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LIVESTOCK INCOME, MALE/FEMALE ANIMALS, AND INEQUALITY IN RURAL PAKISTAN

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ABSTRACT

This paper uses income decomposition techniques to demonstrate the importance of livestock income in improving rural income distribution. It is based on three-year household panel data (1986 to 1989) from rural Pakistan. The paper first decomposes total income among five sources: agricultural, nonfarm, livestock, rental and transfer. This shows that livestock income is inequality-decreasing and that it makes the smallest contribution to overall inequality. The study then decomposes the sources of livestock inequality by type of animal. While livestock income from male animals has a negative impact on equity, livestock income from one female animal (local cow) has a positive effect.

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1. INTRODUCTION

In the past, too much attention has been given to land and land access as the main source of rural income and employment in Asia, Africa, and Latin America. By contrast, too little attention has been given to livestock and nonfarm employment as sources of income for poor and landless farmers. Since most developing countries lack sufficient cultivable land to match future growth in their rural labor forces, more reliance will have to be placed on those rural income and employment activities—such as livestock—which are *not* connected with land.

After crop production, livestock rearing and dairying represents the leading source of rural income and employment in many Asian and African countries. For example, in India and Pakistan, it has been estimated that livestock farming accounts for 15 and 25 percent, respectively, of agricultural gross domestic product (GDP) (Singh 1990). Similar calculations suggest that in Sub-Saharan Africa, livestock production accounts for 25 percent of agricultural GDP (Winrock International 1992).

The large contribution that livestock farming makes to the rural economies of many Asian and African countries is a reflection of the multiple roles that livestock plays in the farming systems in these countries. Although animals are often of poor quality, they nevertheless provide draft power for farming and transport, animal

protein to supplement meager diets, and cash income from a variety of sources, including the hiring out of cattle or buffaloes for draft services; the sale of live animals, and the sale of milk or meat products. Even animal waste products have their uses as fertilizer and as fuel for cooking and heating.

In many developing countries, the distribution of livestock ownership suggests that livestock farming is especially important for the poor and landless. Studies by de Lasson in Bangladesh, Gryseels in Ethiopia, and Glenn in North Africa/Middle East all suggest that there is an inverse relationship between farm size and livestock: small farms consistently have more animals per unit of land than large farms (de Lasson 1981; Gryseels 1988; Glenn 1988). Past research has also shown that income from livestock farming is distributed far more evenly than income from land or agriculture. In India, for example, landless households, which represent 27 percent of all rural households, own between 2 and 10 percent of all cattle and buffalo (Singh 1990, 206).

The purpose of this paper is to provide further evidence regarding the importance of livestock farming to the poor and landless by analyzing the effect of livestock income on rural income distribution in one specific developing country: rural Pakistan. The paper uses the results of a three-year panel survey in rural Pakistan to make two contributions. First, it uses income decomposition techniques to pinpoint the contribution of five different sources of rural income—including

livestock income—to total income inequality. This is useful because few attempts to decompose the sources of rural income inequality have used time-series data in ungrouped (disaggregated) form to analyze the contribution of livestock income to inequality. Second, the study decomposes the sources of livestock income inequality in order to pinpoint the contribution of different types of animals to livestock income inequality. This analysis, which, to the best of my knowledge, has not been done elsewhere, reveals that income from male and female animals has a differential impact on income distribution. While livestock income from male animals (male buffalo and bullock) has a negative impact on income distribution, livestock income from one female animal (local cow) is *very* important to the poor and has a positive effect on income distribution.

The paper proceeds in seven further sections. Section 2 presents the decomposition of several inequality measures. Section 3 reviews the data set and presents the definition of income used in the study. Section 4 explains how livestock income data were collected and measured. Section 5 then decomposes overall income inequality and Sections 6 and 7 decompose livestock inequality by type of animal. Section 8 summarizes the results.

2. THE DECOMPOSITION OF INCOME INEQUALITY

Several different inequality measures have been proposed in the literature. Which one of these measures should be chosen for decomposition? According to Foster (1985), the chosen measure should have five basic properties: (1) Pigou-Dalton transfer sensitivity, (2) symmetry, (3) mean independence, (4) population homogeneity, and (5) decomposability.

Pigou-Dalton transfer sensitivity requires that the measure of inequality increases whenever income is transferred from one person to someone richer. Symmetry holds if the measure of inequality remains unchanged when individuals switch places in the income order. Mean independence holds if a proportionate change in all incomes leaves the measure of inequality unchanged. Population homogeneity holds if increasing (or decreasing) the population size across all income levels has no effect on the measured level of inequality.

The property of decomposability allows inequality to be partitioned either over subpopulations or sources. It is the latter type of decomposition that is the subject of this study. Ideally, an inequality measure can be regarded as source decomposable if total inequality can be broken down into a weighted sum of inequality by various income sources (such as agricultural and livestock income). However, since activities that influence a particular source of income are likely to have an impact on other activities from that total income is comprised, any inequality measure that is

source decomposable must address the problem of covariance among the income sources.

There are several measures of inequality that meet the five preceding properties. These measures include Theil's entropy index T, Theil's second measure L, the coefficient of variation, and the Gini coefficient.[1] The two Theil measures, however, are not decomposable when sources of income are overlapping and not disjoint. While the need for non-overlapping groups is not restrictive when inequality is decomposed over geographic regions, this restriction rules out using the two Theil measures in this study because many of the survey households receive income from several different sources. This study is therefore based on the two remaining inequality measures: the coefficient of variation and the Gini coefficient.

The source decomposition based on the coefficient of variation can be developed following Shorrocks (1982) and Ercelawn (1984). Let total income, y, consist of income from k sources. The variance of total income, σ^2, can be written as the sum of variances of each source of income, σ_i^2, and of the covariances between sources of income, σ_{ij}:

$$\sigma^2 = \sum \sigma_i^2 + \sum_{i \neq j} \sigma_{ij}. \qquad \textbf{(1)}$$

[1] For an overview of these four inequality measures, see Anand (1983).

The contribution of the i^{th} source of income to total income variance consists of the i^{th} income variance and the part of the covariances allocated to the i^{th} source. According to Shorrocks (1982), the "natural" decomposition of the variance assigns to the i^{th} source exactly one-half of all covariances involving the i^{th} income source. This leads to the expression:

$$\sigma^2 = \sum \sigma_{iy}, \qquad \textbf{(2)}$$

where the (absolute) contribution of the i^{th} source is measured by its covariance with total income, y. This relationship can be rewritten so as to express the contribution in relative terms. As is apparent, the relative contributions remain the same whether inequality is measured by the variance or by the coefficient of variation. Since the variance does not meet the axiom of mean independence (that is, it is not invariant to proportional changes in all incomes), the coefficient of variation is adopted here. The decomposition corresponding to the coefficient of variation can be expressed as

$$\sum w_i c_i = 1; \; w_i = \frac{\mu_i}{\mu}; \; c_i = \rho_i \frac{\sigma_i/\mu_i}{\sigma/\mu}, \qquad \textbf{(3)}$$

where $w_i c_i$ is the so-called "factor inequality weight" of the i^{th} source in overall inequality; μ_i and μ are the mean income from the i^{th} source and from all sources, respectively; c_i is the relative concentration coefficient of the i^{th} source in overall inequality; and ρ_i is the correlation coefficient between the i^{th} source and total income.

The decomposition of the Gini coefficient can be developed as follows. Pyatt, Chen, and Fei have shown that the Gini coefficient of total income, *G*, can be written as

$$G = \frac{2}{n\mu} cov(y,r), \tag{4}$$

where *n* is the number of observations, *y* refers to the series of total incomes and *r* refers to the series of corresponding ranks (Pyatt, Chen, and Fei 1980). On this basis, the Gini coefficient of the i^{th} source of income, G_i, can be expressed as

$$G_i = \frac{2}{n\mu_i} cov(y_i,r_i), \tag{5}$$

where y_i and r_i refer to the series of incomes from the i^{th} source and corresponding ranks, respectively. Since total income is the sum of source incomes, the covariance between total income and its rank can be written as the sum of covariances between each source income and rank of total income. Equations (4) and (5) can then be used to express the total income Gini as a function of the source ginis:

$$G = \sum \frac{\mu_i}{\mu} R_i G_i, \tag{6}$$

where *R* is the "correlation ratio" expressed as

$$R_i = \frac{cov(y_i,r)}{cov(y_i,r_i)} = \frac{covariance\ between\ source\ income\ amount\ and\ total\ income\ rank}{covariance\ between\ source\ income\ amount\ and\ source\ income\ rank}. \tag{7}$$

The decomposition corresponding to the Gini coefficient can then be expressed by defining the following terms:

$$\sum w_i g_i = 1;\ w_i = \frac{\mu_i}{\mu};\ g_i = R_i \frac{G_i}{G}, \qquad \textbf{(8)}$$

where $w_i g_i$ is the "factor inequality weight" of the i^{th} source in overall inequality and g_i is the relative concentration coefficient of the i^{th} source in overall inequality.

Assuming that additional increments of an income source are distributed in the same manner as the original units, an income source can be defined as inequality-increasing or inequality-decreasing on the basis of whether or not additional shares of that income source lead to an increase or decrease in overall income inequality. From the decomposition equations (3) and (8), it follows that the i^{th} income source is inequality-increasing or inequality-decreasing according to whether c_i (or g_i) is greater than or less than unity.[2]

[2] This analysis ignores feedback effects, that is, the effects that a change in any source income share might have on distribution within any source income. Of course, such an assumption might be quite unrealistic for large changes in any source income share.

3. DATA SET AND DEFINITION OF INCOME

Data come from a three-year (1986-87 to 1988-89) survey of 727 households in three provinces in rural Pakistan.[3] Since the goal of this survey was to analyze the determinants of rural poverty, the survey was *not* designed to be representative of the rural population as a whole in Pakistan. In each province, the poorest district was selected on the basis of a production and infrastructure index elaborated by Pasha and Hasan (1982). The selected districts included Attock (Punjab Province), Badin (Sind Province), and Dir (Northwest Frontier Province). Since rural poverty also exists in relatively prosperous areas, a fourth district, Faisalabad (Punjab Province), was added to the survey.[4]

While not nationally representative, this study was designed to be *very* intensive: it included 12 sets of interviews with the survey households.[5] Six

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[3] This study was undertaken by the International Food Policy Research Institute (IFPRI) working in collaboration with Pakistani research institutes—Applied Economic Research Centre (University of Karachi), Punjab Economic Research Institute (Lahore), the University of Baluchistan (Quetta), and the Center for Applied Economic Studies (University of Peshawar). See Adams and He (1995).

[4] The sample was randomly drawn with all rural residents in the selected districts having an equal probability of being included. Landowners who reside in urban areas, therefore, are not included in the sample. Since unweighted samples generally tend to miss the apex of a distribution, the fact that there are, for example, far fewer households owning 3,000 acres of land than there are households owing 3 acres may lead to a slight underrepresentation of the skew of landholding in any moderately sized sample.

[5] The 727 survey households were distributed as follows: 148 from Attock District (Punjab), 239 from Badin District (Sind), 193 from Dir District (Northwest Frontier) and 147 from Faisalabad District (Punjab).

interviews were conducted with households in the first year (1986-87), and three interviews in each of the two subsequent years (1987-88 and 1988-89). In these interviews, data were collected on a wide range of topics: income, expenditures, food consumption, education, employment, migration, and landownings.[6]

The concept of income used in this study is fairly comprehensive, including income received in kind as well as in cash. A money value was imputed to receipts in kind, household consumption of crops and crop by-products, and home-consumed livestock. Because of an uncertainty of how to deduct imputed land rent from agricultural income, no values for imputed land rent were calculated. Similarly, because of the thin rental market for housing in rural Pakistan, no values were imputed for the rent of owner-occupied housing. Finally, because of an uncertainty of how to accurately calculate wage rates for family members, no values were imputed for family labor involved in crop and livestock production.

Four further points about income in this study should be noted. First, income is recorded in pre-tax form, since during the study, there was no taxation of agricultural income and general income tax collection in rural areas was virtually nonexistent. Second, all income is measured in terms of per capita household income. No attempt

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[6] In panel surveys like this one, attrition is always a concern because selectivity of sample dropouts could bias the results. In this survey, however, the major reasons for attrition prior to year three reflect more the influence of community politics than household self-selection. For example, in both Sind and Northwest Frontier Provinces, an entire village dropped out following disputes between survey staff and the village head. While unfortunate, this is not likely to have introduced a selection bias.

is made to convert income to equivalence scales to adjust for the age and/or gender composition of household members. According to some sources (Deaton and Mullbauer 1982), the non-use of equivalence scales could lead to an underestimation of the welfare of households with more members and more children because of potential economies of scale in consumption. Third, all income here is expressed in real terms. Income figures are deflated to a base year (1986-87) by using district-specific consumer price indices, consisting of food and nonfood price indices weighted by their respective average budget shares. These price indices are constructed from survey data: they suggest that inflation during the study period averaged 11.8 percent per year. Fourth, this study is based on pooled income data; that is, income data pooled from households in the four survey districts. Because of space limitations, no attempt is made to disaggregate the income data, either by district or by agroclimatic region.[7]

Total income for each household was divided into five sources:

1. Nonfarm—Includes wage earnings from nonfarm labor, government- and private-sector employment, plus profits from nonfarm enterprises;

[7] For an analysis of the income data in this study at the district level, see the appendix tables in Adams and He (1995).

2. Agricultural—Includes net income from all crop production, including imputed values from home production and crop by-products plus returns to own agricultural labor;
3. Transfer—Includes pensions (government), internal and international remittances, and *zakat* (payments to the poor).
4. Livestock—Includes net returns from traded livestock (cattle, poultry) and livestock products (milk, eggs) plus imputed values of home-consumed livestock and livestock products plus traction power;
5. Rental— Includes rents received from ownership of assets such as land, machinery, and water.

Table 1 presents summary data for the five income sources. In all three years, nonfarm income represents the most important income source. In each year, livestock income represents the fourth most important source.

Table 1 Summary of income data from 1986-87, 1987-88, and 1988-89 surveys in rural Pakistan

Source of Income	Mean Annual Per Capita Household Income[a] 1986/87	1987/88	1988/89
		(Rs)	
Nonfarm	1,007.39	1,204.65	959.54
	(1,158.40)	(1,364.28)	(1,086.19)
Agricultural	763.75	851.39	832.90
	(2,170.35)	(2,188.16)	(2,048.37)
Transfer	554.01	573.35	369.38
	(1,497.76)	(1,591.70)	(1,176.10)
Livestock	534.88	444.21	435.05
	(641.98)	(832.35)	(718.71)
Rental	425.07	405.46	473.84
	(1,429.80)	(1,357.63)	(1,610.71)
Total	3,285.10	3,479.06	3,070.71
	(3,015.60)	(3,288.21)	(3,107.57)

Source: IFPRI Rural Survey of Pakistan, 1986/87-1988/89.

Notes: N = 727 households. Numbers in parentheses are standard deviations. Mean income figures include negative source incomes recorded for some households in various years.

[a] In 1986, 1 Pakistan rupee = US$0.062. All rupees are in constant 1986 terms.

4. LIVESTOCK INCOME: DEFINITION AND MEASUREMENT

At this point, two key issues need to be addressed. First, what is the rationale for distinguishing between agricultural and livestock income? Second, how were livestock incomes collected and measured?

On the first issue, some observers claim that within a rural subsistence economy, it is artificial (and empirically difficult) to distinguish between agricultural and livestock income, since outputs from one—such as straw and crop residuals from agriculture, and draft power and manure from livestock—are used as inputs in the other. However, the goal of this study is to disaggregate the sources of income inequality as *finely* as possible. It therefore seems essential to distinguish between agricultural and livestock income, because these two income sources have very different effects on inequality.

In Table 2, the three-year average simple correlation between agricultural income and total income is very high: 0.636. By contrast, the three-year average simple correlation between livestock income and total income is quite low: 0.174. One of the main reasons for this difference is land. In Pakistan, as in many developing countries, land is distributed far more unevenly than income. For instance, in this study, 270 of the 727 survey households (37.1 percent) own no

Table 2 Simple correlations between total income and source incomes

Source of Income	Total Per Capita Household Income			
	1986-87	1987-88	1988-89	Three-Year Average
Nonfarm	0.161	0.179	0.302	0.213
Agriculture	0.632	0.634	0.645	0.636
Transfer	0.465	0.436	0.318	0.413
Livestock	0.142	0.307	0.040	0.174
Rental	0.468	0.521	0.655	0.549

Source: IFPRI Rural Survey of Pakistan, 1986/87-1988/89.

Notes: N = 727 households. All income figures are based on annual per capita household income expressed in constant 1986 terms. All figures are significant at the .01 level.

land.[8] Thus, while the Gini coefficient for three-year average total per capita household income in the survey sites is 0.381, the Gini for landownership is 0.769. The latter figure is almost identical to the Gini coefficient of landownership that can be calculated for Pakistan as a whole: 0.780.[9]

According to Table 3, agricultural income in this survey is highly correlated with land owned: the three-year average simple correlation between the two is positive and highly significant. By contrast, the three-year average simple correlation between livestock income and land owned is negative and statistically significant. These results suggest that while agricultural income is closely linked with landownership, which is unevenly distributed in favor of the rich, livestock income is not linked with landownership and is thus of more potential importance to the poor.

With respect to the second issue, namely, the collection and measurement of livestock data, this study gathered data on the number and type of all household animals, purchase and sale price of animals, offspring born to livestock, milk yields and number of lactating animals, and values of fodder (own and purchased) and

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[8] Of the 727 survey households, 270 houses own no land, 59 houses own between 0 and 1 acres, 154 houses own between 1 and 5 acres, 90 houses own between 5 and 10 acres and 154 own more than 10 acres. Landownership here includes both irrigated and rainfed land. Land classified as uncultivable is excluded.

[9] This Gini coefficient for landownership in Pakistan as a whole comes from Ercelawn (1984), and was calculated from the 1980 Pakistan Census of Agriculture.

Table 3 Simple correlations between size of land owned and source incomes

Source of Income[a]	Size of Land Owned[b] 1986-87	1987-88	1988-89	Three-Year Average
Nonfarm	-0.120**	-0.083	-0.033	-0.080**
Agricultural	0.137**	0.135**	0.282**	0.182**
Transfer	0.001	0.099**	-0.022	0.030
Livestock	0.019	-0.092	-0.223**	-0.099**
Rental	0.438**	0.430**	0.465**	0.444**

Source: IFPRI Rural Survey of Pakistan, 1986-87 to 1988-89.

Note: N = 727 households.

[a] All income figures are based on annual per capita household income expressed in constant 1986 terms.

[b] Land owned includes irrigated and rainfed land. Land classified as uncultivable is excluded.

** = Significant at the 0.01 level.

purchased feed. In addition, information was gathered on egg production, bullock plowing, and hired labor used in livestock care.[10]

Evaluating the contribution of livestock income to the household raises some complex issues of measurement and imputation. First, the output produced by an adult animal includes not just milk but also (sometimes) calves and rental services (in the form of bullock plowing).[11] Second, livestock farming involves both changes in stocks (in the form of animal purchases and sales) and changes due to herd growth (in the form of animal reproduction and maturation). Since animal purchases are generally considered investments, animal sales can be viewed as disinvestments. In this study, however, neither investments or disinvestments are viewed as components of income; rather, both are considered to be decisions on how income is spent.[12] In this study, changes in herd growth (from animal reproduction and maturation) are viewed as income. Yet herd growth, especially in the form of animal maturation, is difficult to measure. If, for example, an animal is still in the household's possession at the end of any time period (not having died or been sold), then changes in the value of

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[10] As explained in the text, no attempt is made in this study to calculate imputed values for household labor used in livestock care.

[11] Manure represents another output produced by livestock. However, the study did not collect data on manure both because of measurement problems and because there is little exchange of manure between households in rural Pakistan.

[12] From the standpoint of the average rural household, this definition of livestock income is quite sensible. Rural households invest and disinvest in livestock. In fact, given the imperfections in most rural capital markets, livestock represents the primary means of investment (and disinvestment) for most poor rural households.

that animal need to be imputed. To capture these processes, the procedure adopted here is to view livestock farming as an annual process employing inputs (fodder, feed, and hired labor),[13] and yielding as outputs both the conventional ones (milk, eggs, and plowing services) *and* the growth in animal.

The goal of this study is to identify *net* livestock income for ten types of animals: local cow, male buffalo, female buffalo, bullock, goat, chicken, donkey, commercial poultry,[14] Sahiwal/imported cow,[15] and sheep. For this reason, outputs and inputs need to be calculated for *each* type of animal.

Six types of livestock output can be identified:

Gross output = Growth of value of livestock
+ Value of milk, milk products (home consumed and sold)
+ Value of bullock plowing (home consumed and sold)
+ Value of chicken (home consumed and sold)
+ Value of commercial poultry
+ Value of eggs (home consumed and sold). **(9)**

[13] It should be noted that in this study hired labor accounts for only a small percentage (less than 3 percent) of total income, even for those households in the lowest quintile group. In the sample the widespread sharing of labor between families apparently serves as a substitute for the hiring of wage labor. For more on this point, see Nabi, Hamid, and Zahid (1986).

[14] In each year of the survey, less than 3 percent of the households produced and sold chicken for the commercial market.

[15] Sahiwal cow is a local breed that is a high milk producer. The average purchase price of a Sahiwal cow is about 70 percent higher than that of a local cow: 4,150 rupees versus 2,439 rupees. However, in this study the number of Sahiwal cows is quite limited. Thus, in calculating net livestock income, Sahiwal and imported cows are combined together.

Table 4 provides summary data on the annual mean values for each output. The interyear variation in the mean values of certain outputs—such as growth of livestock and chicken—is quite high. Unfortunately, it is not clear whether this variation is due to problems in the data set or whether these livestock outputs are, in fact, highly variable.[16]

Since Table 4 shows that growth of livestock is a key output, it is important to explain how this output is measured. If, for example, an animal was born during a survey year, it was assigned a value of half the average district sale price for that type of adult livestock. If the animal was sold its value was the sale price. If that animal was not sold, in the year following birth, its value was imputed to be the full district sale price for that type of adult livestock. Since growth of value of livestock

[16] Since some of the values for livestock outputs and inputs in 1986-87 in Table 4 are much lower than those for the other two survey years, the decompositions of livestock income were re-estimated by dropping the 1986-87 data and using only data from years two and three. These decompositions, however, yielded results quite similar to those obtained by using livestock data for the full three-year data set. Thus, only the three-year results are reported here.

Table 4 Livestock outputs and inputs, 1986/87, 1987/88, and 1988/89

Input/Output	1986-87 Mean Annual Gross Household Value[a]	1986-87 Standard Deviation	1987-88 Mean Annual Gross Household Value[a]	1987-88 Standard Deviation	1988-89 Mean Annual Gross Household Value[a]	1988-89 Standard Deviation
	(Rs)		(Rs)		(Rs)	
Livestock inputs						
Fodder, own and purchased	2,309.5	3,359.1	3,568.3	4,754.9	3,408.5	4,933.0
Feed, purchased	272.3	632.6	59.1	85.4	20.8	41.3
Hired labor	3.9	36.5	92.1	529.1	2.4	22.6
Total	2,585.6	3,380.5	3,719.5	4,801.7	3,431.7	4,939.2
Livestock outputs						
Growth of livestock	3,608.8	3,321.4	3,098.2	3,430.7	3,024.8	3,193.3
Milk, milk products[b]	3,064.9	3,262.5	3,387.7	4,607.1	3,586.7	3,772.6
Bullock plowing	724.6	1,314.1	523.1	991.9	450.4	886.2
Chickens[b]	120.4	255.8	485.9	1,077.9	382.8	785.9
Commercial poultry	58.7	2,214.8	137.7	2,429.2	100.3	1,814.7
Eggs[b]	67.9	91.4	100.5	202.6	127.1	193.0
Total	7,654.2	6,332.8	7,733.1	7,574.7	7,672.1	6,585.9

Source: IFPRI Rural Survey of Pakistan, 1986/87-1988/89.

Note: N = 702 households.

[a] In 1986, 1 Pakistan rupee = US$0.062. All rupees are in constant 1986 terms.

[b] Includes both home-consumed and sold goods.

is measured as a yearly variable, it is possible to take into account inflation. This is useful because during this study, inflation averaged 11.8 percent per year.

In determining the value of two other livestock outputs—milk, milk products and egg, imputed values had to be calculated for home-consumed items using average village—sale prices for milk, butter, ghee, and eggs, respectively. In determining the value of chicken outputs, imputed values for home-consumed meat were calculated in a similar fashion. Determining the value of bullock plowing required calculating imputed values for plowing services used on farm and then adding these values to those recorded for the sale of plowing services.

On the input side, three livestock inputs can be identified:

$$\text{Input} = \text{Fodder (own and purchased)} + \text{purchased feed} + \text{hired labor.} \qquad \textbf{(10)}$$

In calculating inputs, no account was taken of either animal purchases or imputed labor values. As explained earlier, animal purchases are considered to be investments, and are not included as components of income. Imputed labor values are not assigned for household labor because of the difficulty of accurately calculating

wage rates for those household members most directly involved in livestock care, namely, women and children.[17]

Table 4 shows that fodder (own and purchased) represents the main input for livestock. Fodder includes both that produced by the household explicitly for livestock consumption, such as berseem, as well as crop by-products, such as wheat straw. In the calculations, no fodder is allocated to chickens, because none of the households reported using fodder in this manner. For commercial poultry, an allowance was made for purchased feed inputs, but commercial poultry involves less than 3 percent of survey households. Finally, it proved impossible to allocate either fodder or purchased feed among the remaining eight types of animal. Thus, the costs for these two inputs were calculated for each type of animal by regressing the total household cost of fodder (own and purchased) and purchased feed on the following variables: number of animals of each type in the household; percent of bovines (cows, buffalo) lactating in the household; and percent of young bovines in the household. This regression was estimated separately by district and by year, thereby allowing for differences in local costs and feeding practices. The imputed fodder and feed costs

[17] In rural Pakistan, as well as in other developing countries, market wage rates differ dramatically for men, women and children. Even if it were possible to assign market wage rates for different types of laborers, these "full wage costs" would have to be adjusted according to whether or not a particular household member was actually employed outside of the home. Such "adjusted" wage rates—adjusted for length and status of outside employment—are very difficult to accurately calculate.

for the different types of animals are the regression coefficients for the various independent variables.

5. DECOMPOSITION OF OVERALL INCOME INEQUALITY

It is useful to employ the decomposition techniques explained above to analyze the effect of livestock income on overall income inequality. Two questions can be asked. First, does livestock income serve to increase or decrease overall income inequality?[18] Second, how much of overall income inequality comes from livestock income?

Table 5 reports the decomposition results for the five sources of income with respect to the distinction between inequality-increasing versus inequality-decreasing sources of income. Both decompositions agree that for all three years, two income sources—livestock and nonfarm—represent inequality-decreasing sources of income.[19] This means that, ceteris paribus, additional increments of livestock or nonfarm income will reduce overall income inequality. Both decompositions also

[18] In analyzing whether an income source is inequality-increasing or -decreasing, it is assumed that additional increments of that income source are distributed in the same fashion as the original units.

[19] For more on the role of nonfarm income as an inequality-decreasing source of income in rural Pakistan, see Adams (1994).

Table 5 Relative concentration coefficients of source incomes in overall income inequality

Source of Income	1986-87		1987-88		1988-89	
	c	g	c	g	c	g
Nonfarm	0.202	0.555	0.214	0.495	0.336	0.598
Agricultural	1.961	1.622	1.719	1.452	1.570	1.427
Transfer	1.375	1.111	1.280	1.209	1.000	1.063
Livestock	0.184	0.397	0.607	0.857	0.064	0.424
Rental	1.703	1.551	1.843	1.410	2.194	1.543

Notes: N = 727 households. The relative concentration coefficients for the different sources of income are calculated from the coefficient of variation (c) and the Gini coefficient (g).

$$c_i = \rho_i \frac{\sigma_i/\mu_i}{\sigma/\mu} \; ; \; g_i = R_i \frac{G_i}{G}.$$

All estimates are based on annual per capita household income expressed in constant 1986 terms.

agree that for all three years, three sources of income—agricultural, transfer, and rental—represent inequality-increasing sources of income.

Table 6 presents the decomposition results for relative factor inequality weights of source incomes in overall income inequality. With only one exception, the results show that livestock income makes the smallest contribution to overall inequality. Depending on the measure and the year, the two decompositions suggest that livestock income accounts for between 0.9 and 11.0 percent of overall inequality. By contrast, the data reveal that in each of the three years agricultural income makes the largest contribution to overall inequality.

The results of Table 6 can be further explained by analyzing the results of the Gini decomposition. This is done in Table 7, which presents the three elements of the Gini decomposition procedure: (1) source income weight; (2) source gini (G_i); and (3) correlation ratio between source income and total income (R_i).[20]

Row (2) of Table 7 shows that livestock income has a low source gini in each of the three years and is thus a relatively equally distributed source of income. Row (3) of the table reports the correlation ratios between source income and total

[20] One problem with decomposing the sources of income inequality using the Gini coefficient is that the Gini is upwardly biased in the presence of measurement error. Since all survey efforts to measure income contain measurement error, this is a potential matter for concern. For a discussion regarding the magnitude of measurement error for the different income sources in this study, see Alderman and Garcia (1993, 14-17).

Table 6 Factor inequality weights of source incomes in overall income inequality

Source of Income	1986/87		1987/88		1988/89	
	wc	wg	wc	wg	wc	wg
Agricultural	0.456	0.377	0.421	0.355	0.426	0.387
Livestock	0.030	0.065	0.077	0.110	0.009	0.060
Nonfarm	0.062	0.170	0.074	0.172	0.105	0.187
Rental	0.220	0.201	0.216	0.164	0.339	0.238
Transfer	0.232	0.187	0.211	0.199	0.120	0.128
Total	1.000	1.000	1.000	1.000	1.000	1.000

Notes: N = 727 households. wc is the factor inequality weight calculated from the coefficient of variation, and wg is the factor inequality weight calculated from the Gini coefficient.

$$w_i c_i, \text{ where } w_i = \frac{\mu_i}{\mu}, \text{ and } c_i = \rho_i \frac{\sigma_i/\mu_i}{\sigma/\mu}.$$

$$w_i g_i, \text{ where } w_i = \frac{\mu_i}{\mu}, \text{ and } g_i = R_i \frac{G_i}{G}.$$

All estimates are based on annual per capita household income expressed in constant 1986 terms.

Table 7 Decomposition of overall income inequality using the Gini coefficient

Measure/Source of Income	1986/87	1987/88	1988/89
Gini coefficient of total per capita household income	0.400	0.448	0.454
Source income weight			
Agricultural	0.232	0.245	0.272
Livestock	0.163	0.128	0.142
Nonfarm	0.307	0.345	0.312
Rental	0.129	0.117	0.154
Transfer	0.169	0.165	0.120
Total	1.000	1.000	1.000
Source Gini (G_i)[a]			
Agricultural	0.932	0.908	0.866
Livestock	0.617	0.886	0.741
Nonfarm	0.586	0.387	0.580
Rental	0.903	0.901	0.902
Transfer	0.785	0.861	0.877
Correlation ratio between source income and total income (R_i)			
Agricultural	0.697	0.717	0.749
Livestock	0.258	0.434	0.260
Nonfarm	0.379	0.387	0.469
Rental	0.688	0.702	0.778
Transfer	0.566	0.630	0.552

Notes: N = 727 households. All estimates are based on annual per capita household income expressed in constant 1986 terms.

$$G_i = \frac{2}{n\mu_i} cov\ (y_i,\ r_i);\ R_i = \frac{cov\ (y_i,\ r)}{cov\ (y_i,\ r_i)}.$$

[a] Source Ginis are high because they include households with zero and negative incomes from different income sources.

income. The figures reveal that in two of the three years, livestock income has the lowest degree of correlation with total income.

The data in Table 7 serve to explain the factor inequality weights reported in the preceding table. Livestock income makes a small contribution to overall income inequality because it has a low income share, a low source gini, and is poorly correlated with total income. From these results, a clear policy prescription emerges, namely, that efforts to improve income distribution in rural Pakistan should focus on expanding livestock income.

6. LIVESTOCK INCOME BY TYPE OF ANIMAL

Using the procedures outlined in Section 3, net livestock income can be calculated using the following identity:

$$\text{Net income for animal}_a = \text{Gross output for animal}_a - \text{Gross input for animal}_a. \quad \textbf{(11)}$$

The results are presented in Table 8. The net income data here are expressed in per capita terms and are based on 702 households from the original 727 households for which data are available.

Table 8 discloses that most net livestock income comes from four types of animals: local cow, male buffalo, female buffalo, and bullock. In any given year, these four types of animals account for over 80 percent of net annual per capita

Table 8 Summary of net livestock income data by type of animal, 1986/87, 1987/88, and 1988/89

Type of Animal	Mean Annual Per Capita Livestock Income[a] 1986/87	1987/88	1988/89
		(Rs)	
Local cows	174.8	142.0	128.1
	(248.5)	(288.9)	(219.9)
Male buffalo	130.9	-10.9	56.5
	(209.2)	(151.9)	(117.3)
Female buffalo	111.3	196.1	193.9
	(169.0)	(367.0)	(321.1)
Bullocks	85.7	39.6	30.9
	(183.7)	(140.5)	(124.2)
Goats	31.1	40.9	20.0
	(66.6)	(132.6)	(81.5)
Chickens	16.3	35.4	33.2
	(29.7)	(75.9)	(61.0)
Donkeys	10.8	-20.8	-20.2
	(50.3)	(123.2)	(94.7)
Commercial poultry	6.6	7.5	19.4
	(157.4)	(136.9)	(275.5)
Sahiwal/imported cows	4.6	6.6	4.5
	(60.2)	(85.2)	(68.5)
Sheep	2.9	6.5	9.2
	(44.7)	(104.8)	(97.2)
Total	574.7	442.9	475.5
	(614.9)	(759.8)	(715.0)

Source: IFPRI Rural Survey of Pakistan, 1986/87 to 1988/89.

Notes: N = 702 households. Numbers in parentheses are standard deviations.

[a] In 1986, 1 Pakistan rupee = US$0.062. All rupees are in constant 1986 terms.

livestock income. The figures in Table 8 underscore a point made by other studies, namely, the variability of livestock income (Seabright 1991, 1992). For the sample as a whole, the interyear coefficient of variation of livestock income is quite modest: between 1.0 and 1.7 percent. However, for certain types of livestock, such as male buffalo, bullock, and sheep, the interyear coefficient of variation is quite high. For example, the interyear coefficient of variation for male buffalo ranges between 2.1 and 13.9 percent, while that for sheep ranges between 10.6 and 16.1 percent. Such fluctuations in livestock income could conceivably affect any decomposition effort that is based on annual data. It is therefore desirable to base the decompositions on livestock income aggregated over the entire three-year period of the study.

This is done in Table 9. Here the 702 households are ranked by quintile groups on the basis of their three-year average total per capita household income. For each quintile, the rows of the table reveal the percent of net livestock income coming from each of the ten types of animals.

Table 9 shows that households in the poorest quintile receive more than 85 percent of their net livestock income from two female animals: local cow and female buffalo. However, in a rather paradoxical way, local cow and female buffalo are also important to households in the top quintile, who receive over one-half of their net livestock income from these two animals. Yet for these rich

Table 9 Sources of net livestock income ranked by quintile on the basis of three-year average total per capita household income

Total Per Capita Income Quintile	Three-Year Average Per Capita Livestock Income[a]	Percent of Net Per Capita Livestock Income from									
		Local Cows	Male Buffalo	Female Buffalo	Bullocks	Goats	Chickens	Donkeys	Commercial Poultry	Sahiwal/ Imported Cows	Sheep
	(Rs)										
Lowest	254.7	59.7	8.6	27.1	11.6	5.7	9.2	-12.3	-0.5	-3.9	-5.3
Second	449.0	33.1	9.7	28.3	9.1	8.2	6.2	-1.0	2.5	2.7	1.3
Third	499.1	33.4	10.1	30.3	8.3	7.2	6.6	-1.5	1.9	1.2	2.5
Fourth	558.7	28.5	12.5	34.2	10.8	6.0	4.9	-1.7	2.3	1.4	1.1
Highest	738.1	15.3	15.0	41.1	12.2	4.4	4.1	0.5	3.3	1.4	2.8
Total	497.2	29.8	11.8	33.5	10.5	6.2	5.7	-2.0	2.3	1.0	1.2

Source: IFPRI Rural Survey of Pakistan, 1986/87-1988/89.

Notes: N = 702 households. Income figures are calculated by averaging per capita household income over the three years.

[a] In 1986, 1 Pakistan rupee = US$0.062. All rupees are in constant 1986 terms.

households, the relative importance of local cow versus female buffalo income is reversed. According to the data, while the proportion of net livestock income coming from local cow falls steadily with quintile group, the proportion of such income coming from female buffalo rises with quintile.

It is not surprising that households in the poorest quintile are so dependent on livestock income from female, as opposed to male, animals. Previous work in Bangladesh and India also found that poorer farmers (i.e., those with less than 2 acres of land) own more cows and female buffalo than bullocks and male buffalo.[21] According to de Lasson and Dolberg (1985,346), the reasons for this reflect the rationality of the poor farmer. With smaller farm size, plowing requirements decline, but feeding costs remain the same. Since barren cows and female buffalo can plow, and pregnant cows and female buffalo can produce milk and offspring, de Lasson and Dolberg hypothesize that poor peasants receive the bulk of their livestock income from female stock.

This hypothesis can be checked by looking at the three-year average number of animals (except poultry) owned by the different quintile groups of households. Table 10 shows that the three-year average number of local cows varies only slightly by income group, but ownership of female buffalo is strongly and positively

[21] See, for example, de Lasson and Dolberg (1985), Gill (1981), and Vaidyanathan, Nair, and Harriss (1979).

Table 10 Distribution of animals (excluding poultry) among quintiles on the basis of three-year average total per capita household income

Total Per Capita Income Quintile	Three-Year Average Number of Animals Owned Per Household							
	Local Cows	Male Buffalo	Female Buffalo	Bullocks	Goats	Donkeys	Sahiwal/ Imported Cows	Sheep
Lowest	1.77	0.42	0.43	0.28	1.83	0.30	0.02	0.44
Second	1.80	0.62	0.61	0.28	1.85	0.24	0.03	0.38
Third	1.63	0.76	0.76	0.31	2.12	0.25	0.02	0.69
Fourth	1.89	0.95	0.98	0.49	2.08	0.23	0.02	0.21
Highest	1.40	1.41	1.37	0.57	1.98	0.12	0.06	1.07
Total	1.70	0.83	0.83	0.39	1.97	0.23	0.03	0.55

Source: IFPRI Rural Survey of Pakistan, 1986/87-1988/89.

Notes: N = 702 households. Chickens and commercial poultry are excluded. Income figures are calculated by averaging total per capita household income over the three years.

related with income. Households in the top quintile own more than three times the average number of female buffalo as households in the poorest quintile.

Why is this so? In the literature, poor peasants are often depicted as preferring female buffalos over cows because of the higher quantity and quality of buffalo versus cow milk.[22] Buffalo milk has a higher fat content (NRC 1981), which makes it more useful as a supplement in poor diets and in the preparation of ghee, which is, itself, a lucrative cash product. Indeed, data from this study show that the three-year average household value of "milk and milk products" for female buffalo is more than two-and-one-half times higher than that for cows: 1,494 rupees for female buffalo versus 556 rupees for cow.

While poor rural households in Pakistan may well *prefer* female buffalo over cows, a closer analysis of the data suggests that poor households simply lack the means to purchase and keep buffalo. This can be seen in two ways. First, female buffalo are far more costly than cows: the average purchase price for a female buffalo is 4,516 rupees versus 2,439 rupees for a cow. Second, female buffalo are more expensive to feed.[23] Annual fodder (own and purchased) and purchased feed costs for female buffalo are 525 rupees as opposed to 473 rupees for cows. In rural Pakistan, poor households buy and keep cows because they are the "poor man's" animal.

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[22] On this point, see Adams (1986), Shrestha and Evans (1984), and Sharma (1982).

[23] In a detailed study of the livestock market in South India, Seabright (1991, 69) also finds that female buffalo are more expensive to feed than cows.

7. DECOMPOSITION OF LIVESTOCK INCOME INEQUALITY BY TYPE OF ANIMAL

The relative concentration coefficients for livestock income based on the decompositions of the coefficient of variation and the Gini coefficient are presented in Table 11. For the three-year period, both decompositions agree that the two main types of male animals—male buffalo and bullock—represent inequality-increasing sources of livestock income. These results parallel those of Tables 9 and 10, which show that net income from and ownership of male buffalo are concentrated in the upper income quintiles. In Table 11, both decompositions also agree that the two principal types of female animals—local cow and female buffalo—represent inequality-decreasing sources of livestock income. These results are also consistent with previous analyses.[24]

The relative factor inequality weights in Table 11 show that only one source of income—female buffalo—makes a large contribution to livestock income inequality. Initially, this finding may seem to contradict the finding that net income

[24] A decomposition of the Gini coefficient based on three-year average per capita livestock income by *district* shows that in each of the four survey districts male buffalo is an inequality-increasing source of livestock income, and local cow and female buffalo are inequality-decreasing sources of income.

Table 11 Decomposition of livestock income inequality based on three-year average per capita livestock income

Source of Livestock Income	Relative Concentration Coefficients		Factor Inequality Weights	
	c	g	wc	wg
Local cows	0.462	0.562	0.138	0.168
Male buffalo	1.146	1.261	0.137	0.149
Female buffalo	0.862	0.939	0.290	0.316
Bullocks	1.222	1.173	0.128	0.123
Goats	0.979	0.896	0.061	0.055
Chickens	0.321	0.442	0.018	0.025
Donkeys	-1.837	-1.747	0.037	0.035
Commercial poultry	4.663	1.970	0.106	0.044
Sahiwal/imported cows	3.595	3.640	0.038	0.039
Sheep	3.712	3.679	0.046	0.046
Total	...	...	1.000	1.000

Notes: N = 702 households. The relative concentration coefficients for the different sources of agricultural income are calculated from the coefficient of variation (c) and the Gini coefficient (g). wc is the factor inequality weight calculated from the coefficient of variation and wg is the factor inequality weight calculated from the Gini coefficient.

$$w_i = \frac{\mu_i}{\mu},\ c_i = \rho_i \frac{\sigma_i/\mu_i}{\sigma/\mu};\ g_i = R_i \frac{G_i}{G}.$$

from female buffalo represents an inequality-decreasing source of livestock income. However, two points need to be considered. First, in this table, the relative factor weights for all sources of livestock income—including female buffalo—are relatively low. Even net income from female buffalo accounts for less than one-third of livestock inequality. Second, Tables 9 and 10 show quite clearly that net income from and ownership of female buffalo are concentrated among upper-income households. The relative factor inequality weights recorded in Table 11 capture the impact of these phenomena.

8. CONCLUSION

This study has examined the impact of livestock income on inequality in rural Pakistan using three-year panel data. Three key findings and several policy prescriptions emerge.

First, the study shows that livestock, income has a favorable effect on income distribution. Of the five sources of rural household income—non-farm, agricultural, transfer, livestock, and rental, only livestock and nonfarm income represent inequality-decreasing sources of income. This means that, ceteris paribus, additional increments of livestock or nonfarm income will reduce overall income inequality.

Second, the study reveals that livestock income makes the smallest contribution to overall income inequality. In any given year, livestock income accounts for only

0.9 and 11.0 percent of overall income inequality. Livestock income is negatively correlated with landownership, which means that this income source is of more potential importance to the poor and landless. By contrast, agricultural income makes the largest contribution to overall inequality, because it is positively correlated with landownership.

Third, the analysis shows that livestock income from various types of animals has a differential effect on equity. Specifically, livestock income from male animals—male buffalo and bullock—is concentrated among the rich and thus has a negative effect on income distribution. However, income from one female animal—local cow—has a positive effect on income distribution. Income from local cow is well-distributed among the population because the poor receive almost 60 percent of their net livestock income from this income source.

From these findings, several policy recommendations follow. In Pakistan, government officials who are interested in improving rural equity should focus less on land and more on livestock. In Pakistan, as in other developing countries, the shortage of land provides the single greatest barrier to raising the rural incomes of the poor. The scope for redistributing land into viable landholdings is limited; moreover, land reform is difficult and seldom confers good land on the poor. By contrast, a national program in Pakistan to give poor farmers quality cows, or to upgrade the

cattle they already own through artificial insemination, would present far fewer social and political difficulties than land reform.

To have maximum benefit on the poor, such a national program in Pakistan needs to focus on raising the milk output of the local cow. At present, the population of low-grade cows in rural Pakistan is extremely large and their milk production is quite low. Moreover, demand for milk and milk products in Pakistan is likely to grow considerably in coming years as urban incomes increase. Crossbreeding can raise milk output dramatically, but more work is also needed in Pakistan on increasing feed intakes, developing new varieties of forage crops suitable for different locations, and (especially) on establishing an effective network of rural veterinarian and insemination services. Such work is still in its infancy in rural Pakistan.

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