in most of the taluks of Chingleput district, in the Madura Taluk under the Periyar canals and in the Agasthiswaram taluk of Nanjanad under the Kodayar scheme. In the Tiruvallur taluk of Chingleput district, the rice acreage falls to 62% of the cutivated area as the soils are highly porous and hence ill-suited to rice. The proportion of rice acreage decreases from east to west in Chingleput and North Arcot as tank irrigation becomes less and less and well irrigation increases. This decrease towards the interior is due to the decrease in the amount of rains and increase in the ruggedness of land. The high concentration on rice in Chingleput district is partly due to the proximity to the city of Madras. There is a considerable amount of absentee landlordism as many of the landholders are employed in the offices of the city. Labour also is scarce on account of the same urban pull. Under these circumstances much attention cannot be bestowed upon land and only age-long custom of sowing paddy year after year without any change prevails.

Strange as it may seem, the proportion of rice acreage even in the eastern taluks of South Arcot District (of course to the exclusion of Chidambaram taluk, which almost forms part of the Cauvery delta) is as low as 30% to 40%. The soils derived over the greater part of the district from the Cuddalore sandstone formation is very infertile and sandy and unsuitable to rice cultivation. Not only this, the ryots also

are very enterprising and grow commercial crops like groundnut, even in places where paddy can grow, as they bring a greater return.

The rice area in the taluks through which the Tambraparni flows is almost confined to the valley of that river and forms 68% of the cultivated area in Ambasamudram, 55% in Tirunelveli and 32% in Srivaikuntam. The decrease towards the east is due to the diminution in rainfall and irrrigation as one goes down the river. This decrease of rice acreage towards the east is a characteristic feature of the whole of the Tirunelveli and Ramnad districts following the decrease in rainfall. The lowest percentage (under 5%) is found in two areas (1) in the lee of the Palghat Gap and (2) in the Koilpatti-Sattur tract, the two driest areas of Tamilnad.

Duration of rice cultivation and varieties[134] :—Almost all rice cultivation is confined to the two monsoon seasons *i. e.* from the middle of June to the middle of Junuary. The harvest festival of Pongal comes off about the middle of January. In special isolated tracts where water facilities extend beyond February a hot weather crop of rice is also grown between February and May.

The majority of rice areas consists of single crop lands, where a variety of five to six month's duration is grown. Places with better water facilities grow two crops of rice. The first crop is mainly dependent upon river irrigation and the second partly on irrigation and partly on the retreating monsoon rains. In small areas as in parts of North Arcot and Chingleput districts there is even a third crop raised by irrigation from wells and spring channels. In parts of the Cauvery valley in Tiruchirapalli district canal water is available for three crops of rice.

When two crops are raised, one is usually of a short duration (*kar*) and the other of a long duration (*samba*) variety. Which of these is to come first depends upon the regime of

134. K. Ramiah : Rice in Madras, p. 14-15.

rainfall and irrigation facilities of the particular tract. Generally the first crop is a short one belonging to *kar* series and the second crop is a long duration *samba* variety. In the Cauvery valley in Tiruchirapalli district from Karur to Kulitalai it is usual to raise a long crop first and then a shorter variety in summer. This is due to the availability of the water supply in summer. Below Kulittalai a short *kuruvai* crop is followed by a long *samba* due to the lack of summer supply. In the double cropped areas of the Tanjore delta, in the upper reaches, where water is received early, *kar* of a longer duration (four months) is grown, while in the middle reaches the *kuruvai* of a shorter duration (three months) alone is possible. The preference for the longer duration crop wherever possible is due to the higher yields.

Double crop cultivation is confined chiefly to the western portion of the Cauvery delta which receives early freshes. The channels in the middle reaches of the delta and parts of Shiyali and Chidambaram taluks receive the water supply comparatively late but more than the requirements for a single crop. In these places a peculiar practice of raising two crops called '*Udu*' with one and the same cultivation is in vogue. In '*Udu* cultivation, *ottadan*, a species of samba of eight months' duration is mixed with *kadappu*, a three months *kuruvai* in the proportion of one is to four. The two kinds of grain are mixed in the seed-beds and the seedlings are transplanted indiscriminately. After the harvest of the early crop in October, water is let into the field to facilitate the rotting of the *kuruvai* stubbles and encourage the shooting of the *ottadan* crop, which is ready for harvest in February.[135]

In the saline lands near the coast in Tanjore delta a peculiar variety called *kullakar* which can stand a certain amount of salinity is grown. The nursery is prepared in July usually in a high level field after the salts are washed away by flooding and draining. The seedlings are planted in bunches about a foot apart with four or six seedlings in a

135. K. Ramiah, Rice in Madras, p. 63.

bunch. It is considered safer to plant more seedlings in the bunch as the salinity of the land is likely to kill some of them. The crop comes in to ear by the middle of November and is harvested by the middle of January.[136]

In the Tirunelveli district in the upper reaches of the Chittar, in addition to the retreating monsoon rains of the district, the southwest monsoon rains are also ample on account of the Shencottah Gap and hence the cultivation season lasts from July to January. In the single cropped lands here, *kulavalai*, a crop of heavy yield which takes from seven to eight months to mature is preferred.

In the upper reaches of the Tambraparni where water is available for five to six months, *anaikomban* (the most highly valued paddy of the district with long thin white grain) is grown wherever possible. But there are extensive areas in the lower reaches of the valley in which *anaikomban* cannot be grown either because the supply of water is too late or the land is not sufficiently well drained to suit the crop.[137]

The problem of self-sufficiency of Tamilnad with respect to rice:—There are no authentic data to decide what percentage of the population consumes rice and what percentage consumes millets. Generally there is very little movement of millets from place to place as what is produced in a place is usually consumed locally and any surplus left over is stored for future requirements. Taking into account the quantity of millets produced in each district and basing rations on the available local production and normal net imports and exports of rice, Mr. C. R. Srinivasan has calculated figures for production and consumption, surplus and deficit for all the districts of the Madras Presidency, from which those of the Tamil districts are reproduced below.[138]

136. Ibid, p. 76.
137. Tinnevelly District Gazetteer, Vol. I, p. 155.
138. Report on the Rice Production & Trade in the Madras Presidency, Appendix 7, p. 91.

Table showing rice production, consumption, surplus and deficit of each of the ten Tamil districts.

(*Unit—Thousand tons*).

Districts.	Quantity of rice required.	Quantity of rice produced.	Surplus.	Deficit.
Chingleput	262	284	22	—
South Arcot	272	293	21	—
North Arcot	226	244	18	—
Salem	150	58	—	92
Coimbatore	142	54	—	88
Tiruchirappalli	134	131	—	3
Tanjore	413	537	124	—
Madura	202	174	—	28
Ramnad	180	148	—	32
Tirunelveli	229	208	—	21
Madras City	109	—	—	109
Total	2319	2131	185	373

From the above table we see that the deficit viz., the total quantity of rice required minus the total quantity produced, for the ten Tamil districts is 2319—2131 = 188 thousand tons approximately. This deficit is nearly 8% of the consumption figure of 2319 thousand tons and was met by imports from Burma, Siam and Indo-China in normal times and as this supply has become dislocated on account of unsettled conditions in those countries, the problem has become acute.

Trade in rice :—The rice producing areas send rice to the deficit areas in three forms, paddy, parboiled rice and raw rice. As the major portion of the population use only parboiled rice, the movement is essentially of parboiled rice, or paddy to be parboiled at the place of consumption. The comparatively small requirement of raw rice in the deficit areas by the upper classes who alone generally consume raw rice is supplied almost entirely from the Nellore district.[139]

139. C. R. Srinivasan, op. cit. p. 36.

Yield of rice :—The following table gives the average yield per acre in pounds of irrigated and unirrigated rice in the ten Tamil districts.

	Irrigated.	Unirrigated.
Chingleput	1421	1008
South Arcot	1756	1045
North Arcot	1697	983
Salem	2122	893
Coimbatore	1754	739
Tiruchirapalli	1856	977
Tanjore	1645	1035
Madura	1944	897
Ramnad	1264	990
Tirunelveli	1793	897

From the above table, it is clear that the yield of rice per acre is higher when it is irrigated than when it is purely dependent on rainfall. The yields of irrigated rices are lowest in Ramnad and Chingleput Districts. In Ramnad it is probably due to the poor rainfall and the unreliability of the irrigation sources. In Chingleput, though the rainfall is good the yield is low, on account of the dearth of labour and the prevalence of absentee landlordism, both being due to proximity to the city of Madras.

The lands in North Arcot, Salem and Coimbatore districts irrigated from tanks and wells register better yields. The high yield of Madura District is probably due to the use of night soil as manure in the lands under the Periyar system.

In the Cauvery valley the yield per acre decreases as one goes down the river (Salem 2122, Trichinopoly 1856, and Tanjore 1645). This is because in the upper reaches not only is the duration of the cultivation season longer, but there are also good drainage facilities. In the Tambraparni valley also a similar feature of the yield, decreasing down the river has already been noted, but unfortunately figures giving yield per taluk are not available to conclusively assert the same.

For the whole region the average yield per acre is about 1650 pounds whereas it is 1000 pounds for the whole of India. The averages are over 3000 pounds in countries like Spain, Italy and Japan. In these countries, apart from the general fertility of the soil, artificial fertilizers are used in large quantities.

The low yield in Tamilnad can be improved by suitable manuring. Of the several manures, green manuring is the cheapest method of improving the fertility of the soil. The yield can also be improved by controlling diseases and pests which affect the crop. The curative treatment is so difficult that the best method suggested is the breeding of resistant varieties. Though single plant selections by themselves combined with better cultivation practices have brought about great improvements already,[140] still greater results are possible only by breeding of special varieties, or strains from crosses. These strains with a proper adjustment of the cultural and manurial practices for improving the yield attributes will result in the greatest benefit.[141]

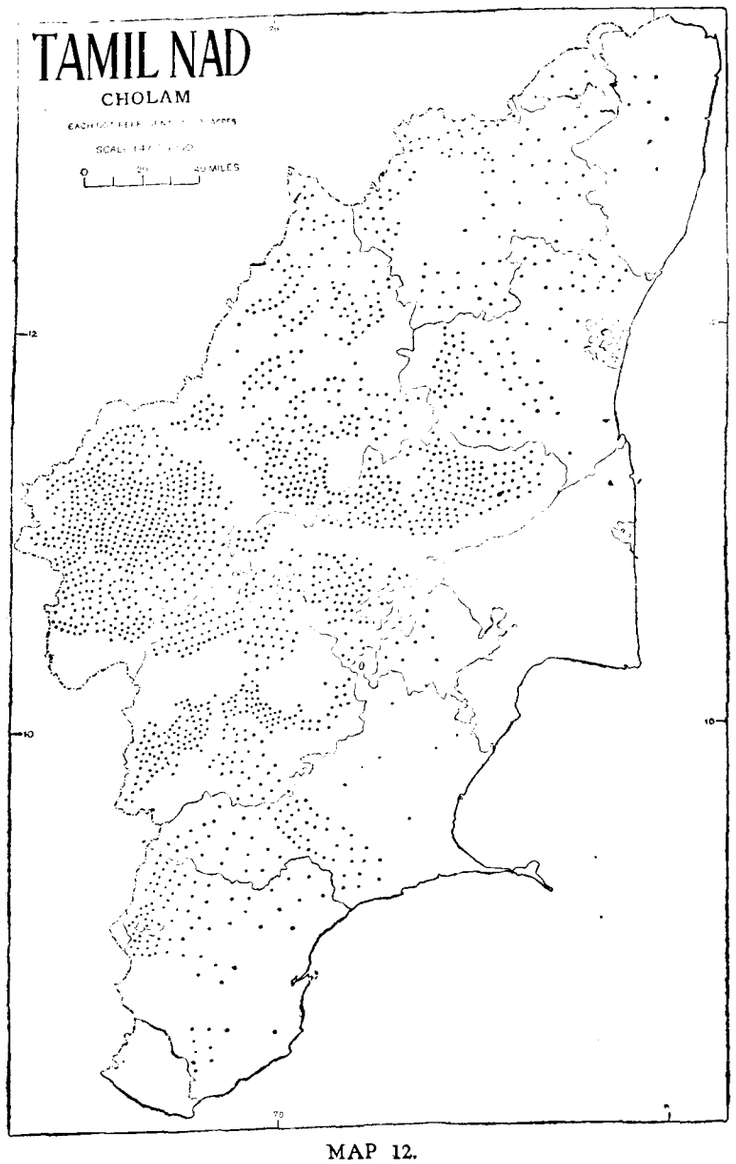
Cholam (Sorghum vulgare[142])—The cultivation of cholam is chiefly confined to the west central region where it is generally over 20% of the total cropped area in each taluk. In the taluks of Coimbatore, Avanashi and Palladam in the western part of this region 30% to 40% of the total cropped area is under cholam. Thus the areas in which cholam is grown has only very light rainfall. In the coastal plains where the rainfall is

140. The agricultural department has already made available a large number of superior strains for most of the important rice areas of the Madras Province. While some of them are limited in their suitability, others are cosmopolitan in nature, doing well under a variety of conditions. G.E.B 24 strain isolated in Coimbatore has met with universal approval and strain. Aduturai 11 has been found suitable for Tanjore, Madura, and Tirunelveli districts.

G. E. B. 24 was the first successful strain evolved in Central farm in 1913-14. This strain is a short duration *Samba* variety very popular on account of its high quality of rice. It can be grown under varied conditions. It gives an average acre yield of 3600 pounds and with intensive cultivation a maximum of 5000 pounds has also been obtained. Profuse tillering, fine size of grain, hard rice taking good polish, non-shedding even when dead ripe, resistance to fungus diseases and drought, high proportion of rice to paldy, are its special features It does best on a light soil with good drainage.

141. K. Ramiah, Rice in Madras, p. 188-189.

142. C. Benson, & C. K. Subba Rao, The Great Millet or Sorghum in Madras, Mad. Ag. Dept. Bull. Vol. III, No. 55.



MAP 12.

heavy, very little cholam is grown. As the ears of cholam ripen from top to bottom, heavy rain washes off the pollen from the flowers.

The seasons for sowing this crop are mainly two—the early (*Kodai or kar*) and the late (*Paruvam*). Leaving out of account the crops grown under irrigation, the early crops are sown at the beginning and the late crops towards the end of the southwest monsoon.

On the retentive black soils found in parts of Coimbatore and Madura the early summer showers are fully utilized for growing *kar* cholam, but over a large portion of the region, enough rain does not fall to allow the sowing of unirrigated cholam until July-August.

Under irrigation, cholam may be sown at any time of the year, but is often adjusted with reference to the main field crops. It is chiefly grown during the dry season and the hot weather when the field is not occupied by the main irrigated crops.

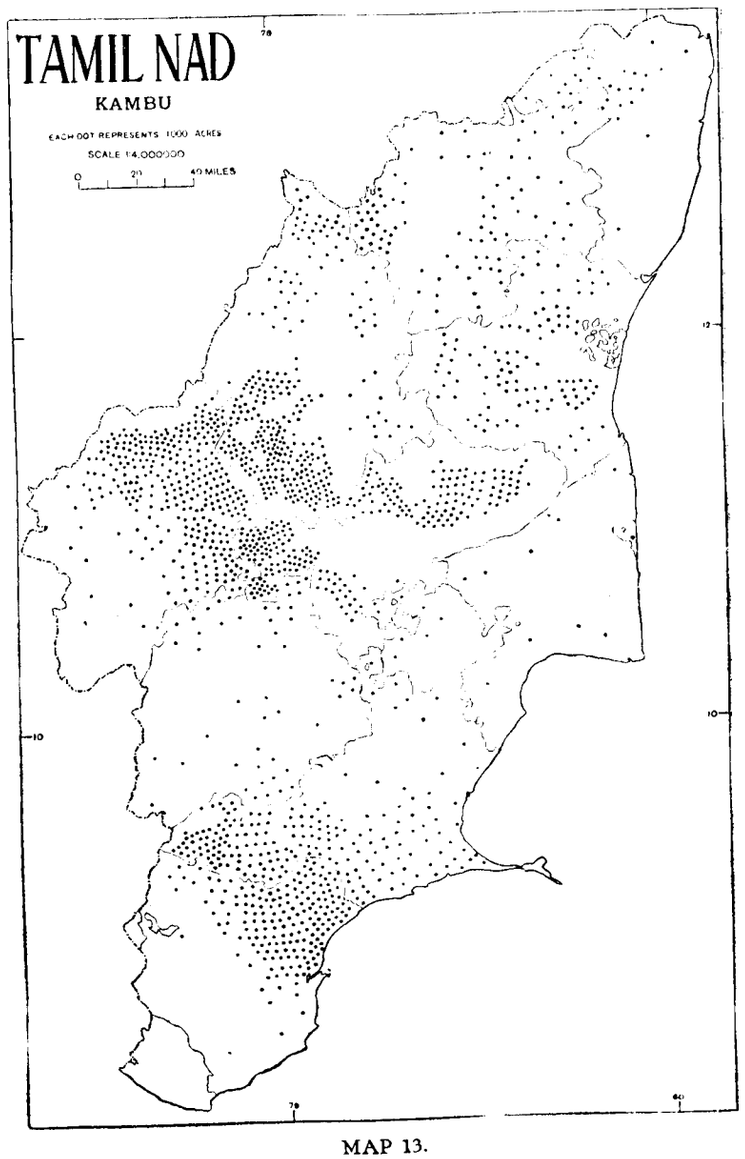
Early cholam is found on lighter soils and the late sown on heavy soils. Sandy soils are not well suited to the growth of the crop, except under good irrigation and heavy manuring. The best soils are those rich alluvial soils found at the foot of the hills, where the crops are most luxuriant. The black cotton soils are valued for cholam crop on account of their power of retaining moisture and the crop is sown late so that the rainfall during its growing season may be very light. Otherwise the crop becomes rank and the grain and straw poor in quailty. The grain and straw from cholam grown on red soils is more palatable and more nutritious than that grown under black soils and the crop does not grow so tall or so thick on the heavy as on the light soils. On the calcareous soils the crop thrives only under irrrigation, whilst if not irrigated it generally turns yellow.

On the shallow red soils of Tiruchirapalli and Madura, a variety called *Irungu* is grown. The same variety is grown as a fodder crop in the black soils of Ramnad and Tirunelveli late in the year.

Cholam grain makes excellent and nourishing food but is only used by the poorer classes. The straw is noted to be very good fodder. Regular fodder crops of Cholam are grown in the Coimbatore district especially in Coimbatore, Dharapuram and Udumalpet taluks and in the black cotton soils of the southern districts. The fodder crop in Coimbatore is called *Adar* cholam. This is sown in April-May in well-ploughed and manured lands and is irrigated and reaped when in flower, little by little, for daily requirements. An acre of *adar* cholam crop will feed a pair of bullocks for about eight months. The fodder crop cholam of Tirunelveli is called chola *nattu* reaped in three months. The stalks after being dried in the field for three days are carted home. Two to five cart-loads on the average are obtained per acre. Eight cart-loads are sufficient for a pair of cattle per annum.

Kambu (Bajra):—Black cotton soils and good loamy soils are best suited for this crop. There are two chief areas of production. The first includes the northern and eastern portions of Coimbatore plains, the Karur taluk and the south-eastern taluks of Salem district. The second includes the black cotton soil region of Koilpatti and Sattur and the red soil tract of Srivilliputtur. It is also found in the upland taluks of Tiruchirapalli, north of Cauvery. In the Karur taluk of Tiruchirapalli district, about half the cultivated area is under Kambu. Kambu cultivation is least in the coastal plains and in the southeastern parts of Coimbatore plains and also in Madura district.

Kambu is grown purely as a dry crop in the northern parts (*i.e.* in Chingleput and North Arcot districts) and in the central and southern parts it is also grown under irrigation from tanks and wells.



MAP 13.

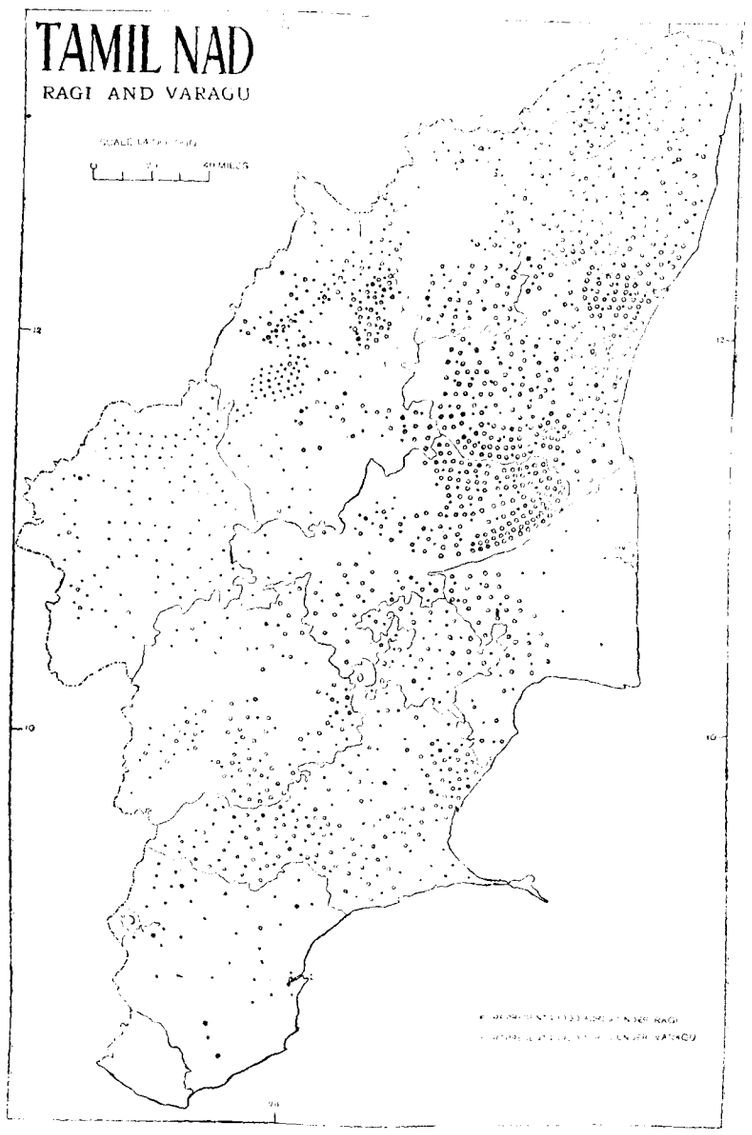
This crop is supposed to exhaust the soil and should not be grown more frequently than in alternate years on the same field. As a dry crop it is grown in the southwest monsoon season, sown in May-June and harvested before the retreating monsoon rains. Rain once a fortnight suits it best, but if healthy, it is unaffected by three week's drought. As the rains of the southwest monsoon are heavy in the northern parts of the region, it is grown on porous soils, and in the central parts where the rains of this season are light, it is grown on heavy black soils. In the black soil regions of the south, kambu takes precedence over cholam and this is attributed to the high temperature throughout the year, which makes kambu a better food than cholam.[143]

Kambu is gathered by cutting off the ears only. Sometimes, if more rain falls, the plants will then send out another crop of ears.

Kambu is particularly a favourite with *kaikolar* weavers, who use it not only as food, but also for making *kanji* as size for weaving. Kambu flour is prepared as thin gruel with butter-milk or water, or as a thick porridge with dhall and vegetables. The straw is bad for cattle and so it is put to use in thatching huts.

Ragi:—The distribution of ragi (*Kaizhvaraġu* in Tamil) acreage is more or less uniform over the whole region with the exclusion of the Cauvery delta. Yet there is some concentration to be seen in the Omalur taluk of Salem district and in the Coimbatore plains. Ragi requires more water than kambu. The best soils are alluvial or red, tolerably retentive of moisture. It is grown both upon irrigated and unirrigated land, but most commonly in that which is commanded by a well. When dependent upon rain alone, it is sown so as to get the benefit of one or other of the monsoons, that is, from May to July and from October to December. Under wells and tanks it is grown at any time of the year. Then it is

143. Tinnevelly District Gazetteer, Vol I, p. 158



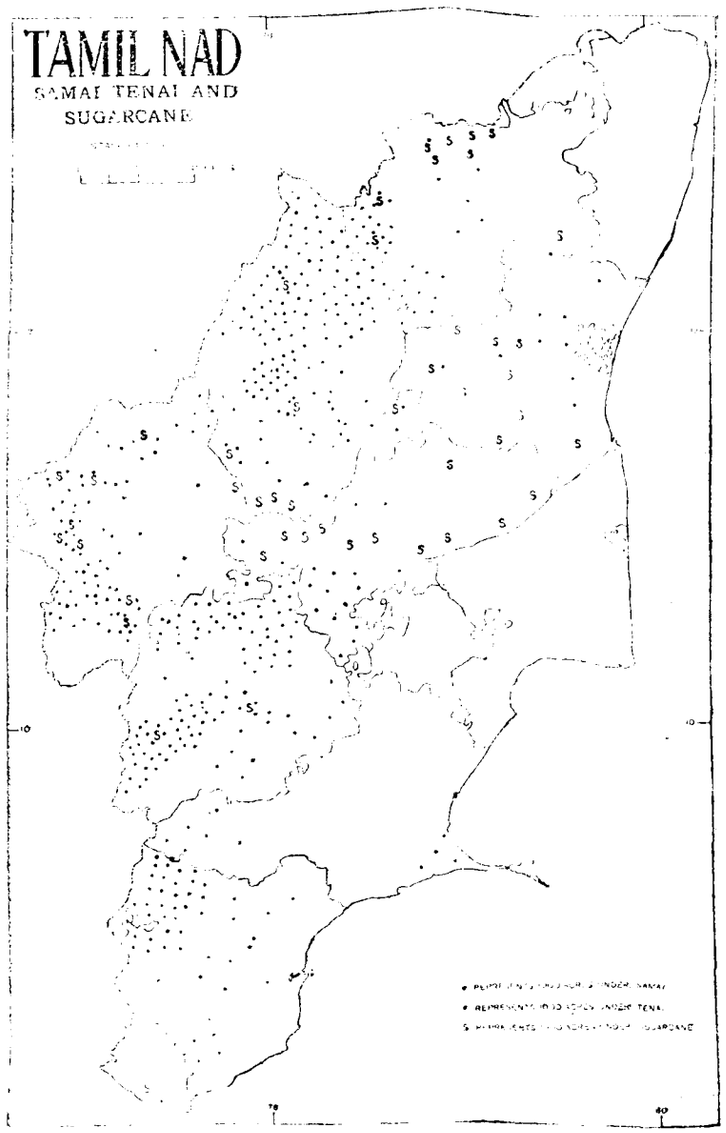
MAP 14.

transplanted from a seed-bed when about a month old in a field laid out into small plots which are watered once a week. Only the ears of ragi are generally first cut and the stalks a week later. Ragi straw is nutritious and hence serves as an important cattle fodder. The flour is mixed with rice powder, or varagu, or with broken rice and boiled into porridge and used by poor people.

Varagu:—Varagu cultivation is not so universal as ragi. It is extensively cultivated in the coastal plains. It is very rarely to be found in the Coimbatore and Tirunelveli districts of poor rainfall. The region of maximum production is the upland tract north of the Cauvery delta comprising Udayarpalayam, Perambalur and Vriddachalam taluks. It is a very hardy crop, capable of withstanding continued drought for a month, and is considered to exhaust the soil greatly so that the ryots often let the field lie fallow for a year after varagu. Though the yield per acre is small and the grain is not nutritious, the cost of cultivation is trivial, and the growth is rapid. Hence a large area of poor soils can be cultivated with varagu, which otherwise would be left waste. With little exertion, the ryot realizes a crop of grain and straw which will suffice for a year's domestic requirements and enable him to dispose of his more valuable products for ready cash.[144]

There are two varieties known as *Periya* (large) varagu and *Chinna* (small) varagu. The first is sown in the middle of July and harvested in the middle of December, being a five months crop. The second is sown in the middle of August and harvested in the middle of December being a four months crop. A rain once a month is sufficient for varagu. The straw and the ears are harvested together. The straw makes a tolerably good fodder for cattle getting cotton seed, but for other cattle it is not considered nutritious. The application of straw as manure is beneficial to saline lands. It is used as food instead of rice by the poor people. The boiled food keeps well over night and tastes well with butter milk.

144. Salem District Gazetter, Vol I, Pt. 1, p. 221.



MAP 15.

Samai:—This is grown on all inferior soils at small cost. It thrives very well in the red soils at the foot of the hills and hence is grown extensively in the foot-hill soils of Salem, and Coimbatore, and of the Southern Ghats. It is also found in the poor upland soils of Dindigal, Pazhani and Kulittalai taluks. As in *varagu*, though the yield per acre is small and the grain is not nutritious, this hardy crop can be cultivated with little exertion even on poor soils. Hence its area extends considerably in seasons of drought. It fails when there is heavy rain. The husked samai is boiled like rice. The food is insipid and hence is taken with buttermilk. Samai straw is said to produce diarrhoea in cattle not fed on cotton seed also. It is however given to buffaloes in the absence of better fodder.

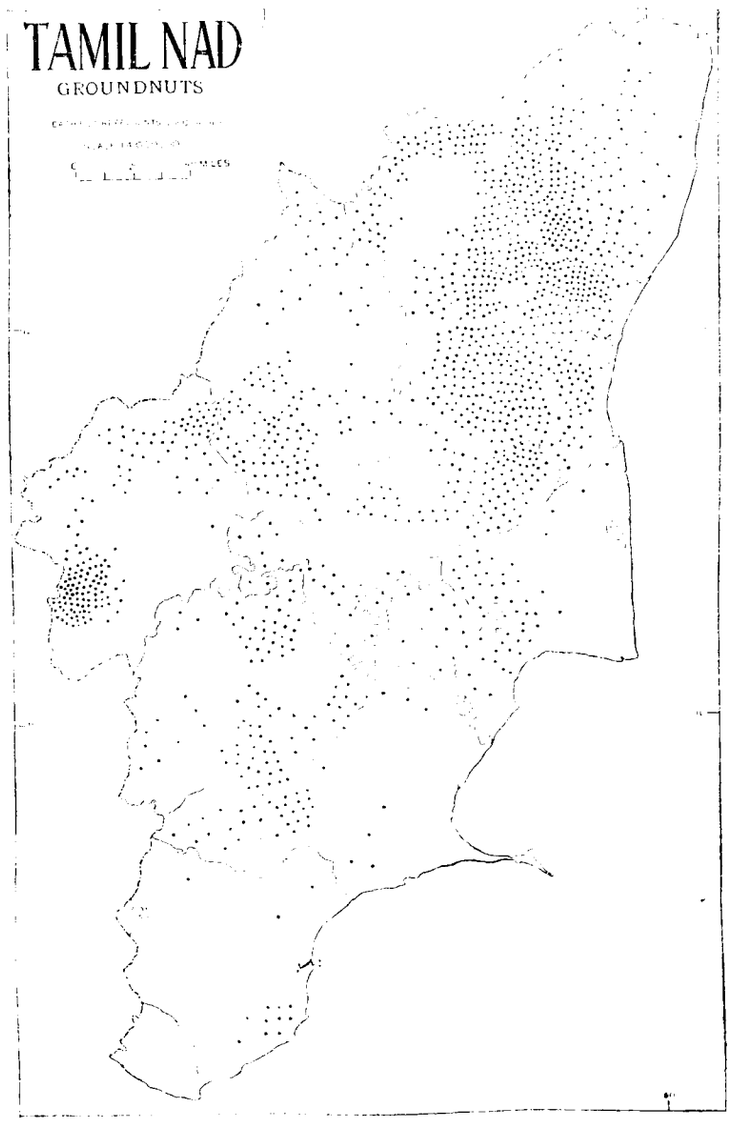
Tenai (Italian millet):—Tenai is not so extensively grown in Tamilnad as in the Telugu area of the Madras Province It is grown to some extent in the eastern parts of South Arcot in Salem and Attur taluks in Salem district and in Pazhani and Dindigal taluks of Madura district. This is a four months dry crop, sown in July, generally upon unirrigated land, but occasionally under wells, when it is irrigated once a week. The husked grain is boiled like rice. Tenai flour mixed with jaggery is also taken as food. The straw is not relished by cattle. Tenai exhausts the soil very much as indicated by the proverb '*தினை விதைத்த கொல்லையில் பனையும் முளையாது*' (Even palmyra will not grow in the land cultivated with Tenai).

Oil-seeds

The important oil-seeds grown in this region are groundnuts, gingelly and castor.

Groundnuts:—[145] The proportion of area under groundnuts to total cropped area is over 20% in the South Arcot district excluding Chidambaram taluk, in the eastern taluks of North Arcot district and in Pollachi, and Bhavani taluks of Coimbatore districts. In the three taluks of Tiruvannamalai, Gingee

145. The Cultivation of Groundnuts, Mad. Ag. Dept. Bull. Vol. III, No. 58. The Groundnut, Mad. Ag. Dept. Bull, IV, No. 87.



MAP 16.

and Wandavashi in the two Arcots, it occupies 30% to 40% of the cultivated area. It is also grown to a minor extent in the western part of North Arcot, southern part of Salem, Tiruchirapalli, Pudukkottai, non-deltaic Tanjore, Western Ramnad and Eastern Madura.

Sandy or loamy soils with facilities for drainage are best suited for this crop. They are not generally grown on heavy stiff soils, as the yield of nuts is small and the difficulty and therefore the cost of harvesting is great.

There are three varieties[146] grown in the region (*i*) the Mauritius (*ii*) the Pea-nuts and (*iii*) the Red Natal. They are borne on two types of plants, the trailing or the spreading type and the erect or the bunch type. The Mauritius belongs to the trailing type, the pods being on the running stem of plants, which creep along the ground. The peanuts and Red Natal are of erect or bunch type, the pods clustering round the bunched stems of plants. The Mauritius also called Coromandel, is the one grown all over the region and hence the latter name. The pea-nuts, also called Spanish pea-nuts, is grown only to a small extent occupying 25% of the area under groundnuts in North Arcot and 10% in Salem district. Red Natal also called Pollachi Red is grown only in the Pollachi taluk of Coimbatore district and in the adjoining parts of Madura district. In the Mauritius the shell is thicker and the oil content is less than in the peanuts. The kernels are large in size, oval in shape and covered with light red coloured skin. In pea-nuts the pods are smaller and shell thinner than in the Mauritius. The kernels are small and round and are covered with light rose coloured skin which peals off easily. The kernels have the highest oil content among these varieties. In Red Natal the kernels are round and have deep dark red coloured skin. It is the finest variety of the nuts, for which a premium is offered in the trade. The crop too comes into the market at a season when there is little harvest outside and

146. Report on the Marketting of Groundnuts in India and Burma, 1941, pp. 16-18.

consequently fetches a good price for the cultivators.[147] This is partly due to the early outbreak of the Southwest monsoon and the consequent early sowing in the taluk.

The Mauritius variety which is the one generally cultivated takes from five to six months to come to maturity. During the first two or three months, the crop requires very little moisture and can withstand considerable drought until it starts to flower and form its nuts. Therefore the sowing is so arranged that the crop receives the benefit of good rains during the last two or three months of its growth. In the western parts of the region as in Salem district, where the hot weather showers are frequent and southwest monsoon is the main season of rains, the sowing is done as soon as the showers fall in April or May. In the eastern parts as in South Arcot district, where the hot weather showers are scanty and the retreating monsoon is the main season of rains, the sowing is done towards the end of July and the beginning of August. Irrigated groundnut is sown between February and May and raised purely as a summer crop as in South Arcot district and in the new delta of the Cauvery.

The chief risk in groundnut cultivation is the occurrence of heavy rain at the time of harvest. Such rain causes the seeds in the pods to germinate leading to the loss of crops. There is a great demand on labour at harvest time and wages are so high that the cost of harvesting forms the heaviest item in the cultivation expenses.

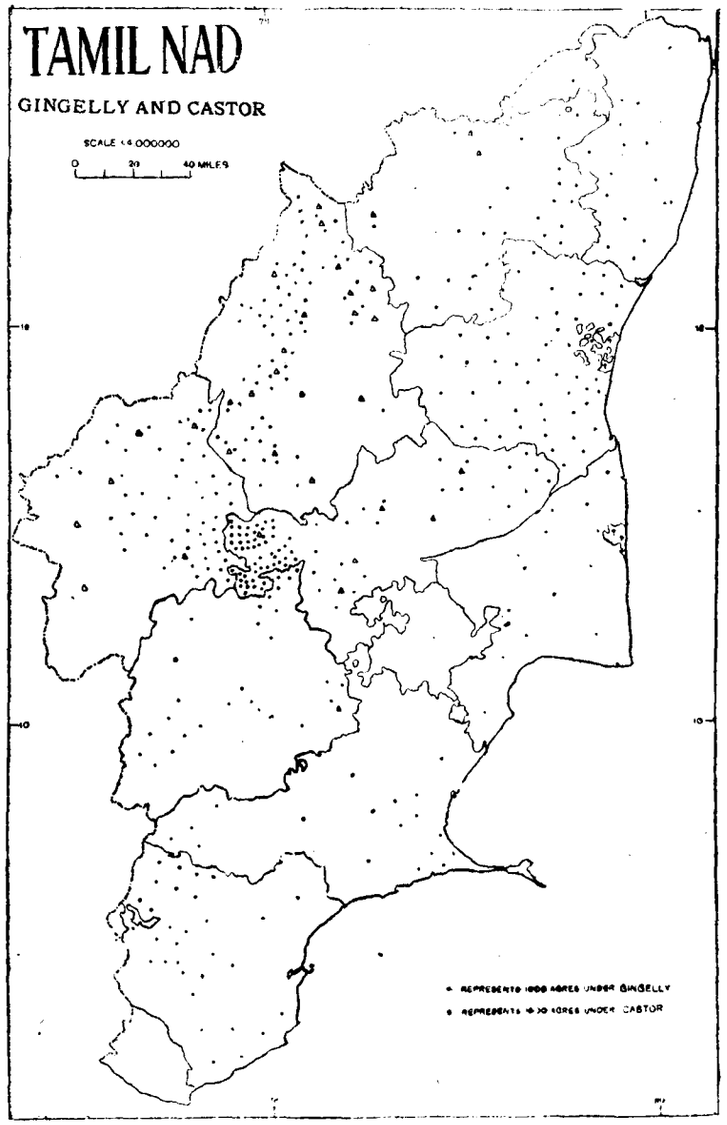
Groundnut cultivation has enormously extended in recent years as it has a double value, as a food-crop in the internal markets furnishing edible oils and as a cash-crop in the external; while the refuse makes good manure and cattle food. As the unexported quantities are readily absorbed in the local market when prices have fallen, the cultivation receives little set-back from drops in prices. There is therefore some steadiness about it. The chief uses of groundnuts abroad are for oil,

147. K. C. Ramakrishnan, J. M. G. A. V, p. 103.

for edible oils, for soap making and for lubricant. It is also much used by perfumers. It is used as a substitute for olive oil, in cookery, and in the manufacture of butter substitutes, confectionery, etc. The refuse is also fully used up.

Gingelly:—Gingelly (*Ellu* in Tamil) is raised commonly in all places. No distinction of soils is made in its cultivation. Hence it is grown more or less over the whole region. The greatest concentration is seen in the Karur taluk of the Tiruchirapalli district where it occupies more than 50,000 acres forming about a quarter of the total cropped area of the taluk. Gingelly is grown both irrigated and unirrigated. The unirrigated gingelly is grown in March to May and harvested in three months. Its cultivation has to be made carefully. It does not admit either a little excess of rain or a slight deficiency of it. A good shower is absolutely necessary as soon as the crop begins to flower but excessive damp is injurious. Irrigated gingelly is sown in wet lands in January or February after the harvest of rice. It requires watering within 20 days after sowing and again when the plants are in flower. Gingelly is sown broadcast and never transplanted. It is a very remunerative crop but greatly exhausts the soil. The crop is a delicate and uncertain one and cannot be counted on till it is threshed and the yield of oil is in proportion to the labour spent in tillage. Gingelly oil is the oil chiefly used by Tamilians for cookery and anointing the body. The cake is commonly used as a cattle fodder.

Castor:—Castor (*Amanakku* in Tamil) is grown chiefly in the northern and western parts of Salem, western parts of North Arcot corresponding to the sub-region Da of the Section on climate and to a considerable extent in Tiruchirapalli and Coimbatore. These areas have only moderate to light rainfall. It is less commonly grown in the eastern parts of the region as heavy rainfall is injurious to the plant after the root system has developed. This crop is rarely sown alone but generally in lines among *ragi*, *cumbu* or other occasionally irrigated crop or by the margin of a water channel. It will, however, grow



MAP 17.

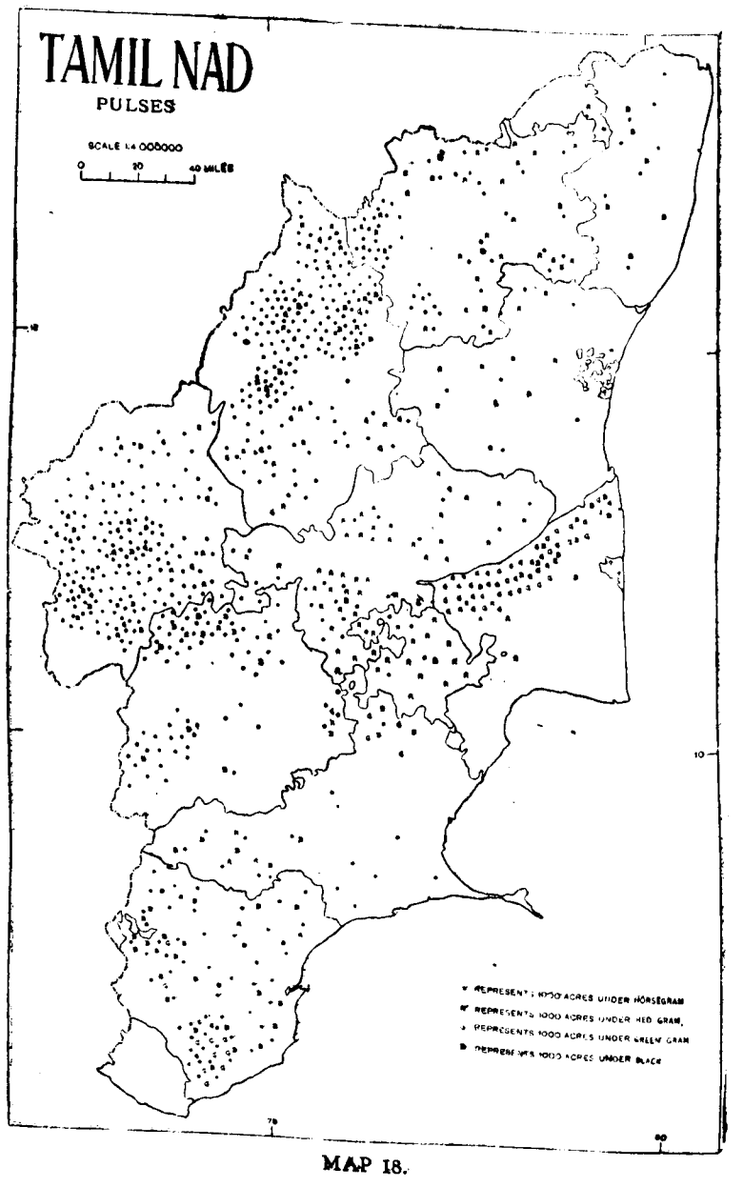
without irrigation, and in all sorts of out of the way places, in backyards, hedges, etc. where it is planted for domestic use. The area under cultivation of this crop has increased in recent years. This is partly due to the demand created by aeroplanes for lubricating oils, as the castro-lubricating oil cools the engine when the plane travels at a tremendous speed and the oil does not get solidified at the very low temperature of great altitudes. This oil is also used as an illuminant (hence the name விளக்கெண்ணெய் or lamp oil) and as a medicine. The cake because of the presence of a poisonous substance called ricin is unsuitable as a cattle feed.[148] However it forms a good manure for garden lands.

Pulses.—Among the pulses (grams), the horsegram, green gram, black gram and red gram are grown to a consideable extent.

Horsegram (*kollu* in Tamil) occupies the greatest area under pulses. It is grown extensively in the districts of Salem and Coimbatore and western Madura. It is also grown to a minor extent in North Arcot and Tirunelveli. All inferior soils are utilized for growing this crop. On richer soils and under heavy rains it runs to leaf and produces little flowers.[149] It is a highly renovative crop and is of great value as a soil fertilizer. It is never irrigated, the retreating monsoon rains and the cold weather dews being sufficient to mature it. The preparatory ploughing is slight and the manure given to the land none. The grain is not used for human consumption, but given to draught cattle and horses.

Black gram (*Ulundu*) is grown in all districts except South Arcot, Tiruchirapalli and eastern Ramnad. This crop generally follows castor and cotton, though it is cultivated after any crop when the land requires cleaning. The spreading character of the plant kills the weeds by shade. This crop is not manured. It is grown upon paddy fields, after or

148. J. C. Bahl, The Oil-Seed Trade of India, p. 50.
149. North Arcot Manual, Vol. 1, p. 271.



MAP 18.

just before the harvest of paddy. The seeds are cast into the cracks which form after irrigation has been discontinued and no further ploughing is given.[150]

Green grams (*Payaru*) is cultivated much in the same way as black gram. It is cultivated to a great extent in the tract between the Cauvery and the Coleroon under the name *Vayal Payar* after the harvest of paddy. It is grown to a minor extent in Coimbatore and Salem districts.

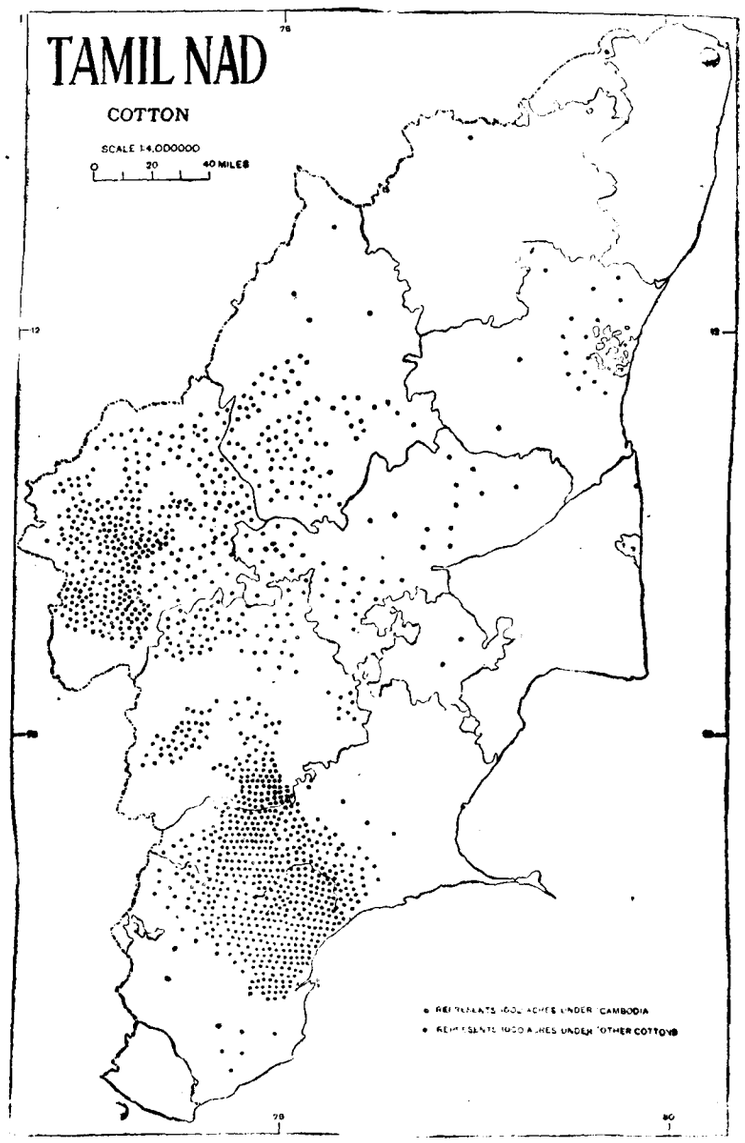
Red gram (*Tuvarai*) is an unirrigated crop sown in dry lands in July and reaped in December. It is found in Tiruchirapalli, Salem, South Arcot, North Arcot, Coimbatore and northern Madura. *Dhall* is considered very nutritious and is an important article used in cookery. The stalks of the plant make an excellent charcoal, esteemed the best for gunpowder.[151]

Industrial Crops.

Cotton:—The cultivation of cotton is mainly confined to the west central region and the southern part of the region north of the Tambraparani, where the rainfall is generally low. The proportion of cultivated area under cotton to the total cropped area is highest (30% to 40%) in the taluks of Koilpatti, Sattur and Tirumangalam which coincides with the black cotton soil region. The next highest percentage (20% to 30%) is found in the adjoining taluks of Aruppukkottai, Sankarankoil and also in Coimbatore, Palladam and Udamalpet taluks.

There are mainly two varieties grown, the indigenous and the Cambodia. In the black cotton soil region of the south the indigenous variety under the name of '*Tinnys*' is grown. In the west central region noted for its intensive cultivation under wells, Cambodia is the main variety cultivated. The

150. Ibid.
151. Ibid, p. 270.



MAP 19.

Tinnys have long tap roots and slender feeding roots penetrating deep into the soil and hence are suited to the dry black cotton soil areas where there is no irrigation. Cambodia on the other hand possesses a tapering tap root and strong feeding roots limited to the upper layers of the soil, and hence cannot withstand prolonged drought. So it is grown only as an irrigated crop in the red soil areas of Coimbatore and Madura. This cotton was introduced in the region in 1904 and is now one of the few long staple cottons and is much sought after by mills spinning 40 counts and more.

The Tinny cotton is really a mixture of two varieties the *karunganni* and the *uppam*. *Karunganni* likes the sea breeze, and except where grown on red soils, is seldom found more than thirty miles from the coast; further inland *uppam* predominates. *Karunganni* is superior to *uppam* being of longer staple and hence yielding finer lint. The superiority of *Karunganni* is probably due to the beneficial influence of the sea breeze, which blows from the southeast in March and April[152]. However, the irrigated Cambodia is decidedly superior to *Karunganni*, being of much longer staple and yielding twice as much per acre as *Karunganni*.

The Tinny cottons are sown in October in the black soil area so as to receive the full benefit of the retreating monsoon rains during its growth. From January to March the weather is clear and sunny, and is just the thing for the crop to put forth flowers and bolls. The picking or harvesting period may last from two to five months, according to the quantity and distribution of rainfall in April and May. The growing period for Cambodia practically coincides with that in the black soil region; and the retreating monsoon rains are utilized in the same way by the young crop in the garden.

The Department of Agriculture has evolved improved strains of cotton to the benefit of the growers. C O (2) or College Paruthi evolved in the Coimbatore cotton breeding

152. S. V. Doraiswamy Iyer, J.M.G.A., VII, p. 218.

station from the bulk Cambodia is one of the best and most popular cottons grown in the region. It yields 15% more than the unselected Cambodia, and is grown on over 275,000 acres chiefly in Coimbatore, Salem, Madura, Ramnad and Tirunelveli districts.[153]

Part of the raw cotton produced in the region is exported to foreign countries and the remaining is used for spinning yarn in the local mills. The consumption of cotton by handspinning for the production of Khadhar is small. The following table gives the number of spindles and looms in local mills, in the order of importance.

Towns.	Number of mills.	Number of spindles.	Number of looms.
Coimbatore	25	496,058	1,363
Madura	4	306,838	82
Ambasamudram	1	140,736	—
Perambur	1	118,972	2,752
Pondicherry	3	84,960	—
Tuticorin	1	60,732	—
Udumalpet	3	42,800	—
Tiruppur	2	38,424	126
Koilpatti	2	32,018	224
Salem	2	30,180	300
Tiruchirapalli	1	16,000	—
Rajapalayam	1	12,300	—
Gudiyattam	1	12,040	—
Mettur	1	11,544	300
Pasumalai	1	10,240	—
Dindigal	1	6,400	—
Tiruchengode	1	6,300	—
Total	51	14,36,992	5,147

Most of the mills are all located in or near the cotton growing regions. Nearly a third of the cotton mill industry of Tamilnad is concentrated at Coimbatore and its suburbs.

153. S. N. Chandrasekara Iyer, J.M.G.A-, XIV, p. 123.

The rapid growth of this town in the recent past is mostly due to the development of these mills based on the supply of cheap electric power available from the Pykara scheme. The biggest mill of this region is, however, situated in Madura. From the above table it is evident that spinning is more important than weaving in the mills. The yarn produced by the mills is therefore in excess of their utilization for weaving and the surplus is used by the handloom weavers all over the region.

The handloom industry ranks in importance and magnitude next only to agriculture. There is no other occupation which is able to absorb the population, not engaged in agriculture to such an extent, or to keep the agriculturists occupied fully when there is less work for them in the fields. It serves also as a suitable part-time occupation for them. In recent years the handloom weavers have had to face increasing competition from Indian mill made cloths, and the Government, are giving a great deal of encouragement and protection to the handloom weaving industry.

Sugarcane:—Sugarcane is cultivated mainly in South Arcot district, the Cauvery valley in Salem and Tiruchirapalli districts, the upper Palar valley in North Arcot district, in the Periyar tract, and under garden cultivation in Coimbatore district. Thus it is always grown in the upper portions of the river valleys, as they have a longer duration of water supply and better drainage facilities. The cane needs constant waterings for ten or eleven months of its growth. It is a very expensive crop to raise, so that only the richer ryots attempt it.

The insignificantly small area under cane in this region even in tracts with good irrigation facilities in contrast with the very large area under cane in the sub-tropical North India looks rather strange. The impediments to the extension of sugarcane cultivation here are more economic than geographic in character. As there are only a few factories, it is very difficult to find a market for this very expensive crop. But no factory is likely to be set up without an assured supply of

canes on a couple of thousand acres in the neighbourhood. To break this vicious circle is by no means easy. But as there is a good demand for jaggery, it would be better to set up small power mills on co-operative lines for the crushing of canes and manufacture of jaggery on improved furnaces.[154]

In addition to the crops discussed above, a great range of other crops are also produced in Tamilnad. The growing of cocoanuts, mangoes, chillies, plantains, tobacco, betels and vegetables is widespread. Tamilnad has great possibilities wih regard to the production of fruits. But at present, excepting mangoes fruit growing is not of much commercial importance. The region produces small quantities of tea, coffee and rubber also.

It will be helpful in this connexion to study the Chinese farmer who, by his diligent and assiduous habits, gets the best results both in respect of quality and quantity of crops from the soil. The lot of the individual farmer in rural China is no way better than that of the individual farmer in Tamilnad. Placed in a similar situation, the Chinese farmer wrings from the soil the utmost that could be got without the use of any of the modern methods. The secret of his success lies in his prodigious energy, the perpetual vigilance and the patient skill.[155]

In a tropical country like Tamilnad our peasants cannot toil like the Chinese peasants. It is here that the Department of Agriculture can do much to help them. They should be enabled to profit by the improved methods evolved by the Department of Agriculture. Surprisingly enough, for all the good work of the Department of Agriculture, there has been no great change in either the system of cropping or in the methods of farming in Tamilnad. The diffusion of the beneficial results of the work of the Department has been very slow.

—(To be continued).

154. K. C. Ramakrishnan, J. M. G. A., V, p. 104.
155. A Resurvey of Some South Indian Villages, University of Madras, p. 423.

Some Observations on the Adyar River, with special reference to its Hydrobiological Conditions

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INTRODUCTION.

Our knowledge about the conditions of existence in lakes, ponds, streams and rivers of India is poor or fragmentary, although certain facts relating to bionomics of fishes, aquatic insects and plants are found scattered in literature. But a complete survey portraying the physical, chemical, biological and ichthyological conditions of inland waters is very necessary for increasing the fishery resources of our country. An attempt is made in this paper to describe these conditions in one of the two important rivers flowing within the City of Madras.

DESCRIPTION OF THE RIVER.

The Adyar river (Fig. 1) has a short course of about 25 miles along the southern border of the Madras City. It commences from the Guduvancheri hills in the Kancheepuram taluk, and flowing through the Saidapet taluk empties into the sea at Adyar, five miles south of the Fort St. George. It collects mainly the surplus water of the Chembarampakkam irrigation tank and other subsidiary natural drainages. It is full only during the North-East Monsoon period (October to December) when there is good flow of fresh water into the sea. The river-mouth is fairly deep and broad during this period. As the strength of the current gradually weakens after two months, tidal effects are markedly felt to a distance of about three to four miles up the river. The maximum tidal range is

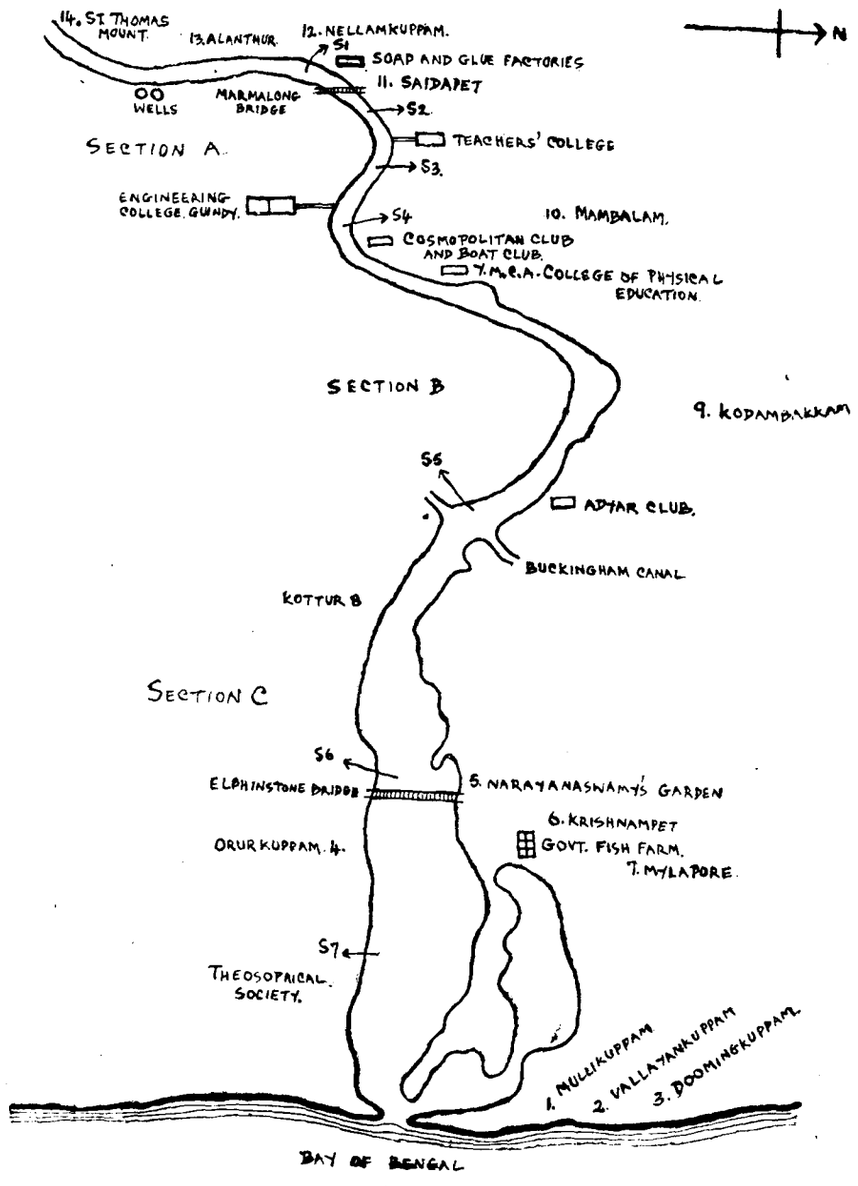

FIG. 1

SKETCH MAP OF ADYAR RIVER SHOWING 14 FISHING VILLAGES, 7 SAMPLING STATIONS AND OTHER IMPORTANT PLACES.

about three feet. The backwater closeby allows a good admixture of sea water and fresh water, and is therefore of much importance. With the advent of summer the fringes of the backwater get dried up, leaving some of the mudflats exposed. The immediate effect is an increased flow of water from the sea into the river and the backwater; but this is soon retarded by the action of breakers, which raise up a sand bank at the mouth of the river on a line with the shore. The connection of the river and the backwater with sea is thus intermittent during February; but it is completely cut off by the end of March. The sand bank, or the bar as it is called, widens out in latter months, reaching a maximum width of about three-quarters of a furlong. The bar is prominent until the next rainy season (October to December) when the river-current is again strong enough to force its way into the sea. The times of opening and closing of the bar may be considered as approximately occurring between October and November, and between February and April respectively.

The bottom of the river as well as of the backwater is of a muddy consistency, but the sandy element in the soil becomes pronounced near the sea. The boulders of the Elphinstone Bridge and the small bridge near the Adyar Cemetry, and the stony embankment near the Theosophical Society's quarters on the southern bank of the river give shelter to rock-dwelling species. During the summer months, the upper reaches of the river are confined to some pools, averaging about 3 furlongs in length, 250 feet in width and 8 feet in depth. The bottom of these pools is muddy, sandy and rocky in different places.

PHYSICAL CONDITIONS.

The river can be roughly divided into three sections within the City:—(*i*) upper reaches, (*ii*) middle portion, and (*iii*) estuary. The river presents one continuous sheet of good flowing water for a few days in the year especially just after a heavy rainfall in the upper reaches of the river during the north-east monsoon season. On other days, it is meandering and forms a number of puddles all along its course.

(*i*) **Upper reaches**:—The portion of the river on either side of the Marmalong Bridge, for a distance of 200 yards, is rocky and is strewn with pebbles and boulders. This section of the river is used by washermen for washing clothes. Besides this kind of pollution, the river is also faecally polluted by the local residents. Wastes from a soap and glue factory are also allowed to drain into the river about hundred feet above the railway bridge. Thus the river in this area is badly contaminated, and the water is therefore discoloured and full of life. Further, about a mile or so above the Marmalong Bridge, several wells have been sunk on its shore for supplying water to the King Institute of Preventive Medicine, Guindy, and for the Saidapet town. The Government House at Guindy is also supplied with water from another well located on the shore of the river. The Teachers' College Hostel at Saidapet is also supplied with water from two wells located on the river bank about half a mile below the bridge. While the wells located above the bridge are free from tidal effects, those below are affected especially during the hot weather and south-west monsoon season.

(*ii*) **Middle portion**:—The stretch of the river from the Teachers' College to the Adyar Boat Club may be considered as the middle portion. This section is fairly deep and continuous and cannot be easily crossed except by boat. Here the wastes from the Engineering College hostels pollute the river. The water is almost always greenish and is rich with phyto and zoo-plankton. Being deep, this stretch is also used for boating purposes. Just below the Adyar Boat Club, the Buckingham Canal joins the river. This river section is not fished to the same extent as the estuary.

(*iii*) **Estuary**:—This forms the most important section of the river, as the fisherfolk inhabiting its shores live mainly upon the catches of fishes, crabs and prawns obtained from it. The colour of water and depth varies during the course of a day and also in different seasons.

The depth of water as well as the temperature of the water follows that of the atmosphere, being hottest during April and May and lowest during December and January. The highest temperature recorded is about 35°C and the lowest about 22°C. The physical conditions of the river on 9th February 1949 are shown below (Table 1), representing typical summer conditions.

Table I.

Showing the physical conditions of Adyar river as on 9—2—1949.

No	Location of sampling station.	Time.	Temperature °C	Colour.	Depth in ft.
	A. Upper reaches.				
S1	Middle of river above Saidapet railway bridge ...	9-20 A.M.	27.6	greyish	3.0
S2	About 100 yards below bridge.	9-35 A.M	29.6	do	2.0
S3	Near Teachers' College Hostel.	10- 0 A.M.	29.9	do	6.0
	B. Middle portion.				
S4	Between sewage outfall from Engineering College and Cosmopolitan Boat Club ...	10-30 A.M.	29.9	dark green.	8.8
S5	Junction of Buckingham Canal and river ...	10-40 A.M.	30.9	greenish	8.0
	C. Estuary.				
S6	Above Elphinstone bridge ...	11-15 A.M.	29.6	do	7.0
S7	Near sand bar opposite Theosophical Society garden ...	11-35 A.M.	29.4	do	7.0

CHEMICAL CONDITIONS

The typical chemical conditions of the river as on 9th February 1949 are shown in Table II. They vary in the three sections. The river is alkaline in character throughout its stretch though showing slight variations. The middle portion of the river is more alkaline than the other two sections, the

estuary showing the lowest. This is probably due to tidal influences. The oxygen content also is seen to be greater in the last two sections than in the first, where it is as low as 1.0448 cc/1 at S1 and nil at S2. At S3, the water is supersaturated; and at other places the percentage of saturation varies between 45 and 100. As regards the nutrient substances of biological importance such as phosphates, silicates and nitrates, phosphates are found to be highest in the middle portion and to be absent in the upper reaches. while they are present in fair amounts in the estuary. Silicates, on the other hand, are found to be more or less uniform, varying between 0.508 and 0.750 parts per 100, 000. Nitrates are conspicuous by their absence. Regarding chlorides, the amount is lowest in the upper reaches, being about 40.0 parts, higher in the middle portion, being 580.0 to 1480.0 parts, and highest, being 1640 to 2800 parts per 100,000, in the estuary.

Table II.

Showing the chemical conditions of Adyar river at seven sampling stations, as on 9—2—1949.
(Results expressed in parts per 100,000).

Chemical conditions.	Sampling Stations.						
	S1	S2	S3	S4	S5	S6	S7
1. Free Carbondioxide ...	nil	nil	nil	nil	nil	nil	nil
2. Carbonates (CO_3) ...	1.152	2.881	3.457	3.169	2.593	0.5762	0.5862
3. Bicarbonates (HCO_3) ...	35.441	111.0	12.595	11. 23	14.645	10.252	10.640
4. pH ...	8.3	8.35	8.5	8.6	8.5	8.0	8.2
5. Dissolved oxygen (cc/l) ...	1.045	nil	6.02	2.652	5.460	2.513	2.373
6. Percentage of saturation ...	18.2	nil	107.9	47.5	99.4	44.7	42.1
7. Phospates (P) ...	nil	trace	0.1	0.1103	0 082	0.072	0.072
8. Silicates (SiO_2) ...	0.641	0.750	0.667	0.568	0.515	0.508	0.508
9. Nitrates (N) ...	nil	nil	nil	nil	nil	nil	nil
10. Chloride (Cl_2) ...	40.0	40.0	580.0	1260.0	1480.0	1640.0	2800.0

BIOLOGICAL CONDITIONS.

(a) Macrovegetation

The vegetation is poor in the river; but the shallow stagnant backwater contains a luxuriant growth of algae, chief among the latter are *Enteromorpha* and *Chaetomorpha.* The shallow portions of the river are covered with *Potamogetons.* Marsh plants like *Avicennia* and *Sueda* are common in the mud-flats and the islands in the river. In the upper reaches, freshwater forms like *Spirogyra, Ceratophyllum, Hydrilla, Pithophora, Vallisneria, Ottelia* and *Alismoides* are found in large numbers.

(b) Phytoplankton

The plankton, which forms the basic food of the fishes of the river, is fairly rich and varied consisting of both marine and freshwater species. Some of these have been described by Panikkar and Aiyar (1937) and by Venkatraman (1939). The following is a comprehensive list of phytoplanktonic organisms recorded from the river by us.

Bacillarieae :—*Melosira, Sceletonema, Thalassiothrix, Cyclotella, Coscinodiscus, Chaetoceras, Synedra, Asterionella, Eunotia, Achnanthes, Mastogloia, Gyrosigma, Pleurosigma, Diploneis, Anomoeoneis, Navicula, Pinnularia, Amphiprora, Amphora, Cymbella, Rhopalodia, Bacillaria, Nitzschia,* and *Surirella ;*

Chlorophyceae :—*Ankistrodesmus, Closterium, Cosmarium, Dictyosphaerium, Euastrum, Kirchneriella, Oocystis, Pediastrum, Scenedesmus* and *Staurastrum ;*

Xanthophyceae :—*Botryococcus ;* and

Myxophyceae :—*Microcystis, Aphanocapsa, Aphanothece, Gleocapsa, Anabaena, Spirulina, Oscillatoria, Lyngbia* and *Schizothrix.*

(c) Zooplankton

The zooplankton of the river is comprised of the following organisms.

Protozoa :—*Peridinium, Ceratium, Noctiluca, Tintinnus, Vorticella, Euglena, Pandorina, Gleocystis* and *Phacus ;*

Crustacea :—*Evadne, Podon, Alonella, Rhopalophthalmus, Mesopodopsis, Acartia, Pseudodiaptomus, Cirripeda nauplii, Ocypode megalopoe, Leucifer* and *Leander ;*

Chaetognatha :—*Sagitta ;* and

Mollusca :—*Veliger larva.*

FISH FAUNA

(a) Species of Fishes.

The fishery of the river is poor, except when the bar is open when several marine species enter the estuary. The following is a comprehensive list of marine, estuarine and freshwater species of fishes that occur in the river.

1. *Anguilla bengalensis* (Gray & Hardw,) 2. *Ophichthys microcephalus,* Day. 3. *Elops indicus* Swainson. 4. *Megalops cyprinoides* (Broussonet) 5. *Chanos chanos* (Forskal) 6. *Engraulis purava* (Ham.) 7. *Stolephorus commersonii* Lacep. 8. *Clupeoides lile* (Cuv. & Val.) 9. *Wallagonia attu* (Bl. Schn) 10. *Plotosus canius* Ham. 11. *Macrones vittatus* (Bloch) 12. *Macrones gulio* (Ham.) 13. *Macrones keletius* Cuv. & Val. 14. *Labeo fimbriatus* (Bloch) 15. *Cirrhina reba* (Ham.) 16. *Barbus sophore* (Ham.) 17. *Barbus dorsalis* (Jerdon) 18. *Barbus ticto* (Cuv. & Val.) 19. *Barbus amphibius* (Cuv & Val.) 20. *Barbus filamentosus* (Cuv & Val.) 21. *Amblypharyngodon microlepis* (Bleeker) 22. *Chela argentea,* Day. 23. *Chela clupeoides* (Bloch) 24. *Nuria danrica* (Ham.) 25. *Barilius bendelisis* (Ham.) 26. *Aplocheilus blochii,* Jerdon. 27. *Oryzias melastigma* McClelland. 28. *Hemiramphus limbatus* Cuv. & Val. 29. *Hemiramphus cantori,* Bleeker. 30. *Belone cancila* (Ham.) 31. *Mugil cephalus* Linn. 32. *Mugil olivaceus,*Day. 33. *Mugil cunnesius,* Cuv. & Val. 34. *Lates calcarifer* (Bloch) 35. *Rhynchobdella aculeata* (Bloch) 36. *Mastacembelus pancalus* (Ham.) 37. *Serranus sexfasciatus* Cuv. & Val. 38. *Ambassis commersoni,*

Cuv. & Val. 39. *Ambassis myops* Gunther. 40. *Ambassis ranga* (Ham.) 41. *Ambassis nama* (Ham.) 42. *Apogon aureus* (Lacep.) 43. *Apogon bifasciatus* (White). 44. *Lutjanus johnii* (Bloch) 45. *Lutjanus lineolatus* (Rupp.) 46. *Therapon jarbua* (Forskal) 47. *Therapon puta* Cuvier. 48. *Gerres oyena* (Forskal) 49. *Sillago sihama* (Forskal) 50. *Scatophagus argus* (Bloch) 51. *Polynemus tetradactylus*, Shaw. 52. *Equula insidiatrix* (Bloch) 53. *Upeneus sulphureus* Cuv. & Val. 54. *Gobius polynema* (Bleeker) 55. *Gobius criniger* Cuv. & Val. 56. *Glossogobius giuris* (Ham.) 57. *Acentrogobius neilli* (Day) 58. *Oxyurichthys tentacularis* (Cuv. & Val.) 59. *Apocryptichthys cantoris* Day. 60. *Boleophthalmus boddaerti* (Pallas) 61. *Eleotris fusca* (Bl. Schn.) 62. *Periophthalmus koelreutri* (Pallas) 63. *Periophthalmus pearsei* Eggert. 64. *Pseudorhombus arsius* (Ham.) 65. *Caranx ciliaris* (Bloch) 66. *Petroscirtes bhattacharyae* Chaudhuri. 67. *Platycephalus insidiator* (Forskal) 68. *Etroplus suratensis* (Bloch) 69. *Etroplus maculatus* (Bloch) 70. *Tricanthus brevirostris* Temm. & Schleg. 71. *Tetradon patoca* Ham. 72. *Tetradon inermis* Temm. & Schleg. 73. *Ophicephalus striatus*, Bloch. 74. *Ophicephalus punctatus*, Bloch., and 75. *Anabas scandens* (Dald.)

(b) Fish Seed

The occurrence of young stages of saltwater species like *Elops indicus*, *Megalops cyprinoides*, *Chanos chanos*, *Mugil spp.*, *Lates calcarifer*, *Lutjanus spp.*, and *Etroplus suratensis*, in the estuary of the river, offers facilities for the acclimatisation of these species into freshwaters as suggested by Job and Chacko (1947). A fish farm for the fuller exploitation of these seed sources has recently been established in the adjoining backwater area, and so far, more than two lakhs of fishlings have been collected and distributed to inland waters in and around Madras.

Many of the species obtain breeding facilites in the river. Jones (1937) has observed the breeding and development of seven species from this area. We have made the following detailed observations on the breeding and development of the

Pearl Spot, *Etroplus suratensis*, which is one of the most economically important fish of the Adyar river. This species is common in the estuary. It becomes sexually mature in the first year itself, ie., when about 8 months old and 6 to 7 inches in size. The males are slightly larger than the females. Breeding takes places throughout the year, with a maxima during December-February. The fertilised eggs are attached to stones, pillars, poles, and other hard submerged substrata, in the form of yellowish oblong patches about 6 inches by 7 inches in dimensions. On an average there are two thousand eggs in each patch, which are guarded by the parents. Segmentation lasts five hours. By twenty hours after fertilisation, gastrulation is completed and the neural ridge appears as a median thickening of the dorsal surface of the embryo. On the fourth day, the optic and auditory vesicles are visible, the heart commences pulsation, and thirteen myotomes become discernible. On the fifth day, prominent pigmentation in the form of stellate chromatophores are developed over the yolk mass. Cement glands appear on the sixth day, and on the same day the larvae are hatched out. The hatchling measures 5.25 mm in length. Rudiments of fins as also the anus are formed the same day. All the oil globules in the larvae coalesce to form a single large oil globule. The cement glands start secreting adhesive filaments. On the second day after hatching, the eyes are pigmented. Chromatophores gradually spread over the body at the pectoral region. On the third day, gills and mouth are formed. The pectoral pigment band becomes clear. On the fourth day, the yolk mass is almost absorbed, and the fry commences independent feeding on microscopic algal filaments and zooplankton. On the seventh day, the fry measure 0.75 to 0.9 inches in length. They are somewhat translucent, the vertebral column showing as an opaque streak. A conspicuous black ocellus is present on the soft portion of the dorsal. The parents guard their offsprings for about 4 weeks. They evade capture by lying flat on the side on the bottom. Conical bamboo traps and fixed engines such as a submerged twig mass are however effective to capture them.

The larval stages of the Indian Taropn, *Megalops cyprinoides*, characterised by a leptocephalus form, are abundant in the estuary from October to December. They ascend the river from the coastal sea through the open bar. These larvae metamorphose into fingerlings, and the latter become available in large numbers from January to March. The fish attains a size of 14 inches in the first year of its life.

SOCIO-ECONOMICS

(a) Fisherfolk

There are fourteen fishing villages along the river course. A census of the fisherfolk of these villages was recently conducted by us (*Vide Table III*). There are on the whole 802 men, 677 women and 571 children. It is not possible to estimate accurately the earnings of these people; but it is considered that Rs. 1-8/- would be the average earning per head per day.

Table III.

Showing census of fisherfolk of 14 villages along Adyar river course.

S. No.	Name of fishing village.	Men	Women	Children
1	Mullikuppam ...	68	61	94
2	Vallayankuppam ...	34	12	24
3	Doomingkuppam ...	288	250	8
4	Ururkuppam ...	68	51	54
5	Narayanaswamy's garden ...	154	157	162
6	Krishnampet ...	21	21	14
7	Mylapore ...	3	3	—
8	Kottur ...	15	12	18
9	Kodambakkam ...	18	19	26
10	Mambalam ...	14	11	25
11	Saidapet ...	31	29	62
12	Nellamkuppam ...	6	4	5
13	Alanthur ...	59	30	49
14	St. Thomas Mount ...	23	17	30
	Total...	802	677	571

(b) Craft and Tackle

The fishing tackles employed by the fisherfolk of the area consist of cast nets (*veechu valai* and *manivalai*), drag nets (*kondavalai*, *nethilivalai*, *kalluvalai* and *kottimethikumvalai*), encircling nets (*pentha valai*, *perravalai*, *paduguvalai*), and *siruvalai*), shore seine nets (*bodivalai* or *agnivalai*), dip net (*kachavalai*) and country rod and line. The meshes of the different nets vary from $\frac{1}{4}$ to $1\frac{1}{2}$ inches. A statement of these tackles and also of the fishing crafts is given in Table IV. There is practically no difference in the quality of the catches of the difterent nets except that the small meshed cast nets and the dip nets are used only for capturing prawns and crabs respectively. The catches of the shore seine nets are however proportionately more when compared to the others. These seine nets are operated only by the Doomingkuppam fishermen. Though there are 29 such nets in the village, they are used only twice a week, one net with a party of about 20 fishermen being operated on a day. Half the catch goes to the owner of the net and the other half shared as wages between the operators. The fishermen of 10 out of the 14 villages know only the use of cast nets. There are more than 800 cast nets in use in the river. There is a heavy destruction of fishlings by the use of these small meshed nets. Since the Adyar estuary and the adjoining backwater are good sources of fingerlings of fishes of economic importance, there is urgent need to regulate the fishing operations by prescribing a mesh regulation of at least 1 inch size for the nets, or a size of 6 inches as the permissible minimum for the capture of all fish. These measures would lead to a substantial improvement of the fishery which will be to the advantage of the fishermen as well as to that of the fish eating public of Madras. These aspects of fishery management of the river are being investgat ed further.

Table IV.

Showing statistics of fishing craft and tackle of 14 villages along the Adyar river course.

Name of fishing village	Kind of tackle					Kind of craft	
	castnet.	dragnet.	encircling net	shore-seine	dip net	boat	catamaran
1. Mullikuppam ...	—	44	—	—	—	—	—
2. Vallayankuppam ...	—	1	2	—	30	—	—
3 Doomingkuppam ...	—	54	28	29	—	2	—
4. Ururkuppam ...	—	34	—	—	—	—	—
5. Narayanaswamy's Garden ...	343	—	—	—	—	—	55
6. Krishnampet ...	64	—	—	—	—	—	—
7. Mylapore ...	4	—	—	—	—	—	—
8. Kottur ...	38	—	—	—	—	—	—
9. Kodambakkam ...	68	—	—	—	—	—	—
10. Mambalam ...	36	—	—	—	—	—	—
11. Saidapet ...	132	—	—	—	—	—	—
12. Nellamkuppam ...	16	—	—	—	—	—	—
13. Alanthur ...	75	—	—	—	—	—	—
14. St. Thomas Mount ...	57	—	—	—	—	—	—
Total ...	833	133	30	29	30	2	55

Conclusion.

The Adyar river serves several purposes. In the nonbrackish region, the river water is used for drinking purposes and for washing purpose by the local residents and dhobies respectively. Lower down the Saidapet area, where the water is deep and brackish, the river affords boating facilites and a fairly good fishery which contributes to the food of a certain percentage of the citizens of Madras. This fishery supports also 800 fishermen and their families. The river is also exploited by the Government Fisheries Department for the collection of fishlings of species which are

acclimatisable to fresh water. A fish farm is located close to the estuary to facilitate these fish cultural operations. The existence of indigenous larvicidal and cyclopscidal species of fishes facilitates public health fishery operations in and around the City. The Socio-economic conditions of the fisherfolk of the area are briefly recounted. With proper conservation, development and exploitation, this small river can be made to yield a good fishery to cater to the needs of the growing population of the city of Madras.

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Potentialities of Tube-Well Irrigation in the Budaun District (United Provinces, India).

BY

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The Western districts of the United Provinces, namely Budaun, Moradabad, Bijnor, Muzaffarnagar, Meerut, Bulandshaher, and Aligarh, with an area of about one and a half million acres of land have long been suffering from low rainfall and the amount received throughout the year is so variable that cultivation, especially winter cropping, seems difficult without the help of irrigation.

The Budaun district, lying within this dry tract, receives an average rainfall of 32 inches mainly during the summer season, which is insufficient for good cropping, particularly for the Rabi Crops. In the past, irregular distribution of rain and even the wide fluctuations in the normal, not only created difficult irrigational problems, but also some times resulted in famines in the district. To improve unfavourable conditions of agriculture of the district, there was only one remedy viz. that artificial watering should be done in some effective way.

The most common method of irrigation, which has been utilised from earliest times in the district, is shallow "kachcha" wells. The greater percentage of cultivated land is irrigated by means of such wells, as their construction is easy and cheap, except at such places where the earth is loose and sandy and the well cannot last long.

Besides, the construction of wells, various other projects were made from time to time with the object of supplying the district with regular canal irrigation. In the year 1855, a scheme was drawn up to irrigate the culturable area of the

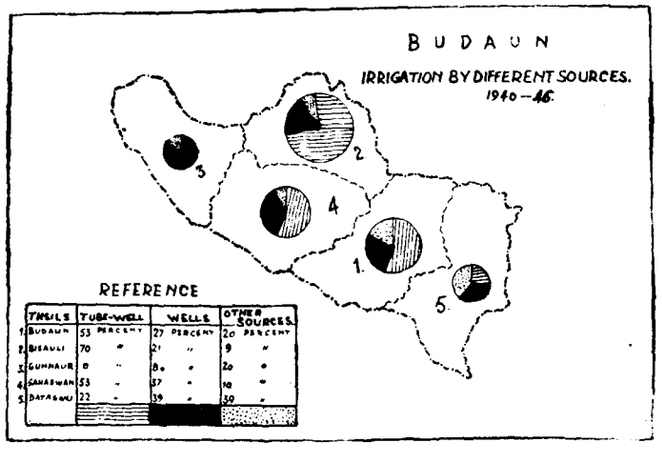
district from a canal cut from the right bank of the river Ramganga. But that project was hampered by the out-break of Mutiny in 1857. Again in the year 1861, the construction of a canal from the Ganges was recommended. But this scheme was also dropped on the ground that the supply from the Ganges was insufficient, as it was feeding the canals which had already been constructed in its upper course. At last, it was decided that no canal from the Ganges or the Ramganga would be possible to carry on adequate supply for irrigating the culturable tract of the Budaun district.

Canal Irrigation not Possible:—Thus the district of Budaun is very unfortunate in this respect; it has never been benefited by canal irrigation, though it is situated in the midst of one of the best canal irrigated tracts. It is not only because the two main rivers of the area have already an inadequate supply of water, but also beacause most of the district has an uneven topography. Its western portion for instance consists of loose sandy soil, with many terraces in it. The cultivable portion lies in the centre of the district.

Tube-Well Scheme:—At last, the utilization of sub-soil water through the tube-wells was considered, as this water was found to be adequate elsewhere and has been utilized in the form of percolation wells. The Royal Commission on Agriculture had already suggested in the year 1926 that a systematic survey of the sub-soil water should be made, so that cheap and efficient irrigation from wells in suitable areas might be possible.

The Water Table:—In the year 1935, began a new phase of development in the irrigation system of the Western United Provinces, for which thanks should go to Sir William Stampe, who took great pains in making a survey of the sub soil water table and prepared a permanent scheme of Tube-well Irrigation. It, not only introduced a new system of irrigation, but also created a new life for cultivators. Much land which was left waste due to the scarcity of water, was brought under the plough thereby.

The Budaun district like the rest of the Doab is fortunate in so far as it has an inexhaustible supply of sub-soil water. The depth of sub-soil water in the district ranges from ten feet to forty feet, so the construction of tube- wells is easy. "Geolo gically the Indo-Gangetic plain is of little interest, except for its river system though it comprises rich agricultural lands"[1]. The sub-soil water, also, flows in the various strata, generally towards the sea, but with lower velocity. Before the construction of the tube-wells in any of the seven districts, a general survey of the sub-soil and water table was conducted and the level of water was recorded in different wells at various stations. The water table was observed in Muzaffernagar, Meerut, Budaun, Moradabad, Bulandshaher, Bijnor and Aligarh. Yearly records were kept. The general lowering of spring level was observed everywhere. It so happened that during those particular years the rainfall was generally low, so it could not be estimated whether it was due to the tube-well pumping or due to low rains. From the year 1939 upto 1942 experiments were made on several tube-wells in the district of Budaun, and the results thus obtained were generally satisfactory.



MAP 1.

Power :—The successful initiation of Hydro Electric power for pumping water from the wells in the year 1931, led to the

1. Krishnan, M.S.—"Geology of India" P. 23".

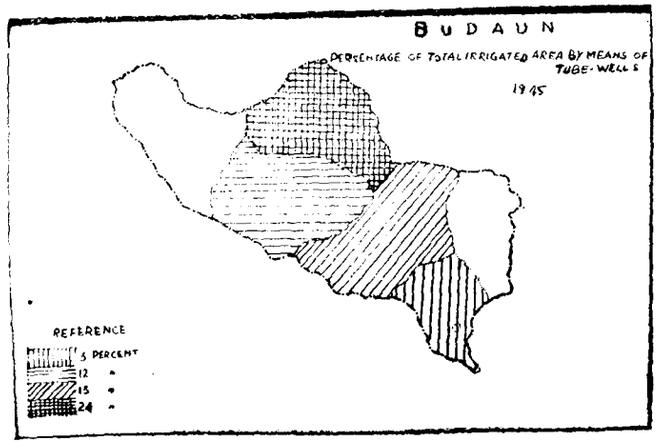
decision that tubewells should be constructed on a considerable scale. In the district of Budaun and Moradabad, power was obtained at a cheaper rate from the Chandausi Hydro Power Station, so it would have been unnecessary to construct any new power station for these two districts. (This power is generated from the water fall of Narora, on the river Ganges, near Chandausi.)

The Programme of Tube-Well Construction :—The develop-ment programme of tube-well construction in the entire Tube-well State was started in the year 1933-34; but in this year no tube-well was erected in the district of Budaun. In the year 1934-35, six tube-wells were constructed and in the year 1935-36 the number went up to 26. In 1936, when the Indian Govern-ment passed the scheme of 1,500 tube-wells, the programme took a speedy turn and in that year 324 more tube-wells were constructed in the district. During 1937-38 the total number of tube-wells in the district was 373.

It was estimated that the projected number of 396 tube-wells for the district would command nearly 810 sq. miles of culturable land. The systematic work of irrigation was actually started from the year 1937, when 367 tube-wells started irrigating nearly 17,000 acres of land. More tube-wells are to be constructed in the district. The projected figures of tube-wells, to be constructed is 49. It has also been estimated that nearly 54,000 more acres of land can be irrigated after the addition of these wells. The percentage of culturable area under the command of tube-wells differs considerably from one part of the district to another, as it depends mostly upon the rainfall during the year, the class of soil, the type of cultivation and the marketing facilities.

Process of Irrigation :—The whole district of Budaun has been divided into six circles, commanding nearly 4,20,000 acres of cultivable land and out of this 1,73,000 acres of land is irrigated each year. The actual area of these circles, irrigated in both the seasons i.e. Rabi and Kharif by means of tube-wells

fluctuates from year to year. This increase or decrease generally depends upon the rainfall distribution over the area in the year and also the nature of the crops grown. Most of the Rabi crops depend upon the tube-well irrigation, and the sugarcane crop is irrigated in both the seasons.



MAP 2.

*** Area Irrigated with 367 Tube-Wells.**

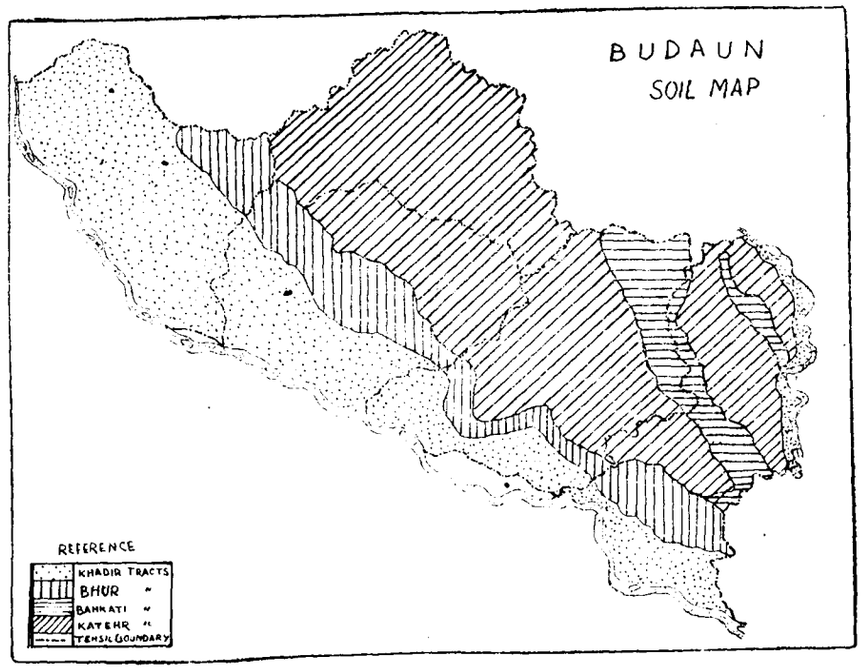
Year.	Total cultivated Area.	Total Irrigated Area in Kharif.	Total Irrigated Area in Rabi.	Total Irrigated Area.
	Acres.	Acres.	Acres.	Acres.
1. 39—40 ...	4,17,787	56,202	2,04,839	2,61,041
2. 40—41 ...	"	19,593	1,06,612	1,26,205
3. 41—42 ...	"	21,693	1,32,405	1,54,098
4. 42—43 ...	"	18,523	95,744	1,14,267
5. 43—44 ...	"	27,989	42,104	70,098
Average. ...	4,17,787	28,800	1,16,340	1,45,140

(* The above figures have been taken from the Tube-well Office, Budaun).

According to the projected scheme, 396 Tube-wells were to command 5,20,000 acres of cultivable land. But in practice the progress has been slow and the target has not yet been attained. It has been anticipated that when the maximum development is attained, the average extent of irrigated land will be 47.5 p.c. But it has reached 40 p. c. and there is marked increase.

	No. of tube-wells.	Cultivated area.	P. C. Kharif.	P. C. Rabi.	P. C. Sugar Cane.	Total irrigated.	Total.
Estimated ...	396	5,20,000	5	35	7.5	...	47.5%
*Actual ...	367	4,20,000	2.3	31	7	1,72,765	40.3%

(*The Figures have been taken in the year 1945-46 from T. W. Office, Budaun).



MAP 3.

Relation of Soil and Tube-Wells.

Kathir Tract:—Taking into view the soil-wise distribution of Tube-wells in the district, we get a large number of tube-

wells in the Kathir or loamy tract. This is the most fertile part of the district and supports a large population. The whole of the tract possesses 5,40,000 acres of cultivable land, of which 94,000 acres are irrigated by means of tube-wells and there is scope for further increase in the acreage of cultivable land, if more tube-wells are constructed there.

Bankati Tract :—The Bankati tract with a modest number of four tube-wells irrigated 5,000 acres of land yearly. This tract needs more water for irrigating the fields, and for this large size tube-wells should be constructed in the area.

Bhur Tract or Sandy Loam Soil Tract :—Bhur or sandy loam soil is another classified soil tract with a number of tube-wells. These wells have been constructed at places, where the soil is not loose; but here the wells can not run for the maximum number of hours, as the condition of the sub-soil does not allow it. 3.000 acres of land is generally watered in this tract through tube-wells.

Khadar or Coarse Alluvial Tract :—Lastly, we come to Khadar tract, where the soil is generally loose and sandy in which the construction of the tube-wells is not possible. It has been marked that the tube-wells in the vicinity of the river near Sahaswan are very little used and the Government has to pay the management charges. In this region the water is very near the surface, so the cultivators are generally seen digging earthen wells which are seasonal and are known as 'Annual wells'. These annual wells cost them very little. The Government therefore have given up the idea of constructing any well in this sub-division.

In all, the district has *373 tube-wells, commanding 1,200,000 acres of culturable land of which 1,000,000 acres are cultivated every year. With the advent of the tube-well irrigation in the district, the percentage of the total irrigated area has also increased from 13 p. c. to 20 p. c. in the whole of the district; nearly 51 p. c. of the total irrigated area is artificially watered by means of tube-wells. (*6 tube-wells are private).

Tahsil	No. of Tube-wells.	Total irrigated acres.	Tube-well irrigated acres.	P. C. of Tube-wells irrigated.
1. Budaun ...	96	48,567	25,967	53
2. Bisuali ...	175	68,522	48,308	70
3. Dataganj ...	27	43,894	5,973	53
4. Sahaswan ...	75	26,030	22,953	22
5. Gunnur ...	...	15,342	...	...
District ...	373	2,02,355	1,03,201	51

(The above stated figures have been taken from the Record Registers of each tahsil of the district).

Tube-Wells and Crops :—The development of tube-well irrigation has increased the acreage under each crop in almost all the districts of the Tube-well State. In the Budaun district, we find that during the last ten years inferior crops have been substituted by cash crops.

Sugar cane :—The most striking development through the Western United Provinces to be discerned is in the increase of the commercial crops, as a result of tube-well irrigation. The expansion of sugar-cane cultivation was made after the introduction of tube-wells in the western districts. Primarily 28,000 acres were devoted to sugarcane in the whole of the Budaun district; but now 40,000 acres of land have been brought under sugar-cane. Budaun, Bisuali and Sahaswan are the chief sugar-cane producing tahsils of the district, where this crop is grown in the loamy soil.

Wheat :—The development of the tube-well irrigation has also increased the wheat production. The crop is irrigated at intervals from December to February. During this period of the year water is available through tube-wells. Prior to tube-wells 21,000 acres were given to wheat cultivation, but now 26,000 acres are devoted to it.

Rice:—The tube-wells have also facilitated the paddy cultivation in the district. It is of local variety and is of coarse type.

Besides these crops, maize, gram, barley are other crops which are watered only if there is a necessity to irrigate them. Sometimes in the tube-well circles, maize is raised before the rains by means of early irrigation. Vegetables and other such crops are raised by means of tube-well irrigation in the district. The double cropped area has also shown an increase by 60,000 acres.

Channels and Pipelines:—The most important thing in a tube-well area is the construction of pipelines, to carry water to the fields. Throughout the district, the lined channels which are one mile in length from the well have been constructed beyond which cultivators have to make their own earthen channels. Sometimes it so happens that due to the bad conditions of such channels, water cannot be carried into the the field or the lack of channnel lines causes considerable damage to the crops. To avoid it, lined channels should be constructed upto each and every possible reach.

The other method of carrying water is through pipelines which should be used instead of open channels. Such pipelines should be laid three feet below ground level. This method has many advantages. Firstly, it eliminates all percolation and evoporation, secondly, once the pipelines are laid down and properly covered with earth there is no obstruction on the surface of the field and the plough can move over the pipeline without any hindrance, or with out any damage to the pipelines. In this way a net work of pipelines can be spread and water can be carried to any place at any time.

The tube-well scheme has exercised a favourable influence upon the rural economy of the district so far as the production of the crops is concerned. It has alleviated the misery of thousands of cultivators who lived frequently on the verge of

starvation due to the uncertainty of crops. But it can also be made helpful in the uplift of the rural life, if drinking and bathing facilities are provided for men and cattle in the vicinity of all tube-wells as it has been done at certain places.

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Geography and the Indian Census 1951.

BY

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"Many kinds of statistics have meaning only as they are given spatial relationship."—*Bowman.*

"The geographical factors are not the only important ones in the study of population, but they are basic."—*Fawcett.*

Why is the Indian Census carried out every decade? Wearing a cynical smile, our Administrator would reply: "In order to fulfil a Departmental routine!" In the past, several census officers were at pains to put up a special defence to prove the usefulness of their labours. Sedgwick, for instance, in the 1921 Bombay Report refers to "abolitional *vs.* constructive crankhood" - almost admitting thereby that a census after all is a cranky business! - and argues that it is as useful to sound administration as to gauging manpower for war purposes.[1] Even as late as 1941, Mr. Yeatts had to combat the impression that a census was a kind of anthropological enquiry.[2] Fortunately, it is now becoming more and more evident that

1. *Census of India, 1921*, Vol. viii, ; pt. 1, p. iv.
2. *Census of India, 1941.* Vol. i, pt. 1, p. 2.

public opinion as well as public administration in this country is regarding the census as a valuable 'bio-social inventory' which no progressive nation could afford to neglect.[3] Mr. Yeatts' appraisal of the Indian Census Reports, therefore, as "Silent Ambassadors of India all over the world" sums up the value of these reports, especially from the international point of view.[4]

To the student of Social Sciences, the census is undoubtedly an important event, because it forms the backbone of his studies in that it supplies him with the basic data without which he could make very little headway. He naturally looks forward to the publication of the Census Reports with great expectations, but often he has to face disappointment because he finds that the data published are not quite those he is after. The fault, however, is not altogether that of the Census authorities, and in any case, it is for those who hope to derive substantial aid from the Census publications to press their point of view, and induce the authorities to appreciate the difficulties. This is the purpose of the present paper. It is a review of the past Indian Census Reports from the point of view of the geographer. It starts with (*i*) a general discussion on the relation between Demography and Geography, and indicates (*ii*) what a student of geography expects to find in Census Reports, and (*iii*) how far it has been present in the past Reports, and (*iv*) how much could be done for the 1951 Report, - not for the use of the geographer alone, but as a measure to promote the general utility of the enterprise.

Relation between Demography and Geography.

Wolfe summarises the relation between Demography and Geography: "In the calculation of density of population, division between urban and rural population and the like, static

3. The recent approach to census operations is well summarised by Wolfe: "Demography may be regarded as a kind of bio-social book-keeping, continous inventory and analysis of the human population and its vital processes collectively considered." *Encyclopaedia of Social Sciences.* Its descriptive aspect is more emphasised by R. R. Kuczynski: "Demography, as is evident from the word itself, aims primarily at a description of the population, using of course, if available, census of birth, marriage, death, and migration, statistics." *Science News; No 8, p. 41.*

4. *Census of India, 1941;* Vol. 1; pt. 1; Introductory Note.

demography and geography come into close contact, although the fruitfulness of the cooperation between them is lessened by the fact that enumeration of population is necessarily made by administrative units rather than by cultural areas or natural regions.....The dynamic phase of demography has as its function the statistical analysis of the movement of population. This includes.... physical movement of individuals from one place to another (migration) and settlement in the study of which demography again comes into contact with geography.....".[5] Professor Fawcett presents this relationship from the geographer's standpoint: "In a geographical study of population, we are concerned directly with three definite groups of facts, and less directly with many others which bear on them. The geographical facts are not the only important ones, but they are basic. They are: (*a*) distribution of the population, (*b*) arrangement of the population, (*c*) migration of the population."[6] From both the static as well as the dynamic aspect of demography, then, the student of geography draws a fund of information for his study of regions and their most important aspect - the human element. There are two things which the geographer, in his search for precision, regards as fundamental: (*i*) the area under study and its measurement, and, (*ii*) the features of natural and cultural landscape and their measurement.[7] In both, it must be noted, precision demands measurement. In the former it is provided by the scale on which the area is mapped, and in the latter by the statistical and other data relating to specific features such as relief and drainage, vegetation, land use, economic development, urban and rural

5. *En. of Soc. Sciences;* On the other hand, it is difficult to understand Dr. J. H. Hutton's point of view when he argues that information obtained by natural divisions "however interesting academically, is of little or no administrative value." *Census of India, 1941* Vol. 1, p. 1. p. 3. Regionalism, now, is a well marked trend in Public Administration and what Dr. Hutton would concede to Provincial Censuses would apply with equal, if not greater, force to the All-India Census.

6. *Geography:* 1923 Vol. XXII; p. 14.

7. "Besides being an explorer, a measurer, a describer, and an interpreter of the earth, the geographer is a synthesiser of the data of his subject according to those realities of experience called regions." I. Bowman, *Geography in Relation to the Social Sciences;* p. 2. The importance of measuring areas may also be gauged from recent contributions; eg. "Measurement of Geographic areas." Proudfoot; Washington, Bureau of Census; 1940. "Nomenclature of Geographic Areas for Statistical Purposes." U. N. Secretariat; 1949.

settlements. It is therefore in the study of a particular aspect of this environment that the population statistics derive their chief use to the geographer. But mere statistical tables relating to birth, marriage, death, rates, or demographic methods dealing with net reproduction rates, or statistics relating to the size of the family, however interesting features in themselves, have little meaning in geography, unless and until they are reviewed in their immediate backgrounds.[8] Thus density of population per sq. mile or per cultivated sq. mile becomes an eloquent index to the study of man-land ratio. A study of the population data of a region against its geographical background unfolds the pattern of human settlement and its response to environment through economic development and cultural growth. The history of population of a specific area may well bring out the fluctuating fortunes of the human factor residing there.[9] A high urban ratio is an index of intensive economic development; its study would bring to light many ancillary problems such as overcrowding and slums. Immigration and emigration movements record thescale of human preferences to different types of environment. Industrial and commercial patterns of population, similarly, illustrate the complex working of an advanced social organisation. Population data in its spatial context, therefore, must always remain the chief aim of the geographer. The administrator, however, would do himself an injustice if he were to regard these as purely academic enquiries, for he too reaps the reward of the fruitful co-operation between Demography and Geography. What precisely is the condition of refugees from Pakistan *in different parts* of India? How much medical relief per man is available *in different regions* of a country that is already notorious for its ill-nourished citizens? How many schools, libraries, teachers etc. would be precisely needed in different parts of our land to wipe out illiteracy? Indeed the list would be long, and one might conclude by saying that the success of our Economic Controls

8. I. Bowman: p. 24.

9. Eg. the declining population of the Kanara Ghats; *Census of India, 1921* Bombay, pt. 1; appendix.

and of our Social Plans would be better assured by such intensive regional enquiries than by the blind alley of generalisations over so vast a sub-continent.

Methods of Geographical Enquiry and its contribution to Demography.

Studies of the above mentioned type must thus start with a critical mapping of the population data, because it is the map which supplies the foundation to all geographical studies. It enforces a rigid discipline to all other data and concepts. It is the framework within which the various factors of regional environment must be studied and correlated. Field studies and statistics supply the geographer with this data. Thus the census statistics are a measurement of a regional population in its several aspects such as density, urban/rural ratio, migration and the like. The two aspects of (*i*) the area, and, (*ii*) the statistics are synthesised by the distribution map.[10] It is by constructing such distribution maps that the geographer crosses his first, and what often proves to him, the most difficult, hurdle, and proceeds to the subsequent task of interpretation and description of the features he has mapped out as summarised forms of geographical measurements. It is the 'synoptic view', so aptly referred to by Mr. Yeatts, that is the cherished ambition of the geographer.[11] Yet, it must be noted that the geographer does not monopolise the fruits of his labours, for, geography in its turn makes a contribution to demography, not only (*i*) by providing a general geographical background to census reports, but by its rigid insistence on (*ii*) regional precision in the compilation of statistical tables, and (*iii*) accurate and neat mapping of the data compiled.[12]

How far have the past Indian Census Reports helped the geographer to cross his first hurdle? And indeed, if we agree with Bowman, have the Indian Population statistics done full justice to themselves by ensuring that they are in their proper spatial relationship?

10. H. S. L. Winterbotham: 'Dots & Distributions': *Geography* 1934 Vol. XIX; p. 211.

11. *Census of India, 1941;* Vol. I; pt. 1. p. 2.

12. This point is elaborated below.

Indian Census Reports.

In the light of the foregoing discussion it is possible to review the past Indian Census Reports. Their utility may be measured from the point of view of (*i*) the Text which is generally Part I of all the Volumes; (*ii*) the Statistical Tables forming Part II; and (*iii*) the maps incorporated to supplement the text.

A. The text and the basic units.

It is difficult to generalise over the written portion. Some of it is written from the geographical point of view, but much of the rest is in the form of generalisations on larger administrative units as the Provinces which have little geographical, and therefore real, meaning.[13] Here, the geographer readily concedes that there are many problems which are essentially demographic and must be considered from he point of view of a Province or a Country, and the value of a purely demographic discussion of such problems would be great to the student as well as the administrator. It must be noted, at the same time, that the geographer regards his science, not as a Procrustean bed to which other sciences must be fitted, but as a measuring rod of regional precision for those who intend to avoid the dangers of over-simplification and over-generalisation. He has therefore a right to feel that a more systematic regional presentation of the features of population would be conducive to greater clarity and precision.[14] This however is possible only if the basic administrative units and their basic outline maps are standardised.

(i) **Basic administrative units**

The choice of the basic administrative unit, on the basis of which all population data must be published, requires careful consideration, since this forms the vital link between

13. *Census of India, 1931*, Madras; pt. 1; Chap. 1; and *1931 C. P. & Berars*: pt. 1, p. 27-57. These Madras and C. P. Volumes are possibly the only ones in the whole series, in which some attention is paid, in the text, to geographical aspects.

14. Other Social Sciences have, possibly, to say something about the Census Reports, from their own point of view. This evidently is no direct concern of the geographer, but who is above the temptation of eavesdropping.

the statistics and the map.[15] In the All-India Volumes it is mostly the Province and the Indian States, except Table XX which gives '*district summaries*'. These summaries, however, have a limited use, because, they lean heavily, as probably all things in this country have so far done, on religion, to the exclusion of more useful data like economic and social aspects. Similarly, emphasis on larger administrative divisions as basic units has seriously reduced the use ot the All-India Volumes for regional studies, and the geographer must therefore depend on the Provincial and the Indian States (now States Unions) volumes, even for inter-Provincial studies. In these Reports the district is the 'reporting' unit in almost all tables.[16] Provincial Tables I and II give the taluka summaries of area, population, religion and literacy. These basic units suffer from at least two drawbacks: (*i*) the States areas do not always report on the district basis, and in most cases their territorial divisions are (now were) fragmentary;[17] Happily for the 1951 Census it is possible to build up an All-India scheme with 'district' as the reporting unit; and (*ii*) in some respects like migration and occupations, 'taluka' would have been more effective. It is worth while exploring, in this context, the desirability of compiling certain data on the basis of *a unit intermediate between the taluka and the village* viz., *the Revenue 'Circle'* or *the 'Thana'*. In many cases the taluka is too large to reproduce faithfully regional variations.[18] The village, on the other hand, becomes far too encumbered with details for the purposes of developing a 'synoptic view'. Population dot

15. "To put life into these inert masses of figures, to bring out their hidden meaning and express the comparative significance of factors on area, either individually or fused in index combinations to admit valid comparison, they must be visualised with the area they come from. This can be only done graphically through representation." Marschner, (quoted by E. Raisz: *General Cartography*).

16. In the Bombay Reports, figures relating to Commissioner's Division are given. It is doubtful whether such statistics of highly artificial divisions have even any administrative value.

17. Eg. *Census of India, 1941*, Vol. I, pt. i, p. 128.

18. "The smaller the unit areas for which we know the numbers of inhabitants the more accurate it is, or can be, our account of that distribution." C. B. Fawcett; "Whither Population" *Geography*. Vol. XXII, p. 14. One may venture to add in the context of the Indian States areas, that the units need be not only small, but contiguous.

This point is illustrated by cartograms discussed in "Notes on the maps" below.

maps, drawn on the Thana basis, as Prof. Ogilvie points out, would be a major contribution of Indian Geography to the understanding of the patterns of populations in our country.[19] The Revenue Circle as it exists today is chiefly a temporary unit, demarcated more for administrative convenience, and subject to frequent changes in area and boundaries. But it very often reflects georgraphical homogeneity, because mostly villages having similar land revenue characteristics are grouped to create such a unit, and hence it deserves to be placed on a more stable footing and accepted as a primary unit for all important statistical compilations. The Province, the District, the Taluka, the Circle, and the Village, all having their specific value at every stage of compilation, it is necessary to make a careful selection and standardisation of these units for each stage in the census compilation, so that the report of the area presents not only a composite picture of the demographic features of the area, but also indicates the regional variations *within* it.

(ii) Basic Maps: Administrative and Geographical

That Geography cannot be neglected in a census operation is well proved by the fact that almost all Reports start with a map as their frontispiece.[20] The 1931 All-India Volume, for instance, gives a good physical map as frontispiece.[21] Often there is a large—and therefore folded,—administrative map which in spite of its generous size gives only district boundaries.[22] But in both these types the more important aspects are left unemphasised, and the maps have become 'flat' and unimpressive cartographical efforts. Every Census Report should better begin with two full-page basic maps on a common

19. A. G. Ogilvie "Technique of Regional Geography." *Indian Geographical Journal*, 1938, Vol XIII, No. 2. p.117.

20. Usually these are prepared by the Provincial Photo-Zinco offices, and show larger administrative divisions only.

21. This is a rare example of a good map being included in these Reports. Its merits are solely due to the Survey of India.

22. Eg. the *1931 C. P.*; pt 1. Even this does not give a well defined outline of administrative units. It is a typical representative of the 'Good Old' Revenue Department days.

cale: (i) one to show, with accuracy, the administrative units of the area, in the order of their importance, and, (ii) the other, to bring out boldly the broad features of relief and drainage which largely guide the human economy of the region. Maps dealing with other aspects such as rainfall and vegetation may be included wherever necessary but these two: the administrative and the relief supply the framework *viz.*, the area, its relief, and its dimensions. It is on the scale of these two maps that others showing the distributional features of population require to be drawn. Transparencies of the administrative and relief maps for superimposition on these would complete the equipment for a better understanding of all these maps and their geographical implications.[23] Unfortunately, the past publications fall far short of this desirable standard. Administrative maps are too large and too cumbrous.[24] They show only the larger units such as the Commissioner's Division and the District, while interpolation of the taluka boundaries would have been more valuable.[25] In many, the district and taluka boundaries are overlaid on very old maps, and are highly generalised.[26] Very often these highly generalised boundaries are crowded out by irrelevant detail. The significance of territorial changes indicated in the text as well as in the statistical tables, would have been clearer if those had been shown in a marginal map.[27] It is hardly possible therefore to

23. This point is developed in the discussion, below, on the Cartographical technique.

24. Eg. the *1921 Bombay*, pt. 1. But the other extreme is reached by the *1931 Punjab* which has 2"x4" sketches!

25. Eg. the *1921 Bombay* and some of the *1931 volumes* present maps wtth outlines of Commissioner's Divisions and Districts, and attempt to correlate natural divisions with their boundaries! These maps would have been more useful, had the limits of the natural divisions been made to coincide with the taluka boundaries.

26. Eg. maps, in the *1931 Bombay*, showing % variation in population.

27. Transference of one area from one unit to another is frequent, and is indicated by statements such as those in *1921 Bombay* which show that the West Khandesh gained as much as 963 sq. miles by the inclusion of the Mehvasi Estates, but this change should have been indicated by a marginal map. Even to this day the statistical returns for this district stand in confusion because these Estate areas have not been clearly defined.

Perhaps the most striking example in the sudden departure in tabulation is to be found in the *1931 Bombay*. The *1921 Report* follows the well recognised division of the natural regions of Gujerat, Deccan, Konkan and Karnatak, but the 1931 'partitions' Karnatak' and attaches N. Kanara to Konkan and the rest to Deccan. In addition to the principle of cultural areas involved in such arbitrary changes, it renders comparison between the decennial data difficult.

exaggerate the value of a good, clear and accurate outline map, as a starting point for all census publications. It is an assurance to the reader of the precision of what follows in the text and the tables. With the integration of Indian States, such a map has become all the more necessary to remove the cobwebs which we have been so long accustomed to see on the map of India.[28]

(*iii*) Urban areas: selection of sub-units, and outline maps.

The special position of urban areas in the Census operations is amply demonstrated by the special text and tables published, in separate volumes in the Provincial series, and by the 'Cities and Towns' tables in the Provincial and All-India Reports.[29] In the Census scheme, only 'Cities' receive detailed attention, and 'Towns' in spite of their regional importance are relegated to a common table and receive a scant notice.[30] It is obviously necessary that these urban areas also receive a greater attention in the forthcoming Census. Even in the 'Cities' volumes there is much scope for improvement. Many Reports contain good maps showing the city and its wards, but suburbs do not receive the care that they increasingly deserve,[31] and satellite villages at their best are only vaguely stated.[32] Hence, distinctive maps to show (a) the city and its wards, (b) its suburbs, and (c) its satellite villages, are necessary to serve as guides to detailed statistics. Further, in view of the rapid urban development, and the increasingly important role of the Town in administering social and economic services to the surrounding rural areas, it is necessary to extend the census operations (a) to cover all towns, small and large, (b) to

28. This map would be something like the 'District Map of India' outline published by the Survey of India, but now the districts of the States Unions would be included.

29. Eg. *Census of India 1931*, Bombay, p. Vol. IX, pts. 1 & 2.

30. In the Bombay Report, an agglomeration with a population of 100,000 and over, is classified as a 'city', and generally the term 'town' is applied to centres with a population between 5000 and 100,000.

31. Eg. the *1931 Bombay* 'Cities' volume contains an old map of 'Greater Poona' showing administrative divisions, but in case of Bombay, the text as well as the tables and maps, end abruptly at the shores of the Bombay 'Island'!

32. Mr. Sedgwick with admirable forethought discusses the problem of 'greater' Poona as early as in 1921. The 1931 report merely reproduces the 1921 Greater Poona map without giving any indication of studying the incidence of the cities on their surroundings.

include more accurate and comprehensive administrative maps of these urban agglomerations, and (c) to provide additional statistical tables as mentioned below.[33]

B. Statistical Tables: certain additions and alterations.

The tables which the geographer is most interested in relate to number, density, movement and occupational distribution of population. These features are to be found in Tables No. 1, 2, 5, 6, 7, 10, 14, 22 of the All-India Report and their complementaries in the Provincial series, and in Provincial Tables I & II.[34] From the geographer's point of view, it is possible to offer suggestions in three categories:

(*i*) In the Central and Provincial Volumes.

The value of the All-India Tables, as stated before, is much restricted by the large size of the reporting units. The '*district summaries*' for instance, could be rendered more useful by adding new columns to give certain economic aspects of the population. In any case, it would not be too much to hope that the district summaries of 1951 would cover every sq. mile of the Indian Union, giving the geographer the satisfaction that there would be no 'blanks' left on the country's map henceforth. Among the several other improvements possible in the Provincial Volumes, a substantial one would be to reintroduce tables to study inter-district migration. Summaries covering a period, say of five decades, relating, for instance, to occupational distribution, migration, literacy, would be welcome as ready references to research workers.[35]

33. How far the 'town' is becoming important in Social Studies may be seen in the recent contributions to literature on urban forms, in U. K. and U. S. A. Eg. R.E. Dickinson's "Smaller Urban Settlements in East Anglia." *Geography 1932* Vol. XVII; p. 20; A. E. Smailes: 'Urban Hierarchy in England and Wales;' *Geography*. 1944. Vol. XXIX, p. 41.

34. These references belong to the *C. of I. 1931* Vol. 1 (India) and Vol. VIII (Bombay).

35. It is quite possible that the statistician and the economist may need several changes to suit their needs.

(ii) **Urban Handbooks: Extension to include 'Towns'**

As pointed out earlier, it is equally necessary to extend the census enquiry to cover towns, and in all urban surveys a more comprehensive data relating to the condition of the resident population need to be provided:—

(a) As urban influence cannot abruptly end at municipal limits, census operations must be extended to suburbs and satellite areas by treating the whole area as a homogeneous unit.[36] (b) Occupational distribution could be more usefully given on the basis of Wards or Sections than for the city as a whole.[37] This would indeed be a very important contribution to the understanding of the social and economic structure of an agglomeration. (c) This could be further improved by carrying out an enquiry into the income levels on the basis of wards, and correlating such data with those of occupation, religion and birth place.[38] (d) Similarly if, 'housing tables' are prepared on 'Ward basis' to show various types of 'building utilisation' *i.e.*, buildings used for residential, factory, commercial and other purposes, they would throw considerable light on the economic use of urban and suburban land. The present tables on the other hand mainly aim at one limited aspect—overcrowding.[40] (e) Finally, a census of leading commercial and industrial units situated in the urban area could possibly round off all these advantages.[41]

(iii) **District Census Handbooks: in place of the Village Handbooks**

Although a vast amount of public money is normally spent on the census operations, it is difficult to understand measures of economy being proposed when it comes to the presentation

36. Those in the *1931 Bombay* (Cities) report only for the Bombay Island.

37. Figures relating to the city as a whole do not give any idea of the *locational aspect*, which is, indisputably, gaining importance, as basis for planning and efficient administration.

38. This means recasting, *eg.*, Table VI (pt. 2, *1931 Bombay*, 'Cities' Vol) p. 184

39. This aspect, it is submitted, is a derivative of the larger one of 'Land Utilization'.

40. Eg. the *1931 Bombay* Vol. IX, p. 79, giving a table for 'tenements' only.

41. This could be on the lines of the data given in the '*Industries of the Bombay City*', Bulletin No. 3. of the All India Manufacturers Organisation, Bombay

of these efforts to the public through publications. Social reform, economic development and intensive planning, so ardently advocated by all sections of the public, demand detailed regional statistics. These are not available to day, and their absence is largely responsible for the vague statements and generalisations made both by the scholar and the administrator in the field of current problems. It would be a national service therefore if the 1941 Village Handbooks were to be changed into more comprehensive 'District Handbooks'. The space in the Village Handbook could be much economised, since out of 17 columns only 4 have a direct use; as many as 6 are literally wasted on 'religion', and the last 5 far from giving any statistical data give only a bare 'Gazetteer' type description of a village as having a market day, a police station or a periodic fair.[42] These columns could be better utilised to show the major occupational details of the village community, especially numbers relating to land-lords, tenants, farm labourers, craftsmen, professions, female labour etc.[43] To the number of 'Dwelling Houses' a complementary statement to show the number of commercial and industrial units, small though they may be, could with great benefit be provided. Finally, if the villages are regrouped into Revenue Circles, the consolidated Circle figures would, as explained above, considerably enhance the value of the Census Reports. This would indeed be a boon to the geographer in his micro-regional studies, and a tool of precision in the hands of the administrator.

C. Cartographical Technique: a survey and some suggestions

It is in the cartographical effort of the past Census Reports that the student of geography is most disappointed. Every Volume of the previous Reports-except the 1941 which, thanks to the political conditions prevailing then, gives no chance for criticism—is supported by at least a dozen maps. If maps are

42. Eg. *Dharwar Village Handbook, 1941.*

43. The following problems, to give some specific examples, urgently demand intensive regional studies: (i) census of proprietors of the land of the village, and actual cultivators; (ii) census of 'Karkhandars' and workers in the village industries, (iii) census of doctors, nurses, etc., to determine the extent of medical relief available in Rural India. Such data must be gathered from every village and well coordinated with that of the urban centres within the influence of which they are situated.

meant to convey all that is claimed in their behalf in the earlier part of this discussion, most of the census maps are unfortunately outdated pieces (i) In size these range from 1½ ft. x 2 ft. on a Survey of India background, to 2" x 3" sketches.[44] These larger maps are not only costly to print, but inconvenient to handle. This could be avoided by taking *a full-page standardised outline*, and drawing over it the required statistical symbols.[45] This would mean more convenient size, economy, and more pleasing visual effect. (ii) The *two basic maps* already referred to, must be drawn on this outline and scale. Mapping on such a plan, however, requires a thorough understanding of the geography of the area. (iii) Transparencies of these two maps are evidently necessary for comparison. (iv) There is also an immense scope in improving the technique of presenting statistical data on maps.

Statistical maps : technique of construction

(*a*) **Choice of shading** :—This is important for all density maps. Although the majority of the Census Maps belong to this category, there is a great variation in quality. The 1931 Madras Report contains some good samples.[46] But most others suffer from lack of good visual scale of shading and appropriate scale of denisty divisions.[47] This is also true of the horizontal 'bars' drawn in some reports to show the character of agricultural seasons.[48] Choice of correct shades is not difficult,

44. Almost every volume of the 1931 Report contains such maps.

45. Good examples are provided by several statistical atlases published in U. K. and U. S. A., Eg. 'Maps for the National Plan, (Lund, Humphreys & Co., London).

46. Maps Nos. 3 to 10 in *1931 Madras*; Map 7 showing density by talukas is good, but could be much improved by better gradation in shading. Good dot maps would have further enhanced the utility.

47. Eg. the rainfall map in the *Census of India 1931*, Vol 1. pt. 1, is an amazing example of the 'administrativeness' of the Census authorities. Even the Indian rainfall must conform to the Provincial boundaries! The density shading produces a completely unreal picture; no area exists with a rainfall between 60 and 70 inches! and 85-100 inches! An isohyet map, with the 20", 40", 60", 'strengthened', on a provincial *cum* district background, would have been the right thing. Other examples, specifically relating to population densities, are: maps on pages 98 and 126; *Bombay 1931*.

48. *Census of India 1931*; Bombay ; pt. 1.

although it must be remembered that the utility of such maps is conditioned both by the very limitations of the shading method and the selection of the administrative units on which they are based. In many cases, the 'dot-density' method could be preferred because of its greater precision and visual effect than shading, but demands more care and patience.[49]

(*b*) **Choice of symbols** :—There does not seem to have been any effort in the past reports to employ other methods of statistical representations than the time worn denisty shading. Hence many maps suffer from strange handicaps. The symbols used are not capable of easy reading and comparison. The 'social' and 'lingusitic' maps almost *les grandes cartes* of every Report, suffer not only from too large size and multi-colour printing, but from 'squares' which render reading difficult because comparisons, must be made both vertically and horizontally, and because of the overcrowding of the squares with varied data.[50] In some other maps even the symbols are dispensed with, and the statistical data are merely planted right inside an administrative unit.[51]

A careful choice of symbols is vital to good statistical mapping which must always aim at ease in reading, visual effect, and quantitative accuracy. A judicious selection of one type of symbol or another, and often a combination, is necessary. 'Pie' graph circles, for instance may be used to show urban population, 'Ring' diagrams for occupational distributions, Columns or 'Bar' graphs for periodic changes, 'Spheres' with 'Dots' for regional distributions, 'Centrograms' and 'Logarithmic line graphs' for trends in population, 'Flow' maps

49. H. S. L. Winterbotham: *Geography*, *1934* Vol. XIX, p. 211.

50. Every report has these maps; see specially the Punjab 1931.

51. Mr. Sedgwick's good report (*Bombay 1921*) unfortunately suffers from this drawback. Eg. % increase/decrease maps p. 6-7; This method is repeated in the 1931 Bombay, p. 12-14.

to portray migration, ' isopleth ' maps for population potentials, and other similar constructions would considerably enhance the value of the Census Reports.[52]

(*c*) **Choice of scales** :—Here, this refers to the divisions on which shadings are drawn in density maps, and also to symbols like ' Spheres ' etc., in other maps. This being largely arbitrary, mechanical and uncorroborated to natural conditions of the area, in most of Census maps, these maps often give an impression of false averages.[53] The choice of scale is as important as the choice of symbols, or even more important, because it is to misrepresent facts by drawing them to a disproportionate scale. Scale is guided by local conditions of the area and the extremes of variations in the data.

(*d*) **The special case of the ' Dot ' map** :—Although the dot maps are absent from the Census Reports, their value can be hardly exaggerated.[54] An accurate and neatly drawn ' dot ' map presents a more faithful picture than any other cartographical effort. It is superior to density and symbol types, because it aims at accuracy both with regard to the statistical data as well as the location. The choice of ' dot ' scale and the placing of dots, however, require careful thought, and adequate knowledge of local conditions, generally acquired through field studies and large scale maps. It is probable that this apparently laborious process involved in their construction, has so far deterred the Census authorities from making a generous

52. English and American geographical studies contain many samples and extensive information: eg. C. A. Close: 'Some centres of England', *Geographical Byways*; J. Q. Stewart: 'Distribution & Equlibrium of Population,' *Geographical Review*, 1947; "Population maps": *Geographical Journal*, 1935, p. 124-159. R. R. Kuczynski: *Geography* Vol. XIX;

Again, the interest shown by the geographer in population maps has been brought in the fore by the resolution passed at the International Geographical Congress, 1949, charging its Commission on Population to arrange for a world population map on a scale of 1/M.

It is intended, in a paper to follow, to present several cartograms, as far as the Census data could permit, to show some demographic features of the Bombay Province.

53. In his Report, Mr. Yeatts recognises this drawback; (*1931 Madras*, p. 21); this is why the dot maps ought to be preferred.

54. Mr. Sedgwick's Report is the only exception that the writer has come across; (*Bombay 1921*); but here too the Province is divided on three sheets and there is overcrowding of the dots.

use of them. After citing the Bengal map prepared by Dr. Geddes as a valuable cartographical aid to demographic studies, Prof. Ogilvie in 1938, expressed the hope that similar maps on 1 : 1 M scale would be constructed with expert assistance for the 1951 Census.[55] Would it be too much to hope that such maps will accompany at least the 1951 Reports ?

(*e*) **Outlines and lettering** :—Although neat, clear and graded outlines and lettering patterns are not directly relevant to the statistical accuracy of a map, these features promote clarity and ease in reading. This factor, however, does not seem to have weighed with the Census authorities in the past. Indeed some maps are contributions to surrealism and the 1931 Punjab Report prophetically anticipates Picasso ![56] The aesthetic side of map making, too, makes it well worth the extra labour involved. [57]

D. Some suggestions for the ' Administrative Routine '

From the foregoing discussion it is possible to offer some suggestions, in a summarised form, for the 1951 Census operations : (i) Whatever the selection of the administrative units ranging from the Village to the Province, it is necessary to settle the unit on the basis of which the enumeration would appear in its published form. This means a careful check up of the boundaries of the selected order. [58] (ii) Urban census could be more comprehensive and extended to cover towns, District Handbooks could usefully replace the 1941 Village

55. 'The Technique of Regional Geography' Paper read at the 1938, Geography Section; Ind. Sc. Congress, 1938 Printed I. G. J. Vol. XIII, No. 2 p. 116.

56. All this implies good draughtsmanship, under expert guidance; clear and graded outlines which distinguish the administrative divisions in order of their importance, clear lettering of suitable size, preferably after the easy 'quill' advocated by the Royal Geographical Society, and constant cooperation between the cartographer and the photo-engraver, are basic conditions for success.

57. Here, there is a possibility of the 'purist' saying that a census cannot be 'all maps'; its main purpose is to give statistics; This point may be conceded, with one reservation: any census worth the name will have to give an outline map of its 'reporting' units.

58. Eg. for the All-India census, Provincial and district outline; for the Province, the district and the taluka, and in some circle; for the district, the taluka and circle.

Handbooks, with statistic compiled on the basis of the 'Circle'. (iv) Maps could be considerably improved and better distributed to cover all the topics in the text.

Such a plan need not be considered as too ambitious or too costly. Mr. Yeatts has already pointed out the virtues of decentralisation, under the Census Commissioner's supervision, of the duties of enumeration, and of entrusting the local tasks to Provincial Governments.[59] The Urban census may well be a special responsibility of the municipal bodies. Special problems could be entrusted to competent bodies like the Bureaus of Statistics and Schools of Social Sciences.

It may be reiterated in conclusion that this paper is not an attempt to 'geographise'—if one may coin such a term,—the Indian Census, in the manner the anthropologists and the economists would almost do, by claiming it as a branch of their science: Its essential purpose is to indicate (i) how the Indian Census Reports could be more useful to geography and other sciences, as well as to the general administration of the country and (ii) how 'Our Silent Ambassadors' could wear a more attractive diplomatic livery with the aid of geography.

NOTES ON THE MAPS.

These maps are reproduced here as samples to support the several suggestions made in the text above. Criticism is invited.

Fig. No. 1:—This map follows the well known method initiated by Dr. Sten de Geer. Its purpose is to portray, as far as the statistical data would permit, the real distribution of Population in the Bombay Province. It is based on the taluka figures given in the 1941 Bombay Report. Urban Centres having a population of 10,000 and over, are shown by 'spheres' to the scale of 0·4": 50,000 persons, in the original drawing. The dots were plotted against the geographical background of the province, with the aid of the Survey of India one inch topo

59. *Census of India 1941*, Vol. 1; pt. 1; p. 17-18.
The Times of India, 16th May 1949.

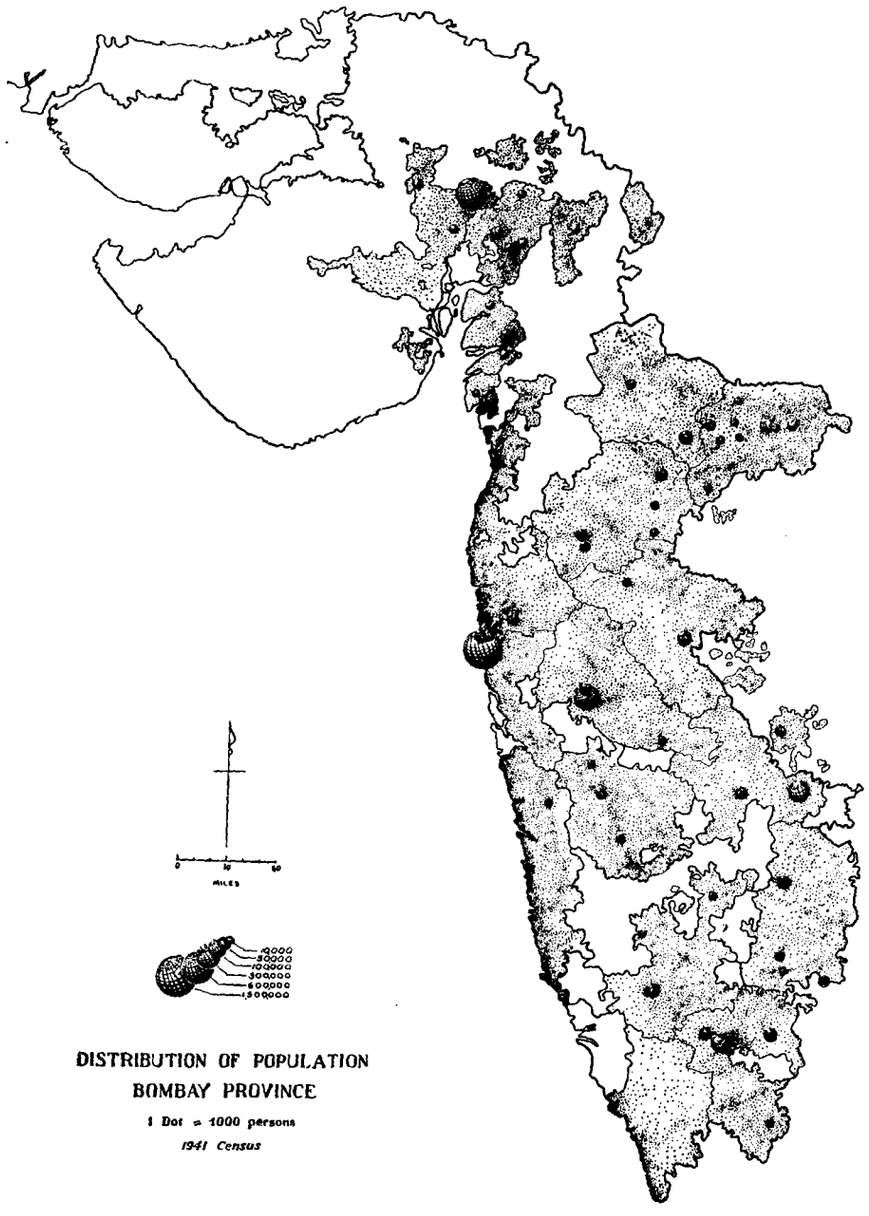

Fig. 1. Distribution of Population, 1941.

(Towns of 10,000 and over, indicated by 'spheres', and the rest by dots, intervening blanks are Indian States areas as they existed before their merger.)

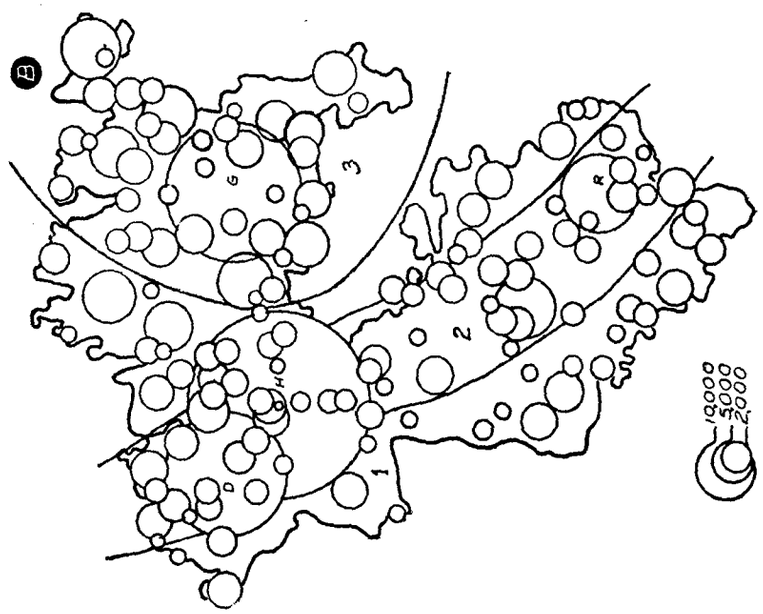

Fig. 2 B. Distribution of Population, by size of settlements.

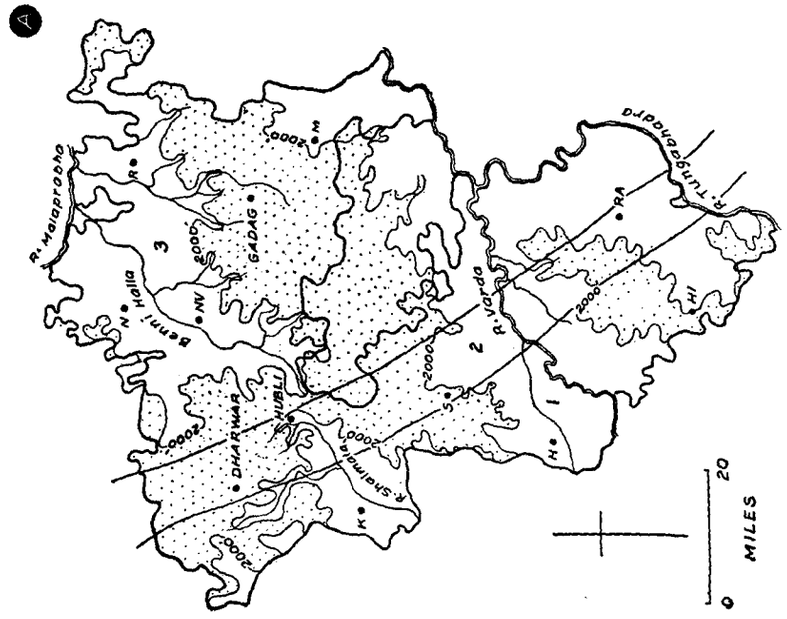

Fig. 2. A. (Dharwar District Bombay Pr.): Relief, drainage and geographical sub-regions; (land over 2,000 ft. shaded); 1. *Sahyadrian Tract*; 2. *Transitional Belt*; 3. *Eastern Black-soil Plain.*
Taluka Towns: *K. Kalaghatgi*; *S. Shiggaon*; *H. Hangal*; *HI. Hirekerur*; *RA. Ranebennur*; *M. Mundargi*; *NV. Navalgund*; *N. Nargund*; *R. Ron.*

sheets. The disconcerting feature of the intermediate 'blanks' is obviously due to the States areas, in the case of which plotting proved very difficult, if not impossible, because of the fragmentary nature of the possessions of many States. Happily, these blanks, it is reasonable to expect, would disappear after the 1951 Census. Such distribution maps require transparencies showing relief, and administrative divisions, and main urban centres, since the visual effect of such maps would be otherwice marred by the inclusion of lettering and boundary lines.

Fig. No. 2:—These six maps are studies to test the greater precision of maps drawn with the 'Revenue Circle' as their basic unit.

Map A:—This map shows relief and drainage pattern as well as the geographical sub-regions of the Dharwar District. This district of the Bombay Province has an area of 4602 sq. miles and a population of 1,201,000 (1941). Its area is spread over three well marked geographical sub-regions: *1. The Sahyadrian Belt*: a wet forested region, with varied landscape; sparsely populated. *2. The Transitional Belt.* A narrow transitional strip between the Sahyadries and the dry black soil plateau tract of the east, economically well developed; dense population; several towns. *3. The Black Soil Plateau:* An undulating plain, between the Malaprabha and Tungabhadra; essentially an agricultural region with large but compact settlements; population mainly rural.

Map B:—This map shows the rural and urban settlements, by means of a circle drawn on a "pie" graph scale: 0.3": 3,000 persons, in the original drawing. The population data are based on the 1941 Village Handbook of the Dharwar District. Crowded though the cartogram appears, it is merely drawn to facilitate comparison between Maps C and D, and E and F, by 'pin pointing' the chief population centres. It could be seen that the settlements of the district fall into four groups: 1. The Sahyadries; 2. The Dharwar-Hubli; 3. The Ranebennur-Haveri; 4. The Gadag-Ron.

Map C:—This shows the density of population per sq. mile *by talukas* from figures supplied by the 1941 Census.

Map D:—This map shows the density per sq. mile *by Revenue Circles*. The outlines of the Revenue Circles of the district were constructed on the basis of the information obtained from the Revenue Dept. and with the aid of the taluka maps of the Land Records Office. The population total of each circle was compiled from the records of the Revenue Dept. and the area of each circle was measured by a planimeter. The density as presented by this map, has, in the opinion of the author, a better correlation with the geographical conditions, than the density shown by Map C. Although the towns exaggerate the density of the circles in which they are situated, such exaggeration is better localised here than in Map C.

Map E:—This is a 'dot' map derived from the 1941 source, and is constructed on the taluka basis. The Survey of India topo sheets were used in plotting the dots. However the distribution of dots in several parts of the district could not remain un-influenced by the author's knowledge of the district and yet Map F corrected the author's general impressions in case of several localities of the district! It must be also stated that this map was completed before Map F was taken up, in order to avoid the latter's bias. A comparison of Map E with Map F shows that there was too much inclination to place dots along stream courses in the black soil tract. (No. 3 of Map A).

Map F:—This is a dot map derived from the 1941 Census source, but is based on the consolidated figures for each Revenue Circle. The dots inside the Circle were 'adjusted' with the help of the Survey of India one inch topo sheets. This dot map, in the author's opinion, more faithfully reflects the distribution of population in the district than Map E. Several important differences between the two maps: Map E and Map F are indicated by arrows in Map F. Among the many interesting points arising out of a careful comparison between these two maps, the following are noteworthy: (i) Contrary to the general belief, the south-western corner of

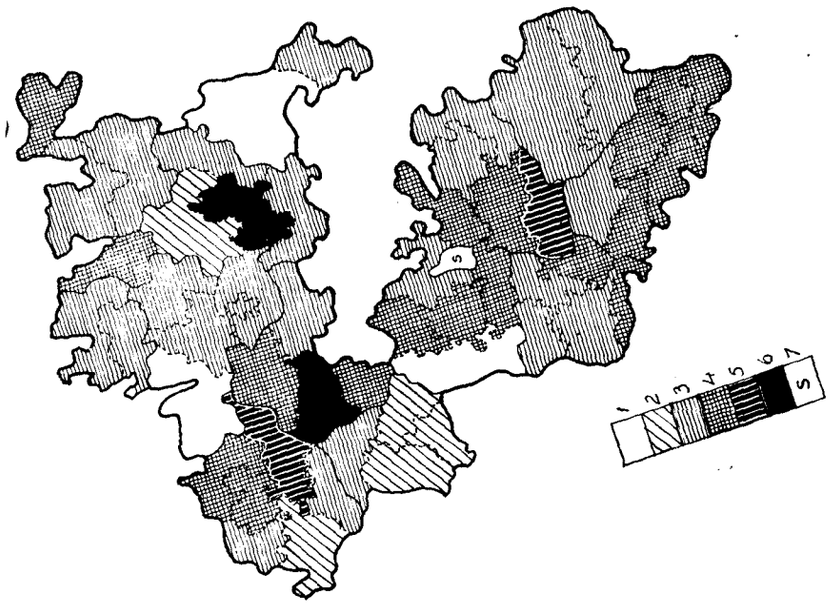

Fig. 2 D. Density of population, by Revenue Circles.
1. 50—100 2. 100—150 3. 150—250 4. 250—400 5. 400—650
6. 650—1,400 7. States area.

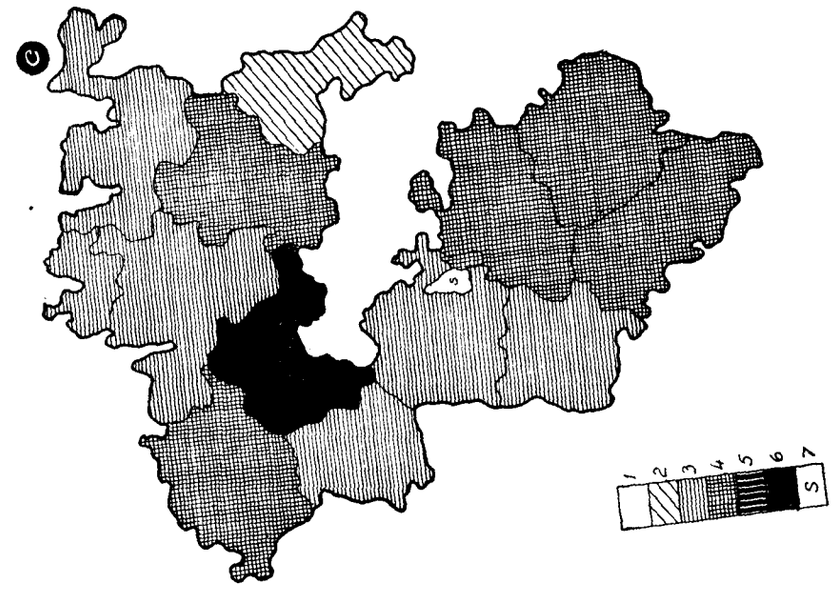

Fig. 2 C. Density of Population, by talukas.
1. Below 100; 2 100—150; 3. 150—250; 4. 250—400;
5. 400—500; 6. 528; 7. States area.

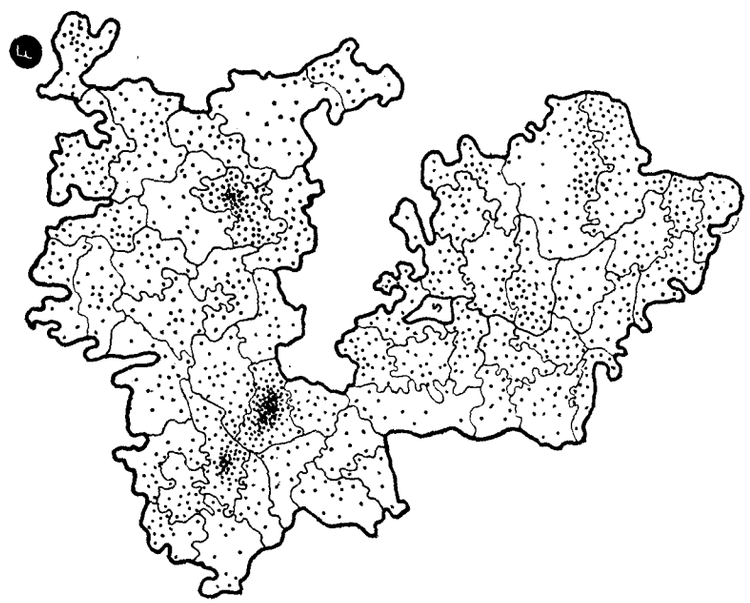

Fig. 2 F. Distribution of population, by Revenue Circles.
1 dot : 100 persons.

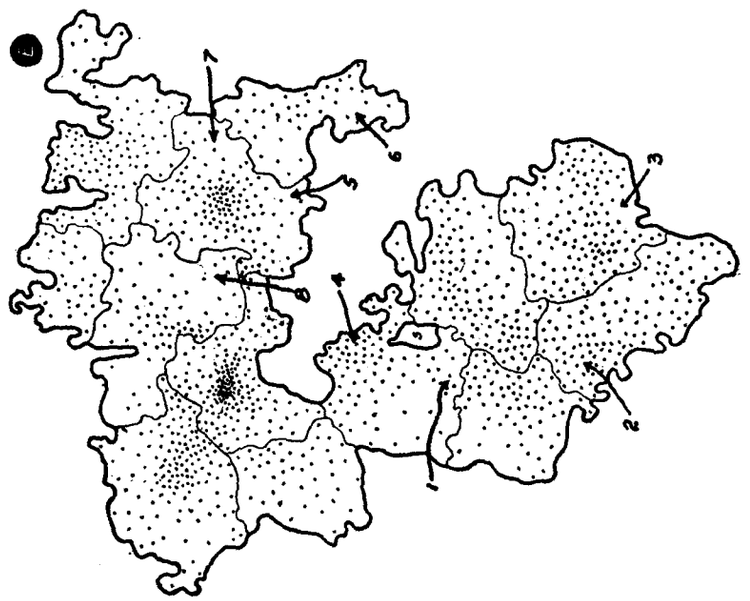

Fig. 2 E. Distribution of population, by talukas.
1 dot : 100 persons. Compare areas indicated by arrows, with those in Map F, which shows a truer distribution.

the district is fairly well populated; (ii) Populations' density follows stream courses in the Sahiyadries, and in the Transitional Belt, (No: 1 & 2 in Map A); (iii) but this is not the case in the Black Soil Tract where it is more uniform, and therefore somewhat disappointing to the 'pattern'-ally minded geographer.

It is likely that the foregoing procedure employed in the construction of Maps D and F would appear too involved and cumbrous. It need not be — if only the Village Handbooks are recast on the lines suggested in the text.

Increased Fish Production in Inland Waters*

BY

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INTRODUCTION

When compared with the total area of sea water, which occupies nearly three-fourths of the earth's surface, the area of the freshwaters of the globe seems to be insignificant. It may therefore strike one that the potentialities of marine fisheries are far greater than those of inland fisheries. But the view is steadily changing in the light of modern aquicultural experience. Allen (1917) has compared the yield of organic substances from a given area of freshwater, seawater and land thus:

Continental carp pond....	95	lbs of fish per acre per year			
Enclosed harbour	89	....		....	
Cultivated land	73	....	beef	....	
Fish from North Sea	15	....	fish	....	

Further, transport facilities and shortage of refrigeration machinery have stood in the way of sea-fish being carried to the people living far away in the interior from the coast. This situation has been responsible for creating the need for local self-sufficiency in all matters affecting food, especially fresh-water fish. The Royal Commission on Agriculture in India and the recent Famine Commission in Bengal laid stress on the development of inland fisheries as one of the most urgent measures of rural amelioration.

India is a land of villages and also of big rivers, reservoirs and lakes. The latter are capable of producing more fish than they do at present; and there are also large undeveloped pieces of water in the form of village tanks, which have not yet been

* Published with the kind permission of the Director of Fisheries, Madras.

developed to the extent to which they have been done in the West. Worthington (1939-40) has stated as follows in connection with the development of Inland Fisheries in England, which merits quoting here. "Most of these waters should be potentially capable of supplying an annual crop of 5 to 100 lbs. per acre per annum. But at present, the largest part of them is hardly cropped at all for purpose of food. Under a careful management, the freshwater could provide a not inconsiderable addition to local food supplies. By contrast, the flourishing fish-pond industry of Germany reckons to provide fishes in crops upto and over 500 lbs. per acre per annum. This production is not only of carp and other coarse fish which are not considered at present with much favour in Britain, but includes rainbow trout which in Britain are used only in the luxury trade. It is a striking fact that in peace time nearly all the rainbow trout on the British market are imported from the continent at prices with which poachers could hardly compete while in places such as Munich, rainbow trouts are grown in ponds fertilised with sewage effluents at the cropping rate of 500 lbs per acre per annum."

In order therefore to increase production of fish in our country as in Germany, our fish farming operations should be governed by certain principles and factors. Some of these are discussed below.

Making the best use of every square inch of water should be the foundation of a sound fish production programme. A better yield can be expected from those ponds which can be drained easily. Lands which are too water-logged or too poor for agricultural purposes may be converted profitably into fish ponds, which after a suitable treatment may be made to produce a good harvest of fish.

Fish culture in farm wells :—Though ponds are ordinarily used for fish culture, farm and irrigation wells which are innumerable in our agricultural country have not been properly used. The ryot, who seeks to grow more food on his land with water from the well could at the same time grow fish in

his well and reap a double harvest with very little extra labour. Experiments conducted at Madras have proved that quite a number of fishes, such as Etroplus, Gourami, Mirror Carp, Labeo, etc., could thrive in wells and that with judicious manuring, an average fish crop of 5 to 15 pounds could be obtained from each well of about 100 sq. ft.

Paddy-cum-fish culture :—This method of increasing fish production has to be popularised in all deltaic areas. Paddy-cum-fish culture is extensively practised in Japan, China and in East Indies. Even in Bengal, simultaneously with the paddy crop, a fish crop of 100 to 300 lbs. per acre is usually harvested in certain areas of the Sundarbans. This method has great possibilites in the East and West Godavari districts in Madras Presidency. Carps like Catla, Labeo, Mrigal, Rohu and Calbasu can grow with paddy.

Utilisation of sewage :—As in Germany and other European countries attempts have to be made to utilise the sewage effluents of all cities and municipalities for fish culture, by which a crop two or three times greater than of ordinary water can be obtained. Active propaganda is required for this new line of fishery development. In Madras, arrangements are being made to utilise for fish culture the clear effluents of Madura sewage, which are now allowed to run towaste.

Utilisation of religious institutional waters :—The large number of ponds and tanks under the control of religious institutions like temples and mosques are at present unexploited for fish production. Under the Grow More Food Campaign, the Madras Fisheries were able to persuade many temple authorities to allow pisciculture in their waters with due regard to the religious functions of the temples. The results are very satisfactory, as the ecological conditions of these waters are quite favourable for fishes like Chanos, Catla, Cirrhina, Barbus and Labeo. The optimum conditions such as temperature, light, nutrient substances and algal growth are found in abundance in them. By proper propaganda all religious institutional waters can be profitably utilised for increasing fish production.

Utilisation of drinking water reservoirs :—At present drinking water reservoirs are not used for fish culture, fearing that such a procedure would endanger public health. This conception is not correct, as the water from these reservoirs are usually filtered before supply to the town. Culture of fish would, on the other hand, enhance the purity of the water, as fish feed on algal growth and other decaying matter. The cost of chemicals used in the purification of such waters can be considerably minimised.

Prevention of mortality :—Large scale mortalities of valuable fisheries commonly occur in the tropics due to various causes. These incidences have to be promptly prevented by taking suitable steps such as regulation of water level, aeration of water and rescue operations, if such losses are to be prevented.

Prevention of pollution of waters :—The discharges from various factories, mills and industrial plants into rivers, streams and reservoirs cause deleterious effects on fish life. This loss has to be prevented by suitable legislation to enforce the mill and factory owners to dispose their effluents either elsewhere, or to treat them in such a way as to make them harmless to fish life.

It is essential to remember always that for increased fish production, just as in agricultural practice, aquatic manuring of fish ponds with appropriate fertilisers is absolutely necessary and that careful attention should be paid to periodical cropping, if fish of good size are to be obtained. Apart from the above, certain factors which may be classified as physical, chemical and biological, have also to be taken into account in this connection.

Physical factors

Among the important physical factors may be mentioned depth of water, water-level and shoal area, wave action, erosion and silt, temperature, colour and transparency of water. The significance of each of these factors in increased fish production is discussed below.

Depth, water level and shoal area of water : —The shape, size and depth of a lake determine the relative amounts of shallower waters. The greater the area of shallow water the greater the biological productivity. Hence depth and not volume of water is the most important factor in determining a lake's fish producing capacity. A lake of 50 acres with an average depth of 80 ft. would produce less fish than a lake of the same area and kind of water but with an average depth of 10-20 ft. Shallow lakes therefore yield more fish per acre than do deep lakes, because they provide a greater abundance of food, of weed beds for shelter and of suitable spawning grounds.

Long narrow lakes with irregular shore line due to islands and bays are generally much more productive than relatively circular lakes, for increased irregularity of shore line results in (*a*) greater contact of water with land, (*b*) increased areas of protected bays and cover, (*c*) increased areas of shallow water for growths of rooted vegetation, (*d*) reduction of the amount of exposed, wave-swept shoal, and (*e*) increased opportunity for more extensive close super-imposition of photosynthetic zone upon the decomposition zone. These and other possible results help to increase the production of microbiotal food of fish. Therefore the form of a lake basin determines the productive volume where the several food cycles take place.

Fluctuation in water level in lakes having gently sloping sides has no effect on shoal area, while it has opposite effect on lakes having steep banks. Increase in shoal area will tend to (*a*) raise the water temperatures, (*b*) benefit the food supply and fish production, (*c*) increase the breeding habitat and production of fishes, (*d*) constitute danger zones to fish by affording opportunities for the fish eating birds, (*e*) favour disease organisms and excessive growth of weeds, and (*f*) cause algal nuisance.

Decrease in shoal area, on the other hand, will result in lowering of temperature, shelter, vegetation, spawning beds, food, erosion, predators and disease. In general any decrease in the area of shoals will tend to lower productivity which is

seldom desirable except in lakes suffering from excessive weed growths and algal nuisances. It is therefore desirable to have a permanent and constant water level for fish productivity. Fluctuating water levels are apt to be injurious in other ways also. A drop of a foot or two during spawning season may destroy the eggs of most fishes; cause considerable loss to fish life, prevent the establishment and normal development of weed beds. For these reasons it is advantageous if a lake surrounded by extensive areas of marsh or low lying ground is provided with arrangements for slightly raising its water level.

Wave action, erosion and silting:—Ponds and lakes unprotected on all sides by barriers are those which produce strong wave action. It is unfavourable to fish life in shallow lakes and on the shoal areas of deep lakes. Waves prevent the formation of weed beds, eliminate fish-food by smoothering the bottom organisms, destroy the spawning beds, cause bank and bottom erosion, keep the water roiled and increase the turbidity of water. Thereby the depth to which light can penetrate into water is reduced and the production of fish food is decreased. Wave breakers built of stone boulders or logs along wave washed shore will prevent wave action and help to increase fish productivity.

The sedimentary products of erosion tend to fill lake basins and thus shorten their life. Sand and mud tend to smoother the food organisms on the shoals, diminish the penetration of light which is indispensable for chlorophyll-bearing plants. Sometimes coarse vegetation is destroyed leading to extensive algal nuisances. On other occasions, they lessen the production of planktonic organisms whicd are at the base of the fish food cycle. But it may also be argued that the sand and mud from the catchment area contain fertilising elements which are necessary for increasing the basic fertility of the aquatic soil. It is safer to allow the nutrient substances in a dissolved form as a result of slow leaching action than allow the surface soil of the surrounding regions to be washed into the lake directly. Devices for silt-catching are, therefore, necessary in such cases for increased fish production.

Temperature:—All life processes are speeded up by a rise in the temperature of water. A rise of 10° C is said to double or treble biological activity. So, lakes and ponds subjected to higher range of temperature give rise to increased production of fish, since the increase of fish food especially is accelerated by higher temperature. Density and viscosity of water decrease with increase of temperature and are responsible for the migration of organisms to deeper waters. Temperature limits most favourable to fish life differ widely according to species. It is very difficult to determine the upper limit to temperature which can be tolerated. The heat may not actually kill fish but may make them susceptible to parasites or diseases. Trouts and English Carps prefer cold waters while Pearlspot and Gourami require warm waters. Chanos, Mirror Carp, Scale Carp and Leather Carp are however found to grow at a rate of two to three inches per month in the first year when grown in warm waters. Attempts should therefore be made to culture quick growing cold water fishes in warm waters for increased fish production.

Colour, transparency and turbidity:—Clear, blue or green water contains less living and dead matter in suspension while more yellowish or brownish or greenish water contains more of them. They constitute the food of fish. Light penetrates clear water to great depths, and influences the migration and distribution of animals. Silted lakes are highly turbid and are almost entirely devoid of weeds except perhaps in shallow water. Clearer waters allow the light rays to penetrate far enough to permit luxuriant growths in rather deep water. Turbidity is also caused by wave action on eroding shores, on soft bottoms of marl, mud or peat, by inflow of silty streams, by heavy algal growths especially after a bloom, by cattle wading and roiling the bottom. Lakes and ponds should therefore be kept free from these disturbing factors, for increased fish production.

Chemical factors.

Among the chemical factors, which play an important role in increased production of fish, may be mentioned the

differences in the chemical constitution of the waters which are primarily responsible for the varying fertility of the aquatic soil on which the entire fish food cycle is based.

Phosphates, nitrates and silicates, which are released into the water from bottom sediments, where microbes decompose the highly complex dead organic substances into simplest substances, are utilised by the chlorophyll-bearing plant organisms for their assimilation. These organisms form the food of fish or the food of zooplankton, which in turn forms the food of fish. The presence of the above inorganic nutrient substances is therefore essential for increasing fish food. Whenever they are absent in lakes and ponds, their deficiency must be restored by frequent manuring with appropriate fertilisers, until there is a formation of a bloom in the water.

The nature of the bottom deposits is extremely important in the formation of the nutrient substances of biological significance. If the sediments are composed of a mixture of rotting organic matter derived from dead animals and plants found in the pond and fine black silt containing essentially black ferrous sulphide, the effect of the fertilisers spread on such a bottom will last for a longer period than when the sediments consist merely of sand and mud. Hence, if productivity is to be augmented, mud bottoms consisting of rotting vegetation and fine silt should be created where there are none in fish ponds.

Along with the above substances, addition of calcium salts is also necessary for increasing fish production. It has been found that fish production in "soft" waters is far lower than in "hard" waters. A minimum amount of 65 parts per 100,000 of Calcium as $CaCO_3$ is very essential for really good production. If this amount is absent, it is essential to increase the concentration of calcium by the addition of powdered chalk or limestone to fish ponds. Thus, making good the deficiences in the natural supply of salts is the most satisfactory way of increasing fish productivity of a lake or pond. Waters high in carbonates tend to produce more crustaceans and

molluscs which form the food of fish. Snails and shrimps may be introduced after noting the ecological requirements of the different species of fish cultured in the particular water.

Biological factors.

Knowledge of the bionomics of fish:—The growth and reproduction of fish depends on the availability of its food in its habitat. Rearing of fishes in ponds and other inland waters to meet the public demand for increased fish-production cannot be successfully accomplished without a knowledge of the food and feeding habits at different stages of growth of the fish cultured. A knowledge of the bionomics and feeding habits of fishes stocked is thus essential for increasing fish production. Increasing the natural food supply by the application of chemical fertilizers is the easiest way, and with proper care, an increase of 100 fold is easy to obtain.

Spawning facilities:—A fishery cannot be perpetuated and increased if adequate spawning facilities are not afforded. Breeding grounds in the rivers should be conserved and protected. Where dams and anicuts are constructed artificial runs have to be provided. In ponds and tanks breeding facilities such as introduction of submerged plants and hard substrata should be given with due reference to the spawning habits of the fish under culture.

Augmenting fish seed supply:—Increased production of fish depends upon a rational policy of stocking of inland waters. The most carefully designed plan of fish stocking is useless without the raw material in the form of young fish which must be derived from the natural nursery areas and artificial breeding ponds. The fact remains that each fingerling planted in a pond, lake or river is an increment to the normal fish resources of that body of water. This aspect emphassies the vital role of nurseries and hatcheries. Mention may be made here of the abundant sources of seed of saltwater species suah as *Chanos chanos*, *Etroplus suratensis*, *Mugil spp.*, *Megalops cyprinoides* and *Lates calcarifer* along the estuaries,

backwaters, and tidal creeks, which could be easily acclimaticed and reared in freshwaters. Mention may also be made here that seeds of cold water fishes such as the Mirror Carp, Scale Carp and Golden Carp and Tench which could be easily acclimatised and grown quicker in waters of the plains. Advantage should be taken of the availability of millions of hatchlings in the rivers like the Godavari, Krishna, Tungabhadra, Cauvery and the Thambaraparani, during the flood seasons. Suitable nurseries should be constructed in a number of places along the banks of these rivers, where the hatchlings can be reared, sorted out in the fingerling stages and then transported to the interior for stocking purpose.

Stocking of ponds with fish of different age groups and species:—Different species of fish have different feeding habits. Some are bottom feeders, others column feeders and still others surface feeders. By introducing these three groups in a pond the entire food available in it can be utilised: and thus maximum production can be obtained.

Control of vegetation:—Reeds, rushes and sedges should be periodically cleared from a fish pond. A good submerged vegetation in a third of the lake or pond is desirable as it oxygenates the water and provides cover for the invertebrate fauna. The vegetation affords spawning facilities for some fishes. Where the growth of vegetation is poor, the provision of shelters of brush wood or heaps of stones is advantageous for increasing fish production.

To conclude, any programme of pisciculture based on the above principles and factors is bound to result in increased fish production in inland waters.

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2. Worthington, E.B. 1939—40. 8th, Annual Report FreshWater Boil. Asson. of the British Empire.

Forty-two years Rainfall Data collected in the Observatory attached to the Agricultural College & Research Institute, Coimbatore.

BY

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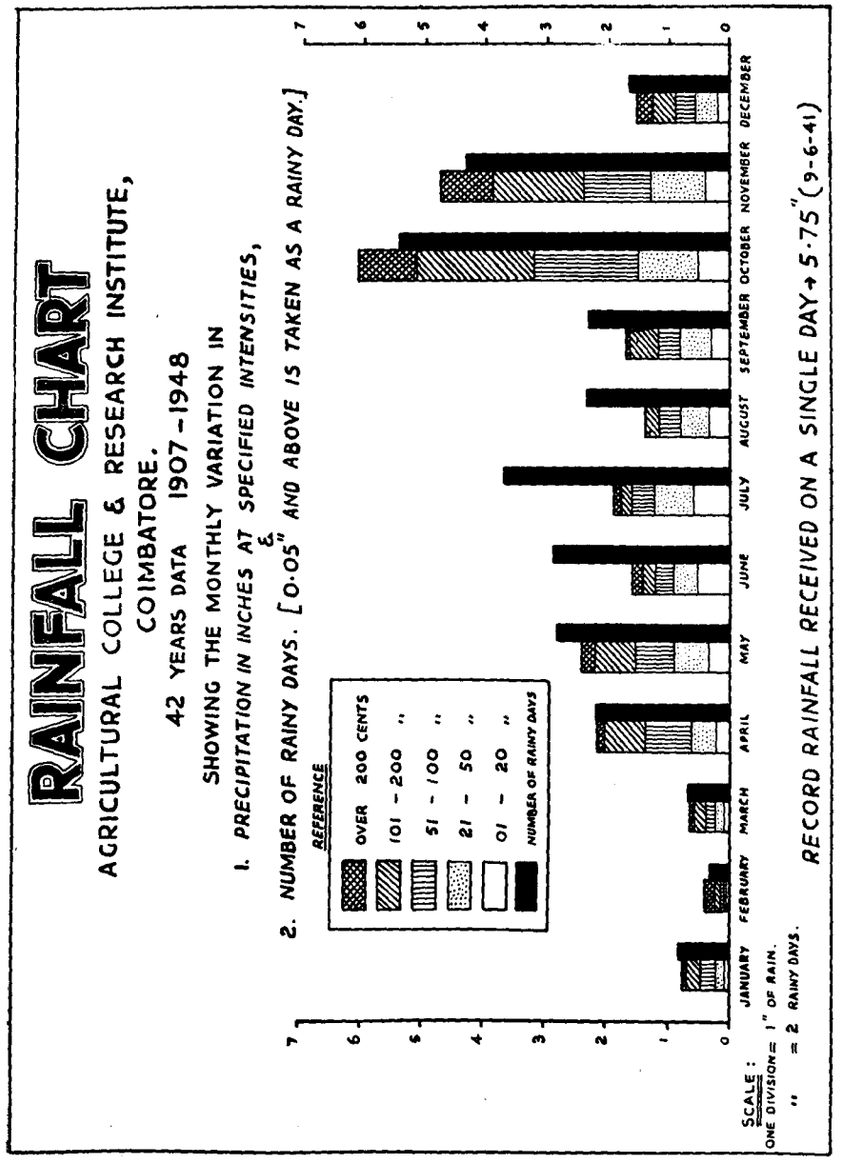
Introduction:

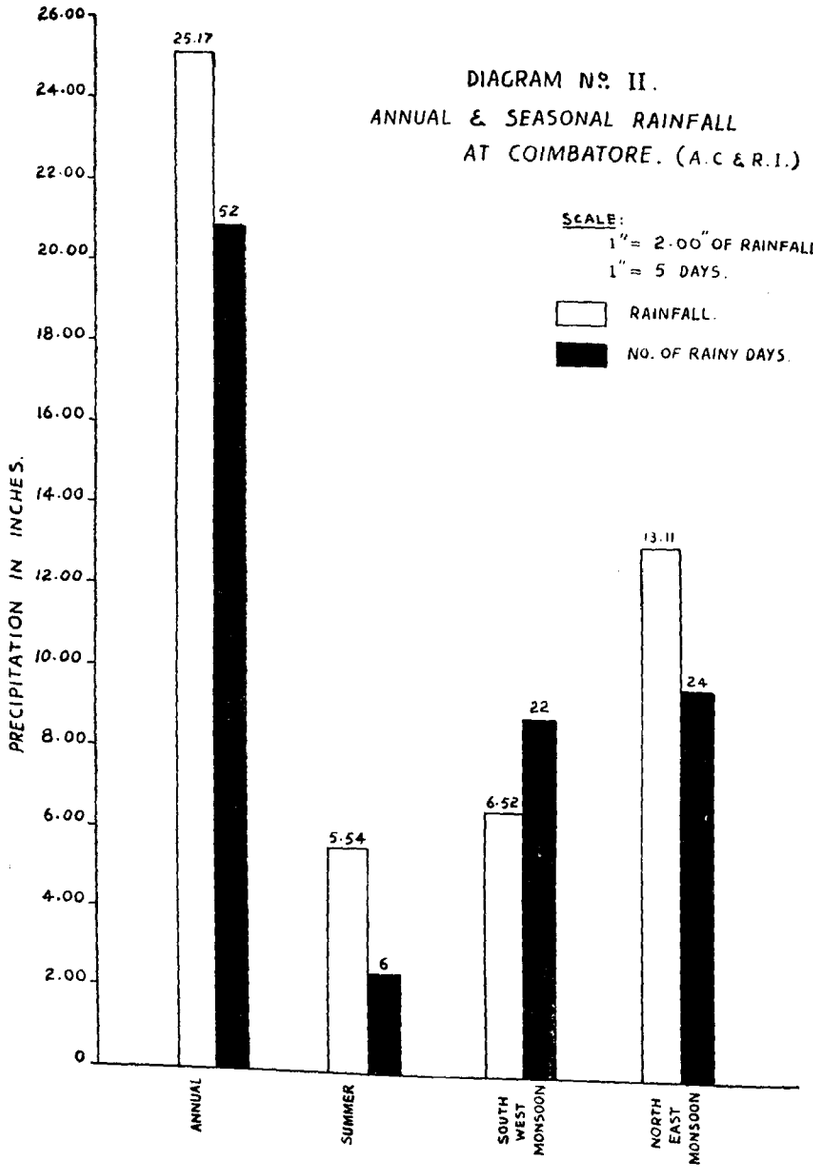
The importance of meteorological observations in agricultural research is at present gaining wide recognition. Of all the various weather elements, precipitation is the most important one from the point of view of the tiller of the soil. If timely rains are received in plenty, the farmer thinks that weather is highly favourable to him.

Analysis of the data:

The rainfall data collected over 42 years in the observatory attached to the Agricultural College and Research Institute, Coimbatore, were taken up for a preliminary analysis. The plan of analysis was so designed, as recommended by L. Dessureaux etal (1), to get information on the frequency, duration and intensity of rainfall, the importance of which has been duly brought to light by Bhumenstock (2).

The total monthly and annual rainfall are given in Table I with particulars regarding their individual range of variation and standard deviation. The total annual precipitation ranges from 12.98" to 42.74", with a mean of 25.19". The variability from year to year is high particularly during the summer season, *viz.*, February to May. So far as Coimbatore is concerned, it has been tentatively concluded (3) that summer commences in February and lasts upto May.





The intensity of monthly rainfall is shown graphically in diagram No. I, for each of the 12 months in the year. Rainfall intensity is highest in October and lowest in February. These data indicate that water run-off is more likely to occur in the months of October and November than in the other months of the year.

The number of days per month in which a fall of 5 cents and above of rain was recorded, is given in Table II for each of the twelve months in the year. It is fairly high from April onwards, barring the month of May. Further, the monthly range seems to be very wide in the case of both the monsoons and not so in the case of summer season.

The degree of possibility of the entire month being without rain was worked out in regard to each of the twelve months and the concerned particulars are given in Table III. It is found that the possibility of the months—May to November—both inclusive, being without rain, is nil indicating thereby that some showers may be expected during these months. In fact, these months cover practically both the main monsoons *viz.*, South-West Monsoon and North-East Monsoon.

The inter-monthly correlations were worked out. Out of the sixty six correlations worked out, only four were found to be significant. The combinations that were found to be significant are:—

(*i*) May—November .... Positive.
(*ii*) June—July .... Positive.
(*iii*) June—September .... Positive.
(*iv*) August—December .... Negative.

June-July is the commencement of the South-West Monsoon, *i.e.*, if June rain is appreciable, the subsequent rains in July and September will also be encouraging. This would mean that if June ushers in the monsoon well, it is a good augury that, in that year, the South-West Monsoon will be normal.

If May happens to be a rainy month, it is an indication that in that year, the North-East Monsoon will be fairly normal. In regard to August-December combination, these two months are practically the waning periods of South-West Monsoon and North-East Monsoon respectively. The negative but significant nature of the August-December correlation points out that if the South-West Monsoon is a failure, the North-East Monsoon will be fairly above normal, the reverse also being equally true.

The year is divided into three seasons, *viz.*, Summer (February-May), South-West monsoon period (June to September) and North-East monsoon period (October to January). Particulars regarding the variation in precipitation of these seasons are given in Table IV. The mean total precipitation and number of rainy days characteristic of these three seasons is presented in diagram No. II together with the mean annual precipitation and number of rainy days. It is evident that more than half the total annual precipitation is received during the North-East Monsoon period. The remaining portion of the total annual precipitation is divided fairly equally between the other two seasons *viz.*, Summer and South-West Monsoon period, the share belonging to the latter being slightly in excess over that pertaining to the former. It can in a way be stated that the seasons are fairly well defined so far as Coimbatore is concerned.

The correlations existing between the total precipitation in these three main seasons, taken two at a time, were worked out. All the three correlations were found to be insignificant. This means, the possibility of forecasting precipitation in one season based on the actual falls received in the previous season seems to be remote under the conditions obtainable at Coimbatore.

Summary.

(*i*) The total annual rainfall for Coimbatore is 25.2". The record fall per day received so far is 5.75" on 9—6—1941.

(*ii*) The season is fairly well defined from the point of view of rainfall. October and November are the most rainy months at Coimbatore.

(*iii*) North-East Monsoon is an important one so far as Coimbatore is concerned. In fact, dry sowings depend only on the timely receipt of the North-East monsoonic showers early in October.

(*iv*) The monthly range of rainy days *i.e.*, days on which 5 cents and above of rains are received, seems to be very wide in the case of both the monsoons and not so in the case of summer season.

(*v*) Some showers can always be expected at Coimbatore during the succeeding six months from May. Heavy falls will occur only in October and November.

(*vi*) It may be tentatively recorded that:—

(*a*) Normal rains in June indicate normal rains in July and September, *i.e.*, favourable South-West monsoon.

(*b*) Good showers in May foretell the probable normality of the North-East monsoon in that year.

(*c*) The possibility of one of these two monsoons being favourable when the other one fails, is not entirely ruled out, though there is no correlation existing between the total precipitations received during the summer season, South-West monsoon period and North-East monsoon period.

Acknowledgments.

The authors wish to acknowledge their sense of gratitude to all those who have been responsible for the collection of the data, forming the basic material for this paper. Further,

their thanks are due to Sri. R. Velumurugan, Computer, Agricultural Meteorology Section, Coimbatore, for the help he has rendered in the computation of the data.

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(2) Rainfall Characteristics as related to Soil Erosion-Bhumenstock, D.I., U.S.A. Department of Agriculture, Tech. Bull. 698, 1939.

(3) A preliminary note on the statistical analysis of the maximum temperatures at Coimbatore—By C. Balasubramanian and M. B. Venkatanarasinga Rao, Madras Agricultural Journal, Vol. XXXVI, No 11, 1949.

TABLE I

Characteristics of the Monthly Precipitations—1907-1948

(42 years data)

S. No.	Month.	Mean in Inches.	Range in Inches.	Standard Deviation.	Remarks.
1	January ...	0.75	Nil to 3.93	1.08	January & February alone — 1908 to 1948
2	February ...	0.39	Nil to 6.00	1.04	
3	March ...	0.63	Nil to 3.78	0.82	Rest: 1907 to 1948
4	April ...	2.14	Nil to 5.85	1.43	
5	May ...	2.41	0.16 to 6.20	1.71	
6	June ...	1.59	0 05 to 6.56	1.50	
7	July ...	1.89	0.17 to 14.18	2.11	
8	August ...	1.36	0.02 to 4.94	1.10	
9	September ...	1.68	0.03 to 4.98	1.37	
10	October ...	6.08	2.04 to 16.03	3.00	
11	November ...	4.75	0.34 to 12.77	3.07	
12	December ...	1.52	Nil to 5.55	1.68	
	Year ...	25.19	12.98 to 42.74	6.61	

TABLE II

Average Number of Rainy days per month

S. No.	Month.	Mean in Inches.	Range in Inches.	Standard Deviation.	Remarks.
1	January ...	1.56	0 to 6	1.75	Day, on which precipitation is 5 cents and above, is taken as a rainy day.
2	February ...	0.61	0 to 3	0.95	
3	March ...	0.13	0 to 7	1.50	
4	April ...	4.29	0 to 10	2.49	
5	May ...	0.56	1 to 11	2.43	
6	June ...	5.72	0 to 14	3.40	
7	July ...	7.34	2 to 17	3.30	
8	August ...	4.57	0 to 11	3.02	
9	September ...	4.62	0 to 10	2.64	
10	October ...	10.83	6 to 21	3.42	
11	November ...	8.55	1 to 17	4.09	
12	December ...	3.33	0 to 10	2.75	

TABLE III

Possibility of the entire month being drought

(41 years data)

S. No.	Month.	Number of years of data analysed.	Number of drought years.	Possibility of the month being completely drought.	Remarks.
				%	
1	January ...	41	13	32	
2	February ...	,,	21	51	
3	March ...	,,	12	29	
4	April ...	,,	1	2	
5	May ...	,,	NIL	...	
6	June ...	,,	,,	...	
7	July ...	,,	,,	...	
8	August ...	,,	,,	...	
9	September ...	,,	,,	...	
10	October ...	,,	,,	...	
11	November ...	,,	,,	...	
12	December ...	,,	,,	10	

TABLE IV

Particulars regarding Seasonal Rainfall

(41 years data)

S. No.	Name of the Season.	Rainfall characteristic of the Season in inches.	Range of variation of total precipitation in inches.	Standard deviation.	No. of rainy days characteristic of the Season.	Remarks.
1	Summer ...	5.54	0.86 to 11.10	2.45	6	Day, on which precipitation is 5 cents & above, is taken as a rainy day.
2	South-West Monsoon ...	6.52	0.77 to 22.88	3.71	22	
3	North-East Monsoon ...	13.11	4.97 to 28.37	4.97	24	

Ganges Canal Hydro-electric Scheme and Development of Industries in Western U. P.

BY

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The generation of hydro-electric power from a number of water-falls of the Upper Ganges canal has helped much in the economic development of the Western United Provinces. The main objectives of the Hydro-electric grid scheme were the following:—

(1) To supply power for pumping water to extend irrigation.

(2) To supply electricity to all the towns within the grid with a population of 5,000 or over.

(3) To supply power to the villages in order to develop agricultural and cottage industries.

In a previous article the writer has already discussed the effect of extension of irrigation on the agricultural development of the region. Here it is proposed to consider in brief how far the other two objectives have been achieved in the area served by the grid scheme.

(1) Electrification of Towns:

One of the main objects of the Ganges canal hydro-electric scheme was to supply cheap electricity to large and small towns within the grid area. Before the installation of the present scheme only the city of Meerut in this area had electrical energy. The power house was installed mainly for the benefit of the Meerut Cantonment.

After the sanction of the grid scheme the area of supply was divided into three licensed zones, and since then agreements have been made with supply companies who take over bulk power fom the grid and retail it under specified terms to the consumers. The supply companies are under agreement to

supply power to all towns with a population of 5,000 and over within the grid area. By this scheme it has been possible to supply electricity to 95 towns within the area of supply. Ordinarily in India it is not economical to instal a power house in such small towns. It is only because of their fortunate location within the grid that they are having the amenities of electric supply, otherwise for decades to come, they would probably have had to depend on oil as a source of light and power.

Map No. 1 shows the towns in the Province which have electric supply. It will be seen that outside the hydro-electric grid area there are only a few electrified towns and these are all with a population above 10,000. Roughly speaking, in the grid area one electrified town occurs in every 110 sq. miles, whereas in the rest of the Province one electrified town occurs in every 8,000 sq. miles.

The importance of domestic electric supply will be clear from the fact that in 1938—39 it supplied 27.2 per cent of the revenue although the number of domestic units consumed represented only 10.4 per cent. of the total units sold. The high rate of domestic electric supply ($5\frac{1}{2}$ annas per unit 1935) helps to lower the charges for power used in manufacturing industries. The domestic consumption of electricity has increased every year and there is scope for its further increment, especially as the rate may be reduced to 4 annas per unit with further increase of consumption.

(2) Rural electrification and industrial development :

The area now served by the Ganges canal hydro-electric grid is devoid of the essential raw materials of heavy industries and is far away from the coal and iron deposits of the Ganges basin. The only source of power before the present hydro-electric grid was either coal from the Punjab and Bihar, or fuel oil imported from abroad. Mainly due to the heavy cost of fuel it was difficult to establish any large-scale industry. With the installation of the grid scheme a large number of industries have gradually developed, both in rural and urban

Fig. 1.

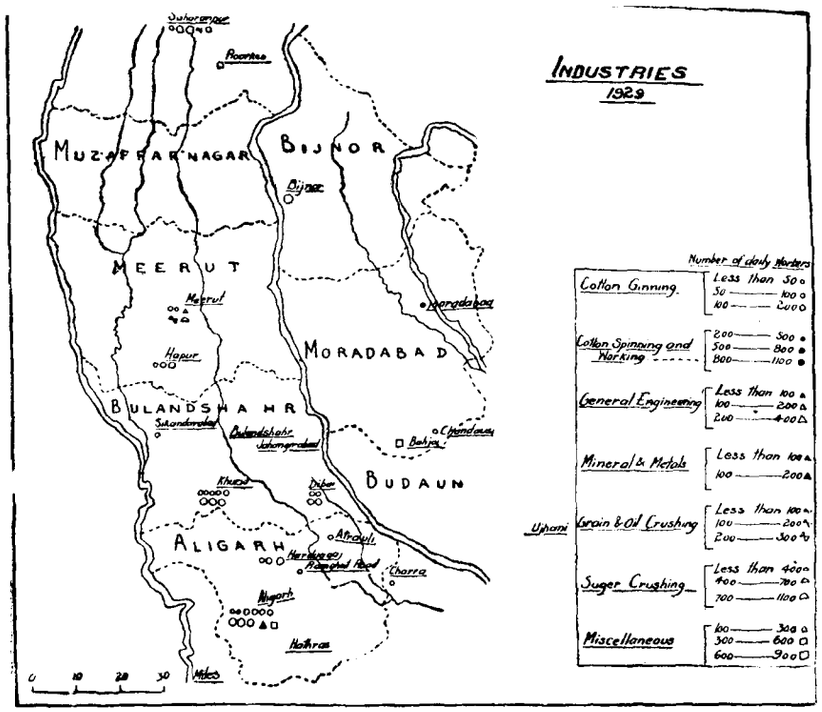
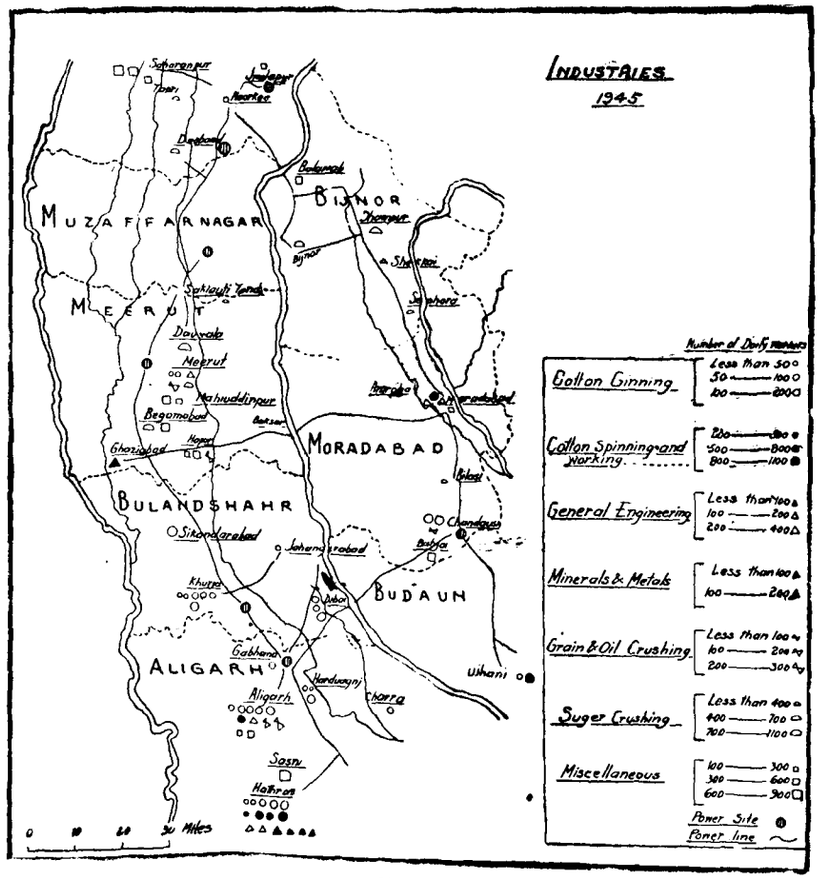


Fig. 2.



areas. These industrial establishments chiefly depend on local raw material and there is a ready demand for the produce. Obviously these industries are mainly concerned with such agricultural industries as flour milling, oil pressing, sugar manufacturing etc., and light metallurgical industries which require more of processing and less of raw material.

The task of supplying electricity to the rural areas has been much simplified due to the existing transmission lines of the tube-well network. The tube-wells have been arranged into concentrated groups, in the centre of each of which there is a main 37,000/11,000 volt transformer bank and switching station for controlling the various local tube-well feeders. This transformer station also provides power for local industries. Many small scale industries, such as sugar crushing, oil pressing, cotton ginning etc. have grown up near these stations in the interior villages.

Out of a total length of 4,324 miles of transmission lines constructed up to the end of 1942, some 2,677 miles accounted for rural extensions. In many cases special power lines have been extended to regions where there is no tube well network, but demand existed for industrial purposes, *e.g.*, two sub-stations were created in Saharanpur to supply power to several rice hulling factories in rural areas.[1]

In order to demonstrate to the villagers the utility of electric power in small-scale industries, the government erected several factories in the villages for ginning cotton and crushing cane. The Dharamnagar experimental sugar factory was started with the object of demonstrating to the zamindars the advantage of manufacturing sugar locally in places situated at considerable distances from large factories so that transport to those factories was uneconomic.[2]

Due to the unfailing efforts of the government, rural electrification became increasingly popular, chiefly for private

1. Irrigation Administration Report. U. P., March 1935, p. 14.
2. Ibid. March 1936. p. 19.

irrigation pumping and sugar crushing machinery. No statistical record is available regarding the increase in rural industries, apart from the fact that the " agricultural load " rose rapidly from 1367 horse power in 1933 to 3990 horse power in 1942, which indicates clearly the progress in rural industries, because " agricultural load " includes only such rural industries as pumping for irrigation, sugar cane crushing, sugar refining, chaff culling, crushing of cereals, manufacture of bone meal manure, etc.

On the other hand, in the case of large scale industries, in addition to the indications of the rise in the industrial load from 7080 horse power in 1931 to 15,137 horse power in 1942, the records of the Department of Commercial Intelligence and Statistics show[3] the great increase in large-scale industries, mainly due to the availability of cheap and efficient power and also the increase in industrial raw materials.

Flour Milling:

Before the installation of the hydro-electric scheme, flour milling was carried out by a large number of small oil-driven factories. These were chiefly located in Meerut, Hapur, Barant, Chhaprauli, Khikra, Ghaziabad and Sardhana. There were only two large factories, one in Meerut and the other in Saharanpur. The cost of milling was rather high. From the map of electrified towns it is evident that all these towns come under the grid scheme of electrification and with the supply of cheap power a number of large factories grew up.[4] In 1933 there were 270 flour mill motors of a total capacity of 26,760 H. P. With the introduction of power, the average cost of grinding flour has been reduced from 6 annas per maund to 3 annas per maund and continues to fall in competition with other sources of power. The saving in cost has been estimated at R. 375,000.[5]

3. " Large-Scale Industrial Establishments in India " 1945.
4. U. P. Commercial Directory, pp. 504 and 541. 1941-42.
5. Rizvi, S. M. T. An Economic and Regional Geography of U. P., Ph. D. Thesis, London University. 1937. p. 242.

Oil Pressing and Sugar Crushing:

These are two industries in which a large number of bullocks are employed. The work is consequently slow and wasteful. The district of Muzaffarnagar alone used to produce more than 5,000,000 maunds of 'gur' every year from small bullock driven cane crushers. With the introduction of the grid scheme and supply of power to the rural areas, a large number of bullocks have been relieved from the task of crushing oil and sugar cane. This has provided some rest to the underfed cattle and they can also be employed, more frequently, to carry agricultural produce to distant markets.

Textiles:

Cotton ginning is a wide-spread industry in the western districts of the United Provinces. Before the grid scheme there were some 50 ginning factories in the area, employing on an average 46 people during Season; and during the off-season most of these undertook grain splitting and oil pressing. The work was mainly done by hand labour. With the availability of cheap power, some of these factories combined into larger units and by the end of 1940, although the total number of factories was reduced to 30 only, the average number of persons employed in each during the season rose to 95. Moreover, 10 of these factories were perennial. Similar improvements have been shown in spinning and weaving industries as well.

Metallurgical Works:

Amongst these the manufacture of brassware is the most important, and its chief centre is in Moradabad city. Before 1931 there were no electrically driven polishing plants in the city, but within two years the number of such factories rose to 22 using 99 horse power annually. Since then, quite a large number of factories have taken up electric connection.[6]

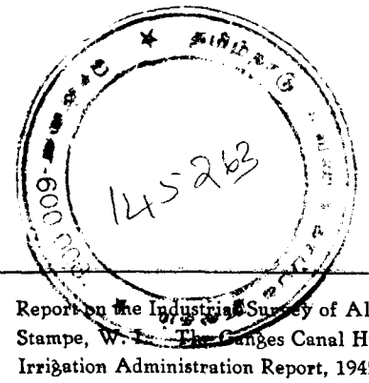
One other popular hardware industry is the manufacture of locks which is mostly confined to the Aligarh district. As early as 1924 this district used to manufacture locks worth

6. U. P. Commercial Directory. 1941-42. p. 511.

R. 28,000,000, chiefly for export, to other parts of India. No machinery was used and the work was done by hand. There were only a few power buffing lathes for polishing.[7] With the starting of the Aligarh Eelectric Supply Company, and more so after the completion of the hydel grid scheme, a large number of small lock factories are now using power driven machinery.

Apart from the industries above mentioned, the grid supplies power to many other large and small manufacturing concerns. It became possible to start the card board factory and paper factory at Saharanpur mainly because of cheap power. A special power line was constructed to supply power to these factories at a cost of R. 13,936.[8] Due to the impetus of the last war a number of metallurgical and other miscellaneous industries grew up in the grid area.

The great saving in coal by the grid scheme is in itself a boon to the country. The total capacity of the generating stations of the hydro-electric scheme was 29,700 K. ws. at the end of 1942,[9] and the number of units sold in 1940—41 was 87,898,946. To generate this large amount of energy from coal-fired electric generators would have required about 100,000 tons of coal every year. At the high rate of coal in this locality, about R 14 per ton (Delhi, 1938) the price of electric energy would be rather high for most industries.



7. Report on the Industrial Survey of Aligarh District 1924, p. 22.
8. Stampe, W. I. The Ganges Canal Hydro-electric Grid Scheme 1935. p. 5.
9. Irrigation Administration Report, 1945. p. 13.

Towns Receiving Electric Supply from the Ganges Grid have been numbered as follows :—

1. Hardwar
2. Jwalapur
3. Saharanpur
4. Nakur
5. Tapri
6. Roorkee
7. Gangoh
8. Rampur
9. Deoband
10. Manglaur
11. Purqazi
12. Laksar
13. Kiratpur
14. Najibabad
15. Nagina
16. Garthawan
17. Thana Bhavan
18. Muzaffarnagar
19. Khatauli
20. Janseth
21. Miranpur
22. Mandawar
23. Bijnor
24. Jhalu
25. Haldaur
26. Nehtaur
27. Haldwani
28. Sherkot
29. Dhampur
30. Shamli
31. Kairana
32. Kandhla
33. Chaprauli
34. Barant
35. Sardhana
36. Saulantitanda
37. Daurala
38. Baghpat
39. Meerut
40. Mawana
41. Chandpur
42. Seohara
43. Gurmukteswar
44. Gajveola
45. Hasanpur
46. Amroha
47. Bachhraon
48. Shaspur
49. Kanth
50. Moradabad
51. Kundarkhi
52. Sambhal
53. Sirsi
54. Bilari
55. Shahdara
56. Kherkra
57. Begamabad
58. Faridnagar
59. Pelkhna
60. Hapur
61. Gulothe
62. Gajiabad
63. Dasna
64. Muradnagar
65. Sikandarabad
66. Bulandshahar
67. Dankaur
68. Khurja
69. Shikarpur
70. Jahangirabad
71. Anupsahar
72. Bahjoi
73. Chandausi
74. Gabhna
75. Harduaganj
76. Dibai
77. Atrauli
78. Islamnagar
79. Aonla
80. Budaun
81. Soron
82. Kasganj
83. Morahra
84. Chharra
85. Sikandra Rao
86. Etah
87. Aligarh
88. Sasni
89. Hathras
90. Sadabad
91. Brindaban
92. Muttra
93. Itimadpur
94. Tundla
95. Firozabad

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