CENTRE FOR DEVELOPMENT STUDIES
TRIVANDRUM
LIBRARY

CENTRE FOR DEVELOPMENT STUDIES

WORKING PAPER No.15

ENVIRONMENTAL FACTORS IN PRODUCTION AND PRODUCTIVITY OF RICE IN KERALA

By

P.G.K. Panikar

Centre for Development Studies
Ulloor, Trivandrum-695011

September 1973

ENVIRONMENTAL FACTORS IN THE PRODUCTION AND PRODUCTIVITY OF RICE IN KERALA

INTRODUCTION

The rice crop in Kerala has made significant gains over recent years. The output increased from 8.73 lakh tonnes in 1956-57 to 13.52 lakh tonnes in 1971-72 and gross area from 7.62 lakh hectares to 8.75 lakh hectares. The State also registered a moderate increase in per hectare yield. However, the rise in yield rate has been disparate. A substantial chunk of the crop even today has low and stagnant productivity. Significant yield differences are observed between regions and between seasons. These interregional and interseasonal variationsseem to be largely due to differences in environmental factors. In this paper an attempt is made to bring out the dimensions of the variations and their policy implications for rice production in the State.

The estimates of area, yield rate and production of rice are available in the several publications of the State Bureau of Economics and Statistics and the State Planning Board, such as Season and Crop Reports, Reports on Crop Cutting Surveys, the Fact Book on Agriculture, Kerala Economic Review, Statistics for Planning: Serial No.1, Agriculture, etc. Area under rice is estimated through regular sample surveys conducted by the Bureau of Economics and Statistics. Theestimates of area involve some degree of error but the margin of error has not been worked out. The yield rate and production are estimated on the basis of crop cutting surveys conducted by the Bureau every crop season in all the taluks of the State. The annual estimates for individual taluks might involve a large

The author gratefully acknowledges valuable help from Messers. A. Vaidyanathan, K.N. Raj, N. Krishnaji, T.N. Krishnan, P. Ibrahim and M. Purushothaman Nair in the preparation of this paper.

margin of sampling error, say upto 30 percent*

I. FRAMEWORK OF ANALYSIS

The interregional and interseasonal variations in the yield of rice are the main theme of this study. Before we proceed with the analysis, let us examine the salient characterstics of the paddy regions and seasons in Kerala.

(a) The Three regions

(i) In terms of topography and physical features, Kerala falls into three broad natural divisions, viz., the lowland, the midland and the highland. Area with a mean elevation upto 25 feet above the sealevel are classified as lowland; the area lying between 25 feet and 250 feet above the sealevel belong to the midland; and those that are 250 feet and above the sealevel constitute the highland. In terms of location, the lowland is the strip of land stretching along the seacoast on the west. The highland spreads along the eastern boundary and includes the high ranges and the Western Ghats. The midland falls between the lowland and the highland.

(ii) In the following analysis, the taluks in the State are grouped into these three natural divisions. A majoriy of the taluks clearly fall into the regional grouping. Thus 10 taluks belong to the

---

* The Sampling design adopted for the crop cutting surveys is one of multi-stage random sampling. The taluk is taken as the stratum, a census village the first stage unit, survey sub-division number as the second stage unit a 'Kandom' as third stage unit and finally a square plot of 5 x 5 meters as the ultimate sampling unit. From each taluk, six census villages are selected with euqal probability. From each of these census villages a systematic sample of three survey sub division numbers is selected from a frame consisting of the consequti numbers of wet landsurvey sub-division. A square plot of side 5 mete is harvested, threshed, winnowed, and weighed. A sample of grains fr every 5th cut is forwarded to the District Statisticsal Officer for conducting driage experiments for estimating loss due to driage. Ther has not been any significant change in the sampling design over the period under reference in the present study.

highland, 17 taluks fall in the midland and 9 taluks belong to the lowland. The remaining 19 taluks overlap into two or three natural divisions* The focus of our analysis is on the 36 taluks which lend themselves to clear-cut demarcation. It should, however, be noted that the demarcation is to a great extent arbitrary and that the area in any particular region is not strictly homogenous. In fact considerable differences in elevation soil, rainfall, and other agro-climatic conditions do exist as between different taluks in one region as well as between different parts of the same taluk.

(iii) The rainfall generally tends to increase as one moves from the south to the north and from the lowland to the highland. "As regards the georgraphical distribution of the rainfall it can generally be said that there is a similar (to that from the south to the north) increase from stations on the coast to the stations at the foot of the Ghats".[1] Thus, the annual rainfall in the lowland ranges from 890 mm in the extrme south to 3560 m.m. in the north. The midland receives an annual rainfall from 1400 m.m. in the south to 4000 m.m. in the north. The annual rainfall in the highland varies from 2540 m.m. in the south to 5080 m.m. in the north.[2]

---

*The highland taluks are Pathanamthitta, Pathanapuram, Devikulam, Peerumedu, Udumbamchola, Thodupuzha, Chittoor, Palghat, S. Wynad and N.Wynad. To the midland belong Neyyattinkara, Trivandrum, Chirayinkil, Kottarakkara, Kunnathur, Mavelikkara, Thiruvalla, Changanacherry, Alwaye, Kunnathunad, Moovattupuzha, Thalappilli, Ottappalam, Ponnani, Kozhikode, Thirur and Cannanore. The taluks of Karunagappally, Ampalapuzha, Karthikapally, Kuttanad, Shertal. Conchin, Parur, Chowghat and Crangannore are situated in the lowland, The residual group of taluks which are spread over more than one natural division comprises Nedumangad, Quilon, Chengannur, Kanjirappally, Kottayam, Meenachil, Vaikom, Kanayannoor, Mukundapuram, Trichur, Alathur, Perinthalmanna, Badagara, Ernad, Hosdurg, Kasergode, Thalipparamba, Tellicherry and Quilandy.

1. Director of Statistics, Season and Crop Report, July 1956 to June 957, Government of Kerala, 1959, P.6

2. Director of Statistics, Season and Crop Report for the years 1957- and 1958-59, Government of Kerala, 1961- P.1.

CENTRE FOR DEVELOPMENT STUDIES LIBRARY. TRIVANDRUM.

It may be borne in mind, however, that "most of the rain-guage stations are in taluk offices and there is reason to believe that the rain-gauges are not properly maintained and the readings are not correctly recorded."[3]

(iv) The soil in most parts of the lowland is sandy, varying in texture from sandy loan to pure sand. In some parts of the lowland, e.g., Kanayannoor, Shertallai, Ambalapuzha and Kuttanad taluks, one com acress peaty or 'kari' soil. The soil in the midland is mostly laterit The western fringes of a few taluks in the midland region have sandy s while the eastern sectors of some have forest soil. In certain taluks the midland, such as Mavelikkara, Thiruvalla and Changanacherry stretch of alluvial soil are also observed. The highland region has both later and forest soil.

(b) The Three Paddy Seasons

(i) There are three main paddy seasons in Kerala -- 'Virippu', 'Mundakan' and 'Punja'. The first crop, Virippu, is sown during April-Juneand harvested in August-October. The sowing andharvesting periods the second, Mundakan, crop are August-October and December-January res ctively. Themain Punja crop is sown in November-December and harvested in February-March. The Virippu and Mundakan crops account for the bul of the area under paddy in the State. As of 1969-70, 45 percent of th area was under Virippu, 44 percent under Mundakan and the rest, 11 perc came under Punja.

---

3. Season and Crop Report, 1956-57, op.cit. P.6.

paddy. In the lowland region, Punja is the predominent crop. Punja is also prevalent on an extensive scale in Chengannoor, Vaikom, Kottayam, Mukundapuram, and Trichur, the taluks belonging to the heterogenous region. It may, however, be noted that sizeable parts of these taluks lie in the lowland region. The distribution of paddy area among the three seasons in the different regions is given in Appendix Table.

(ii) Whereas Virippu and Mundakan crops are raised in almost all parts of the State, the Punja crop is to a large extent concentrated in central Kerala comprising the four districts of Alleppey, Kottayam, Ernakulam and Trichur. Of the total area under Punja in 1969-70, viz. 98146 hectares, the above four districts claim 82830 hectares or a little over 84 percent. The rest of the Punja area, that is, 15311 hectares , is distributed over the other five districts where Punja crop on the average accounts for only 2 to 3 percent of the total area under paddy. Further, among the four districts which claim 82830 hectares under Punja, 41704 hectares are concentrated in Alleppey district, which cameto about one half of the total paddy area in the district. Moreover, the Punja crop is concentrated in a few taluks viz., Kuttanad, Vaoikom, Kottayam, Mavelikkara, Thiruvalla, Changanacherry, Chengannoor, Ambalapuzha, Karthikappally, Alwaye, Parur, Kunnathunad, Mukundapuram and Trichur. These fourteen taluks account for a little over 83 percent of the total Punja area in the State. Of this, Kuttanad taluk alone has 26 percent of the total and Kottayam taluk claims another 12 per cent. It may be noted that these fourteen taluks form two clusters in the erstwhile states of Travancore and Cochin. The Punja fields are situatied near rivers, lakes and backwaters. They remain submerged during most of the year and the crop is sown after dewatering the fields. The proximity to the rivers and backwaters assures controlled irrigation to the fields and their

submersion after harvest leads to the replenishment of the soil through theannual deposit of silt. The major part of the alluvial belt in the State is contained in the two clusters formed by the fourteen taluks covering the main Punja zone.

II. INTERREGIONAL VARIATIONS IN YIELD RATES OF RICE

(i) In this section we shall analyse the variations in yield between the three regions, the highland, midland, and lowland. As mentioned earlier, in the highland, Punja crop is practically absent. Therefore comparison of yield rates between the three regions has to be confined to Virippu and Mundakan, the crops which are prevalent in all the three regions.

(ii) The variations in yield amongthe three regions during four years viz. 1961-62, 1964-65, 1965-66 and 1968-69 are analysed here. The first two years are comparatively normal years of annual rainfall, with a total precipitation of 3309.5 m.m and 3169.5 m.m. respectively. The year 1965-66 is an abnormal period when the State received a total of 2009.1 m.m. very much below the normal rainfall. The last year under reference, 1968-69, is a normal period in terms of total rainfuall, but also a recent period which might reflect the impact of the new agricultural technology. The average yield of dry paddy per hectare in the two seasons among the three regions is shown in Table 2. For estimates of average yield in the different taluks of each region see Appendix Table II.

Contd...

Table 2: AVERAGE YIELD OF PADDY IN THE THREE REGIONS

(K.G. Per hectare)

Region	1961-62		1964-65		1965-66		1968-69	
	Viri-ppu	Munda-kan	Viri-ppu	Munda-kan	Viri-ppu	Munda-kan	Viri-ppu	Munda-kan
Highland	1831	2744	1959	2749	2234	2012	2242	2750
Midland	1663	2343	1712	2298	1830	1700	1793	2346
Lowland	1701	1839	1330	1750	1721	1295	1396	1387

The foregoing table shows the average yield rates for the two seasons in 10 highland taluks, 17 midland taluks and 9 lowland taluks. It is seen that in all the four years, and in both the crop seasons, the average yield is the highest in the highland and the lowest in the lowland, with the solitary exception of Virippu season in 1961-62. The difference in yiled between regions also appeares to be significant. To test the significance of inter-regional differences in yield, the data were put to analysis of variance. The results of the analysis are summarised below:-

Contd.....

Table 3:

ANALYSES OF VARIANCE

(i) 1961-62

Variation	d.f.	S.S.	M.S.	F.
Seasons	1	5928325	5928325	26.52*
Taluks	28	4689545	167484	0.74
1. Between regions	2	2476746	1238373	5.54*
ii. Within region	26	2212799	85108	0.38
Error	28	6258647	223523	-
Total	57	16876517		

(ii) 1964-65

Variation	d.f.	S.S.	M.S	F.
Seasons	1	5271778	5271778	22.62*
Taluks	30	8709204	290307	1.25
1. Between regions	2	4645151	2322575	9.97*
ii. Within regions	28	4064053	145145	0.62
Error	30	6990062	233002	
Total	61	20971044		

(iii) 1965-66

Variation	d.f.	S.S.	M.S.	F.
Seasons	1	224691	224691	2.35
Taluks	28	9596022	342715	3.59
1. Between regions	2	3266227	1633114	17.11*
ii. Within region	26	6329795	243454	2.55
Error	28	2672158	95434	
Total	57	12492871		

(iv) 1968-69

Variation	d.f	S.S	M.S	F.
Seasons	1	315159	3151959	20.80*
Taluks	29	1579 0053	544485	3.59
i. Between regions	2	9934655	4967327	32.77*
ii. Within region	27	5855398	216810	1.4C
Error	29	4394729	151542	
Total	59	23336741		

115379

The results of the analysis of variance show that the interregional variations in yield rate is highly significant at 1 percent level for all the four years. Further, it may be noted that variations within the regions are not at all significant. Incidentally, interseasonal variation is also highly significant during all the years except 1965-66, a year characterised by subnormal rainfall.

III. INTERSEASONAL VARIATION IN YIELD RATE

Next we proceed to examine the yield differentials between the three seasons, Virippu, Mundakan, and Punja. The analysis is confined to the taluks where all the three crops were present. All the three crops are reported in 25 taluks, of which 10 are in the midland, 6 in the lowland and 9 in the miscellaneous region. The estimated average yield of paddy for 10 years from 1961-62 through 1970-71 for the three seasons in the 25 taluks are given in the Appendix Table III. The average yields for each region and season over the ten years are summarised in Table 4.

Table 4: AVERAGE YIELD OF PADDY IN THREE SEASONS
(Kg. per hectare)

Year	Season	Midland	Lowland	Others	Average
1	2	3	4	5	6
1961-62	Virippu	1672	1635	1447	1588
	Mundakan	2499	1730	1891	2129
	Punja	2553	2447	2334	2470
	Average	2275	1971	1890	2071
1962-63	Virippu	1367	1517	1875	1803
	Mundakan	2286	1944	2091	2137
	Punja	2284	2477	2136	2212
	Average	2146	2014	2034	2076

1963-64 Contd....

Year	Season	Midland	Lowland	Others	Avera
1	2	3	4	5	6
1963-64	Virippu	1722	1729	1961	180
	Mundakan	2264	1942	2190	216
	Punja	2375	2019	2151	222
	Average	2120	1891	2102	205
1964-65	Virippu	1617	1298	1652	154
	Mundakan	2289	1879	2241	217
	Punja	2156	1770	2079	203
	Average	2021	1649	1991	191
1965-66	Virippu	1692	1500	1765	166
	Mundakan	1659	1357	1750	161
	Punja	1929	1643	1576	176
	Average	1760	1500	1697	167
1966-67	Virippu	1777	1413	1841	170
	Mundakan	2033	1567	2058	192
	Punja	2068	1785	2073	199
	Average	1960	1582	1992	187
1967-68	Virippu	1879	1418	1792	173
	Mundakan	1969	1675	1872	189
	Punja	2312	2124	2050	217
	Average	2053	1739	1904	193
1968-69	Virippu	1727	1378	1776	164
	Mundakan	2432	1430	2106	207
	Punja	1980	1672	2154	196
	Average	2046	1476	2012	199
1969-70	Virippu	1706	1412	2186	180
	Mundakan	2074	1567	2183	199
	Punja	2402	2060	2735	244
	Average	2060	1680	2149	200
1970-71	Virippu	1941	1708	2331	202
	Mundakan	2279	1798	2612	217
	Punja	2624	2907	2794	275
	Average	2282	2137	2404	227

The broad picture emerging from the above Table is that the yield rate is the lowest in the Virippu season and the highest is the Punja crop. When all taluks are taken together, by and large, the average yeild rises as one moves from the Virippu through Mundakan on to the Punja season. In the mid-land taluks,over the entire period, the Virippu crop has the lowest yield. During three years, that is, 1962-63, 1964-65 and 1968-69, the Mundakan yileded the highest, and in the remaining seven years, Punja yield led all the three seasons. As far as lowland is concerned, in all the years except 1964-65 Punja has the highest yield among the three seasons. On the otherhand, in the lowland taluks, the Virippu crop has reported the lowest average yield in nine out of the ten years. In the mixed group of taluks, the picture is slightly mixed, and naturally so. However, we notice that the summer crop is on top in seven out of 10 years. The departures from the general pattern of interseasonal variation in yield are presumably due to random factors. This is supported by the results of the analysis of variance referred to earlier in Table 3. In Table 5 the summary of the analysis of variance covering ten years is presented.

Table 5: ANALYSIS OF VARIANCE

Variation	d.f.	S.S.	M.S.	F
Taluks	24	37135698	1547321	11.22
Years	9	18179772	2019974	14.64
Seasons	2	29180843	14590421	105.78**
TXS	48	20419073	425397	3.08
YXS	18	11686528	649251	4.71
TXY	216	20987446	97164	0.70
Error	432	59585237	137929	
Total	749	197174597		

The results of the analysis of variance clearly bring out the fact that interseasonal variations in yield are highly significant at 1 per cent level.

IV. FACTORS UNDERLYING YIELD DIFFERENCES

We noted above that the yield rates varied significantly between three regions and between the three seasons. We shall now attempt to identify the factors which account for the interregional and interseasonal variations.

(a) As between the regions, the average yield of rice was seen to be the highest in the highland and the lowest in the lowland. Interregional differences in yield rate may be due to differences in climate, soil, cropping pattern, etc.

(i) Climatic conditions show some variations among the three regions. Climate in the highland is cool and bracing for most part of the year; over the winter months in the high ranges the temperature drops to 10°c during the day and touches the freezing point at night. In the midland and lowland, the climate is hot, the temperature ranging from 20°c to 25°c. It may be borne in mind that the rice crop required high temperature. Relative humidity is higher in the lowland than in the midland and highland. But, then, opinions are divided on the influence of humidity on the performance of the crop. Coming to rainfall, it tends to increase as we move from the lowland to the highland. But the impression one gets from looking at the annual rainfall data for a period of fifty years, 1901-1951, is that interregional variation in rainfall is not much. Further, with regard to rainfall, after all, it is its distribution, rather than the total, which is more relevant. Thus, the interregional differences in climate do not suggest a definite pattern so as to explain the observed differences in yield between the three regions.

(ii) The higher yield from the highland region is perhaps due to cropping pattern prevailing there. The cropping intensity in the highland region is generally low compared to the paddy areas in the other two regions. In taluks like Peermede and Udumbanchola only one crop is raised. In no taluk more than two crops are taken; even where two crops are grown, one crop claims the bulk of the area. In Devikulam for instance, a little over 94 per cent of the paddy area is accounted for by Mundakan or winter crop, and only 6 percent is sown to Virippu. In the North Wynad and South Wynad taluks, over 90 percent of the area is under the winter crop and the rest is under Punja or summer paddy. It is worth examining whether the lower cropping intensity in the highland is the reason behind the higher yield rate there.

(iii) It is generally held that a substantial proportion of the inherent yield of a plant is governed by the genetic constitution of the strain of the seed and only a part of the actual yield is atributable to environmental conditions, the quantity and quality of inputs and agronomic practices. In some of the highland taluks, long-duration strains are cultivated. Other things remaining the same, the long-duration strains are known to give higher yields than the medium or short-duration varieties. This hunch is also a matter for further investigation.

(iv) As with topography and climate, we also observe differences in soil texture and fertility between the regions. It may be recalled that the highland region is dominated by laterite and forest soil, In the mid-land one comes across stretches of laterite, forest soil, and alluvial soil. As against these, the lowland is predominently sandy; in a few lowland taluks peaty or 'Kari' soil is also found. The sandy soil is highly porous and extremely deficient in all major plant foods. The peaty soil is characterised by poor aeration and drainage and low fertility. Further the Kari lands are

subject to annual inundation under salt water with serious adverse effec on soil fertility, leading to frequent crop failures. Thus, the soil in the lowland appears to be inferior to the soil in the midland and the highland. However, paddy is a highly adaptable crop in terms of soil co ditions. At the same time, differences in the soil texture may have som bearing on yield differences. The highly porous sandy soil in the lowla region has poor retention capacity compared to the laterite, alluvial or forest soils covering the other two regions. In this context, the criti variable affecting the yield rates in the three regions may perhaps be t greater loss of water through percolation and seepage in the lowland reg rather than the lower fertility of the lowland soil. "The types of soil suitable for paddy cultivation depend more on the conditions under which plant is grown than upon the nature of the soil. The semi-aquatic condi under which it is cultivated necessitate a heavy soil through which irri gation water will not percolate, for the demands of the plant regarding water are more precise than are its demands on soil conditions."[5] Pendl observes: "Rice is doubtless the most adaptable food crop man grows, and enough water remains on the soil until the maturing of the crop, it can duce atleast a little grain on soils that are unbelievably poor in plant nutrients."[6]

(b) Yield differences between the three seasons were found to be highly significant. The Virippu crop registered the lowest yield while highest yield was realised in the Punja season. To what extent are the interregional variations in yield due to differences in climatic and oth environmental conditions? How much are the variations due to genetic factors and agronomic practices? Is there any interaction between

---

5. G.H. Grist, Rice, Longmans, Green and Co. 1960, p.11
6. Loc. cit.

environmental conditions and cultural practices? We turn to these questions now:

(i) The Virippu and Mundakan crops are raised during the monsoon season. The Virppu season synchronises with the Southeast monsoon. The crop is grown under cloudy conditions; the available sunlight during the Virippu season is less than that in other months of the year. However it is difficult to form a firm judgement on the effect of the seasonal variations in sunlight on the performance of the crop. In the first place, the data on sunlight (reckoned in terms of, say the number of sunny/rainy days) during the period under survey, are not readily available. Secondly, one does not know whether the actual sunlight usually available during the Virippu season, though less than that of the other two seasons, is not sufficient for photosynthetic efficiency. The inter-seasonal variation in temperature and relative humidity in most parts of the State does not seem to be very great. The temperature during the Virippu season is evidently lower than that of Mundakan and Punja seasons; but the difference is not much. At any rate, it is an open question whether the temperature during the Virippu season is so low as to depress its yield. As mentioned earlier, there is no consensus on the effect of high humidity on the yield rate of paddy. But it has been observed that the high humidity during the monsoon season is a serious environmental problem. "The humidity increases the severity of attacks by insects and diseases."[7] Cloudy atmosphere, low temperature and high humidity obtained during Virippu season favour the rice blast disease and bacterial leaf blight. On the otherhand, the Punja crop is relatively free from these adverse conditions. During the Punja season the temperature is high; the sky is clear and there is adequate sunlight; and relative humidity is low. Notwithstanding the above, one is led to the conclusion that interseasonal variations

7. Randolph Barker and Mahar Mangahas, "Environmental and other Factors Influencing the Performance of New High Yielding Varieties of Wheat and Rice in Asia", Agricultural Development in Developing Countries - Comparative Experience, Indian Society of Agricultural Economics, Bombay, 1972, p.228.

in climatic conditions do not fully explain the difference in yield.

(ii) There is however, a crucial environmental factor which differentiate Virippu and Mundakan from the Punja crop. The first two cr depend upon the not too dependable rains, while the punja is irrigated pa The Punja unlike the other two crops, is raised only in such areas where is assured supply of water.

(iii) The risk element in the Punja crop is comparatively low, tha to controlled irrigation. Therefore, the cultivators should be prepared experiment with new inputs and new techniques. Available evidence seems support this hypothesis. As of 1970-71, about 54 percentof the Punja fi was under the new high yielding varieties, as against 13 percent of the Mundakan area and 15 percent of the Virippu area. The proportion of the paddy area using chemical fertilizers, for the same period, has been esti at about 95 percent of land not receiving any manures is the least in the of the Punja.[8] Thus the Punja crop leads the other two in respect of ado tion of modern inputs and practices. The availability of irrigation wate seems to be the main factor inducing the adoption of improved seed, appli cation of fertilizers, etc. to a greater extent in Punja than in Mundakan Virippu.

/in the case of Punja, as against 72 percent under Mu /and a little over 40% in Virippu; the percentage

(iv) Availability of water emerges as the critical variable affe ing yield rates. In the course of a recent survey among sample cultivato and other knowledgeable persons in some twenty selected areas in the Stat learned that the main constraint or the expansion of Punja crop was lack irrigation facilities, for during this season rainfall is reduced to a t It may be mentioned that even in areas where some major and mediun irrig

8. The State Planning Board, Kerla Economic Review, 1971, Government of K 1972.

projects were completed, for example in Palghat and Trivandrum districts, the cultivators complained that they do not get water for the Punja season. This is exemplified by the limited extent of the Punja crop in these two districts where the major irrigation projects so far undertaken in the State are mostly concentrated. In such areas in the two districts where Punja crop is reported, the cultivators depend on other sources of water like rivers, lakes and private tanks and wells. It is significant, to note that the existing irrigation schemes serve at best to stabilise the Virippu and Mundakan crops and are not able to release any water for a third crop.

SUMMARY AND CONCLUSION

Environmental factors play a decisive role on the yield of rice in Kerala. Among the environmental factors, the most crucial one appears to be the availability of water. A vast proportion of the paddy crop today depends on the rainfall. Even in areas where major irrigation projects have been completed, their essential role is one of protecting the crops raised during the monsoon season. Significantly enough, the Punja crop which gives the highest yield, remains outside the stream of irrigation provided by the Government.

The conclusion emerging from the present study is that Kerala has failed to fully exploit its abudant water resources. The State receives about 3000 m.m. of rainfall a year. Moreover, the year to year variation in total rainfall is comparatively small. Todate the investment has been concentrated on surface irrigation. A proper irrigation system should seem to supply water when it is most needed and at the rate in which it

will be most productive. Herein, perhaps, lies the significance of utilisation of ground water resources. Given the heavy precipitation there should be a large reservoir of ground water in the State which still remains untapped, if not unexplored. The Task Force on Ground Water Resources constituted by the State Planning Board observed that "groundwater investigation and survey in the State is in its infancy". Studies carried out by the Geological Survey of India in Alleppey Dist experiments of tube well construction by the Public Health Engineering Department in Quilon and Alleppey Districts, exploratory drilling by t Central Ground Water Board in some parts of the State have all yielded promising results. The exploitation of groundwater is at present negl The future irrigation plans of the State must redress the present imb by resorting to what the Irrigation Commission calls, "conjunctive use surface and ground water". But the nature and extent of the adoption of such "conjunctive use" programme should, of course, be based on a careful analysis of all the economic aspects involved.

1.9.1973 P.G.K.Panikar

APPENDIX TABLE I

Area under three crops in three regions

Taluk	1961-62 % area under paddy			1970-71 % area under paddy		
	Virippu	Mundakan	Punja	Virippu	Mundakan	Punja
Highland						
Pathanamthitta	21.66	78.34	..	30.65	67.24	2.11
Pathanapuram	50.68	49.32	..	47.11	52.89	..
Devikolam	..	..	..	5.92	94.08	..
Peermede	..	..	..	..	100.00	..
Udumbanchola	..	..	..	..	100.00	..
Thodupuzha	51.47	48.53	..	52.28	47.72	..
Chittoor	56.57	43.43	..	48.91	51.09	..
Palghat	68.62	31.38	..	62.73	37.27	..
South Wynad	..	100.00	..	..	87.11	12.89
North Wynad	..	94.12	5.88	..	93.70	6.30
Average for highland	41.04	56.85	2.11	48.98	48.98	2.04
Midland						
Neyyattinkara	50.04	49.96	..	48.62	50.06	1.32
Trivandrum	49.68	50.32	..	47.11	49.01	3.88
Chirayinkil	44.81	55.19	..	42.09	55.25	2.66
Kottarakkara	46.34	53.66	..	47.40	51.66	0.94
Kunnathur	37.66	62.02	0.32	41.02	57.40	1.58
Mavelikara	28.34	31.72	39.94	30.11	35.48	34.41
Thiruvalla	26.61	28.44	44.95	23.62	37.12	39.26
Changanacherry	16.10	24.34	59.56	26.51	21.69	51.80
Alwaye	40.02	35.41	4.57	34.22	48.28	17.50
Kunnathunadu	37.05	58.27	4.68	36.15	54.77	9.08
Moovattupuzha	35.17	63.42	1.41	40.00	57.11	2.89
Thalappilly	40.97	55.34	3.69	48.50	47.99	3.51
Ottappalam	61.65	38.35	..	61.40	38.60	..
Ponnani	64.34	21.03	14.63	42.86	39.76	17.38
Kozhikode	56.34	43.66	..	43.14	54.27	2.59
Thirur	68.58	27.05	4.37	48.57	44.82	6.61
Cannanore	82.08	17.92	..	85.89	14.11	..
Average for Midland	46.34	45.37	8.29	49.74	42.92	7.34
Lowland						
Karunagappally	28.46	68.48	3.06	32.99	60.85	6.16
Ambalapuzha	9.02	22.72	68.26	12.35	32.25	55.40
Karthigappally	34.56	40.12	25.32	37.35	39.12	23.53
Kuttanad	5.68	..	94.32	2.10	..	97.90
Shertallai	72.06	27.94	..	59.50	40.50	..
Cochin	100.00	..	..	100.00	..	..
Parur	24.71	26.73	48.56	38.30	21.35	40.35
Chowghat	17.38	72.16	10.46	25.31	63.47	11.22
Crangannoor	24.31	73.78	2.31	19.80	78.31	1.89
Average for Lowland	28.10	31.37	40.53	27.17	30.62	42.21

APPENDIX TABLE II

Average Yield of Virippu and Mundakan in Different Taluks for the period 1961-62 to 1970-71

(Kg. per hectare)

Taluks	Virippu	Mundakan
Pathanamthitta	1848	2617
Pathanapuram	1917	2725
Devikulam	..	2085
Udubanchola	..	2813
Thodupuzha	1832	2217
Chittoor	2667	2756
Palghat	2587	2848
Peermade	..	2287
S. Wynad	..	2194
N. Wynad	..	1905
Neyyattinkara	2227	2364
Trivandrum	2031	2230
Chirayinkil	1798	2220
Kottarakkara	1857	2601
Kunnathur	1538	2607
Mavelikara	1681	2259
Thiruvalla	1902	2276
Changanacherry	2179	2223
Alwaye	1748	2177
Kunnathunadu	1647	2048
Muvattupuzha	1835	2228
Thalappilly	2131	2239
Ottappalam	2351	2370
Ponnani	1474	2107
Kozhikode	1290	1829
Thirur	1464	1621
Cannanore	1694	1477
Karunagappally	1603	2076
Ambalapuzha	1319	1338
Karthikappally	1661	2033
Kuttanad	1941	..
Shertallai	1351	1137
Cochin	2007	..
Parur	1758	1806
Chowghat	1416	1478
Crangannure	1278	1463

APPENDIX TABLE III

Average Yield of Paddy, 1961-62 to 1970-71

(Kg. per hectare)

	Virippu	Mundakan	Punja
1. Kunnathur	1538	2607	2313
2. Mavelikkara	1681	2259	2615
3. Thiruvalla	1902	2276	2722
4. Changanacherry	2179	2223	2505
5. Alwaye	1748	2177	2041
6. Kunnathunadu	1647	2048	1839
7. Moovattupuzha	1835	2229	1990
8. Thalapilly	2131	2239	2812
9. Ponnani	1474	2107	2033
10. Thirur	1464	1621	1913
11. Karunagappally	1603	2076	1696
12. Ambalapuzha	1319	1338	2056
13. Karthigappally	1661	2033	2513
14. Parur	1758	1806	2122
15. Chowghat	1416	1478	2040
16. Cranganmure	1278	1463	2118
17. Chengannur	2003	2249	2670
18. Kottayam	2011	2269	2244
19. Meenachil	1686	2082	2052
20. Vaokom	1550	1912	2060
21. Mukundapuram	1489	1820	2318
22. Trichur.	1760	2132	2343
23. Hosdurg	1982	1857	1903
24. Kasaragod	2076	2011	2024
25. Quilon	1736	2068	1948

This work is licensed under a
Creative Commons
Attribution – NonCommercial - NoDerivs 3.0 Licence.

To view a copy of the licence please see:
http://creativecommons.org/licenses/by-nc-nd/3.0/