Staff Paper Series

Staff Paper P72-24 September 1972

HIGH RETURNS FROM FIELD CHANNELS IN IRRIGATED INDIAN VILLAGES

By

B.B. Batra and K. William Easter

Department of Agricultural and Applied Economics

University of Minnesota
Institute of Agriculture
St. Paul, Minnesota 55108

Staff Paper P72-24 September 1972

High Returns from Field Channels in Irrigated Indian Villages

B. B. Batra and K. William Easter

Sept. 1972

High Returns from Field Channels in Irrigated Indian Villages*

B.B. Batra and K. William Easter**

The problem of improving the efficiency of existing irrigation systems has become increasingly important. The advent of high yielding varieties and the increased use of fertilizers have increased the returns to water and made better water management essential. Yet the limited improvement in management of existing irrigation projects indicates the impossibility of individual farm improvement and the need for group action. In addition the growing population and increasing disparity between regions with different resource endowments have highlighted the importance of water as the limiting resource in many areas.

The Report of the Irrigation Commission highlights many of these problems. "The states are unanimous that the absence of field channels has been a major reason for serious lapse in the utilization of irrigation potentials. In 1966, Mysore state took upon itself the responsibility of excavating field channels. This brought about a spectacular improvement in the utilization of the irrigation potential. Andhra Pradesh took action on similar lines in the Nagarjunsagar project and this also had a salutary effect."1/

---

* Report prepared for the use of Sambalpur District, Orissa and the Ford Foundation, India Field Office.

** B.B. Batra is Program Analyst, Ford Foundation, New Delhi, India. K. William Easter is Associate Professor, Department of Agricultural and Applied Economics, University of Minnesota and Consultant, Ford Foundation. The authors would like to thank P. Kumar, S. Mahapatra, U.C. Padhi and Shrinath Singh for their valuable help in the study.

1/ The Report of the Irrigation Commisssion 1972, Vol. 1, Ministry of Irrigation and Power, New Delhi, 339 p.

This study evaluates the impact of field channels on the irrigated area of Sambalpur district in eastern India. Here a program of providing field channels for villages has been underway since 1966-67. If such a program has been successful it has implications for all the eastern rice regions of India from Orissa and Madhya Pradesh to Bihar and West Bengal.

Study Area

Sambalpur district is the second largest district of Orissa State with a total area of seventeen and a half thousand square kilometers and a 1961 population of 1.5 million of which 92 percent was classified as rural. One hundred hectares of net cultivated area in the district support nearly 220 persons as compared to the all-India average of 272. The district is situated in the northern part of Orissa State surrounded by Sundergarh district in the north, Dhenkanal in the south and Bolangir in the southwest. It is in the high rainfall area, east of the 80° longitude and is divided into two parts by river Mahanadi. Sambalpur district is divided in 29 National Extension Service blocks having 3,426 villages and 320 thousand cultivating families. The major development projects in the district have been the Hirakud Dam and the Intensive Agricultural District Program (IADP).[2/] (See Appendix Maps)

IADP

Since independence India has made steady progress. But by the end of 2nd Five Year Plan, despite this progress, food production did not meet the

[2/] Expert Committee on Assessment and Evaluation, Modernizing Indian Agriculture (Report on the Intensive Agricultural District Programme 1960-68) Vol. 1 and 2 (Ministry of Food, Agriculture, Community Development & Cooperation, 1970).

rising demands caused by higher than predicted increases in population and higher per capita income. In 1959 the Government of India, after a comprehensive survey, invited an Agricultural Experts Team to make recommendations for increasing the food production.[3/] This led to the birth of the Intensive Agricultural District Program in 15 districts, generally one in each state. The basic idea of the program was an intensive effort to increase agricultural production through a package of the best available agricultural practices and the concentration of extension manpower and resources in selected areas which had optimum conditions for accelerating agricultural production. The Sambalpur IADP which has been functioning for the past decade, has concentrated on the irrigated portion and had a significant impact on the district's agriculture.

Hirakud Project

The history of Hirakud Project dates from 1858 when Sir Arthur Cotton was asked to report on how the water of the Orissa rivers could be harnessed and the flood problem eliminated. He suggested weirs across the Mahanadi river and the construction of irrigation canals, drainage channels and embankments. Although the scheme was not considered productive subsequent "Flood Inquiry Committees" of 1927, 1937 and 1940 made similar suggestions and the first official document relating to the Hirakud project was prepared in 1947. The scheme after many revisions was estimated to cost Rs. 68.35 crores and the work started on the dam in April 1948.

[3/] The Agricultural Production Team, Report on India's Crisis and Steps to Meet It (The Government of India, New Delhi) April 1959.

The original scheme provided for the irrigation of 1,094,953 acres of land. However, this figure was revised down in 1953 and the Hirakud canal system actually supplies water to 447 villages and 282,000 acres in Sambalpur district. The regulated supply of water also provides protective irrigation to existing irrigated areas in the delta, which were not cultivated before the Hirakud Dam because of the flood danger. The main dam was completed in all its aspects by 1957-58 but irrigation water was released on 7th September, 1956.[4/]

As the cultivators were not used to irrigated agriculture they didn't use the canal water and resisted paying canal dues. The idea of two crops a year was unbelievable and the common example quoted was how can a woman bear two children in one year's time. The other excuse put forward was that the summer (Kharif) production would fall. The resistance to growing a second crop of paddy was so great that in Budelpali Village the local agricultural extension officer had to go on hunger strike. He lay down in the village temple and refused to take any food until the peasantry agreed to sow a second irrigated winter (Rabi) crop of paddy. In many places police help was sought to prepare the cultivators for growing a second padddy crop.[5/]

In the meantime Andhra Farmers started settling in Sambalpur because of the irrigation facilities and very low land prices. They sold land in

---

4/ Programme Evaluation Organization, Evaluation of Major Irrigation Projects, (Some Case Studies) Government of India, Planning Commission, 1965, pp. 126-161.

5/ Nair, Kusum, Blossoms in the Dust (The Human Element in India Development) 1961, Gerald Duckworth & Co. Ltd., London, pp. 141-4.

coastal Andhra Pradesh for high prices and then purchased the relatively low price land in Sambalpur. These farmers with the experience of irrigated cultivation and double cropping have worked as agents of change.

Natural Resources

The land in Sambalpur is rocky and undulating in character which makes it very difficult to regulate the flow of water. The cultivated lands of this region consist of ridges, slopes, dales and bottom. These lands have been classified into four broad categories according to their location. They are locally known as Att (ridges), Mal (slopes), Berna (dales) and Bahal (bottom) lands. All classes of land except Att lands are generally level enough to irrigate with proper bunding.

Fertility of soil varies according to location. The Att lands are the least productive since the soil is shallow and low in nitrogen but with assured irrigation shallow rooted crops can be grown. Mal lands are loamy and can grow any crop with assured irrigation. Berna lands are even more productive because water from Mal land percolates to these lands along with the soluble nutrients. The heavy textured Bahal lands have been historically the most productive but the lack of adequate drainage has caused water logging of Bahal land in the irrigated tract.[6/]

The district climate is relatively homogenous with respect to humidity, temperature and rainfall. The maximum temperature varies from 40°C to 45°C in May and the minimum temperature drops to 7°C in the winter.[7/]

6/ The changes in land productivity due to irrigation have caused shifts in relative land values. Within the village these changes in relative wealth have had some interesting effects on the local power structure and needs further investigation. Some individuals from the bottom (labor groups) have been able to move into top leadership positions.

7/ Intensive Agricultural Distirct Program, Sambalpur, mimeograph, Sambalpur Distirct 1972, p. 2.

The relative humidity varies between 56 and 97 percent. The average rainfall of the region is 153 cm with more than 95 percent confined to the months of June to October with occasional showers in the winter season. There is considerable variation in rainfall which leads to uncertainty and variations in production particularly in the non-irrigated areas.

Paddy is the main crop of the district and of the study block. It is grown in both the Kharif and Rabi seasons where irrigation is available. The other crops grown include Pulses, Potato, Sugercane, Groundnut and Wheat (see Table 1).

Table 1

Percentage of Gross Cropped Area Under Different Crops in Sambalpur District (1970-71)[b/]

Crops	District	Study block[c/]
	- percentage -	
1. Local Paddy	70	62
2. HYV Paddy	11	33
3. Wheat	1	(a)
4. Pulses	5	1
5. Oilseed crops	5	1
6. Vegetable	5	2
7. Other crops	4	1

(a) Less than .45 percent.

b/ percentages may not add to 100 percent due to rounding.

c/ Attabira block.

In the canal irrigated area the major crop is now Rabi paddy which is quite a change for farmers who once only grew Kharif paddy.[8/]

Water Management Program

On canal irrigated lands water flows continuously from the water course to the fields. Irrigation is by gravity flow from field to field with the surplus water accumulating on the low Bahal lands or finding some natural drainage stream as an outlet. Farmers have no control over either the timing or quantity of water. If the farmer above shuts off the water while fertilizing his fields, the farmers below go without water.

In 1966-67 IADP introduced the water use and management program which demonstrated the use of field channels in selected villages. The basic idea of the water use and management program was to provide field channels for irrigation and to teach the farmer how to better use his water. A major extension effort was required to convince the villagers of the program's utility and to obtain the approval of the entire village. In villages where cultivators agreed to the idea the IADP district staff has demonstrated the use of high yielding varities (HYV's), fertilizer, pesticides, etc. in areas where field channels were constructed.[9/]

8/ The common crop rotation pattern followed by farmers in irrigated areas is as follows:

	One Year Rotations	
Type of Land	Kharif	Rabi
Att	Groundnut	Potato
Att	Black Gram	Vegetables
Mal	Paddy	Wheat, Paddy or Veg.
Berna	Paddy	Paddy
Bahal	Paddy	Paddy

9/ Demonstrations have been implemented in the following villages:

	Area in demonstration
Bhursipalli	580 acres
Kherapalli	1300 "
Jayantpur	800 "
Gautikra	500 "

The economic impact of the improved irrigation system could include additional irrigated area, changes to more profitable cropping patterns and a greater use of high yielding varieties and inputs. Adoption of relatively more labor intensive crops and a higher intensity of cropping would both increase the opportunities for employment in agricultural occupations.

Village Survey

Given the above situation it was decided to select six villages within the irrigated area for a detailed survey during both the 1970-71 Rabi and Kharif seasons. The primary objectives were to (1) measure the costs and returns from the water use and management program, (2) measure changes in farming practices and (3) identify other problems which might limit further agricultural development of the irrigated area.

Three types of villages were selected (1) villages which have an improved irrigation system with field channels and a demonstration (improved villages), (2) villages where the work is in progress (partially improved), (3) villages which should improve their irrigation system but have not (control villages).[10/] This paper is only concerned with the improved and control villages.

10/ The following villages were selected as representative of the other villages:

1.	Bhursipalli and Kherapalli	Improved villages
2.	Jayantpur and Gautikra	Partially improved villages
3.	Dhulampur and Kumel Singha	Control villages

At the time of selecting the villages there were only four improved villages and six partially improved.

A random sample of 195 farmers was drawn from the six villages. Approximately 20 percent of the cultivating families were included from each set of two villages. The sample was selected so that it was representative of the following three size groups; 0.5 acres to 3.5 acres, 3.6 acres to 7.5 acres and above 7.5 acres. The average size of holding in the villages was 5.7 acres and the average was almost the same for improved and control villages. The minor differences were found statistically insignificant (Table 2).

Table 2

Average Size of Sample Farms, 1970-71

	IMPROVED VILLAGES		CONTROL VILLAGES	
Farm size	Number of Farmers	Average holding size	Number of Farmers	Average holding size
		Acres		Acres
Small	18	2.2	22	2.1
Medium	20	5.2	21	5.0
Large	22	12.9	20	12.3
Total	60	7.1	63	6.3

Cropping

Paddy is the major crop in the sample villages while HYV's are more popular in Rabi than Kharif (Table 1 and 3). This preference is due to two factors. First the Kharif crop is very susceptible to gall midge attack to which the local varieties are more resistant. Second most land owning villagers don't consume high yielding varieties and grow the improved local varieties for their consumption during Kharif. Thus except for the small farmer the HYV's are grown for sale.

Table 3

Percentage of Crops Grown on Sample Farms by Season, 1970-71[b/]

Crops	Kharif Improved Villages	Kharif Control Villages	Rabi Improved Villages	Rabi Control Villages
	- - - - - - - - - - -	Percentage	- - - - - - - - - - -	
Local Paddy	92	94	27	44
HYV Paddy	5	1	72	54
Wheat	-	-	1	(a)
Pulses	(a)	1	-	-
Oilseed crops	2	1	-	1
Vegetables	1	1	-	(a)
Other crops	(a)	1	-	1

(a) less than .45 percent.

b/ percentages may not add to 100 percent due to rounding.

In the canal irrigated area two paddy crops are a routine pattern. The area under double cropping in the district has gone from 84,000 acres in 1961-62 to 257,283 acres in 1971-72. Farmers in the irrigated area have grown three crops on Att and Mal lands. A few farmers were reported to be trying this cropping pattern in the study area. But so far there has not been a significant change in the cropping pattern or diversification in the villages surveyed. One reason for the lack of diversification may be that installation of field channels is still in its infancy and it is too early in the process of change for any appreciable shift in cropping patterns. Another reason may be that the field channels have firmed up the water supply and made it unnecessary for the farmers to grow crops requiring less water. The farmers prefer growing paddy and hesitate at growing other crops unless their alternatives are limited.

in the control villages and 45 percent in the improved villages. For the Rabi season the percentages were 54 and 72 respectively for the control and improved villages. However, as pointed out earlier, due to the insect, gall midge, and the villagers preference for consuming local varieties the percentage of HYV's during Kharif was only 1 and 5 percent respectively.

The adoption of HYV's of Paddy had its obvious effects on fertilizer use. Farmers use high applications of fertilizer not only for HYV's but also for local varieties. In both sets of villages per acre use of fertilizers rises with the size of holding (see Table 5). But farmers in the improved villages are using higher applications of fertilizers for all paddy crops. This difference appears to be largely due to the field channels which afford better water control and have eliminated the fear of fertilizers being washed away in the improved villages in sharp contrast to the control villages.

The difference in fertilizer use between villages is not statistically significant during Kharif because the heavy rains limit water control. But the picture is entirely different during Rabi. Farmers in the improved villages used 48 kgs. and 82 kgs. of plant nutrients per acre for local and high yielding varieties respectively as compared to only 36 kgs. and 64 kgs. in the control villages.

So far as the use of human labor and bullock labor is concerned, there is little variation between the size groups and between the two sets of villages (see appendix tables). But the use of plant protection is definitely higher in improved villages (see Table 6). It may be at least partly due to the construction of field channels since once the farmers improve their water control the returns from adopting other improvements increases. The demonstration should also encourage the use of new inputs such as pesticides.

Table 5

Fertilizer Use on the Sample Farms by Season and Paddy Variety, 1970-71[a/]

Kharif Season Local Varieties[b/]

Farm size	Improved Village N	P	K	Total Nutrients	Control Village N	P	K	Total Nutrients
				- Kgs per acre -				
Small	20	8	2	31	14	8	0	22
Medium	22	7	2	31	21	8	0	29
Large	23	12	3	38	21	10	1	32
All Farms	22	10	3	35	21	9	1	30
				Rabi Season Local Varieties				
				- Kgs per acre -				
Small	26	7	5	38	18	10	0	29
Medium	30	12	5	47	21	8	3	32
Large	35	13	5	52	30	11	0	41
All Farms	32	12	5	48	25	10	1	36
				Rabi Season High Yielding Varieties				
				- Kgs per acre -				
Small	37	11	8	57	27	11	0	37
Medium	46	18	15	79	45	10	4	59
Large	52	18	15	85	50	16	4	70
All Farms	50	17	15	82	46	14	4	64

a/ Figures may not add due to rounding.

b/ So little acreage of high yielding paddy was grown during the Kharif season that only local varieties were shown for the Kharif.

Table 6

Plant Protection on the Sample Farms by Season and Paddy Varieties, 1970-71

Farm Size	Improved Villages Local (Kharif)	Improved Villages Local (Rabi)	Improved Villages HYV (Rabi)	Control Villages Local (Kharif)	Control Villages Local (Rabi)	Control Villages HYV (Rabi)
	- Rs. per acre -			- Rs. per acre -		
Small	4	1	7	1	0	1
Medium	5	0	11	4	2	5
Large	9	4	18	4	2	8
All Farms	6	2	15	4	2	7

Yields

In the improved villages the local varieties yield 13.7 quintals per acre for all farms during Rabi while in Kharif the yield was only 10 quintals per acre (Table 7). In the control villages for local varieties the average yield in the Kharif was 7.1 quintals per acre for all farms as compared to 10.2 in the Rabi season. Thus the improved villages obtain a little over 3 quintals per acre more local paddy than the control villages with the largest difference being between the medium size farms.

For high yielding paddy in Rabi season, yield difference per acre was also highest for medium size holdings, 4 quintals per acre. In the improved villages the yield per acre for all farms was 18.9 quintals while in the control villages it was 15.7 qtls. per acre. Thus the difference of 3 qtls. per acre for all farms is the same as for local paddy varieties. Interesting enough yields increased only slightly with the size of farm. In fact, the medium size farms were not significantly different from the large farms and in some cases the small farms.

Table 7

Paddy Yields on Sample Farms by Season and Variety, 1970-71[a]

	Improved Villages			Control Villages		
Farm size	Local (Kharif)	Local (Rabi)	HYV (Rabi)	Local (Kharif)	Local (Rabi)	HYV (Rabi)
	- quintals per acre -			- quintals per acre -		
Small	9.8	12.9	17.4	7.0	8.9	13.9
Medium	9.2	14.0	19.5	6.5	9.7	14.9
Large	10.5	13.7	18.9	7.3	11.0	16.1
All Farms	10.0	13.7	18.9	7.1	10.2	15.7

a/ A quintal equals 100 Kgs. or 4.9 bushels.

The yields reported particularly for Rabi may be somewhat lower than were actually obtained. The larger farmers were a little reluctant to give information during the second interview. They were concerned that the state government might find out how much they produced and charge them an income tax. This may explain the lack of relationship between farm size and yield particularly in the improved villages.

Benefits[11]

The net return per acre during Kharif season is the lowest for medium size farms in improved as well as control villages, Rs.229 and Rs.69 respectively, and highest for large size farms, Rs.280 and Rs.119 respectively (see Table 8). During Rabi net returns per acre rise with the size of holding for HYV's as well as improved local varieties in the control villages. But in the improved villages the medium size farms had the highest returns during Rabi. The net returns per acre for all farms

11/ The cost of field channels has not been accounted for in the net return figures.

Table 8

Net Returns on the Sample Farm by Season and Paddy Variety, 1970-71

Farm size	Improved Villages Local (Kharif)	Improved Villages Local (Rabi)	Improved Villages HYV (Rabi)	Control Villages Local (Kharif)	Control Villages Local (Rabi)	Control Villages HYV (Rabi)
	- Rs. per acre -			- Rs. per acre -		
Small	268	408	498	108	160	382
Medium	229	429	586	69	240	395
Large	280	396	564	119	313	488
All Farms	275	410	567	105	259	462

in the improved and controlled villages is lowest in the Kharif season Rs. 275 and Rs.105 respectively and highest for Rabi, Rs.410 and Rs.259 respectively for local varieites. For HYV's the net returns per acre in the improved villages is Rs.567 and in the control villages it is Rs.462. However, the greatest difference in per acre net returns between improved and control villages is Rs.170 during Kharif. For Rabi the differences are Rs.105 for HYV's and Rs.151 for local varieties. The lower difference in the net returns for HYV's is perhaps due to pest and disease problems which is indicated by the relatively high expenditures for plant protection in the improved villages.[12/]

Another indication of the benefits from the water management project is the farmers response to questions about the irrigation system. Ninety percent of the farmers surveyed in the improved villages reported receiving a dependable supply of water, eight-seven percent said they had better

12/ Further analysis will, hopefully, indicate more clearly the reasons for this difference in net returns between seasons and varieties.

water control and an equal number reported better utilization of fertilizer while thirty eight percent said the field channels reduced flooding (see Table 9). Yet substantial diversification of cropping had not occurred but as pointed out earlier this lack of diversification may be partly due to the more dependable water supply.

Table 9

Benefits from the Field Channels in Improved Villages

Farmers Response	Farmers Benefitted Percent
More dependable water supply	90
Better water control	87
Better utilization of fertilizer	87
Reduce flooding	38
Diversification	3

A comparison between the improved and control villages shows that improved villages have less irrigation problems than control villages (see Table 10). Lack of field channels, insufficient water available, undependable water supply, land not leveled and inadequate drainage are all less of a problem in the improved villages. Insufficient water is the most pressing problem because it is the most easily understood by the farmers. While 65 percent of the farmers in improved villages reported no difficulty with their irrigation system, only 25 percent in control villages reported no difficulty.

Table 10

Problems with Irrigation System

Farmer Response	Improved Villages		Control Villages
	-	percent	-
No difficulty	65		25
Lack of field channels	5		50
Inadequate drainage	7		20
Undependable water supply	10		31
Land not leveled	10		28
Insufficient water available	17		66

Cost of Field Channels

The IADP project staff engaged in water management has three responsibilities: (1) installing new systems, (2) repair and maintenance of existing systems and (3) approach and survey of new villages. When the IADP selects a village for the water management project it establishes a 500-1000 acre demonstration. The cultivators are required to dig the channels and the IADP provides the technical guidance and pays for the masonary structures, i.e. hume pipes, road crossings, and drop structures. Every year the field channels need clipping and repairs at the time of puddling. Since the water management team has been divided into three units, they can do three villages at one time and complete them within one year.

The canal authorities provide certain outlets from the water course depending upon the size of the village. The work of the IADP water management team starts from these outlets. The field channels are dug from the outlets one foot deep, one and a third feet at the base and two feet at the top and the costs are based on these specifications. On an average there is approximately one hundred and ten feet of field channels per acre.

Over half the cost of installing field channels is the technical assistance which is an average of Rs.18 per acre (see Table 11). The material and masonary charges are approximately Rs.10 per acre while the cost of labor is only Rs.6 per acre. This makes the total average installation cost per acre Rs.34. These costs will probably drop as the technical staff becomes more experienced and is able to complete more villages within a year. As the benefits from field channels become clearer the staff will not need to spend any time getting villagers interested in the program. In fact, the district already has a demand for technical assistance which exceeds their capacity. Thus less time is needed for the approach and survey of new villages. These factors should lead to a reduced cost per acre such that Rs.30 per acre would be a realistic figure for future planning.

Table 11

Costs and Benefits of Field Channels

Cost of Field Channels	Rs. Per Acre
Cost of administrative and technical staff[a/]	18
Cost of material and masonary inputs[b/]	10
Cost of labor[c/]	6
Total cost	34
Cost of Maintenance of Field Channels	
Cost of administrative and technical staff	2
Cost of material and masonary inputs	2
Cost of labor	2
Total cost	6
Increase in Net Return	
Average return in improved villages	521
Average return in control villages	231
Average difference in net return	290

---

a/ Based on the annual staff salaries listed below and the understanding that the staff can complete about 3 villages or 2,500 acres per year.

Title	Number working	Salary per month per individual
Water Management Specialist	1	Rs.500
Oversears (Engineering)	2	300
Oversears (Agriculture)	2	325
Surveyors	4	250
Ammin	4	150
Fieldman	6	150

(footnotes continued on next page)

b/ The costs of the elements included in the materials are listed below.

Cost of digging and dressing	Rs.3 per cubic foot or Rs.5 per acre
Masonary charges	Rs.8 to Rs.10 per acre
Average cost of a drop structure*	Rs.30 to 40
Average cost of an outlet	Rs.38
The cost of hume pipe	Rs.3.50 per rft

*The cost of drop structures varies with the flow of water, distance from the water outlet and the topography. The cost ranges between Rs.20 and 80.

c/ Digging of the field channels is done by farmers themselves. Per acre cost of digging and maintenance of the field channels is based on information collected during our survey.

Costs and Benefits

Although the difference in net returns between the improved and control villages cannot all be directly attributed to field channels, even ten percent of the difference would cover the costs of installation within two years (see Table 11). If the indirect effects of field channels are included such as the higher use of fertilizers and pesticides and the better utilization of inputs it can be concluded that a high percentage of the difference in returns is due to the field channels. Thus there is no need to calculate the benefit cost ratio to determine that the construction of field channels is a highly profitable activity.

The only important question not answered is how much should be spent on field channels. By spending more per acre less maintenance would be required and the channels would last longer. A more detailed study is needed of alternative systems and their costs to determine what would be the optimum system to install. For example, should some of the field channels be lined or more drop structures used in areas where there are significant changes in topography. With lined channels the maintenance cost of Rs.6 per acre per year could almost be eliminated for the first five years.

Problems and Prospects

The high returns from field channels has interested other villages in the water management project. This is evident from the fact that in 1971 the installation of field channels started in nine villages and other villages were asking for help. Presently the IADP has a total staff of about nineteen people working on the water management project. With this staff the water use and mangement program cannot progress faster than about nine villages a year. At this rate it would take nearly fifty years to cover all the irrigated villages. What is now happening due to the slow progress is that a few farmers are installing field channels on their own. But they lack the technical assistance with the results that field channels are being constructed in a haphazard manner and are of only limited benefit to the farmer and the village. The lack of people technically trained to design and lay out village systems of field channels puts a definite limit on the water management program and the number of systems which can be adequately installed.

Consolidation of holdings is another bottleneck hindering improved water use. A large number of small scattered plots increase the length of field channels required per acre and raise the cost. Further the smaller the plots the more difficult it is to get the farmers to use part for field channels. Once the land is consolidated and land is provided for field channels the task of installing the system becomes easier. Therefore, it is advisable that the plans for installing field channels should be included in any program of land consolidation so that the question of losing land does not arise.

A related problem is the lack of drainage channels. A drainage channel involves considerable earth work because of its size and poses the problem of land acquisition. If land for drainage channels is provided during land consolidation, it will not be difficult to dig the channels once funds are available. In the absence of the drainage channels, water logging of the low Bahal lands will become worse.

The District Agricultural authorities have realized these bottlenecks and have started consolidation work in one village on experimental basis. In this village they are providing land for field channels and drainage channels. There is some resistance especially from the big land holders who fear that the size of their land holdings can be checked because of the consolidation. Another reason for resistance is the topography of the land. A farmer who has Berna land resists exchanging it for Mal land and so on.[13/]

Additional Restraints

Two additional restraints should be mentioned which became clear during the survey. Although other problems exist, inadequate paddy marketing and roads are two which should be of particular concern to the government.

13/ The IADP has from its existing funds started another experiment in Jayantpur village with drainage channels. They have selected an area of ten acres where they are laying out covered drainage channels. The project was started after the 1972 Rabi crop harvest.

Paddy trade in Sambalpur district is almost the monopsony of the Food Corporation of India (FCI). It is the sole procuring agency for paddy and rice.[14/] Export of paddy and rice outside the district by individuals and traders is not allowed beyond 5 quintals of rice or 10 quintals of paddy. FCI has its authorized agents for procuring paddy who appoint their own sub-agents. In addition, all the district rice millers, 20-25 in all, work as FCI agents. FCI has its own Modern Rice Mill near Hirakud Dam with a capacity of 200 tons of rice per day.

FCI has very high and ridged quality standards for paddy procured, from its agents. If the mositure content is above 14 percent or damaged by rains during threshing the paddy is rejected. But the millers buy the damaged paddy at lower prices, and convert it into rice and sell it to FCI. In 1971 FCI didn't accept much of the Rabi paddy due to high moisture content and discoloring. The moisture content was 22-24 percent due to rain during the threshing operations. The millers were buying at 18 percent moisture and somewhat above at discounted prices. Still not much Rabi paddy had been sold by the time of the survey due to the moisture problem.

In addition to the purchase of paddy by agents and their sub-agents there are three regulated markets in the district. Bargarh is the most important among these and it covers 724 villages with 5 sub-yards at

---

14/ Paddy is the rough rice before processing.

different market places in its area of operation. The method of sale of agricultural produce is open auction. The bid price is subject to the approval of the seller, if unsatisfactory the producer can keep the lot for the next days auction. But the millers' agents for FCI act together and bring the prices down to the minimum procurement price level fixed by the state government and thus negate the purpose of open auction. Only the regular participation of the local cooperative marketing societies acts as a check on the millers and creates some competition in the market.

Cooperatives have also been appointed agents of FCI, but their involvement is very restricted because of limited storage capacity. The cooperative has a rice mill but they have been hampered by the negative attitude of FCI towards cooperatives. When FCI sends rice outside the district it does not insure the wagons but it insists that the cooperatives insure any wagons sent outside, which adds to their cost.

In addition to the above there are approximately 200-250 haulers in Sambalpur and FCI has no control over their activities. Small farmers bring in limited quantities of paddy and have it converted to rice. They keep some for home consumption and sell a few bags of rice directly to retailers. This tends to be an important outlet for small farmers due to their small market surplus.

The condition of the link roads is poor and some of the villages are three to five miles from the main road. The dirt link roads become unfit and risky for use in the rainy season. In many cases the agents of FCI and millers don't come to villages and the farmers must carry the marketable paddy to the mandis. During the rains even the trucks refuse to come to the village and it is too costly unless one has a full truck-load. The poor road system works to the particular disadvantage of the smaller farmer who has only a small quantity to sell. Many times they sell at a low price to the large farmers of the village who market enough rice to pay the cost of transportation to the mandis.

Conclusion

The village survey in the irrigated zone of Sambalpur has clearly indicated that field channels offer high returns. The current water use and management program is expanding and changing to meet new problems of land consolidation and drainage. The technical assistance offered by the program will have to continue indefintely but more of the costs should be borne by the farmers. In fact, in the near future IADP should charge each village or farmer a fee for the technical assistance as well as have the farmers pay the full cost of materials. This would allow IADP to expand their services to more villages while the net returns to the farmers from field channels would easily cover any reasonable fee.

Water management is not the only restraint facing the area. Marketing and roads pose problems which need to be solved. If farmers can't move their rice to the market or get a fair price for it then there is no incentive to increase production. This appears to be a particularly severe problem with the small farmers. All weather link roads would help with the transportation problem. A relaxation of FCI rules to allow more free trading and permission to sell the produce outside the district would help improve the prices received by farmers. However, to help the small farmers additional assistance will be required because of the relatively small quantities they have to sell.

Appendix Table 1

Yields, Input Use and Net Returns from Local Varieties, Kharif Season, 1970-71

Farm size	Yield in quintals[a]	Human labor days	Bullock labor days	Plant protection Rs.	Chemical fertilizers & manures Rs.	Working expenditure Rs.	Gross returns Rs.	Net returns Rs.
		----	----	----	per acre	----	----	----
Improved Villages								
Small	9.8	44.9	6.4	4.6	90.2	261.6	529.7	268.2
Medium	9.2	47.3	6.9	5.0	86.8	268.1	496.8	228.7
Large	10.5	47.4	7.2	8.9	97.4	284.6	564.8	280.3
All Farms	10.0	47.0	7.1	6.3	87.3	264.8	540.0	275.2
Control Villages								
Small	7.0	53.6	7.3	0.5	73.1	270.7	379.1	108.4
Medium	6.5	52.8	8.0	3.6	82.2	284.0	352.6	68.6
Large	7.3	49.5	7.3	4.2	87.4	276.3	395.3	119.0
All Farms	7.1	50.8	7.5	3.6	84.2	277.6	382.3	104.7

a/ One quintal equals 100 Kgs.

Appendix Table 2

Yields, Input Use and Net Returns from Local Varieties, Rabi Season, 1970-71

Farm size	Yield in quintals[a/]	Human labor days	Bullock labor days	Plant protection Rs.	Chemical fertilizers & manures Rs.	Working expenditure Rs.	Gross returns Rs.	Net returns Rs.
		---- per acre ----						
Improved Villages								
Small	12.9	37.6	8.8	0.7	104.3	261.7	669.2	407.6
Medium	14.0	40.8	9.1	0.0	128.3	296.2	725.4	429.2
Large	13.7	43.6	8.0	3.6	140.0	314.3	709.8	395.5
All Farms	13.7	41.8	8.5	2.0	130.6	300.5	710.3	409.8
Control Villages								
Small	8.9	43.7	11.2	0.0	115.1	303.4	463.3	159.9
Medium	9.7	42.7	9.6	1.7	88.4	265.8	506.0	240.2
Large	11.0	37.8	8.0	2.1	103.3	258.8	571.5	312.7
All Farms	10.2	40.4	10.1	1.7	99.2	272.8	532.0	259.2

a/ One quintal equals 100 Kgs.

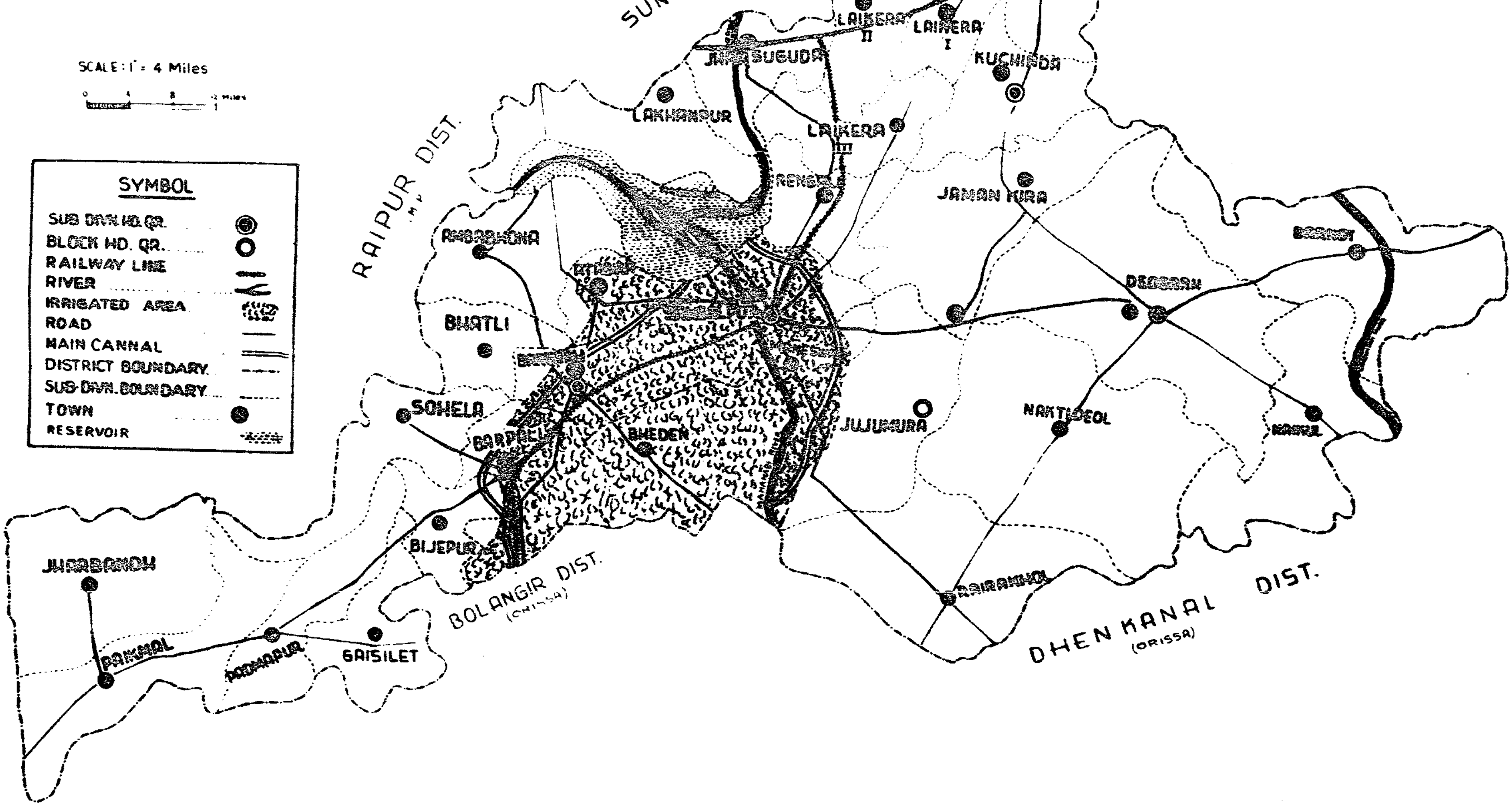
Appendix Table 3

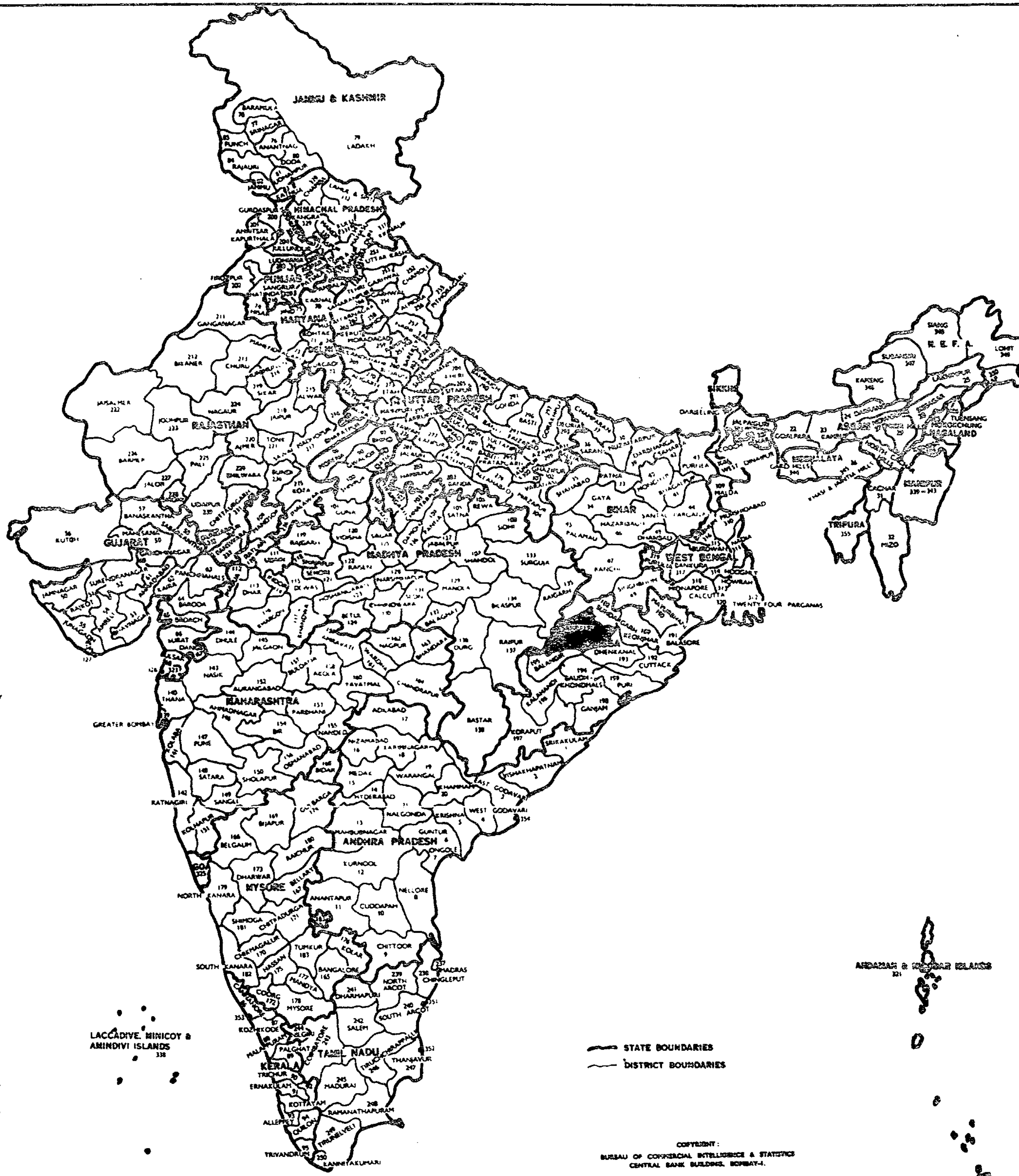
Yields, Input Use and Net Returns from HYV's, Rabi Season, 1970-71

Farm size	Yield in quintals[a]	Human labor in days	Bullock labor in days	Plant protection Rs.	Chemical fertilizers & manures Rs.	Working expenditure Rs.	Gross return Rs.	Net returns Rs.
		per acre						
Improved Villages								
Small	17.4	48.7	11.2	7.1	162.7	372.0	870.0	498.0
Medium	19.5	47.0	11.8	10.6	178.1	388.7	974.5	585.8
Large	18.9	41.8	9.2	17.5	189.2	378.1	942.5	564.4
All Farms	18.9	43.5	9.7	15.2	184.9	379.0	946.0	567.0
Control Villages								
Small	13.9	45.4	11.5	1.0	117.7	312.5	694.0	381.5
Medium	14.9	47.8	11.4	5.2	143.8	349.0	744.0	395.0
Large	16.1	38.0	8.8	7.9	148.5	314.1	802.5	488.4
All Farms	15.7	40.5	9.5	6.6	143.7	322.5	784.0	461.5

a/ One quintal equals 100 Kgs.

SAMBALPUR DISTRICT





ANDHRA PRADESH

1 SRIKAKULAM
2 VISAKHAPATNAM
3 EAST GODAVARI
4 WEST GODAVARI
5 KRISHNA
6 GUNTUR
7 ONGOLE
8 NELLORE
9 CHITTOOR
10 CUDDAPAH
11 ANANTAPUR
12 KURNOOL
13 MAHBUBNAGAR
14 HYDERABAD
15 MEDAK
16 NIZAMABAD
17 ADILABAD
18 KARIMNAGAR
19 WARANGAL
20 KHAMMAM
21 NALGONDA

ASSAM

22 GOALPARA
23 KAMRUP
24 DARRANG
25 LAKHIMPUR
26 SHILLONG
27 NOWGONG
28 SIBSAGAR
29 MIKIR HILLS
30 NORTH CACHAR HILLS
31 CACHAR
32 MIZO

BIHAR

33 PATNA
34 GAYA
35 SHAHABAD
36 SARAN
37 CHAMPARAN
38 MUZAFFARPUR
39 DARBHANGA
40 MONGHYR
41 BHAGALPUR
42 SAHARSA
43 PURNEA
44 SANTAL PARGANAS
45 PALAMAU
46 HAZARIBAGH
47 RANCHI
48 DHANBAD
49 SINGHBHUM

GUJARAT

50 JAMNAGAR
51 RAJKOT
52 SURENDRANAGAR
53 BHAVNAGAR
54 AMRELI
55 JUNAGADH
56 KUTCH
57 BANASKANTHA
58 SABARKANTHA
59 MAHESANA
60 GANDHINAGAR
61 AHMADABAD
62 KAIRA (KHEDA)
63 PANCHMAHALS
64 BARODA (VADODARA)
65 BROACH (BHARUCH)
66 SURAT
67 DANGS
68 BULSAR (VALSAD)

HARYANA

69 AMBALA
70 KARNAL
71 ROHTAK
72 GURGAON
73 MAHENDRAGARH
74 HISAR
75 JIND

JAMMU & KASHMIR

76 ANANTNAG
77 SRINAGAR
78 BARAMULA
79 LADAKH
80 DODA
81 UDHAMPUR
82 JAMMU
83 KATHUA
84 RAJAURI
85 PUNCH

KERALA

86 CANNANORE
87 KOZHIKODE
88 MALAPPURAM
89 PALGHAT
90 TRICHUR
91 ERNAKULAM
92 KOTTAYAM
93 ALLEPPEY
94 QUILON
95 TRIVANDRUM

MADHYA PRADESH

96 MORENA
97 BHIND
98 GWALIOR
99 DATIA
100 SHIVPURI
101 GUNA
102 TIKAMGARH
103 CHHATARPUR
104 PANNA
(CONTINUED)

(CONTINUED)
105 SATNA
106 REWA
107 SHAHDOL
108 SIDHI
109 MANDSOR
110 RATLAM
111 UJJAIN
112 JHABUA
113 DHAR
114 INDORE
115 DEWAS
116 KHARGONE
117 KHANDWA
118 SHAJAPUR
119 RAJGARH
120 VIDISHA
121 SEHORE
122 RAISEN
123 HOSHANGABAD
124 BETUL
125 SAGAR
126 DAMOH
127 JABALPUR
128 NARSIMHAPUR
129 MANDLA
130 CHHINDWARA
131 SEONI
132 BALAGHAT
133 SURGUJA
134 BILASPUR
135 RAIGARH
136 DURG
137 RAIPUR
138 BASTAR

MAHARASHTRA

139 GREATER BOMBAY
140 THANA
141 KOLABA
142 RATNAGIRI
143 NASIK
144 DHULE
145 JALGAON
146 AHMADNAGAR
147 PUNE
148 SATARA
149 SANGLI
150 SHOLAPUR
151 KOLHAPUR
152 AURANGABAD
153 PARBHANI
154 BIR
155 NANDED
156 OSMANABAD
157 BULDANA
158 AKOLA
159 AMRAVATI
160 YAVATMAL
161 WARDHA
162 NAGPUR
163 BHANDARA
164 CHANDRAPUR

MYSORE

165 BANGALORE
166 BELGAUM
167 BELLARY
168 BIDAR
169 BIJAPUR
170 CHIKMAGALUR
171 CHITRADURGA
172 COORG
173 DHARWAR
174 GULBARGA
175 HASSAN
176 KOLAR
177 MANDYA
178 MYSORE
179 NORTH KANARA
180 RAICHUR
181 SHIMOGA
182 SOUTH KANARA
183 TUMKUR

NAGALAND

184 KOHIMA
185 MOKOKCHUNG
186 TUENSANG

ORISSA

187 SAMBALPUR
188 SUNDARGARH
189 KEONJHAR
190 MAYURBHANJ
191 BALASORE
192 CUTTACK
193 DHENKANAL
194 BAUDH - KHONDMALS
195 BALANGIR
196 KALAHANDI
197 KORAPUT
198 GANJAM
199 PURI

PUNJAB

200 GURDASPUR
201 AMRITSAR
202 FIROZPUR
203 LUDHIANA
204 JULLUNDUR
205 KAPURTHALA
206 HOSHIARPUR
207 ROPAR
208 PATIALA
209 SANGRUR
210 BHATINDA

RAJASTHAN

211 GANGANAGAR
212 BIKANER
213 CHURU
214 JHUNJHUNUN
215 ALWAR
216 BHARATPUR
217 SAWAI MADHOPUR
218 JAIPUR
219 SIKAR
220 AJMER
221 TONK
222 JAISALMER
223 JODHPUR
224 NAGAUR
225 PALI
226 BARMER
227 JALOR
228 SIROHI
229 BHILWARA
230 UDAIPUR
231 CHITTAURGARH
232 DUNGARPUR
233 BANSWARA
234 BUNDI
235 KOTA
236 JHALAWAR

TAMIL NADU

237 MADRAS
238 CHINGLEPUT
239 NORTH ARCOT
240 SOUTH ARCOT
241 DHARMAPURI
242 SALEM
243 COIMBATORE
244 NILGIRI
245 MADURAI
246 TIRUCHCHIRAPPALLI
247 THANJAVUR
248 RAMANATHAPURAM
249 TIRUNELVELI
250 KANNIYAKUMARI

UTTAR PRADESH

251 UTTAR KASHI
252 CHAMOLI
253 TEHRI GARHWAL
254 GARHWAL
255 PITHORAGARH
256 ALMORA
257 NAINI TAL
258 BIJNOR
259 MORADABAD
260 BUDAUN
261 RAMPUR
(CONTINUED)

(CONTINUED)
262 BAREILLY
263 PILIBHIT
264 SHAHJAHANPUR
265 DEHRA DUN
266 SAHARANPUR
267 MUZAFFARNAGAR
268 MEERUT
269 BULANDSHAHR
270 ALIGARH
271 MATHURA
272 AGRA
273 ETAH
274 MAINPURI
275 FARRUKHABAD
276 ETAWAH
277 KANPUR
278 FATEHPUR
279 ALLAHABAD
280 JHANSI
281 JALAUN
282 HAMIRPUR
283 BANDA
284 KHERI
285 SITAPUR
286 HARDOI
287 UNNAO
288 LUCKNOW
289 RAE BARELI
290 BAHRAICH
291 GONDA
292 BARA BANKI
293 FAIZABAD
294 SULTANPUR
295 PRATAPGARH
296 BASTI
297 GORAKHPUR
298 DEORIA
299 AZAMGARH
300 JAUNPUR
301 BALLIA
302 GHAZIPUR
303 VARANASI
304 MIRZAPUR

WEST BENGAL

305 DARJEELING
306 JALPAIGURI
307 COOCH BEHAR
308 WEST DINAJPUR
309 MALDA
310 MURSHIDABAD
311 NADIA
312 TWENTY FOUR PARGANAS
313 HOWRAH
314 HOOGHLY
315 BURDWAN
316 BIRBHUM
317 BANKURA
318 MIDNAPORE
319 PURULIA
320 CALCUTTA

UNION TERRITORIES

321 ANDAMAN ISLANDS
322 CHANDIGARH
323 DADRA & NAGAR HAVELI
324 DELHI

GOA

325 GOA
326 DAMAN
327 DIU

HIMACHAL PRADESH

328 CHAMBA
329 KANGRA
330 MANDI
331 KULU
332 LAHUL & SPITI
333 BILASPUR
334 MAHASU
335 SIMLA
336 SIRMAUR
337 KINNAUR

338 **LACCADIVE ISLANDS**

MANIPUR

339 MANIPUR NORTH
340 MANIPUR WEST
341 MANIPUR SOUTH
342 MANIPUR CENTRAL
343 MANIPUR EAST

MEGHALAYA

344 GARO HILLS
345 KHASI & JAINTIA HILLS

N. E. F. A.

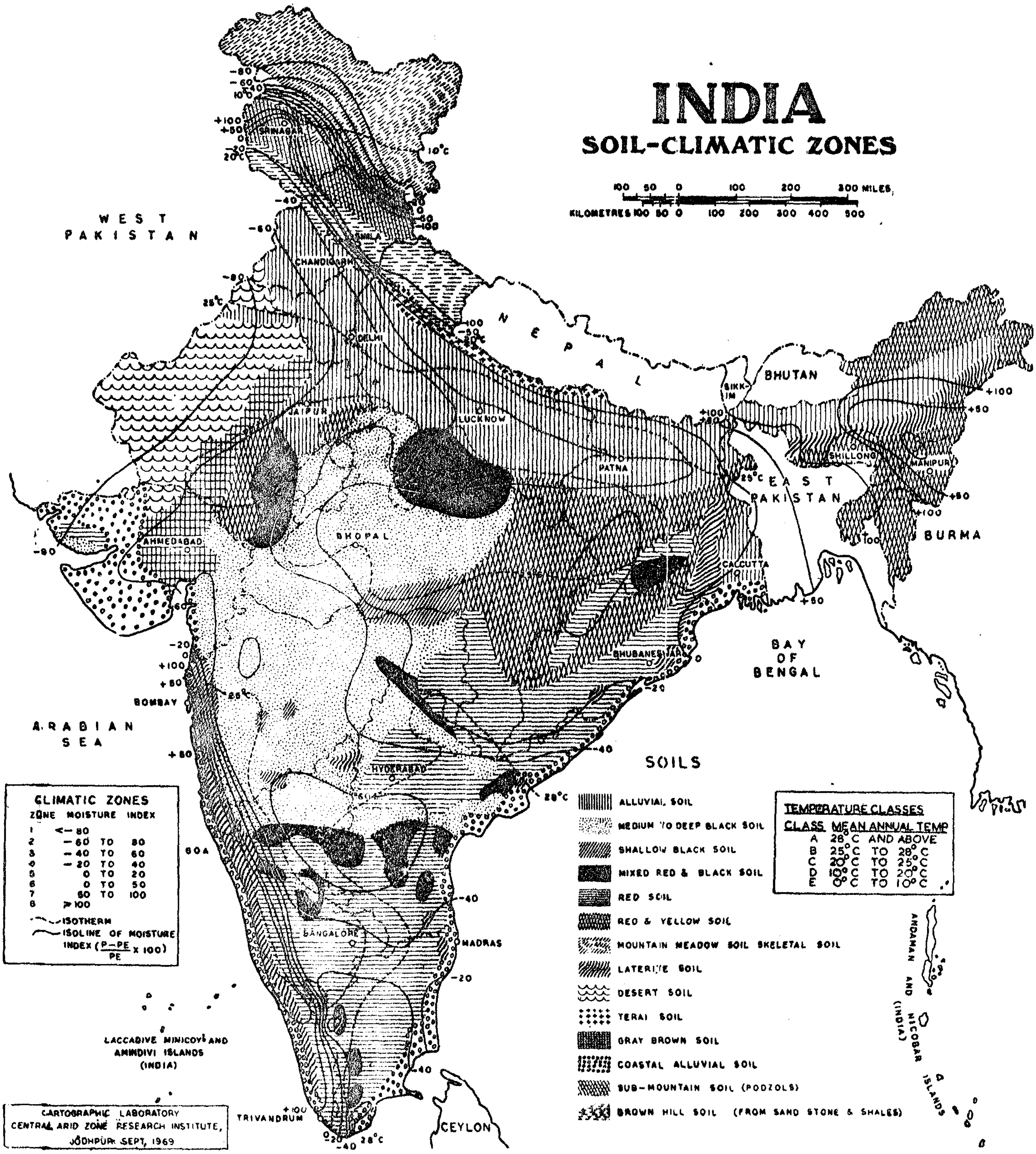
346 KAMENG
347 SUBANSIRI
348 SIANG
349 LOHIT
350 TIRAP

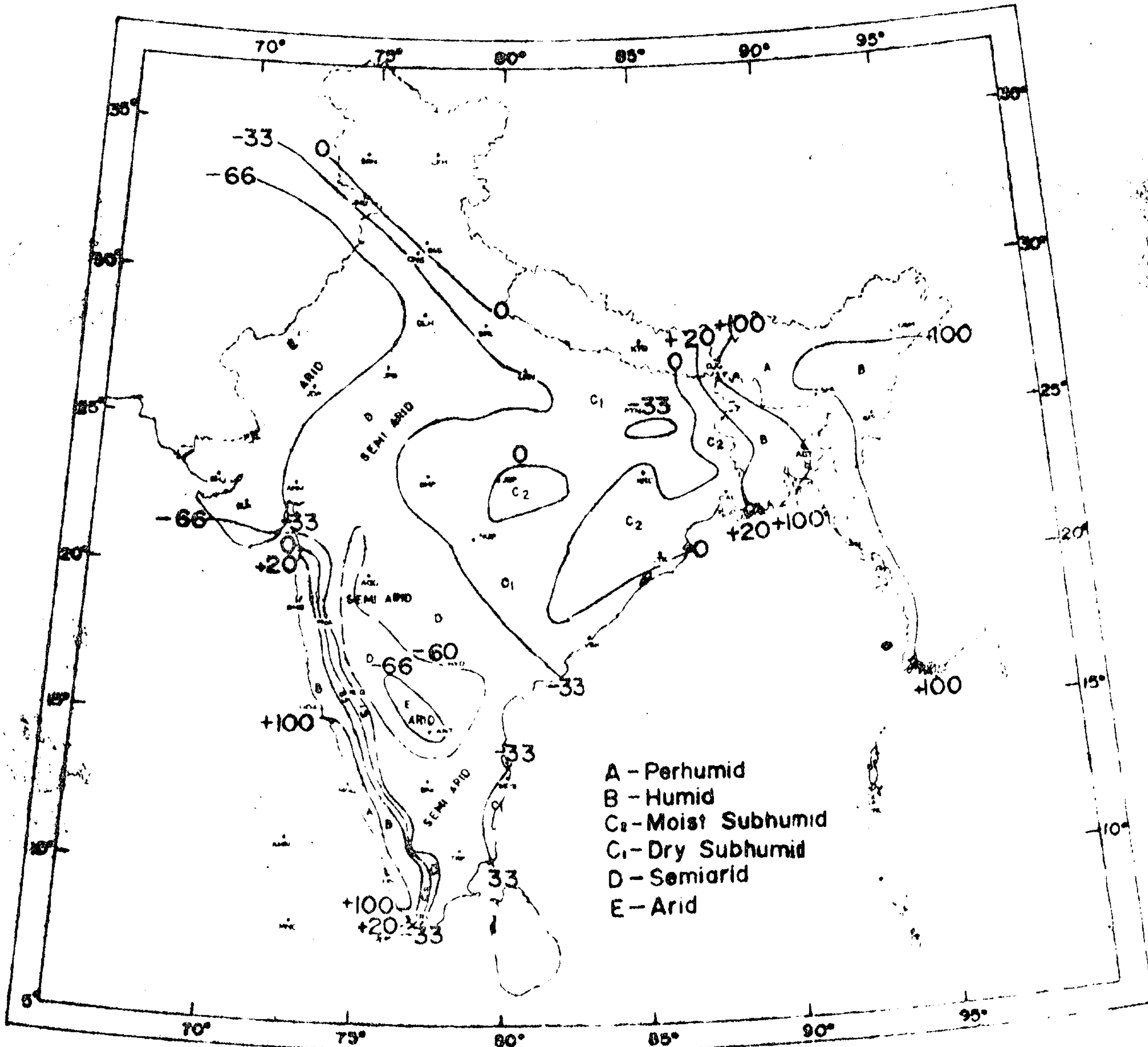
PONDICHERRY

351 PONDICHERRY
352 KARAIKAL
353 MAHE
354 YANAM

TRIPURA

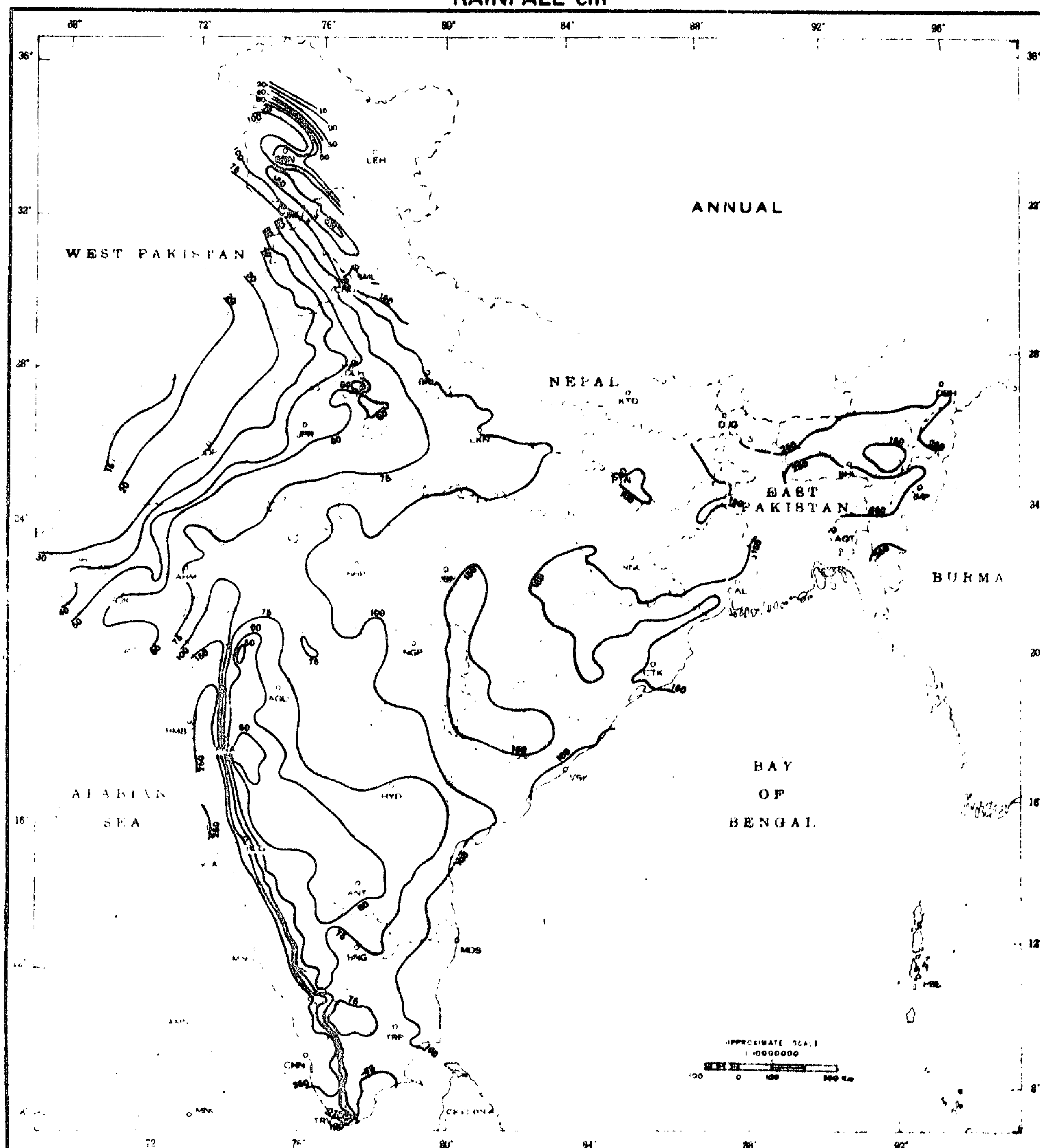
355 TRIPURA


INDIA
SOIL-CLIMATIC ZONES
100 50 0 100 200 300 MILES
KILOMETRES 100 50 0 100 200 300 400 500
WEST PAKISTAN
NEPAL
BHUTAN
SIKKIM
EAST PAKISTAN
BURMA
BAY OF BENGAL
ARABIAN SEA
CEYLON
SRINAGAR
SIMLA
CHANDIGARH
DELHI
JAIPUR
LUCKNOW
PATNA
SHILLONG
MANIPUR
CALCUTTA
AHMEDABAD
BHOPAL
BHUBANESWAR
BOMBAY
HYDERABAD
GOA
BANGALORE
MADRAS
TRIVANDRUM
LACCADIVE MINICOY AND AMINDIVI ISLANDS (INDIA)
ANDAMAN AND NICOBAR ISLANDS (INDIA)
CLIMATIC ZONES
ZONE MOISTURE INDEX
1 <-80
2 -60 TO 80
3 -40 TO 60
4 -20 TO 40
5 0 TO 20
6 0 TO 50
7 50 TO 100
8 >100
ISOTHERM
ISOLINE OF MOISTURE INDEX ((P-PE)/PE x 100)
SOILS
ALLUVIAL SOIL
MEDIUM TO DEEP BLACK SOIL
SHALLOW BLACK SOIL
MIXED RED & BLACK SOIL
RED SOIL
RED & YELLOW SOIL
MOUNTAIN MEADOW SOIL SKELETAL SOIL
LATERITE SOIL
DESERT SOIL
TERAI SOIL
GRAY BROWN SOIL
COASTAL ALLUVIAL SOIL
SUB-MOUNTAIN SOIL (PODZOLS)
BROWN HILL SOIL (FROM SAND STONE & SHALES)
TEMPERATURE CLASSES
CLASS MEAN ANNUAL TEMP
A 28°C AND ABOVE
B 25°C TO 28°C
C 20°C TO 25°C
D 10°C TO 20°C
E 0°C TO 10°C
CARTOGRAPHIC LABORATORY
CENTRAL ARID ZONE RESEARCH INSTITUTE,
JODHPUR SEPT, 1969



Classification of climate (Thornthwaite)
(Isopleths - moisture index value %)

RAINFALL cm


ANNUAL
WEST PAKISTAN
NEPAL
EAST PAKISTAN
BURMA
BAY
OF
BENGAL
SEA
LEH
SML
JPR
LKN
PTN
KTM
DJG
SHL
IMP
AGT
CAL
AHM
NGP
CTK
HYD
VSK
ANT
MDS
BNG
TRP
CHN
TRV
MNK
CEYLON
APPROXIMATE SCALE
1:10000000