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Inequality in Irrigation Distribution in Pakistan

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This paper provides estimates of the level of inequality in the distribution of land and other irrigation-related land variables among agricultural households, across farm size groups both at the national and provincial levels, at a point in time as well as over a period of time; it decomposes the levels of inequality in terms of its two components, namely, "within province" and "between provinces" inequality; and it estimates the relative performance of the four provinces in achieving equity in irrigation distribution. In doing this analysis, the paper makes use of the agricultural census reports pertaining to the years 1959-60, 1971-1972, and 1979-1980. The paper's major results are that there exists considerable intra- and interprovincial inequality in Pakistan. Of the two major contributors to the overall inequality in the country as a whole, the within-province inequality component contributes more than 90 percent of the total inequality. The paper identifies the two main reasons for the high within-province inequality as being (1) the very highly skewed distribution of land across cultivating households and (2) the lack of regressivity in the distribution of irrigation across farm size groups, especially that of government-controlled canal irrigation. The paper recommends a lexicographic ordering of canal irrigation distribution, under which irrigation water will be provided first to irrigate all the irrigable land of the smallest of farms, and after fulfilling their demands, it will fulfil the demands of the second smallest farm size group, and so on.

1. INTRODUCTION

Pakistan is predominantly a rural country with a majority of people still deriving their livelihood from agriculture and other related activities. The country mostly has an arid climate. While the annual evaporation averages about 152 centimeters in the northern regions, and about 190 centimeters in the south, annual precipitations are just 50 centimeters in the north and a negligible 7.5 centimeters in the south. Thus, irrigation is the life-blood of agriculture in Pakistan. Without irrigation, there would be virtually no agriculture [Merry and Wolf (1986); Government of Pakistan (1988)].

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Irrigation paves the way for the adoption of high-yielding crop varieties and, ultimately, for the alleviation of poverty in the country. In a study of India's agricultural development during 1954 – 1985, Seckler and Sampath (1985) concluded: "The green revolution in India is not just biochemical technology, it is mainly the application of this technology to irrigated land." In the case of Pakistan, Dilawar (1982) quoted a study conducted by Falcon and Gotsch, which found that of the annual crop production growth rate of 4.9 percent during the sixties, 2.7 percent was to be attributed to irrigation, 1.0 percent to fertilizer, and the remaining 1.2 percent to other factors.

Irrigation not only helps improve agricultural production, but also plays an important role in poverty reduction both directly and indirectly. Directly, it helps by increasing agricultural production and productivity, especially that of foodgrains, which in turn helps in eradicating the problems of malnutrition by making food available to the rural poor at affordable prices. Indirectly, irrigation helps in increasing the employment of underemployed landless labourers and small and marginal farmers through its positive impact on cropping intensity and agricultural productivity; the increased employment, in turn, puts more purchasing power into the pockets of the poor. Thus, because of its critical role in determining the level of agricultural production and productivity, it is imperative to know how this critical input is distributed among farmers. Further, the nature of irrigation distribution will also determine the direction and level of impacts it will create on the reduction of inequality and the eradication of poverty and malnutrition in the rural areas. As O'Mara (1988) notes: "In an arid or semi-arid environment, however, water is the factor input that determines the scale and intensity of agricultural production" and "thus, control over water is equivalent to control over income and wealth". As such too much inequality in its distribution would lead to severely straining social and economic relationships among farmers.

Recognizing the importance of irrigation development for solving several of its economic problems, the government of Pakistan has made massive investments in the construction of dams, link canals, public tubewells, and other water-related projects to enhance the water availability at farm gate. At present the irrigation system is comprised of three dams (Chashma, Mangla, and Tarbela), 16 barrages, 12 inter-basin link canals, two siphons, and 43 main canals. For the establishment and maintenance of this system, the government has spent billions of dollars from domestic and foreign sources, provided by the World Bank and other donor countries and agencies [Government of Pakistan (1988)]. These development efforts have made possible the substantial progress in increasing water availability to Pakistan's agriculture. In 1960-61, a total of 52.52 million acre feet (MAF) of water was available. This has gone up to 112.22 MAF in 1987-88. In terms of delivery, the water availability has gone up from 2.04 feet to 2.57 feet per irrigated acre [Government of Pakistan (1988)]. In 1987-88, of the total irrigated area of 17 million hectares, 71.5 percent (12.15 m.ha.) was canal-irrigated and 22.4 percent (3.81 m.ha.) was tubewell-irrigated. The rest, 6 percent of the area (1.04 m.ha.), was under irrigation by tanks, wells, and other sources.

The irrigation system of Pakistan is based on the Indus river and its tributaries, and constitutes the largest integrated irrigation system in the world today. It provides irrigation to about 17 million hectares out of a total of about 20 million hectares of cultivated land in the Indus basin. The system is designed to spread the existing supplies of water at the minimum possible cost to the largest number of cultivators in the settled canal command areas. The irrigation system is basically supply-based and not demand-based, catering to the changing crop water requirements during a particular season or time. This leaves the farmer with no option but to adjust his cropping pattern to the available supply. This practice has led to both over- and under-irrigation, resulting in the problems of water-logging, salinity, inefficient application, and inequity in the distribution of water [Badruddin (1987); Merry and Wolf (1986) and Government of Pakistan (1988)].

The present distribution system of irrigation water in Pakistan is highly centralized. Reservoirs are controlled by the federal Government. The provincial irrigation departments of the respective four provinces of Pakistan, namely, Balochistan, North West Frontier Province (hereafter referred to as the NWFP), the Punjab, and Sindh, receive water from dams and reservoirs and carry their water through a system of canals, branch canals, minors, and distributories to the water courses. From the watercourse/outlet onward, it is the responsibility of the farmer to carry water to his fields in sequence through water channels and ditches. The distribution beyond the outlet is based on the principle set by the British at the time of their rule, and is still in operation. Under the current system, each farmer can claim water in proportion to the size of his operational holding in the command area. From the water channel, the farmers get water by rotation on a weekly basis. Each farmer is allotted a period of time during the week to draw water from the watercourse adjacent to his field.

2. THE OBJECTIVES

The major objectives of this paper are:

2.1. To provide estimates of the level of inequality in the distribution of land and other irrigation-related land variables among agricultural households, across farm-size groups both at the national and provincial levels, at a point in time as well as over a period of time.

2.2. To decompose the levels of inequality in terms of its two major components, namely, "within province" inequality and "between provinces" inequality.

2.3. To estimate the relative performance of the four provinces in achieving equity in irrigation distribution.

3. THEIL'S INFORMATION THEORETIC INEQUALITY MEASURE

For the purpose of our study, we follow the methodology used by Sampath (1990, 1990a and 1990b) in analyzing the problems of inequality in irrigation distribution. He discussed in some detail the empirical and conceptual problems involved in determining practical measures of inequality in irrigation distribution. In that context, he argued that for a measure to be measurable (quantifiable), comparable (consistent), and useful (that it incorporates certain value judgements or norms that have been accepted generally by the government or the irrigation management authorities as reflecting properly the ethical judgements with regard to equity in irrigation distribution, to be satisfied by the irrigation distribution policy or goal), it needs to satisfy certain axioms. Among the measures discussed in the literature, only Theil's information theoretic measure [Theil (1967)] is the one that fulfils all relevant axioms, in addition to being easily amenable to decomposition analysis, which is important if we want to decompose the overall inequality in the country as a whole in terms of its constituent parts. [For a detailed theoretical discussion on the axioms, see Cowell (1977), and for its relevance in the context of irrigation distribution, see Sampath (1990b).]

For our purpose, given the grouped data we have for Pakistan, Theil's information theoretic measure is defined as:

$$T_1(y:x) = \sum_{i=1}^{n} y_i \log \frac{y_i}{x_i} \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad (1)$$

and

$$T_2(x:y) = \sum_{i=1}^{n} x_i \log \frac{x_i}{y_i} \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad (2)$$

Where,

x_i = Cultivating households in *i*th farm-size class as a proportion of the total cultivating households; and

y_i = Irrigation (or any other attribute) share of the *i*th farm-size class, as a proportion of the total.

As can be easily seen, the above two variants are analogous. The only difference is in terms of the weighting of the within-set inequalities. Since our interest is in showing the extent of inequality in irrigation distribution across cultivating households, it makes sense to use T_2 instead of T_1 and that is what we have done in our study. Theil's measure is interpreted as the expected information content of the indirect message that transforms the irrigation shares as prior probabilities into household shares as posterior probabilities. When per household irrigated areas in all farm-size groups are equal, it takes a value of zero. Its extreme value is log n, the number of households that corresponds to a situation where one household receives all irrigation and no others do; where equivalent proportions receive corresponding irrigation shares (in terms of irrigated area), the measure is identical regardless of the absolute number of households. It is worth noting here that the estimates given by the above formulae are lower bounds since they are based on grouped data. We can make use of the grouped data only if we assume that within each size class every household receives the size class average value, which in reality may not be so.

As we noted earlier, another principal attraction of Theil measure's is its convenient aggregation property. The aggregation procedure involved is as follows:

We write Sg, $g = 1 \cdots G$ $(=4)$ for the gth province, X_g = gth province's household share, Y_g = gth province's irrigation share.

$$X_g = \sum_{i \varepsilon s_g} x_i; \quad Y_g = \sum_{i \varepsilon s_g} y_i \quad g = 1 \ldots G$$

We write x_i for the ith farm-size class household population share of gth province and y_i for ith conditional irrigation share and

$$p_i = \frac{x_i}{X_g} \; ; n_i = \frac{y_i}{Y_g} \quad i \varepsilon s_g \, , g = 1 \ldots G$$

Then, the inequality decomposition can be written as follows:

$$I(x:y) = I_o(x:y) + \sum_{g=1}^{G} X_g \, I_g(x:y) \qquad \ldots \quad \ldots \quad \ldots \quad \ldots \qquad (3)$$

Where $I_o(x:y)$ is the between-province inequality and $I_g(x:y)$ the inequality within-province.

$$I_o(x:y) = \sum_{g=1}^{G} X_g \log \frac{X_g}{Y_g} \qquad \ldots \quad \ldots \quad \ldots \quad \ldots \qquad (4)$$

$$I_g(x:y) = \sum_{i \varepsilon s_g} p_i \log \frac{p_i}{n_i} \; ; g = 1 \ldots G \qquad \ldots \quad \ldots \quad \ldots \quad \ldots \qquad (5)$$

4. THE DATA SOURCES

The farm size-wise/province-wise cross-section data of Pakistan come from the three agricultural censuses conducted by the Agricultural Census Organization of the Government of Pakistan in the years 1959-1960, 1971-72, and 1979-1980. These publications present farm size-wise data both at national and provincial levels. The other supporting statistics are taken from the Government of Pakistan publications mentioned in the references.

5. THE SOURCES OF IRRIGATION AND THEIR PROVINCIAL DISTRIBUTION

Information collected from different publications of the Government of Pakistan about cultivated and irrigated areas according to the sources of irrigation for the two census years 1971-72 and 1979-80 is presented in Table 1, from which we can make the following observations:

5.1. Of the total cultivated areas of 19.09 and 20.23 million hectares, 12.99 and 14.74 million hectares were irrigated in the census years 1971-72 and 1979-80, respectively. In other words, about 68 percent and 73 percent of the cultivated area in Pakistan was irrigated in those two years, respectively.

5.2. There exists considerable regional inequality, which is evident from the fact that in 1979-1980 as much as 90 percent of the cultivated area is irrigated in the Punjab versus only 36 percent for the NWFP. That this in-gap has widened over time is also evident from the fact that while the Punjab's proportion of the cultivated area irrigated has gone up from 83 percent in 1971-72 to 90 percent in 1979-80, the NWFP's has gone down slightly from 40.1 percent to 35.7 percent. During the 1971-1980 period, while the Punjab's irrigated area went up from 9.18 m.ha. to 10.34 m.ha., registering an increase of 12.6 percent, it went up by 10.4 percent for Balochistan, 7.7 percent for the NWFP, 18.3 percent for Sindh, and 13.5 percent for Pakistan as a whole. Thus, Sindh and the Punjab were the chief beneficiaries of irrigation development during the 1970s.

5.3. In terms of the physical sources of irrigation, namely, canals and tanks (surface water sources), and tubewells and wells (groundwater), we find that of the total irrigated area, 74 percent in 1971-72 and 73 percent in 1979-80 received irrigation from canals, showing virtually no change in the importance of canals as the major source of irrigation in Pakistan. Wells and tubewells provided irrigation to 21 percent of the total irrigated area, with no change in their contribution between the years 1971-72 and 1979-80. The rest of the sources provided irrigation to the remaining 5-6 percent of the irrigated area. Between tubewells and wells, while the importance of tubewells increased during this period, that of wells declined. Thus, for Pakistan as a whole, canals and tubewells provided irrigation to 90 percent and

Table 1

The Irrigated Cultivated Area by Different Sources in 1971-1972 and 1979-1980

Province	CAT	ICAT	CANALS GOVT	CANALS PRVT.	TUBE-WELLS	WELLS	TANKS	OTHERS
Irrigated Cultivated Area (in M.HA.) by Different Sources (1971-72)								
Balochistan	1.18	0.48	0.15	0.10	0.02			0.21
NWFP	1.62	0.65	0.28	0.27	0.03	0.04		0.03
Punjab	11.04	9.18	6.40	0.01	1.98	0.60	0.01	0.18
Sindh	5.25	2.68	2.36		0.07	0.03		0.22
Pakistan	19.09	12.99	9.19	0.38	2.10	0.67	0.01	0.64
Percentage Distribution of the Total across Provinces								
Balochistan	6.20	3.70	1.60	26.30	1.00	32.80		
NWFP	8.50	5.00	3.10	71.10	1.40	6.00		4.70
Punjab	57.80	70.70	69.70	2.60	94.30	89.50	100	28.10
Sindh	27.50	20.60	25.70	3.30	4.50	34.40		
Pakistan	100	100	100	100	100	100	100	100
Percentage Distribution of ICAT across Different Irrigation Sources								
	ICAT/CAT							
Balochistan	40.70	100	31.20	20.80	4.20		43.80	
NWFP	40.10	100	43.10	41.50	4.60	6.20		4.60
Punjab	83.20	100	69.70	0.10	21.60	6.50	0.10	2.00
Sindh	51.10	100	88.10	2.60	1.10		8.20	
Pakistan	68.10	100	70.70	2.90	16.20	5.20	0.10	4.90
Irrigated Cultivated Area (M.HA.) by Different Sources (1979-80)								
Balochistan	1.40	0.53	0.34	0.04	0.04	0.02	0.09	
NWFP	1.96	0.70	0.29	0.30	0.02	0.04	0.05	
Punjab	11.45	10.34	7.19	0.01	2.62	0.27	0.05	0.20

Continued –

Table 1 – (*Continued*)

Province	CAT	ICAT	CANALS GOVT	CANALS PRVT.	TUBE-WELLS	WELLS	TANKS	OTHERS
Sindh	5.42	3.17	2.57	0.06	0.01	0.53		
Pakistan	20.23	14.74	10.39	0.35	2.74	0.34	0.05	0.87
Percentage Distribution of the Total across Provinces								
Balochistan	6.90	3.60	3.30	11.40	1.50	5.90	10.30	
NWFP	9.70	4.70	2.80	85.70	0.70	11.80		5.80
Punjab	56.60	70.20	69.20	2.90	95.60	79.40	100	23.00
Sindh	26.80	21.50	24.70		2.20	2.90		60.90
Pakistan	100	100	100	100	100	100	100	100
Percentage Distribution of ICAT across Different Irrigation Sources								
	ICAT/CAT							
Balochistan	37.90	100	64.20	7.50	7.50	3.80	17.00	
NWFP	35.70	100	41.40	42.90	2.90	5.70		7.10
Punjab	90.30	100	69.60	0.10	25.30	2.60	0.50	1.90
Sindh	58.50	100	81.10	1.90	0.30	16.70		
Pakistan	72.90	100	70.50	2.40	18.60	2.30	0.30	5.90
Percentage Change from 1971-72 to 1979-80								
Balochistan	18.60	10.40	126.70	–60.00	100		–57.10	
NWFP	21.00	7.70	3.60	11.10	–33.30		66.70	
Punjab	3.70	12.60	12.30		32.30	–55.00	400	11.11
Sindh	3.20	18.30	8.90		–14.30	–66.70	141	
Pakistan	6.00	13.50	13.10	–7.90	30.50	49.30	400	35.90

CAT = Cultivated Area Total.
ICAT = Irrigated Cultivated Area Total.
NWFP = North West Frontier Province.
M.HA. = Million Hectares.

91.5 percent of the irrigated area in the years 1971-72 and 1979-80, respectively. Of the total increase of 1.75 m.ha. in the irrigated area over 1971–1980, 1.17 m.ha. and 0.64 m.ha. came respectively from canals and tubewells for a total of 1.81. In other words, they not only provided for the entire increase in the irrigated area but also compensated for the decline in the irrigated area due to negative growth in the well-and tank-irrigated areas.

The considerable interregional differences and inequalities of importance and distribution of the two physical sources of irrigation are evident from the fact that while for the Punjab the contribution of tubewells is and has increasingly been much more important, that is not so for Sindh and the NWFP. In fact, not only is the contribution of tubewells to irrigation minimal for Sindh and the NWFP, its importance as a source of irrigation over 1971–1980 has gone down. For Balochistan, while tubewell irrigation is still only the third important source of irrigation, its importance has increased over the period. The extreme inequality in the distribution of tubewell development is evident from the fact that of the total tubewell-irrigated area in Pakistan, 94.3 percent in 1971-72 and 95.61 percent in 1979-80 were in the Punjab. The basic reason for this is that the Punjab is endowed with the largest underground lake of water in the country, and also that inadequate attention and support is given by authorities in developing groundwater in the other provinces. Almost the entire increase in the tubewell-irrigated area of 0.64 m.ha. in the country over this period came from Punjab. Though the tubewell-irrigated area went up by 0.02 m.ha. in the Balochistan, it declined by 0.01 m.ha. each in Sindh and the NWFP. Thus, the entire investment in tubewell development made by Pakistan during 1971–1980 accrued to the Punjab, with an insignificant amount accruing to Balochistan and virtually nothing to Sindh and the NWFP.

5.4. In terms of the sources of irrigation, canal irrigation controlled by the government is the major source. It constituted as the source of irrigation for about 70 percent of the total irrigated area, showing virtually no change in its importance as the major source of irrigation over the period 1971–1980; but it is interesting to note here that there is considerable interregional difference in its importance at a point in time as well as over a period of time. While in the Punjab it constituted around 70 percent of the irrigated area and virtually remained the same over time, in Sindh it constituted 88 percent in 1971-72 but declined to 81 percent in 1979-1980. In contrast to the Punjab and Sindh, it constituted only around 43 percent in the NWFP and remained the same over the period; but in Balochistan, its importance went up from 31 percent in 1971-72 to 64 percent in 1979-80. Private canals provided irrigation to 0.38 m.ha. in 1971-72, which went down slightly to 0.35 m.ha. in 1979-1980. Tubewells are mostly owned by private individuals. As we have seen earlier, the Punjab is the province that benefited the most from tubewell development.

6. INEQUALITY IN IRRIGATION DISTRIBUTION ACROSS FARMSIZE GROUPS IN PAKISTAN

All three agricultural census reports of Pakistan provide farm sizewise and provincewise distribution of various economic quantities. The reports classify the entire farms into nine operational sizewise categories[1] and provide data relating to all the variables that this study deals with, and more. We made use of these data in conducting our analysis. Though the census of 1960 differs significantly from that of 1972 and 1980 in some respects, the variables and the data that constitute our study are comparable and consistent with one another.

Our analysis are conducted at both the aggregate all-Pakistan level as well as at the disaggregate provincial levels. In our aggregate analysis, we first study the overall level of inequality in the distribution of various irrigation variables, and then we decompose the aggregate level of inequality into two components, namely, the within-province inequality and across-province inequality. Because irrigation distribution is fundamentally a provincial-level decision problem for the provincial government, an understanding of the decomposition of inequality in terms of the above-mentioned two components will help us see how much of the level of aggregate inequality is due to lack of equitable irrigation distribution policy at the provincial level, and how much of it is due to differences in the levels of development across provinces. Later, we further extend the analysis by estimating the levels of inequalities across farmsize groups at the provincial levels.

6.1. Inequality in Land and Irrigated-area Distribution

Table 2 provides estimates of inequality (in terms of Theil's information theoretic measure) pertaining to four land variables, namely, the farm area total (FAT), the cultivated area total (CAT), the net sown area (NSA), and the irrigated cultivated area total (ICAT) across the nine farmsize categories in Pakistan.

The farm area inequality tells us about the nature of distribution of operational holdings across farmsize groups. Since farm area includes the cultivated as well as the uncultivated land, from a welfare point of view, inequalities in terms of the cultivated area and the net sown area are more important in determining the distribution of farm income, especially in the short run.

From the results reported in Table 2, we can infer the following:

6.1.1. Farm area inequality, which was quite high in 1960, declined substan-

[1]The nine farmsize categories are:

under 1.0 acre	7.5 to under 12.5 acres	50.0 to under 100.0 acres
1.0 to under 2.5 acres	12.5 to under 25.0 acres	100.0 to under 150.0 acres
2.5 to under 7.5 acres	25.0 to under 50.0 acres	150.0 and above acres.

Table 2

Inequality across Farmsize Groups in Terms of FAT, CAT, NSA, and ICAT

	TI			BPI		
	1960	1972	1980	1960	1972	1980
FAT	0.8157	0.5776	0.6140	0.0492	0.0215	0.0171
CAT	0.5992	0.4215	0.4867	0.0574	0.0170	0.0218
NSA	0.5364	0.3944	0.4607	0.0420	0.0217	0.0228
ICAT	0.5926	0.3841	0.4433	0.0906	0.0465	0.0485
	WPI			WPI/TI		
	1960	1972	1980	1960	1972	1980
FAT	0.7665	0.5561	0.5969	0.9397	0.9628	0.9722
CAT	0.5417	0.4045	0.4649	0.9041	0.9596	0.9553
NSA	0.4944	0.3728	0.4380	0.9217	0.9450	0.9506
ICAT	0.5021	0.3375	0.3948	0.8472	0.8789	0.8906

FAT = Farm Area Total; TI = Total Inequality; CAT = Cultivated Area Total; BPI = Between Provinces Inequality; NSA = Net Sown Area; WPI = Within Province Inequality; ICAT = Irrigated Cultivated Area Total.

tially in 1972 but went up slightly in 1980, though still remaining well below the 1960 level. A similar pattern is observed in the distribution of the cultivated and the net sown areas as well. The substantial reduction in inequality in farm area distribution in 1972 was mainly due to the land reforms implemented during the 1960s. To some extent, this reduction is fictitious in the sense that the implementation of land reforms during the 1960s also led to the landed aristocracy often transferring some of their lands to own family members, or even registering part of their lands under fictitious names. The reversal of the trend in 1980 is attributable to three plausible reasons: First, the ejection of tenants by large farmers due to the advent of the Green Revolution, which made self-cultivation more profitable; second, the beneficiaries of land redistribution of the 1960s either sold out their lands or were forced to leave those tracts and did not pursue the matter because of a lengthy and costly process of litigation; and third, the fictitious transfers may have been readjusted by the landed class once the dust of the land-reforms rhetoric had settled.

With regard to the levels of inequality in the cultivated area and the net sown area as compared to total farm area, we find them to be substantially less, indicating far less inequality in the distribution of farm income than what would be indicated by FAT; but still, the levels of inequality in the CAT and the NSA distribution are very high. One of the reasons for this anomaly is the fact that as the size of the farm increases, the proportion of farm area that is either uncultivated or uncultivatable also increases, either because larger farmers hold land for other reasons such as prestige, power, and hedge against inflation, or because of poor-quality soil or lack of rainfall or the presence of problems like water-logging and salinity. So in the short run, distribution analysis in terms of the CAT and the NSA will tell us more about the nature of income and economic welfare distribution across farmsize groups than the FAT. But, in the long run, to understand the dynamics of distribution, we need to pay serious attention to farm area distribution since with improvement in technology and other infrastructural development over time, presumably the uncultivated and uncultivatable lands can be brought under cultivation.

Comparing the level of inequality in 1972 with that in 1980, we find that it increased for farm area by just 6 percent while it went up by 15 percent and 17 percent, respectively, for the cultivated and the net sown areas. This happened because the land reclamation schemes and the irrigation development undertaken during the last two decades benefited the large farmers more than the others: first, the reclaimed lands were mostly the uncultivated areas in the possession of large farmers, thereby benefiting the large farmers disproportionately; and second, the proportionality principle underlying the government-owned canal irrigation distribution along with the inherent economies of scale involved in private tubewell development contributed during the 1970s to increasing the levels of inequality in the distribution of the CAT and the NSA.

About 95 percent of the level of inequality is explained by inequality in the distribution of the resource across farmsize groups within the provinces, and only the rest (5 percent) is due to differences in the endowment of the resource between the provinces. The inequality pattern for all three variables is the same. But, over time, the contribution of the within-province inequality to the total inequality has been increasing except for the CAT between 1972 and 1980. This indicates that the interprovincial differences in development over time have been somewhat narrowed and, thus, the major source of inequality in the country is essentially in terms of the within-province inequality across farmsize groups. Thus, corrective actions are called for more at the provincial level than at the federal level, which we discuss further in the concluding section of this paper.

6.1.2. The Theil index of inequality for the irrigated cultivated area total

(ICAT) declined substantially from 1960 to 1972, and the decline was much larger than the decline for the total cultivated area (CAT) for the same period; but the comparison of 1972 with 1980 brings forth a different picture altogether. During this period, the Theil indices of inequality in the ICAT increased. This overall increase in the ICAT inequality was due to the increase in inequality in canal- and other-irrigated areas and the continued presence of high inequalities in tubewell development and distribution. It is worth noting here that during the 1970s with the advent of the Green Revolution, the rapid spread and development of tubewells became necessary and profitable especially for large farmers because of the huge costs and the inherent economies of scale involved in their development.

In terms of the decomposition of overall inequality into its two constituent parts, we find that, for the irrigated area as a whole, the within-province inequality is the predominant component, which accounted for more than 84 percent of total inequality as it increased over the 1960–1980 period.

6.2. The Inequality Analysis in Terms of Crop Seasons

The cropping pattern, the total cropped area, and crop yields are the basic determinants of the income levels in the farming community. Along with arable farming, vegetable and fruit cultivation is growing at a very fast rate as the agriculture is becoming more and more commercialized. The returns from vegetable, fruit, and cash crops are much higher than from other crops. These commercial and income-earning crops are more water-consuming, too. As the cultivation of these crops is getting intensified, the struggle for the acquisition of more and more irrigation water is becoming more grim with the passage of time. With this background in mind, we will now analyze the inequalities across farmsize groups in the distribution of cropped area, irrigated cropped area, and unirrigated cropped area in different crop seasons.

Comparison of the irrigated cropped area inequalities with the total cropped area inequalities will tell us something about the nature of irrigation distribution. If the irrigated cropped area inequality is higher (or lower) than the total cropped area inequality, then that would indicate an anti-egalitarian (or egalitarian) irrigation distribution. The unirrigated cropped area inequality will give us some idea about what would happen in the near future when further irrigation development takes place, which would irrigate the currently unirrigated cropped areas. If the unirrigated cropped area inequality is currently higher (or lower) than the irrigated cropped area inequality, then any future irrigation development would lead to still higher (or lower) inequality in the distribution of the irrigated cropped area inequality, finally resulting in more (or less) inequality in the distribution of income and wealth.

Crop water requirements, and consequently the yield response of crops to irrigation, are different for different crops. They are also different for different seasons for the same crop since the temperature, the climate, and the rainfall are different in different seasons. So, a comparative analysis of the inequality in irrigation distribution in different seasons would throw some light on the likely welfare consequences of inequality for different farmsize groups. Irrigation during the Rabi season is somewhat more important that during the Kharif season since there is considerably more rainfall during the Kharif. So, the same level of inequality in the Rabi as in the Kharif will have more serious adverse consequences in terms of distribution of welfare across farmsize groups.

Table 3 provides estimates of inequalities on the above-mentioned aspects, from which we can derive the following inferences:

6.2.1. The pattern of movements in inequality turns out to be the same as in Table 2, i. e., the levels of inequality decreased during 1960–1972 but increase during 1972–1980, in the distribution of total cropped area (TCRA), total Kharif cropped area (TKCRA), and total Rabi cropped area (TRCRA). Further, we can also notice from Table 3 that around 90 percent of the inequality in the country is due to the within-province inequality.

6.2.2. In terms of inequality in the distribution of the irrigated cropped area (ICRA), the irrigated Kharif cropped area (IKCRA), the irrigated Rabi cropped area (IRCRA) and the irrigated orchard area (IOA), for all of which data are available for only two years, 1972 and 1980, we find that for all four variables the levels of inequality increased over the period 1972–1980; but the level of inequality in the distribution of orchard area irrigated was considerably more than the rest. Once again, the major source of inequality is the within-province inequality.

6.2.3. In terms of inequality in the distribution of the unirrigated cropped area (UICRA), the unirrigated Kharif cropped area (UKCRA), the unirrigated Rabi cropped area (UIRCRA) and the unirrigated orchard area (UIOA), for all of which data were available for only two years, 1972 and 1980, we find that for the first three unirrigated area variables the levels of inequality went up during 1972–1980, in contrast to a reduction in the level of inequality for the unirrigated orchard area. This was because the orchard areas are mostly operated by large farms and the increase in the irrigated orchard areas during 1972–1980 resulted in lowering the amount of the unirrigated orchard area among the large farms, resulting in reduction in its inequality. Except for the unirrigated orchard area, the within-province inequality was the main contributor to the level of inequality in the country as a whole.

6.2.4. An important point to note here is that the Kharif cropped area inequality is slightly higher than the Rabi cropped area despite the fact that water availability is almost twice as much during the Kharif season, in addition to the monsoon. One would expect the level of inequality to be lower during the Kharif.

Table 3

Inequality across Farmsize Groups in Terms of Crop Seasons

	TI			BPI			WPI			WIP/TI		
Variable	1960	1972	1980	1960	1972	1980	1960	1972	1980	1960	1972	1980
					Total Cropped Area							
TCRA	0.4954	0.3488	0.4037	0.0394	0.0195	0.0231	0.4560	0.3292	0.3806	0.9205	0.9440	0.9427
TKCRA	0.5438	0.3223	0.4003	0.1105	0.0285	0.0438	0.4333	0.2938	0.3565	0.7969	0.9116	0.8906
TRCRA	0.4922	0.3764	0.4213	0.0115	0.0198	0.0240	0.4808	0.3566	0.3973	0.9767	0.9473	0.9430
TOA	0.8469	0.8213	0.9723	0.1723	0.0558	0.0561	0.6746	0.7654	0.9162	0.7966	0.9320	0.9424
					Irrigated Cropped Area							
ICRA		0.3466	0.4035		0.0427	0.0500		0.3039	0.3535		0.8766	0.8761
IKCRA		0.3507	0.4062		0.0596	0.0673		0.2910	0.3390		0.8299	0.8344
IRCRA		0.3586	0.4042		0.0470	0.0476		0.3117	0.3566		0.8690	0.8823
IOA		0.8424	0.9845		0.0528	0.0562		0.7896	0.9283		0.9373	0.9429
					Unirrigated Cropped Area							
UICRA		0.4504	0.5239		0.0096	0.0160		0.4408	0.5079		0.9787	0.9694
UIKCRA		0.4666	0.6492		0.1322	0.0925		0.3344	0.5567		0.7167	0.8576
UIRCRA		0.4989	0.5693		0.0005	0.0242		0.4984	0.5451		0.9989	0.9575
UIOA		0.6856	0.5853		0.2742	0.3086		0.4115	0.2767		0.6001	0.4727

TCRA = Total Cropped Area; TKCRA = Total Kharif Cropped Area; TRCRA = Total Rabi Cropped Area; TOA = Total Orchard Area; ICRA = Irrigated Cropped Area; IKCRA = Irrigated Kharif Cropped Area; IRCRA = Irrigated Rabi Cropped Area; IOA = Irrigated Orchard Area; UICRA = Unirrigated Cropped Area; UIKCRA = Unirrigated Kharif Cropped Area; UIRCRA = Unirrigated Rabi Cropped Area; UIOA = Unirrigated Orchard Area; KHARIF = Crop Season from May to October; RABI = Crop Season from November to April.

7. PROVINCIAL LEVEL ANALYSIS OF INEQUALITY

In this section, we analyze inequality in the distribution of various irrigation-related land variables among different farmsize groups within each of the four provinces of Pakistan. The Theil measure of inequality at the provincial level is defined as:

$$I = \sum X_i \log (X_i/Y_i)$$

Where

X_i = The proportion of households in farmsize group *i*; and

Y_i = The proportion of the attribute (variable) that pertains to the *i*th farmsize group.

7.1. Inequality in Land and Irrigation Distribution in the Four Provinces

Table 4 provides estimates of inequality in the distribution of the farm area (FAT), the cultivated area (CAT), the net sown areas (NSA), and the irrigated cultivated area total (ICAT), from which the following are evident:

7.1.1. The pattern of changes over time in the inequality across farmsize groups in all the four provinces is the same. Inequality decreased in 1972 as compared to 1960, but increased in 1980 as compared to 1972; but to a level still lower than the level of 1960. This is true for all the provinces and for all the variables in Table 4, except for the cultivated and the net sown areas in Sindh, where they were slightly greater than the 1960 level.

7.1.2. In the distribution of FAT, CAT, and NSA at a point in time as well as over a period of time, Balochistan and the NWFP show highly unequal distribution as compared to the Punjab and Sindh due to a number of reasons, among which two of the important ones are: (i) tribal ownership pattern, which permits and even helps and encourages large ownership of land under tribal lords, chieftains, and leaders; and (ii) the relatively abundant availability of land due to a lower population density, particularly in Balochistan.

7.1.3. In terms of the levels of inequality in the irrigated cultivated area total (ICAT) across provinces, we find that through the three years Balochistan and the NWFP had a higher inequality than the Punjab and Sindh (except in 1960 when the Punjab had a higher inequality than the NWFP), with Sindh having the lowest level of inequality in the distribution of the irrigated cultivated area total. Between the two, while Balochistan had a substantial reduction in inequality, the NWFP had moderate increases in inequality during 1960–1980.

Table 4

The Inequality in Provinces in Terms of FAT, CAT, NSA, and ICAT

	Balochistan			NWFP		
Variable	1960	1972	1980	1960	1972	1980
FAT	1.1023	0.9138	0.8349	1.2686	0.9352	0.9898
CAT	0.8421	0.5482	0.6337	0.6938	0.6285	0.6323
NSA	0.5508	0.4527	0.5396	0.6406	0.5264	0.5405
ICAT	0.9736	0.3785	0.4727	0.4817	0.5404	0.5809
	Punjab			Sindh		
Variable	1960	1972	1980	1960	1972	1980
FAT	0.6964	0.4884	0.5460	0.5371	0.4442	0.4868
CAT	0.5484	0.4031	0.4684	0.3431	0.2912	0.3441
NSA	0.5379	0.3914	0.4553	0.3042	0.2413	0.3226
ICAT	0.5536	0.3559	0.4239	0.24444	0.2445	0.2537

7.1.4. Another observation worth noting from Table 4 is that of all the four provinces, Sindh is the one that has the most moderate levels of inequality in 1980 in the distribution of the irrigated cultivated area (ICAT) as a whole.

The main reason for the reductions in inequalities in almost all the variables in the four provinces during the 1960s was the vigour with which the land-reform measures were taken up and implemented. But during the 1970s, the advent of the Green Revolution and the high profitability of private tubewell irrigation, with its inherent economies of scale in operation and the high cost of initial investment, coupled with a greater degree of commercialization of agriculture in general and the waning of political interest in land-reform measures, led to the increase in inequalities in the distribution of various land variables.

8. THE PROVINCEWISE AND SEASONWISE INEQUALITIES IN CROPPED AREAS

Table 5 provides estimates of the provincewise and seasonwise inequalities for the three types of cropped areas, namely, the total cropped area (TCRA), the irrigated cropped area (ICRA), and the unirrigated cropped area (UICRA).

Table 5

Inequality in Provinces in Terms of Crop Seasons

	Balochistan			The NWFP			The Punjab			Sindh		
Variable	1960	1972	1980	1960	1972	1980	1960	1972	1980	1960	1972	1980
Total Cropped Area												
TCRA	0.5071	0.431	0.5272	0.5491	0.4153	0.4156	0.5126	0.3558	0.4072	0.2496	0.198	0.2567
TKCRA	0.5994	0.432	0.6721	0.3346	0.2453	0.2418	0.4859	0.324	0.3724	0.3236	0.208	0.3066
TRCRA	0.4378	0.4596	0.4708	0.704	0.5575	0.5529	0.5262	0.3758	0.4242	0.176	0.1771	0.1859
TOA	0.2001	0.1997	0.1807	0.2654	0.344	0.4328	1.1408	0.7328	0.9194	0.2191	1.2535	1.2661
Irrigated Cropped Area												
ICRA		0.3632	0.4491		0.3618	0.4332		0.324	0.3850		0.2234	0.2219
IKCRA		0.3681	0.4687		0.2563	0.2709		0.3288	0.3896		0.2047	0.2114
IRCRA		0.4078	0.4719		0.4705	0.5837		0.3142	0.3692		0.2392	0.2163
IOA		0.2021	0.1724		0.3622	0.4327		0.7581	0.9332		1.2584	1.2673
Unirrigated Cropped Area												
UICRA		0.5739	0.6229		0.4838	0.4063		0.4998	0.5284		0.0984	0.4664
UIKCRA		0.6264	0.9158		0.2298	0.2030		0.3123	0.2621		0.5098	0.9752
UIRCRA		0.5491	0.4785		0.6492	0.5430		0.5941	0.6424		0.0853	0.0996
UIOA		0.2985	0.5248		0.1767	0.4753		0.4351	0.1517		0.8964	0.9760

From the estimates of inequalities reported in Table 5, we can infer the following:

8.1. There are significant differences in the levels of inequality in the distribution of all four types of the total cropped areas across farmsize groups spatially (across provinces), temporally over the time-period 1960–1980, and between different agricultural seasons. There is no consistent pattern in the movement of inequalities over time in the four total cropped area variables that is applicable to all four provinces.

8.2. Since data for the provincewise/seasonwise irrigated and unirrigated areas across farmsize groups are available for only two years, namely 1972 and 1980, our inferences concerning the irrigated and unirrigated area distribution are somewhat more limited compared to the total cropped areas.

Once again, we find that there are significant differences in the levels of inequality in the distribution of the irrigated cropped areas across the four provinces and the two agricultural seasons. Except in the cases of the IOA for Balochistan, and the ICRA and IRCRA for Sindh, we find there is a consistent increase in the levels of inequality for the rest of the variables in all four provinces over the period 1972–1980.

Now comparing the inequalities in the distribution of the irrigated areas between the two crop seasons, namely, the Kharif and the Rabi, we find that except for the Punjab, in all the other provinces the Kharif inequality is strictly lower than the Rabi inequality for both 1972 and 1980. We would expect this because the Kharif is the rainy season and the water flow in the rivers is higher and the demand for irrigation water is somewhat lower; in contrast, the Rabi is the dry season and the water demand is higher but the water flow in the rivers is lower, and so the competition for water is stiffer. The anomaly in the case of the Punjab may be due to the free water trading and sales that take place in the case of the tubewell water during the Rabi season, which promotes equity in irrigation distribution; whereas the canal water, which is used heavily during the Kharif, does not allow legal water trading or sales. It is this anomaly in the Punjab, the largest canal-irrigated province, that led to the anomaly at the national level that we observed earlier.

8.3. Once again, we find that there are significant interprovincial and interseasonal differences in the levels of inequality in the four unirrigated cropped area variables. There is no consistent pattern in the changes in the levels of inequalities that is applicable to all the four provinces.

8.4. Now, comparing the levels of inequality in the distribution of the unirrigated cropped area results with the levels of inequality in the irrigated cropped areas, we find that in Balochistan the levels of inequality in the distribution of the unirrigated cropped areas are consistently higher than the levels for the corresponding irrigated crop areas for each of the four categories. In contrast, this is not so for the NWFP in 1980, and Sindh in 1972, in the distribution of the irrigated cropped area total; for the NWFP in 1972 and the Punjab in 1980 in the distribution of the Kharif irrigated cropped area total; for the NWFP in 1980 and Sindh in 1972 and 1980 in the distribution of the Rabi irrigated cropped area; and for the NWFP in 1972, the Punjab in 1972 and 1980, and Sindh in 1980 in the distribution of the orchard irrigated cropped area. Thus, out of the 32 pairwise comparisons, we find that in 18 of them the levels of inequality in the distribution of the irrigated cropped areas are lower. The implication of the above observation is fairly obvious. Where the inequalities in the distribution of the irrigated areas are lower than the inequality in the unirrigated areas, they indicate equity-improving conditions since the irrigated areas are generally much more productive, and lower inequalities in their distribution contribute towards improving the equity in income distribution substantially; on the other hand, since current distribution of the unirrigated areas is highly unequal, any future development of irrigation would lead to a higher inequality and this should be taken into consideration in any future irrigation development policy.

8.5. Now, comparing the results from Table 5 on the levels of provincewise inequalities in the distribution of different irrigated areas, namely, the ICRA, the IKCRA, and the IRCRA, with the results from Table 4 on the levels of provincewise inequalities in the distribution of different types of lands, namely the FAT, the CAT, and the NSA, brings out two *remarkable* facts:

8.5.1. For each and every year and for each and every province, the level of inequality in the FAT, the CAT, and the NSA is higher than the inequalities for the three irrigated areas mentioned above.

8.5.2. For every province in each year, the level of inequality in the NSA is lower than that for the corresponding inequality for the CAT, which is lower than the level of inequality for the FAT.

Since we know that the overall agricultural productivity of land on a per unit basis, given all other things are constant, is the highest in the irrigated areas followed in the descending order by the NSA, the CAT, and the FAT, the two remarkable facts mentioned above clearly show that the distribution process at work is one that ensures that the higher the level of productivity of land the more equitable is its distribution.[2] In this comparison, we did not include the orchard area because orchards are grown under special conditions, are highly localized, and mostly grown by large farms. We did not extend the scope of the above hypothesis to compare the inequalities between the IKCRA and the IRCRA since we neither

[2]It should be noted here that, by definition, the ICRA is more productive than the NSA, which is more productive than the CAT, which is more productive than the FAT; because, by definition, the NSA includes all the unirrigated and irrigated lands that are sown; the CAT includes the NSA plus fallow land that produces nothing; the FAT includes the CAT plus the uncultivated land.

had *a priori* grounds nor empirical evidence to argue that either one of these irrigated areas is more productive than the other. From the above analysis we venture to advance a testable empirical hypothesis in the context of agricultural development in the Third World in general, and in Pakistan in particular, that the distribution process at work is such that the higher the productivity of an agricultural asset, the lower is the level of inequality in its distribution. We do not know the conceptual basis or the empirical causes that have given rise to this phenomenon, which was also observed by one of us [Sampath (1990b)] in the Indian context.

8.6. A Provincewise Analysis of the Performance of Irrigation Distribution

Our objective in this section is to measure the relative performance of each of the four provinces in achieving equity in irrigation distribution. This is done in terms of a measure of equity performance developed by Sampath (1988), which is defined by the following equation:

I_{ep} = Level of equity performance in the distribution of any attribute;
I_{id} = Level of inequity in the distribution of any attribute; and
I_{ld} = Level of inequity in land distribution.

I_{id} and I_{ld} are given by the Theil indices. It could be easily seen that I_{ep} will lie between 0 and ∞. The higher the value of I_{ep}, the lower the level of equity performance. When every household receives an equal amount of the attribute irrespective of their holding size, the value of I_{id} will be zero and I_{ep} will be zero indicating perfect equity. When I_{ep} is between zero and unity, the distribution is inequity-reducing. When the households receive an amount of irrigation in proportion to the amount of land they hold, then $I_{id} = I_{ld}$ and I_{ep} will be unity, thereby indicating that irrigation distribution is neither equity-improving nor equity-impairing; in fact, it is inequity-perpetuating. Whenever I_{id}, $> I_{ld}$, I_{ep} will be greater than unity, indicating that the distribution is inequity-increasing.

Table 6 provides estimates of the equity performance indices for the three census years for each of the four provinces. The following inferences could be drawn from the information given in Table 6.

8.6.1. The cultivated area distribution in comparison to the total land area distribution is less inequitable, which is evident from the fact that the values of the equity index in all four provinces for all census years are less than unity. But, over time, it is consistently inequity-reducing only for Balochistan. For the other three provinces, the values of the indicator have gone up to higher levels compared to their 1960 levels. This indicates that the cultivated area inequalities are moving towards the total land area inequality level in the other three provinces, and only in Balochistan they are moving towards still lower levels.

Table 6

The Irrigation Distribution Performance

	Balochistan			The NWFP		
Variable	1960	1972	1980	1960	1972	1980
CAT/FAT	0.7639	0.5999	0.4160	0.5469	0.6720	0.6388
NSA/FAT	0.4997	0.4954	0.3542	0.5050	0.5629	0.5461
ICAT/FAT	0.8832	0.4142	0.3103	0.3797	0.5778	0.5869
TCRA/FAT	0.4600	0.4717	0.3461	0.4328	0.4441	0.3532
TOA/FAT	0.1815	0.2185	0.1186	0.2092	0.3678	0.4373
ICRA/FAT		0.3975	0.2948		0.3869	0.4377
IKCRA/FAT		0.4028	0.3077		0.2741	0.2737
IRCRA/FAT		0.4463	0.3098		0.5031	0.5897
IOA/FAT		0.2200	0.1132		0.3873	0.4371

	Punjab			Sindh		
Variable	1960	1972	1980	1960	1972	1980
CAT/FAT	0.7875	0.8253	0.8579	0.6388	0.6556	0.7069
NSA/FAT	0.7724	0.8014	0.8339	0.5664	0.5432	0.6627
ICAT/FAT	0.7949	0.7287	0.7764	0.4550	0.5504	0.5212
CICAT/FAT	0.8459	0.6521	0.6745	0.4658	0.4926	0.4829
TWICAT/FAT		0.9814	0.8826		2.5862	1.1783
WICAT/FAT	0.4925	0.3542	0.1949	0.4656	2.4973	0.5417
TCRA/FAT	0.7361	0.7285	0.7457	0.4647	0.4457	0.5273
TOA/FAT	1.6381	1.5004	1.6839	0.4079	2.8219	2.6009
ICRA/FAT		0.6634	0.7051		0.5029	0.4558
IKCRA/FAT		0.6732	0.7136		0.4608	0.4343
IRCRA/FAT		0.6433	0.6762		0.5385	0.4443
IOA/FAT		1.5522	1.7092		2.8330	2.6033

The net sown area distribution performance behaviour is roughly the same as the CAT except in the case of Sindh, where its 1972 level was actually lower than its 1960 level, indicating an equity-improving performance; otherwise, there is virtually no difference between the NSA and the CAT performances, except for the fact that the level of inequality that the NSA started off with in 1960 was much lower than that of the CAT.

8.6.2. There are wide interprovincial differences in the distribution performance of the irrigated cultivated area (ICAT) as a whole. There was a remarkable improvement in the equity performance in distribution in Balochistan, where the value of the performance indicator dropped from 0.8832 in 1960 to 0.3103 in 1980. In contrast, in the NWFP, equity performance consistently went down from 1960 to 1980; in Sindh, equity performance went down in 1972 but went up a bit in 1980, but still only to a lower level compared to that in 1960; and in the Punjab, it went up in 1972 but declined in 1980, though still to a higher level of performance than in 1960. In terms of the ranking of equity performances in 1960, the best performance was by the NWFP, followed by Sindh, the Punjab, and Balochistan; in 1972, it was Balochistan followed by Sindh, the NWFP, and the Punjab; and in 1980, the rankings remained the same as in 1972. But, on the whole, as compared to the 1960 performance, in 1980, Balochistan and the Punjab improved their equity performance, while the NWFP and Sindh worsened theirs.

8.6.3. Relative equity performance for the irrigated cropped area total improved for Balochistan and Sindh and worsened for the NWFP and the Punjab in 1980, as compared to 1972. Relative equity performance for the irrigated Kharif cropped area (IKCRA) improved for Balochistan and Sindh, worsened for the Punjab, but remained the same for the NWFP. Equity performance for the irrigated Rabi cropped area (IRCRA) improved for Balochistan and Sindh; but worsened significantly in the NWFP, and moderately in the Punjab. Relative equity performance behaviour for the irrigated orchard area (IOA) was very similar to the irrigated Rabi cropped area (IRCRA).

In this Section (8.6), we are only able to show the existence of significant interprovincial differences in the levels of equity performance in the distribution of various land variables. More detailed research studies need to be conducted at the provincial levels to understand the underlying causes for the differential performances, but that is beyond the scope of this paper.

9. CONCLUSION

The major results that emerge from the above analyses are the following:

9.1. There exists considerable interprovincial inequality in Pakistan, and its level has widened over time. Punjab is the chief beneficiary, followed by a distant second, Sindh, in the development of irrigation as a whole as well as in terms of each of the two major sources of irrigation, namely, canals and tubewells. Given the lack of rainfall and perennial rivers in Balochistan and the NWFP, the only way to bring irrigation and consequently agricultural development in these regions is by making possible interprovincial transfers of the Indus river water. This could be accomplished without any great sacrifice (in terms of agricultural production and productivity) on the part of Sindh and, especially, the Punjab – by developing their ground water potential to the maximum. In fact, higher ground water development in many locations in the Punjab and Sindh would also contribute indirectly to an improvement in productivity by lowering the water table (which has gone up due to canal irrigation seepage) and thereby mitigating the problems of water-logging and salinity.

9.2. There exist significant inequalities in Pakistan in the distribution of land and irrigation in several respects. Severe inequalities exist across regions and across farmsize groups in each major category of land and irrigation at a point in time as well as over a period of time. Of the two major contributors to the overall level of inequality in the country as a whole, namely, the "within-province inequality" and the "between-provinces inequality", the former contributes more than 90 percent of the total inequality. This means that more has got to be done at the provincial level in terms of the irrigation distribution policy than in terms of the balanced regional development policy at the federal level.

The two main reasons for a high within-province inequality are: (1) the very highly skewed distribution of land across cultivating households, and (2) the lack of regressivity in the distribution of irrigation across farmsize groups, especially of the government-controlled canal irrigation. In fact, if the national and provincial governments of Pakistan do not introduce some kind of lexicographic ordering in the development and distribution of irrigation in general, and in canal irrigation in particular, to favour the small farmsize groups, then given the current highly skewed distribution of irrigable but not yet irrigated lands, the levels of inequality in the distribution of irrigated lands will increase significantly in the near future and result in still higher inequality in the distribution of agricultural income and wealth.[3] One type of the lexicographic ordering of irrigation distribution is to irrigate all the irrigable land of the smallest farms first; and, after fulfilling their demands, to fulfil the demands of the second smallest farmsize group, followed by the third smallest farmsize group, and so on. This is the extreme form of an egalitarian policy, according to which the welfare of the most unfortunate gets the highest weightage. A second, somewhat moderate, form of an egalitarian policy is to treat all rural cultivating households equally by providing each household a potentially equal absolute share in irrigation water subject to a maximum equal to the amount of irrigable land that a cultivating household operates in the command area. Or, alternatively, if the government is keen on distributing the benefits of irrigation equally across rural households, then it could give all the cultivating households

[3]A very similar argument is given in the context of India [Sampath (1990), (1990a)]. A further analysis of the lexicographic ordering of irrigation distribution across farmsize groups and its implications for inequality is done in Sampath (1990a).

equal quantities of irrigation water in the command areas irrespective of the size of operational holding, with the option given to the households to trade/sell water rights. This will create an active market for water, leading to an improvement in both water use efficiency and equity in the distribution of irrigation benefits.

One silver lining to the above picture is that the levels of inequality in the distribution of different types of irrigated areas are significantly lower than the levels of inequality in the distribution of the total land area, the cultivated land area, and the net sown area, indicating a somewhat equitable distribution policy. In fact, what we see in Pakistan is that as the productivity of a class of land increases, the level of inequality in its distribution decreases.

As far as movements in inequality in the distribution of land and irrigation are concerned, there is no monotonic trend either at the overall national level or at the provincial level. Overall, compared to 1960, in 1972 the inequalities were lower but they went up in 1980 as compared to 1972 for the reasons we discussed earlier. Finally, at the provincial level, we find that different provinces seem to have different levels of and movements in inequality in the distribution of different types of irrigated areas across farmsize groups, with no overall trend. This means that neither the national nor the provincial governments seem to have any long-term policy with regard to equity in irrigation development and distribution in Pakistan.

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