PUBLIC, PRIVATE, AND SHARED WATER: GROUNDWATER MARKETS AND GROUNDWATER ACCESS IN PAKISTAN

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ABSTRACT

Determining water rights in Pakistan is complex, with canal water changing from state to common to individual property as it moves from the main system to farmers' fields. Overlaid on this system is growing use of groundwater that is pumped and owned by those who can afford to invest in tubewells. Groundwater markets, through which tubewell owners sell water to other farmers, have become the major means of access to valuable groundwater resources for those who are unable to purchase wells. This paper examines the implication of water rights for the operation of groundwater markets in Pakistan, with particular reference to their impact on equity, agricultural productivity, and incomes.

Findings indicate that larger and older farmers are more likely to own tubewells, and hence control groundwater supplies. Groundwater markets improve the access to groundwater for small farmers, landless tenants, and younger households. Although groundwater legally belongs to the owners of the overlying land, in practice it is owned by the owners of the tubewells. However, well owners do not charge full scarcity value for the water. Nevertheless, tubewell water purchasers do not have full access rights: they are frequently denied access when water or energy supplies are scarce. Small and younger farmers are significantly more likely to be cut off. This limits the productivity of groundwater for purchasers.

Joint tubewell ownership provides an alternative means of access to groundwater for small farmers. Because shared tubewell ownership gives farmers a stronger right to groundwater than water purchases, it may be a preferable option. However, the transactions costs of negotiating the joint investment, as well as the sharing of water on an ongoing basis, need to be carefully examined and traded off against the gains of stronger water rights.

INTRODUCTION

The rights to surface and groundwater in Pakistan are part of complex and overlapping physical, as well as legal systems. Canal water changes from state property in the main delivery system, to common property of a group of farmers on a watercourse, to individual property it moves on to farmers' fields. Overlaid on this system is growing use of groundwater that is pumped and owned by those who can afford to invest in tubewells. Groundwater can also be public, private, or common property (depending on whether wells are owned by the state, individual farmers, or groups of farmers), though in practice, most is controlled by private well owners.

Groundwater markets, through which tubewell owners sell water to other farmers, have become the major means of access to valuable groundwater resources for those who are unable to purchase wells. This paper examines the implication of water rights for the operation of groundwater markets in Pakistan, with particular reference to their impact on equity, agricultural productivity, and incomes. It also explores the potential for shared tubewell ownership to provide small farmers with a stronger claim on groundwater resources.

This analysis is based on a study of groundwater markets in villages in two districts of Pakistan: Faisalabad District, in the heart of the canal-irrigated plains of Punjab, and Dir District, in hilly areas of Northwest Frontier Province. It combines household survey data on agricultural production and operation of water markets from 1991/92 with information on current and historic statutory and customary water rights.

intensive irrigation in Pakistan's predominantly arid environment. Since the 1970s groundwater irrigation has been the most rapidly-growing source of irrigation: it now serves approximately 25 percent of the irrigated area, and provides over 36 percent of the irrigation water available at the farm gate (Pakistan: Ministry of Food, Agriculture and Livestock 1991).

From the mid-1950s to 1980 government policy on groundwater development focused on public tubewells, to provide vertical drainage in canal command areas with high water tables. Water from the public tubewells was mixed with canal water, and allocated in the same manner. Because the systems were tied to the same rigid *warabandi* as public canal systems, they did not increase flexibility of irrigation. Rising operation and maintenance expenses for public tube-wells, in conjunction with their poor performance in terms of timeliness and reliability of irrigation supplies (and a general global trend favoring greater private sector involvement), led the government to devolve responsibility for groundwater irrigation development from the public to the private sector. There are now over 374,000 private tubewells in Pakistan, compared to 16,000 public tubewells (Pakistan 1994).

Groundwater rights are not as clearly defined as rights to surface water. Although formally groundwater belongs to the owner of the land over it, in practice this is impossible to monitor. Access to privately-managed groundwater irrigation requires investment in wells and pumping devices, and the well-owners control the water that can be pumped from their well. To the extent that large and wealthy farmers are most likely to own tubewells and small or poor farmers are unable to make the necessary investment, the latter may be excluded from the benefits of highly productive groundwater resources. On the other hand, widespread private ownership leads to overinvestment in wells and pumpsets, particularly where holdings are small or fragmented. Institutional arrangements are needed to spread access to groundwater to other

Although well owners may sell water, this is not a primary enterprise in the study areas Well owners remain farmers first, and only sell surplus water after meeting the needs of their own crops (see also Strosser and Kuper 1994). This is linked to both the price and productivity of purchased groundwater.

Price of Purchased Groundwater

Those who do sell water do not extract much rent from the water: the cost of purchased groundwater was not much higher than the cost of pumping for well owners. The two most common ways of charging for groundwater are a flat charge per hour of pumping (ranging from Rs 14 to Rs 80 per hour, depending on the pump type, capacity, and location), and a "buyer brings fuel" arrangement whereby the buyer supplies the diesel and motor oil for the pump, and pays an additional fee of Rs 4 to Rs 6 per hour to the well owner to cover the wear and tear on the engine. Water sellers with diesel pumps are apparently only recovering their own costs under either type of contract.[2]

A larger sample of water sellers and purchasers under different ecological and socioeconomic conditions would be necessary to estimate the effect of these factors on the cost of private tubewell water. However, it is notable that under both the hourly charge and buyer-brings-fuel contracts, the price of water does not vary over the course of a season to reflect changes in its scarcity and value. It does not appear that the prices reported under either system

[2] Unfortunately, much of the information on price of purchased tubewell water comes from water buyers, rather than from the sellers. There are thus not enough data on tubewell operations costs and water delivery rates to determine the profit margin for water sales or the exact price per unit water pumped.

unavailable for sale or purchase during periods of electricity shortage, and during periods of peak water demand. Not surprisingly, water buyers were more likely to identify problems with water availability than were the water sellers. Over a fourth of Faisalabad water buyers reported that they were unable to purchase water to meet crop needs during times of electricity shortage, although no sellers reported being unable to sell because of electricity shortage. Times of peak water demand are more problematic: nearly a fourth of all sellers and over half of all buyers reported that purchased tubewell water was not always available when needed during such periods.

What influences the reliability[4] of purchased irrigation water? Table 2 presents results of a logistic regression for reliability as a function of tubewell characteristics (source of power, diameter, and depth), buyers' characteristics (land ownership, age), relationship between buyer and seller (relative, landlord), and regional dummy variables (Jaranwala village, Dir District). Results indicate that the type of tubewell and status of the buyer (indicated by land ownership and age) had a significant effect, but the relationship between seller and buyer did not. Electric tubewells are more susceptible to power outages, and are therefore likely to be less reliable. Larger-capacity tubewells are more reliable, but deeper tubewells are not--perhaps because they are located in groundwater-scarce areas. Buyers with higher social status, indicated by land ownership and age, also have more reliable access to purchased tubewell water. If social ties influence reliability of water markets, farmers who buy water from close relatives or their landlords would be expected to receive more reliable irrigation service, but this was not found

[4] It may be argued that, if particular farmers know they cannot purchase water at certain times, their supply is still reliable. In practice, farmers do not have know with certainty whether they will or will not be able to get water at a given time; hence, it is unreliable.

much less than those obtained by tubewell owners. Renfro (1982: 83) concludes that, in comparison with water purchasers, "obviously actual sampled tubewell owners can exert more control over water supplies with favorable impacts on productivity."

In the present study, the contribution of different sources of irrigation to gross margins provides an estimate of the irrigation surplus derived from greater control of water. The gross margin is computed by deducting all cash input costs (including the costs of irrigation) from gross crop revenues. This indicates the returns to land, family labor, and own capital.[5] The present analysis uses a reduced form equation to model differences in household gross margins as a function of season, household size, tenure, land holding, tractor ownership, soil salinity, and district.

Separate dummy variables are used for each source of irrigation or combination of sources, with unirrigated farms as the base. Those farmers using tubewell irrigation conjunctively with canal water have greater recharge and water availability than those who use groundwater outside the command of surface systems. Farmers' decision-making on cropping patterns and input use, and their returns to those decisions, are more likely to take into account the total water availability from all sources. Thus, the benefits derived from each source of irrigation are likely to be affected by whether it is the sole source of irrigation, or is used conjunctively with other sources.

Results of this model are presented in Table 3. Gross margins are higher in kharif than in rabi, in part because of the higher water availability and cropping intensity in that season. Neither household size, tenancy, nor the dummy variable for Dir District have a significant

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[5] Rental payments for land have not been deducted from the gross margins, to ensure comparability between land owners and tenants.

WATER RIGHTS AND WATER MARKET OPERATION

To what extent can the behavior of informal water markets in Pakistan be explained in terms of water rights? The answer is far from clear--as, indeed, the rights to groundwater are far from clear. There is a range of overlapping legal and normative repertoirs (Spiertz 1995) which may apply: statutory laws such as the Canal and Drainage Act; religious laws based on Islamic tradition; rights based on inheritance and relationship; and norms regarding behavior to neighbors and kin. Statutory law gives rights to groundwater to the owner of overlying land. This would imply that well owners could sell water, but it is conceivable that farmers with land near a well could claim that the groundwater was pulled from under their land, and hence they have right to it. Islamic law forbids the sale of water, especially surplus water (Wescoat 1995). While water confined in a reservoir or vessel can become private property, it is unclear whether a well constitutes such a vessel. There may be other bases for non-owners of wells to assert a claim on groundwater, especially where there is common descent from the original well owner (e.g. where land has been partitioned between brothers, leaving the well on the land of one).

The limits on the price in informal groundwater markets could therefore be seen as reflecting limits on private "ownership" of groundwater, and an acknowledgment of the implicit claims of neighboring farmers to water from a tubewell. If tubewell owners are not seen as the owners of the water, the transaction would be more the rental of tubewell equipment (akin to tractor rental), rather than sale of water (see Saleth 1994). However, Shah (1994) suggests that this is mostly an academic distinction, and in interviews farmers did not conceptually distinguish between the two.[6] Nevertheless, given the evasiveness of definitions of rights

[6] Based on extensive IIMI research, VanderVelde (personal communication, 1996) also finds no evidence "that anyone other the land owner is entitled to the water in the

Wood (1995) explains that a fixed price reduces transactions costs, and it avoids perceptions that a seller is profiting from the misfortunes and water needs of the buyer (who is often a neighbor, or relative, or both). Maximizing profits from water sales can lose reputation and goodwill, and cost the seller more in the long run. This is especially true in Pakistan, where "izzat", or honor, is a prized commodity. Providing water to others can earn "izzat", but charging prices in excess of what is locally sanctioned, would lose "izzat". This is consistent with Islamic hadiths, or traditions: well owners do not profit from the sale of "surplus" water, but are under no obligation to cut back on their own water use (especially in periods of scarcity or peak demand) in order to provide water to others. Vander Velde (personal communication, 1996) reports that farmers in Pakistan persistently assert "that water cannot and will not be denied anyone facing disaster (i.e. actual loss of crop)." For well owners to assert this norm and ask only a "reasonable" price to cover their costs is important to preserving "izzat," and a local reputation as a good Muslim.

While the norm of providing water to anyone facing disaster is widely held, it is not always followed, especially if it would involve putting the well owners' crop at risk. In Pakistan as in Bihar,

> the notional existence of such a general price does not translate into economic entitlement for those prepared to pay the price. Such families can be, and often are, denied the use of a pumpset (Wood 1995:29).

The limited access in times of scarcity reflects the subordinate rights of purchasers.

JOINT TUBEWELLS AS ALTERNATIVES TO WATER MARKETS

Neither public (canal or tubewell) nor private (tubewell) water supply systems adequately meet the needs of small farmers for reliable water under their control. Joint tubewell ownership

the initial purchase and deciding where to locate the tubewell. Then agreements must be reached for how to share water, expenses, and maintenance responsibility on an ongoing basis. Aggarwal's (1995a) study of group wells in Andhra Pradesh, India, found that in existing group wells, everyday allocation of water could be managed by simple rules of thumb, but mobilizing resources for maintenance and expansion was more difficult. If such investment is difficult for existing groups, the obstacles to organizing for the initial investment would be even greater. This would be especially problematic in areas without established traditions of cooperation, as in many areas of Pakistan (see Byrnes 1992; Merrey 1979).

Furthermore, the water sharing arrangements may restrict a farmer's degree of control over tubewell use. Strosser and Kuper (1994) found that, while sole owners of tubewells in their study area had a higher cropping intensity and larger areas under the main crops (wheat and cotton) than other farmers, tubewell water purchasers and tubewell shareholders had similar cropping intensities and areas under wheat and cotton, suggesting that tubewell water purchasers and tubewell shareholders face irrigation services of similar quality. Examination of gross margins from agricultural production in Faisalabad and Dir indicates that even shareholders in tubewells do receive higher returns than water purchasers. Further research with a larger sample of sole and joint tubewell owners is required to determine how much water control each type of farmer is able to exercise, and the consequent impact on productivity and incomes.

Promoting joint tubewell ownership among small farmers requires more than simple policies such as preferential access to credit or technical assistance for groups of farmers (though these may help). What is required is attention to ways to facilitate cooperation, both for initial investment and ongoing operation. Studies of the history of formal and informal joint tubewell groups would be valuable in this regard. This should include information on how they came

and have become a major means of spreading access to groundwater.

Evidence from study areas in Faisalabad and Dir districts indicates that in these informal exchanges, well-owners do not extract a large "rent" for the water resource. The implicit rights of adjacent farmers to groundwater from a tubewell, based on statutes, shariat edicts, and inheritance may play a role in limiting the price of groundwater, but it is likely that repeated interactions among neighbors plays a greater role. However, water purchasers cannot always obtain access to groundwater, especially at times of peak demand, when tubewell owners use much of the well's capacity for their own fields. This subordinate right and unreliability of access limits agricultural productivity for those who must depend on water from other people's wells.

Shared tubewells provides an alternative means for small farmers to obtain access to groundwater. While joint ownership of irrigation infrastructure is likely to provide stronger rights to the resource, they also entail higher transactions costs. The need for farmers to cooperate in initial investment, allocating and distributing the water, and in maintaining and expanding the system provides a significant barrier to the creation of common property groundwater resources, even among small groups at the local level. However, as fresh groundwater resources become scarce, such institional mechanisms for sharing the resource are likely to become increasingly important to ensure the productivity and equity of resource management.

Table 2—Logistic regression model for reliability of purchased groundwater

Independent Variables	Coefficient	T Ratio	Wald Statistic
ELECTRIC	-2.189 **	-2.934	8.617
DIAMETER	1.267 **	2.368	5.587
DEPTH	-.026	-1.245	1.553
LANDOWN	.072 **	1.986	3.949
AGE	.045 *	1.844	3.398
RELATIVE	.855	.866	.750
LANDLORD	10.613	.435	.189
JARANWALA	.668	.726	.527
DIR	4.209 **	2.397	5.745
Constant	-5.929 *	-1.838	3.378

Model Chi-Square = 58.2 ** with 9 degrees of freedom
Number of observations = 96.0

Classification Table for Reliability of Purchased Tubewell Water

	Predicted		Percent
	NOT RELIABLE	RELIABLE	Correct
Observed			
NOT RELIABLE	49	6	89.1
RELIABLE	9	32	78.5
		Overall	84.4

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