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Milk, Fodder, and the Green Revolution: The Case of Mixed Farming in the Pakistan Punjab

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This paper analyses household decisions in producing cereal crops, green fodder crops, and milk, for the case of mixed farming in the Pakistan Punjab. In the Punjab agriculture, increased household income and increased yields of cereal crops after the Green Revolution have resulted in the growing importance of milk in household economy. Using a sensitivity analysis based on a household model of crop choices under uncertainty, this paper emphasises the constraint that fodder represents for further increases in food-grain output. Results show that the welfare cost of production risk is significant, it is higher for land-poor households, and its significant part is attributable to green fodder price risk. The welfare and supply effects of more elastic fodder demand and increased fodder yields are investigated. These innovations in fodder technology are suggested to have a higher potential to improve household welfare and to induce a robust supply response of cereal crops with respect to their prices, than a crop insurance scheme to hedge against yield risk.

1. INTRODUCTION

The Punjab agriculture, both in India and in Pakistan, has been known as the centre of the Green Revolution in South Asia. Due to its highly developed network of public irrigation canals, high yielding varieties of wheat and rice were adopted rapidly in the late 1960s and the early 1970s, resulting in a phenomenal increase in cereal production. The Punjab regions have become the granary of each country, supplying surplus food-grains to other parts.

A recent phenomenon that deserves attention is an increase of the importance of dairy production in the Punjab agriculture [Kurosaki (1995a)]. It has occurred both at the macroeconomic level as an increase of the livestock share in agricultural value-added and at the microeconomic level as an increase of the milk income share in rural household economy.

Despite its importance, very few studies have investigated a microeconomic mechanism underlying this phenomenon. To analyse the micro mechanism, it is necessary to pay due attention to the fact that the major part of dairy activities are carried out in the backyard of farms where crops and dairy production are combined.

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The crop sector and the livestock sector are closely interrelated, among which, the most important connection is the provision of green and dry fodder from the farm land to animals.[1] At the same time, in the contemporary Punjab agriculture, all kinds of fodder are traded so that households need not be in autarky in fodder.

This paper incorporates these observations in a theoretically consistent way. Its emphasis is on the growing importance of milk in household economy after the Green Revolution has increased household income and cereal yields. Using a sensitivity analysis based on a household model of crop choices under uncertainty, this paper emphasises the growing constraint that green fodder represents for further increases in cereal output.

The paper proceeds as follows. Section 2 describes the study area and data sets used in this paper. Section 3 briefly explains the structure of the household model used for the sensitivity analysis. Simulation methods for the sensitivity analysis are described in Section 4. Section 5 evaluates the welfare cost of risk, followed by Section 6 that investigates the effects of changes in the market structure. The last section concludes the paper with policy implications.

2. STUDY AREA

The model in this paper is calibrated for mixed farming households in the rice-wheat zone of the Pakistan Punjab. Parameters are obtained from household data of production and consumption, originally collected in the Sheikhupura district by the Punjab Economic Research Institute, Lahore. The data set comprises 97 household observations each for three years from 1988-89 to 1990-91, for which Kurosaki (1995a) provide more detailed information.

Table 1 summarises information on crop and livestock production and income sources for the sample households in 1990-91. Major cereal crops are Basmati paddy (major cash crop) in the Kharif season and wheat (staple food crop) in the Rabi season. In addition to these two cereal crops, most farmers keep livestock animals and allocate a significant share of cultivated land to fodder crops used as green fodder—mostly, Jowar in Kharif and Berseem in Rabi. The sum of areas devoted to these fodder crops and the dominant cereal crops (rice in Kharif and wheat in Rabi) is 80 to 90 percent in the study area. Milk is the most important livestock product sold to markets regularly. Most households keep several cows and she-buffaloes for milk production. Households feed livestock animals on green fodder from farm land, dry fodder from crop byproducts such as wheat and rice straw, and concentrate feeds such as cottonseed cake. Among these, the expenditure on green fodder (including unpaid costs imputed from village prices) occupied the largest share of the total feed cost at around 70 percent.

[1]In the traditional Punjab agriculture before, the provision of draft powers by bullock to crop cultivation was more important. However, this function is becoming less important today due to rapid development of tractor rental service markets.

Table 1

Land and Livestock Characteristics and Household Income of Sample Households (1990-91)

		Mean	Std. Dev.
Land (Acres)			
Total Operated Land		11.198	9.363
Total Owned Land		9.036	8.724
Acreage under Basmati		6.595	6.375
Acreage under Wheat		6.888	5.830
Acreage under Kharif Fodder		1.916	1.188
Acreage under Rabi Fodder		1.825	1.285
Livestock Size			
Number of Adult She-buffaloes		2.979	1.014
Number of Adult Bullocks		0.856	1.173
AU # of Total Milch Animals		5.693	2.109
AU # of Total Draft Animals		1.389	3.506
AU # of Total Livestock Animals		7.082	4.150
Household Income by Sources (Nominal Rupees)			
Livestock Income	(1)	16978	10751
Crop Income	(2)	24978	20493
Farm Income	(3)=(1)+(2)	41957	24903
Off-farm Income	(4)	8122	3514
Total Household Income =	(3)+(4)	50079	23034

Source: The author's calculation. The original information was collected by the Punjab Economic Research Institute.

Note: The number of observations is 97.

The adult animal units (AU) for livestock animals are defined as follows. Draft animals: 1.0 for adult bullocks/he-buffaloes, 0.57 for young bullocks/he-buffaloes, 0.57 for adult donkeys, 0.28 for young donkeys, and 1.0 for adult horses. Milch animals: 1.28 for adult she-buffaloes, 0.96 for young she-buffaloes, 0.72 for adult cows, 0.54 for young cows, and 0.20 for adult goats.

Markets for agricultural products in the region are well developed so that households need not be self-sufficient in green fodder for their animals or in wheat for their family consumption. Compared with the cases for cereals, however, the number of the sample households participating in green fodder markets was not large. About one-third of the sample households sold surplus fodder and less than 10 percent purchased deficit fodder [Kurosaki (Forthcoming)]. This seems to suggest that smaller farms prefer to be self-sufficient in green fodder even it may imply that they need to purchase deficit wheat. As is shown in Kurosaki (1997), market prices of green fodder are the most volatile among major agricultural commodities in the area, suggesting the localised nature of green fodder markets. From the viewpoint of risk-averse farmers, this structure of green fodder markets implies high risk of transactions. Data indicate that households were well aware of the existence of green fodder markets and participated in them if necessary, but only marginally.

3. A HOUSEHOLD MODEL

A household model in this paper is based on Kurosaki (1996). Its unique feature is that households' crop choices are affected not only by their willingness to bear risk but also by their ordinal consumption preferences for individual goods, when both income and consumption prices are stochastic. The household model is an attempt to link the intertemporal consumption model of risk-coping mechanisms (insurance in a broad sense) with the risk management production model in which the distribution of household income is endogenously determined [Morduch (1990, 1995); Rosenzweig and Wolpin (1993); Rosenzweig and Binswanger (1993)].

Households' objective function is $v(Y, p; \beta, \gamma, \psi)$, where Y is the household income defined below, p is a price vector of consumption goods, and β, γ, and ψ are parameters characterising the function v. Vectors β and γ represent ordinal consumption preferences for individual goods such as the income and price elasticities of demand for a commodity and the share of the budget spent on the commodity. ψ characterises households' observed risk aversion. As discussed in Kurosaki (1996), when households have no *ex post* risk coping measures contingent on a realisation of stochastic elements, the function $v(..)$ is reduced to an indirect utility function and ψ is equivalent to households' *actual* risk aversion (actual risk attitudes); when households have some *ex post* risk coping measures, $v(..)$ should be interpreted as an approximation of a households' value function derived from their stochastic dynamic optimisation and ψ reveals the mixture of households' risk attitudes and the availability of these measures [Kurosaki (1996); Rosenzweig and Binswanger (1993)].

In the model, households choose the acreage shares of the four major crops in the study area (Basmati paddy, wheat, and Kharif and Rabi fodder crops). They are denoted l_{si}, where subscripts s (=k, r) represent two cropping seasons of Kharif and Rabi, and i (=1, 2) represent cereal and fodder crops. These crop activities together with milk production in Kharif and Rabi, and non-farm income Y_N that is assumed to be non-stochastic, constitute households' income flow Y as:

$$Y \equiv f(l,\varepsilon) \equiv \sum_{s=k,\,r} \sum_{i=1,2} \pi_{si}(\varepsilon) l_{si} L_s + \sum_{s=k,r} \pi_{sm}(\varepsilon) A_s + Y_N \qquad \ldots \qquad (1)$$

where π (ε) is per-unit profits from farm activities net of production costs, L_s is the acreage of land available in s, and A_s is the size of a livestock herd in s. π (ε) is stochastic due to price and yield risks represented by ε. ε is revealed after households choose production.

The empirical model has additional, technological constraints on production, which represent resource constraints or lumpiness of some inputs [Eswaran and Kotwal (1986); Chavas and Holt (1996)]. With this addition, the household's optimisation problem becomes

$$\max_{l} E[v(f(l,\varepsilon), p(\varepsilon); \beta, \gamma, \psi)]$$
$$s.t. \quad g_s(l_{s1}, l_{s2}; \alpha_s) = 0, \quad s = k, r \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

where E is an expectation operator, $g_s(..)=0$ are the technological constraints, and α characterises the technical substitutability of the two crops. It is assumed that the optimisation problem in (2) has a well-defined interior solution, denoted by l^*. Kurosaki (Forthcoming) explains the procedure for deriving explicit forms for the first order conditions, based on Taylor approximation following Fafchamps (1992).

This model is able to incorporate in a theoretically consistent way the tradeoff among crops, not only in terms of relative profitability, but also in profit variability and consumption stability. By growing crops whose profits are less variable and less positively correlated with other sources of income, households can obtain income insurance (portfolio effects); by growing crops whose profits are positively correlated with prices of major consumption items, households can obtain consumption price insurance (consumption price effects) [Kurosaki (1995); Fafchamps (1992)]. Using the household data set described in Section 2, structural parameters of this model, i.e., α, β, γ, and ψ have been estimated econometrically in Kurosaki (1996).[2]

4. SIMULATION METHODOLOGY

The strength of structurally estimated household model is that welfare impacts of changes in exogenous parameters can be evaluated in a theoretically consistent way. This is in sharp contrast to a more common, reduced-form approach, which can derive only supply response. In this paper, welfare effects are evaluated by equivalent variation. The welfare status under regime ε_i is expressed as $E[v(f(l_i^*, \varepsilon_i,), p(\varepsilon_i))]$, where household income $f(..)$ is determined by the optimal crop choice (l_i^*) and a stochastic vector of ε_i. Denoting a lump-sum transfer by τ, supply response of the optimal production choice (Δl^*), a change in expected income (Δ $E(Y^*)$), and

[2]The estimated version adopts a specification of the linear expenditure system (LES) for ordinal preferences, constant relative risk aversion (CRRA) with respect to the LES real income that allows structural differences in ψ according to households' ability to smooth consumption *ex post*, and quadratic functions for the production constraints.

equivalent variation (τ_E) of a change from the initial regime ε_0 to a new regime ε_1 are defined as

$$\Delta l^* \equiv l_1^*(\varepsilon_1) - l_0^*(\varepsilon_0)$$
$$\Delta E(Y^*) \equiv E[f(l_1^*, \varepsilon_1)] - E[f(l_0^*, \varepsilon_0)]$$
$$E[v(f(l_1^*, \varepsilon_1), p(\varepsilon_1))] = E[v(f(\hat{l}_0^*, \varepsilon_0) + \tau_E, p(\varepsilon_0))] \quad \cdots \quad \cdots \quad (3)$$

where

$$l_i^* = l_i^*(\varepsilon_i) \equiv \arg\max_l E[v(f(l, \varepsilon_i), p(\varepsilon_i))] \;\; i = 0,1$$
$$\hat{l}_0^* = \hat{l}_0^*(\varepsilon_0, \tau_E) \equiv \arg\max_l E[v(f(l, \varepsilon_0) + \tau_E, p(\varepsilon_0))]$$

Equivalent variation τ_E for a riskless environment, for example, is interpreted as the amount of money that should be given to a farmer under the initial risky regime to make him indifferent between the two regimes. Therefore, it gives the monetised valuation of the welfare cost of risk. These measures of supply response and welfare changes are estimated using numerical methods, whose details are given in Kurosaki (Forthcoming).

5. WELFARE COSTS OF RISK

Table 2 gives results simulated for a riskless environment. It shows that the reference household group ("AVG") would increase the area devoted to Basmati paddy by 29 percent and that to wheat by 47 percent. This resource reallocation results in an increase in expected income to the magnitude of 2.0 percent of the initial expected income. This is the amount of expected income sacrificed for risk diversification. The welfare cost of risk measured by τ_E is estimated at 7.9 percent of the initial expected income in the case of the reference group and it is higher for land-poor households. These numbers are comparable with the estimates for semi-arid India [Walker and Ryan (1990)].

In the second column of the table, the welfare costs of fodder price risk are estimated by eliminating the variability of green fodder prices only. A surprising finding is that, of the total welfare cost of 7.9 percent in the first column, as large as 4.9 points (or about 62 percent) are attributable solely to the price risk of green fodder. Only by eliminating the green fodder price risk in Kharif and Rabi, can households eliminate more than half of the total welfare cost of risk. The finding that the fodder area would decrease dramatically implies that the volatile price of green

Table 2

Simulation Results for Welfare Costs of Risk

	Complete Risk Elimination	Green Fodder Price Elimination
"AVG" Household		
1. Supply Response (Change in Area)		
Basmati Paddy	29.2%	11.3%
Kharif Fodder	–37.0%	–13.3%
Wheat	47.0%	32.7%
Rabi Fodder	–100.0%	–66.9%
2. Change in Expected Income (EY)		
% to the Initial EY	2.0%	1.6%
3. Welfare Change (Equivalent Variation)		
% to the Initial EY	7.9%	4.9%
"Land-Poor" Household		
3. Welfare Change (Equivalent Variation)		
% to the Initial EY	10.9%	9.2%
"Livestock-Poor" Household		
3. Welfare Change (Equivalent Variation)		
% to the Initial EY	7.2%	1.9%

Notes: "AVG" is the reference household group with median characteristics among sample households. It is likely to be close to self-sufficiency in green fodder and almost always have surplus in wheat and Basmati paddy. "Land-Poor" is the household group with half the size of operational land and other characteristics remaining the same. This group is a purchaser of green fodder on average and sometimes is a purchaser of wheat for family consumption. "Livestock-Poor" is the household group with half the size of livestock herd and other characteristics remaining the same. It is a net seller of green fodder, wheat and Basmati paddy, on average.

fodder forces households to grow green fodder to avoid the price risk. This is in sharp contrast to Sandmo's (1971) classic result that a risk-averse firm produces less output under price risk. In our case, a risk-averse firm produces more green fodder under green fodder price risk.

These results suggest a vicious circle. Volatility in green fodder market prices induces farmers to pursue self-sufficiency in green fodder. Low market participation in green fodder markets by these households, in aggregate, results in thin markets with inelastic supply and demand. These are indeed the major reasons for price volatility in local fodder markets.

Another implication is the relative ineffectiveness of crop insurance schemes focused on major cereal yields. At least for the sample farmers in the study region, simulation results confirm that the welfare costs of yield risk are not large. Therefore, crop insurance schemes that are currently debated in Pakistan are not likely to attract farmers' keen interests. This finding is similar to that reported for rural households in semi-arid India [Walker and Ryan (1990)]. It is more likely that interests on crop insurance schemes observed for some farmers in Pakistan are based on their expectation for purely distributive effects of these schemes.

6. EFFECTS OF CHANGES IN FODDER MARKET STRUCTURE

An obvious question is, then, how a change in the structure of local green fodder markets induces a change in household decisions so that the vicious circle is broken. Table 3 gives a summary of results based on a model that incorporates the market equilibrium effects in local green fodder markets. Considering the fact that green fodder is almost a nontradable commodity, a simple, iso-elastic demand curve from the households' perspective is adopted in this section. Since wheat and Basmati markets are more integrated with national markets [Kurosaki (Forthcoming)], their market equilibrium effects are neglected as in the previous section.

Table 3, Column 1 shows what would happen if the green fodder prices are stabilised because the market demand from the households' viewpoint becomes more price elastic. The fodder price stabilisation gives households an incentive to grow more Basmati paddy and wheat whose expected profitability is higher. However, due to the opposite incentive from induced fodder price rises, households would be able to increase the areas for cereal crops only marginally: 0.7 percent in paddy and 0.2 percent in wheat. Nevertheless, the adjustment would increase households' expected income by 1.3 percent and households' welfare by 2.7 percent. As Table 2 has shown, the experimental, complete fodder price stabilisation would enhance households' welfare by 4.9 percent. Of this 4.9 percent welfare gain, 2.7 points (or about 55 percent) could be achieved by a more practical fodder price stabilisation.

Table 3, Column 2 shows what would happen if a change occurs in fodder crop technology as an increase in expected fodder yields per acre. Results indicate that Basmati paddy supply increases by 12.3 percent and wheat supply increases by 8.2 percent. Because production of green fodder is increased, expected fodder prices in local markets would decrease by 21 percent in Kharif and by 15 percent in Rabi. The net effect on expected household income is a 6.4 percent gain and that on household welfare is a 7.4 percent gain. These results show that an increase in fodder yields would free more land for cereal crops whose expected profitability is higher. The land that would be available for cereal crops under increased fodder yields is relatively larger for households with a larger livestock herd ("Land-Poor" group).

Table 3

Effects of Changes in Market Structure

Experiment	(1)	(2)	(3)	(4)	(5)
"AVG" Household					
1. Supply Response (Change in Area)					
Basmati Paddy	0.7%	12.3%	2.6%	3.9%	14.1%
Kharif Fodder	–0.8%	–14.6%	–3.0%	–4.5%	–16.9%
Wheat	0.2%	8.2%	0.7%	1.1%	8.7%
Rabi Fodder	–0.4%	–15.5%	–1.2%	–2.1%	–16.5%
1. Supply Response (Change in Output Quantity)					
Basmati Paddy	0.7	12.3%	2.6%	3.9%	14.1%
Kharif Fodder	–0.8%	2.5%	–3.0%	–4.5%	–0.2%
Wheat	0.2%	8.2%	0.7%	1.1%	8.7%
Rabi Fodder	–0.4%	1.4%	–1.2%	–2.1%	0.2%
2. Change in Expected Income (EY) % to the Initial EY	1.3%	6.4%	11.5%	17.2%	19.2%
3. Welfare Change (Equivalent Variation) % to the Initial EY	2.7%	7.4%	4.4%	13.5%	14.7%
4. Induced Changes in Expected Green Fodder Prices					
Kharif Fodder	3.5%	–21.1%	24.6%	18.5%	1.9%
Rabi Fodder	2.2%	–14.7%	12.3%	10.6%	–2.2%
"Land-Poor" Household					
3. Welfare Change (Equivalent Variation) % to the Initial EY	3.8%	10.6%	–4.3%	6.5%	9.5%
"Livestock-Poor" Household					
3. Welfare Change (Equivalent Variation) % to the Initial EY	1.5%	3.8%	12.5%	18.7%	18.4%

Notes: In Column (1), price elasticities of green fodder demand in Kharif and Rabi are doubled. In Column (2), expected yields of Kharif and Rabi fodder crops are increased by 20 percent. In Column (3), expected prices of Basmati and wheat are increased by 20 percent. In Column (4), these prices are increased similarly, simultaneously with doubling price elasticities of green fodder demand in Kharif and Rabi. In Column (5), these prices are increased similarly, simultaneously with increases in expected yields of Kharif and Rabi fodder crops by 20 percent.

As a final experiment, the effects of rises in the mean prices of wheat and Basmati rice are investigated with or without changes in the fodder market structure (Table 3, Columns 3, 4, 5). As described in Kurosaki (Forthcoming), the government of Pakistan is implementing deregulation policies in grain marketing, which are likely to produce an upward movement of domestic prices for the two commodities. Considering the existing estimates for implicit commodity taxation for wheat and Basmati rice during the 1980s [Qureshi, Ghani and Mushtaq (1988); Salam (1992); John Mellor Associates (1993)], the effects of 20 percent increases in their prices are reported in this paper.

When cereal prices are increased by 20 percent without changes in fodder market structure (Column 3), supply response is very marginal—Basmati paddy area increases by only 2.6 percent and wheat area by only 0.7 percent. If not for the effects of induced fodder price increases, households would want to expand cereal production more substantially. However, because of the market equilibrium effects in local fodder markets, households would be able to increase cereal crops' areas only marginally. The adjustments would enhance households' expected income by 11.5 percent but because of increased variability in household income and due to other repercussions, the welfare gain in terms of equivalent variation would be only 4.4 percent. Furthermore, the net welfare effect on the "Land-Poor" household group is negative (–4.3 percent). Households with smaller land areas and larger livestock herds would not gain much by increased cereal prices since their cereal surplus is small or sometimes negative; they might lose more from increases in expected fodder prices.

Column 4 in Table 3 shows the effects when cereal price increases are accompanied by a more elastic fodder demand and thereby stabilised fodder prices. Column 5 shows the effects when cereal price increases and fodder yield improvements occur simultaneously. Both experiments show that the cereal supply response would become larger than the case without a change in the fodder market structure. An important finding is that when changes in the fodder market structure occur simultaneously, welfare changes would become positive for all types of household groups. Their magnitudes would become larger also—"AVG" households' welfare gain would be as high as 13.5 percent for the case with more elastic fodder demand and 14.7 percent for the case with higher fodder yields. At the same time, there is a change in green fodder market participation by households—households with relatively larger livestock herds would turn more to purchased fodder and households with relatively larger land areas would sell more fodder to markets.

7. SUMMARY AND POLICY IMPLICATIONS

This paper has investigated the microeconomics of mixed farming in the Pakistan Punjab with an emphasis on the growing importance of milk production in household economy. It has been found that the welfare cost of risk is in the range of 7 to 11 percent of the initial expected income, being higher for land-poor households. Of these welfare costs, those attributable to green fodder price risk alone account for the major part. Only by eliminating green fodder price risk, can households eliminate more than half of the total welfare cost of risk. This finding suggests that, since a crop insurance scheme to hedge against crop yield risk may not enhance households' welfare significantly, there may not be substantial demand for such a scheme from households in the study area.

Simulation results based on a simple model of iso-elastic local fodder markets have highlighted the importance of elastic fodder demand or yield innovation in fodder crops production. It is suggested that these changes would result in much improved welfare, especially that of poorer households, and with deeper green fodder markets. Simulation results have also shown that the supply response of cereal crops to an increase in their expected prices would be much larger when the market demand for fodder is more elastic or fodder yields are increased.

Demand for green fodder becomes more elastic when technological innovations occur that create cheaper substitutes for green fodder or that make green fodder more storable and easier to transport. Improved infrastructure for agricultural marketing in general is also expected to contribute to more elastic fodder demand, as well as to more efficient marketing of milk and milk products. Fodder crop productivity at the individual farm level could be improved by extension services and R&D activities which are more focused on these crops. In Pakistan, public expenditure on agricultural research and extension has concentrated on increasing productivity of cereal crops, neglecting fodder crops, since "fodder crops seem to be nobody's responsibility" [Government of Pakistan (1988), p.192]. This paper has shown that additional public investment in fodder technology could contribute to an enhanced production of cereals and to the improvement of household welfare.

Since the analysis in this paper has focused on a static side of production decisions (crop choices), dynamic response in the livestock sector is not investigated fully. Analysing the dynamics of livestock, incorporating the effects of thin fodder markets on crop choices, deserves further study.

REFERENCES

Chavas, Jean-Paul, and M. T. Holt (1996) Economic Behaviour under Uncertainty: A Joint Analysis of Risk Preferences and Technology. *Review of Economics and Statistics* 78:2 329–335.

Eswaran, Mukesh, and A. Kotwal (1986) Access to Capital and Agrarian Production Organisation. *Economic Journal* 96: 482–98.

Fafchamps, Marcel (1992) Cash Crop Production, Food Price Volatility, and Rural Market Integration in the Third World. *American Journal of Agricultural*

Economics 74:1 90–99.

John Mellor Associates, Inc. (1993) *Agricultural Prices Study, Main Report*. Washington, D. C.: John Mellor Associates, Inc.

Kurosaki, Takashi (1995) Risk Attitudes, Consumption Preferences, and Crop Choices in the Pakistan Punjab. Ph.D. dissertation, Stanford University.

Kurosaki, Takashi (1995a) Risk and Insurance in a Household Economy: Role of Livestock in Mixed Farming in Pakistan. *Developing Economies* 33:4 464–485.

Kurosaki, Takashi (1996) Risk, Crop Choices, and Consumption Preferences in the Pakistan Punjab. Paper presented in the AAEA Annual Meeting, San Antonio, (Forthcoming.)

Kurosaki, Takashi (1997) Production Risk and Advantages of Mixed Farming in the Pakistan Punjab. *Developing Economies* 35:1 28–47.

Kurosaki, Takashi (Forthcoming) *Risk and Household Behaviour in Pakistan's Agriculture*. Tokyo: Institute of Developing Economies.

Morduch, Jonathan (1990) Risk, Production and Saving: Theory and Evidence from Indian Households. Harvard University. (Mimeographed.)

Morduch, Jonathan (1995) Income Smoothing and Consumption Smoothing. *Journal of Economic Perspectives* 9:3 103–114.

Pakistan, Government of (1988) *Report of the National Commission on Agriculture*. Islamabad: Ministry of Food, Agriculture and Co-operatives.

Qureshi, Sarfraz K., E. Ghani and M. Mushtaq (1988) Taxes Subsidies on Agricultural Transfer Produces as Elements of Intersectoral of Resources: Magnitude of the Transfer and Search for Policy Options. *The Pakistan Development Review* 37:4 551–556.

Salam, Abdul (1992) Terms of Trade for Agriculture in Pakistan: 1980-81 to 1990-91. *Pakistan Journal of Agricultural Economics* 1:1 60–80.

Rosenzweig, Mark R., and H. P. Binswanger (1993) Wealth, Weather Risk and the Composition and Profitability of Agricultural Investments. *Economic Journal* 103 56–78.

Rosenzweig, Mark R., and Kenneth I. Wolpin (1993) Credit Market Constraints, Consumption Smoothing and the Accumulation of Durable Production Assets in Low-income Countries: Investments in Bullocks in India. *Journal of Political Economy* 101:2 223–44.

Sandmo, Agnar (1971) On the Theory of the Competitive Firm under Price Uncertainty. *American Economic Review* 61:1 65–73.

Walker, Thomas S., and J. G. Ryan (1990) *Village and Household Economies in India's Semi-arid Tropics*. Baltimore: Johns Hopkins University Press.