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Land Inequality by Mode of Irrigation in Pakistan, 1990-2000

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1. INTRODUCTION

In Pakistan agriculture land accounts for a large portion of total wealth and the distribution of this land effects household welfare and agriculture efficiency. Evidence shows that in developing countries, land inequality is detrimental to overall efficiency due to incomplete markets and therefore results in welfare losses to those with little or no land as there are several benefits associated with access to land [Vollrath (2007)].

Agriculture plays a pivotal role in the economy of Pakistan which contribute 22.4 percent to Gross Domestic Product, 43.05 percent of labour force engaged in agriculture sector and 67 percent of population reside in rural areas out of which 30 percent of people living below the official poverty line. As the climate of Pakistan is arid to semi arid, its 80 percent agriculture is irrigated. Pakistan has one of the largest irrigation system in the world based on Indus basin irrigation system which plays an important role in the development of agriculture and the nature of distribution of irrigation water across farm size groups determines to a significant extent the nature of distribution of agriculture income.

During the second half of the sixties Green Revolution technology has brought an unprecedented growth of agriculture sector. However, it has been claimed that the Green Revolution technology by its very nature has a tendency to increase the concentration of agriculture land which implies a continuous deterioration in the distribution of rural income [Alavi (1976); Falcon (1970); Gotsch (1973); and Khan (1985)]. Their argument basically revolves around the indivisibilities of technology and sound financial position of the landlord coupled with their access to credit. On the other hand Kaneda (1969) and Chaudhry (1980, 1999) have refuted this argument and asserted that because the small farmer can use tubewell and tractor services which make them more productive, thus Green Revolution was more inclined to reduce income inequalities.

Some scattered evidence of increasing income inequalities and land concentration in Asia, in the seventies was due to induce increase in profit per acre High-Yielding Variety (HYV) which provide an incentive towards increasing farm size through eviction of share tenants and buying out pressurised farmers [Cleaver (1972) and Byer (1972)]. In Pakistan concentration of operated land was facilitated by host of other factors, such as

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inducement towards eviction of share croppers, tractorisation; etc., Hussain (1980) explored that the middle category of 7.5 to 25 acres farmers had decreased in the area and numbers while smaller and larger categories had increased.

Inequality in the distribution of land and other irrigated related land variables also exist at intra and inter provincial level from 1960 to 1980 [Gill and Sampath (1992)]. The districts of Pakistan also observed a considerable inter- district variation in their levels and movements over time; between the 'within district' inequality and 'between district' inequality [Ahmad and Sampath (1994)]. Irrigation not only determines the scale of intensity of crop production but also plays an important role in rural poverty alleviation. The nature of distribution of irrigation water across farm size groups determines a significant extent the nature of distribution of agriculture income. Since irrigated cropped areas are more productive than unirrigated cropped areas, the levels of inequality in their distribution will give us some ideas about their likely influence on the distribution of income.

The contribution of this study is to identify level of overall and provincial land inequality by mode of irrigation across two census periods that is 1990 and 2000. It also evaluates the relative performance in achieving equity in land distribution by irrigation facilities.

The paper proceeds as follows. Section 2 gives a brief review of literature on land distribution. Section 3 contains methodology to measure land inequality and the data utilised to create it. Section 4 includes analysis and Section 5 contains conclusions and suggestions.

2. REVIEW OF LITERATURE

The question of whether the benefits of irrigation have accrued to wider sections of the society has not yet been answered adequately as the existing literature on this topic is either ambiguous or unconvincing. Several studies have mentioned that surface flow irrigation (canal or tank) has produced higher inequality in the distribution of benefits across farms than lift irrigation (deep tubewell or micro pump sets). The effect of unequal distribution of irrigation benefits becomes severe when it is coupled with skewness in landholding as large farms can obtain disproportionately large share of incremental benefits from irrigation development both in relative as well as in absolute terms [Sampath (1990)]. This section reviews empirical evidence on land distribution and benefits from irrigation development in Pakistan.

Anwar and Qureshi (2004) explained that land inequality is quite high at provincial level and it is the main manifestation of poverty in rural Pakistan. The results illustrated that incidence of poverty is the highest among landless at 54.89 percent and Gini coefficient of land holding is 0.651 in 2000-01. Punjab had a highly skewed landownership pattern followed by NWFP, Sindh and Balochistan. It was recommended that land redistribution would be source of increased efficiency, increased demand for labour and reduced poverty.

Qureshi and Qureshi (2004) explored that land ownership is highly skewed in Pakistan and its provinces and it has increased from 1972 to 2000. A sharp increased in inequality was found for two provinces Punjab and NWFP. A high degree of inequality in the distribution of operational holdings was also witnessed as it was worsened somewhat

between the 1972-2000 periods. Among the different tenurial classes, the distribution of farm area among farms of various sizes has been relatively more unequal under owner-operated farms.

Chaudhry (1989) studied the pattern of land distribution with a view to check the legitimacy of the thesis that land distribution deteriorated under the Green Revolution in Pakistan. The paper indicated that land distribution in Pakistan either improved from 1960 to 1972 or remained unchanged between 1972 and 1980. The land distributional trend showed that technological changes were accompanied by significant improvement in land distribution between 1972 and 1980 *vis-à-vis* decrease in the ownership area of large farmers during the same period render untenable the view that under the Green Revolution land distribution had worsened because of land purchases by large farmers.

Dorosh, *et al.* (2003) captured the major implications of the skewed distribution of ownership of land and the dependence of much of the poor on non-agricultural income sources. They explored that because of inequality in the distribution of land, landless agricultural labourers and the rural non-farm poor who together, account for 61 percent of rural poor do not benefit directly from growth in the crop sector thus, unlikely to significantly reduce poverty among landless agricultural labourers and the rural non-farm poor.

World Bank (2007) acknowledged that unequal land distribution is a major cause of income inequality in rural Pakistan. It was explored that over all Gini coefficient of land ownership in 2000 in Pakistan was 0.66; if rural landless households are included, the Gini coefficient was 0.86 whereas Gini coefficient for land ownership are 0.71 in India, 0.42 in Bangladesh, and 0.85 in Brazil. The study also indicated that in Pakistan land sales markets are thin because of high transaction costs, potential disputes about accuracy of land records, land prices in excess of the discounted value of potential agricultural earning from the land and lack of access to credit by those without land which helps to perpetuate the highly unequal distribution of land, hamper labour mobility and reduce returns to family labour.

Gill and Sampath (1992) estimated the level of inequality and other irrigation-related variables among agricultural households across farm size groups both at the national and provincial levels, from 1960 to 1980. The paper explored that there exist considerable intra and inter provincial inequality and its level has widened over time. The reason for high within-provincial inequality was a highly skewed distribution of land across cultivating households and the lack of regressivity in the distribution of irrigation across farm size groups.

Ahmad and Sampath (1994) estimated the magnitudes of the level of inequality in the distribution of land and irrigation-related attributes among agricultural households across farm size groups at provincial and district. It was found that there exist considerable inequality in the distribution of various land area variables across farm size groups in all the districts of Pakistan, with considerable inter-district variation in their levels and movement over time; between the 'within-district' inequality and 'between district' inequality.

The existing literature captured the major implications of skewness of land distribution and inequality in benefits from irrigation development. It is acknowledged that the inequality in land distribution is a major cause of income inequality and poverty in rural Pakistan.

3. METHODOLOGY AND DATA

In estimating the indices of inequality, Theil's entropy measure is used which was employed by Gill and Sampath (1992). Theil's information theoretic measure is the one that fulfills 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. Theil's information theoretic measure is defined as;

$$L_{jt}(X:Y) = \sum_{i=1}^{n} X_{it}(\ln X_{it} / Y_{it}) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

L_{jt} = Level of Theil's inequality index for '*jth*' land variable in period *t*.
X_{it} = Number of cultivating households in *ith* farm size classes as a proportion of the total number of cultivating households in period *t*.
Y_{it} = Share of Irrigated area in *ith* farm size classes as a proportion of the total irrigated area in period *t.*

To evaluate the relative performance of each of the four provinces in achieving equity in land distribution by mode of irrigation, a measure of equity performance developed by Sampath (1988) is identified by the following equation:

$$LEP_{jt} = {L_{jt}}/{LC_t} * 100 \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

Where,

LEP_{jt} = Level of equity performance in the distribution of '*jth*' land variable in period *t;*
L_{jt} = Level of inequity in the distribution of '*jth*' land variable in period *t*;
LC_t = Level of inequity in the distribution of total cultivated land in period *t*;
L_{jt} = and LC_t are given by Theil's inequality indices (see Tables 5 to 9) whereas LEP_{jt} will lie between 0 and *8* .

The higher the value of LEP_{jt}, the lower the level of equity performance.

When $0 > LEP_{jt} < 100$ the distribution is inequity-reducing.

When LEP_{jt} = 100, the distribution is neither equity-improving nor equity-impairing, then

$L_{jt} = LC_t$, it is inequity-perpetuating.

When $LEP_{jt} > 100$, the distribution is inequity-increasing, then

$LC_{jt}, > LC_t$, it is inequity-increasing.

The cross section data used in this study are from two Pakistan Agricultural Census reports, published by Agricultural Census Organisation of the Government of Pakistan relating to the year 1990, 2000 [Pakistan (1999, 2000)]. The basic objective of the agricultural census is to generate basic information on the agriculture structure, to develop detailed basic information about agriculture resources, state of their utilisation, to find out the degree of acceptability of modern farming practices among the farming community and to fulfill data needs of the international agencies.

4. ANALYSIS

Some of the Asian economies have succeeded in increasing agricultural production significantly over a short span of time by accelerated provision of irrigation facilities. Irrigation infrastructure is one of the critical factors for improving agricultural production, farm incomes and rural wealth accumulation. The massive investments in irrigation infrastructure in India, China and Pakistan in the 1960s and the 1970s and their success in achieving food self-sufficiency were also driven by the same underlying philosophy. These countries have succeeded in reducing the scale of poverty to a large extent. The upliftment of mass populations above the poverty line (in absolute numbers of people as well as in relative terms) in some of these Asian countries, with the overall success of poverty reduction due to irrigated agriculture, is considered one of the significant achievements of the 20th century—unprecedented in the past.

Most of South Asian countries have still less than half of their agriculture area covered by irrigation. Pakistan is the only exception to this pattern: by 1999 it had a remarkable 82 percent of its agricultural area covered by irrigation which is the highest proportion in the entire region. Tables 1 and 2 represent the percentage distribution of cultivated area by mode of irrigation in all four provinces of Pakistan in two agriculture census period 1990 and 2000. The major share in cultivated area is for Punjab, then comes Sindh, NWFP and lastly Balochistan. Sindh gets the major share in irrigated area by canal while Punjab acquires major share of cultivated area with irrigation by tubewell only in 1990and 2000. NWFP and Balochistan attain major share of irrigated facilities by other source which comprises of tank, spring, karez, etc. Over time percentage share of total cultivated area has not change significantly across provinces.

Table 1

Distribution of Cultivated Area across Province (%): 1990-91

Area	Total Cultivated Area	Cultivated Area with Irrigation Facilities				
		Total	Canal	Canal and Tubewell	Tubewell Only	Other Sources
Punjab	63.3	67.6	41.6	96.3	87.74	21.9
Sindh	18.4	20.2	45.4	3.12	2.80	4.8
NWFP	10.9	7.1	8.6	0.58	4.21	39.9
Balochistan	7.4	5.1	4.4	–	6.05	33.5
Pakistan	100	100	100	100	100	100

Source: Computations are based on Pakistan Agricultural Census, 1990.

Table 2

Distribution of Cultivated Area across Province (%): 2000

Area	Total Cultivated Area	Cultivated Area with Irrigation Facilities				
		Total	Canal	Canal and Tubewell	Tubewell Only	Other Sources
Punjab	62.48	65.0	34.5	95.47	84.98	17.28
Sindh	19.75	23.2	52.1	3.40	1.82	9.0
NWFP	10.05	6.2	7.9	0.79	4.01	41.7
Balochistan	7.72	5.6	5.5	0.34	9.19	33.0
Pakistan	100	100	100	100	100	100

Source: Computations are based on Pakistan Agricultural Census, 2000.

In terms of sources of irrigation Tables 3 and 4 illustrate that canal and tubewell are the major source of irrigation in Pakistan which constitute more than 90 percent of total irrigated area, virtually no change in its importance is observed over the period 1990 to 2000 (Figure 1) . In Punjab canal and tubewell are the major source of irrigation while in Sindh about 90 percent area is irrigated by canal only in two census periods that is in the years 1990 and 2000. As noted in census 2000, the importance of cultivated area irrigated by tubewell only have increased in Punjab and Balochistan while mode of irrigation by other source such as tank, spring, karez, etc. have decreased in all areas. It is also illustrated that tubewell which are mostly owned by private individuals, Punjab province get advantage the most from tubewell development.

Table 3

Distribution of Cultivated Area Classified by Mode of Irrigation (%): 1990

Variables	Pakistan	Punjab	Sindh	NWFP	Balochistan
Irrigated Area by Canal	40.44	48.31	90.71	48.75	35.00
Irrigated Area by Canal and Tubewell	37.03	32.12	5.71	3.09	0
Irrigated Area by Tubewell	15.37	13.61	1.87	8.07	17.88
Irrigated Area by Other Sources	7.53	5.96	1.70	40.10	47.11
Total Irrigated Area	100	100	100	100	100
Ratio of Cultivated and Irrigated Area	74.33	76.44	81.80	48.57	50.76

Source: Computations are based on Pakistan Agricultural Census, 1990.

Table 4

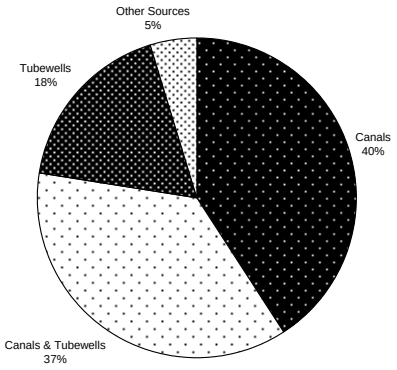
Distribution of Cultivated Area Classified by Mode of Irrigation (%): 2000

Variables	Pakistan	Punjab	Sindh	NWFP	Balochistan
Irrigated Area by Canal	40.95	21.7	91.46	52.1	40.15
Irrigated Area by Canal and Tubewell	36.65	53.96	5.3	4.7	2.23
Irrigated Area by Tubewell	17.67	23.16	1.4	11.4	28.82
Irrigated Area by Other Sources	4.8	0.10	1.8	31.7	28.80
Total Irrigated Area	100	100	100	100	100
Ratio of Cultivated and Irrigated Area	75.54	78.35	89.28	47.0	55.20

Source: Computations are based on Pakistan Agricultural Census, 2000.

In Pakistan, ratio of cultivated to irrigated area indicates that approximately 75 percent cultivated area is irrigated by different mode of irrigations in two census periods. At provincial level the ratio has increased slightly except in NWFP where it has gone down from 48 percent to 47 percent. Thus, Punjab and Sindh are the main beneficiaries of irrigation development over time.

Fig. 1. Distribution of Cultivated Area by Mode of Irrigation in Pakistan, 2000



Irrigation access is a crucial instrument for reducing rural poverty within a region through direct impacts of increased yield and farm returns per se but more through indirect impacts associated with increased rural employment. However, in reality unequal distribution of irrigation benefits across sub system is a common feature in most systems. Equity in water allocation and access in irrigation is a major concern in Pakistan. Tables 5 to 9 show dimensions of land inequality by mode of irrigation in Pakistan and its four provinces for two census years. The distribution of total cultivated area, total irrigated area, irrigated area by canal and tubewell are estimated by Theil's indices of inequality. It is illustrated that there exist a considerable levels of inequality in the distribution of all land variables in all areas as it is evident from the fact that the index values are all greater than zero. Generally, an index value of 0.25 or higher can be considered as indicating significant level of inequality in distribution.

Table 5

Land Inequality by Mode of Irrigation: Pakistan

Variables	1990	2000
Total Cultivated Area	0.568	0.609
Irrigated Cultivated Area Total	0.562	0.599
Cultivated Area Irrigated by Canal	0.549	0.618
Cultivated Area Irrigated by Tubewell	0.545	0.586

Source: Computations are based on Pakistan Agricultural Census, 1990 and 2000.

Table 5 indicates that there is considerable level of inequality in Pakistan in all land variables which are also increased over time (Figure 2). Qureshi and Qureshi (2004) also explored that land ownership is highly skewed in Pakistan and its provinces that has increased from 1972 to 2000. Table 6 shows that Punjab follows the trends in the movement of level of inequality as over all Pakistan. There is a significant level of increase in inequality in cultivated area irrigated by canal in 2000.

Table 6

Land Inequality by Mode of Irrigation, Punjab

Variables	1990	2000
Total Cultivated Area	0.559	0.594
Irrigated Cultivated Area Total	0.545	0.558
Cultivated Area Irrigated by Canal	0.406	0.548
Cultivated Area Irrigated by Tubewell	0.474	0.509

Source: Computations are based on Pakistan Agricultural Census, 1990 and 2000.

Fig. 2. Trends of Inequality in Land Distribution, Pakistan

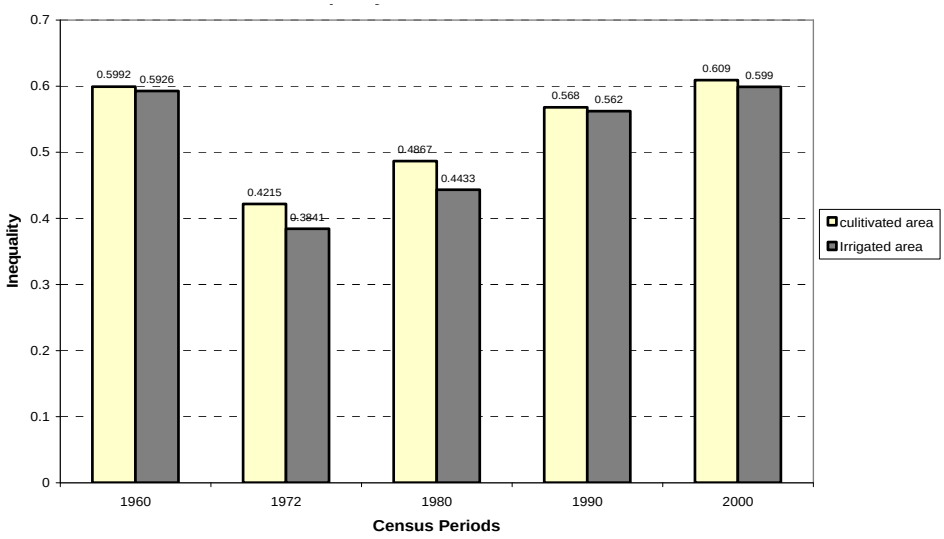


Table 7

Land Inequality by Mode of Irrigation: Sindh

Variables	1990	2000
Total Cultivated Area	0.373	0.430
Irrigated Cultivated Area Total	0.304	0.380
Cultivated Area Irrigated by Canal	0.302	0.370
Cultivated Area Irrigated by Tubewell	0.474	0.557

Source: Computations are based on Pakistan Agricultural Census, 1990 and 2000.

Table 7 summaries the estimates land of inequality classified by mode of irrigation for Sindh province. It is observed that the level of inequality is lower as compare to inequality in other provinces in all land variables. There appears significant increase in the level of inequality with respect to the movement of the levels of inequality applicable to all the provinces for these land variables.

Table 8

Land Inequality by Mode of Irrigation, NWFP

Variables	1990	2000
Total Cultivated Area	0.554	0.57
Irrigated Cultivated Area Total	0.549	0.568
Cultivated Area Irrigated by Canal	0.594	0.527
Cultivated Area Irrigated by Tubewell	0.767	0.897

Source: Computations are based on Pakistan Agricultural Census, 1990 and 2000.

Table 8 provides estimates of inequality in different land variables by mode of irrigation in the province of NWFP. There are significant levels of inequality in different irrigated areas in 1990. Although there had substantial reduction in the level of inequality for irrigated area by canal but at the same time a significant increase in the level of inequality is observed for irrigated area by tubewell.

Table 9

Land Inequality by Mode of Irrigation, Balochistan

Variables	1990	2000
Total Cultivated Area	0.55	0.56
Irrigated Cultivated Area Total	0.40	0.45
Cultivated Area Irrigated by Canal	0.75	0.79
Cultivated Area Irrigated by Tubewell	0.61	0.66

Source: Computations are based on Pakistan Agricultural Census, 1990 and 2000.

Table 9 shows highly inequitable distribution in cultivated area irrigated by canal and tubewell as compared to Punjab and Sindh which also increased in the census year 2000.

Balochistan had a tribal ownership pattern, which permits and even encourages large ownership of land under tribal lords and leader. It has also abundant availability of land due to lower population density.

Finally, it can be concluded from the above discussion that for all the four provinces for two census periods, the levels of inequality are higher for cultivated area irrigated by tubewell. In Pakistan ground water levels are either declining or the quality of water is deteriorating, either directly through aquifer depletion or through increasing pumping costs which will again affect poorer farmers to a greater extent. Equity is a difficult problem to solve as it is not a technical one rather it is driven by bribery and corruption within the irrigation systems.

Table 10a

The Land Distribution Performance by Mode of Irrigation

	Pakistan		Punjab		Sindh	
Variables	1990	2000	1990	2000	1990	2000
Total Irrigated Cultivated Area	98.9	98.3	97.5	93.9	81.5	88.3
Cultivated Area Irrigated by Canal	96.6	101.5	72.6	92.2	80.9	86.0
Cultivated Area Irrigated by Tubewell	95.5	96.2	84.8	85.7	127	129

Source: Computations are based on Pakistan Agricultural Census, 1990 and 2000.

Table 10.b

The Land Distribution Performance by Mode of Irrigation

Variables	NWFP		Balochistan	
	1990	2000	1990	2000
Irrigated Cultivated Area Total	99.1	99.6	72.7	80.3
Cultivated Area Irrigated by Canal	107.2	99.6	136.3	141.1
Cultivated Area Irrigated by Tubewell	138.4	157.4	111	117.8

Source: Computations are based on Pakistan Agricultural Census, 1990 and 2000.

Tables 10a and 10b illustrate estimates of the equity performance indices for the two census years for Pakistan and its four provinces. The irrigated cultivated area, irrigated area by canal and tubewell distribution in comparison to the total cultivated area distribution is less inequitable in 1990, which is evident from the fact that the values of the equity index are less than 100. In the 2000, equity index for irrigated area by canal, the value has gone up indicating that the distribution is inequity increasing in Pakistan. For the province of Punjab all the equity indices are inequity reducing as compared to total cultivated area but over time the indices is moving towards inequity perpetuating. In Sindh the picture is not encouraging for irrigated area by tubewell as the value for equity index is greater than 100, indicating that the distribution is inequity increasing. The distribution performance behaviour is roughly same for total irrigated cultivated area in NWFP and Balochistan, where the levels are lower in 2000 as compare to its 1990 levels, illustrating an equity improving performance. Relative equity performance for irrigated area by tubewell is worsened for the NWFP and Balochistan in 2000, as compared to 1990. It can be concluded that there exist significant interprovincial differences in the levels of equity performance in the distribution of irrigated land as compared to total cultivated land.

5. CONCLUSIONS

The aim of this study is to estimate the magnitude of inequality in land distribution by mode of irrigation in two agriculture census periods, 1990 and 2000. It also analyses relative equity performance in cultivated irrigated area as compare to total cultivated area. The distribution of total cultivated area shows that Punjab has 65 percent and Sindh has about 23 percent share in cultivated area with irrigation facilities while NWFP and Balochistan have nominal share. The distribution of cultivated area by different irrigation facilities indicate that Punjab and Sindh have more than 90 percent cultivated area irrigated with canal and tubewell. It is encouraging to note that irrigated area by tubewell has increased in Balochistan in the agriculture census period 2000.

Inequality in distribution of total cultivated area, total irrigated area, irrigated area by canal and tubewell are estimated by Theil's index of inequality. It is illustrated that there exist a considerable levels of inequality in the distribution of all land variables in all areas. It has also increased over the two agriculture census periods from 1990 to 2000. There is a significant level of increase in inequality in cultivated area irrigated by canal except in the NWFP whereas inequality in irrigated area by tubewell has increased in all provinces in 2000. The estimates of the equity performance indices for the two census years for Pakistan and its four provinces indicate that irrigated cultivated area, irrigated

area by canal and tubewell are less inequitable in comparison to the total cultivated area in 1990. The equity index for irrigated area by canal has gone up indicating that the distribution is inequity increasing in Pakistan in 2000. In Sindh the picture is not encouraging for irrigated area by tubewell as the distribution is inequity increasing in two periods. Relative equity performance for irrigated area by canal and tubewell is worsened in Balochistan in census periods 2000, as compared to 1990.

Finally, in can be concluded that the levels and movements of inequality in the distribution of cultivated land by different mode of irrigation have no over all trends. The present highly skewed land distribution provides to large farms disproportionately large shares of incremental benefits from irrigation development. The policy goal, at least in the case of an irrigation command is to reduce the inequality to a level accepted by society through institutional and policy changes in the irrigation system operation.

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