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GROUNDWATER MANAGEMENT: EQUITY, FEASIBILITY AND EFFICIENCY

Camilla Toulmin and Mary Tiffen

ODI/IIMI Irrigation Management Network Paper 87/1e April 1987

Papers in this set

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ISSN: 0951 189X

GROUNDWATER MANAGEMENT: EQUITY, FEASIBILITY AND EFFICIENCY

A Discussion Paper

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GROUNDWATER MANAGEMENT; EQUITY, FEASIBILITY AND EFFICIENCY

Camilla Toulmin and Mary Tiffen

1. INTRODUCTION

This paper is intended to provoke discussion of issues related to groundwater management. It stems from various sources. First we received two papers by Professor Tushaar Shah of the Institute of Rural Management, Anand, India, which followed on from his previous work, which members may remember (Paper 11d, "Transforming groundwater markets into powerful instruments of small farmer development", November 1985). We summarised some of Shah's arguments relating to the externalities caused by well interference and a permanent decline in the watertable and circulated them to a few members of the Network with a specific interest in groundwater development. The responses revealed the difficulties in managing groundwater in situations where it is scarce, with conflicts between equity, efficiency and feasibility. We would particularly welcome more comment from members in countries where groundwater is a scarce resource, on feasible methods of rationing it.

The second source was a stimulating Workshop held in February 1987 at the Water Resources Development Training Centre, University of Roorkee, India, with the title Common Property Resources with special reference to Access of Small and Marginal Farmers to Groundwater. Most of the participants were Indian researchers who reported on the studies they had made on the operation of groundwater markets in different localities, (with assistance from the Ford Foundation). The Workshop was extremely useful in pooling existing information on groundwater markets in India. It also began to define the different types of groundwater situation, and areas for further research. Shah, Niranjan Pant and Chambers subsequently visited Eastern UP, including the Deoria District where Pant had worked earlier on groundwater development, and this resulted in further reflections written up by Chambers.

It is useful to distinguish two levels of management: management of the aquifer, which is usually a government responsibility and which may involve various monitoring and regulatory activities; and management of the water extraction mechanism, (WEM), which may belong to an individual, a group, or a local or central government organisation.

2. ROLE AND IMPORTANCE OF GROUNDWATER

With so much money and research work carried out on developing and improving the management of large-scale irrigation schemes, there is a tendency to forget the very great role played by groundwater exploitation for irrigating crops. In the case of India, about one-third of all irrigated land depends on groundwater and Dhawan estimates that groundwater productivity is double that of surface water. He accounts for this difference by the fact that well water is under the farmer's control (subject to the availability of water for purchase and power for pumping) and can thus be applied at the appropriate time and in the right quantity (Dhawan, 1987). The gains are particularly great in the case of private tubewells, since public tubewells are not at the command of the farmer. This was shown in a study in Pakistan, (Table 1).

Kolawalli, in his presentation at Roorkee, was concerned to find out why farmers were prepared to pay more for well water than canal water. He found in the area he observed that farmers used well water to give themselves virtually an on-demand system instead of relying only on the scheduled supplies from canals. This enabled them to eliminate risk of crop stress, augment the canal supply to stretch the beginning or end of a cropping season, or to increase intensity from two to three crops a year. The value of well water at certain seasons in terms of adding to production or preventing loss justified its higher cost.

The fact that much groundwater in India and Pakistan is used in conjunction with canal water or tank water raises many issues concerning the proper management of canals in large gravity systems and of field

Table 1: Average Yields per Hectare for Four Water Supply Situations in Pakistan (1978)*

Water Supply Situations	Average Yield per hectare (kg)			
	Wheat		Paddy Rice	
	No. farms	kg/ha	No. farms	kg/ha
1. No control (no tubewell)	170	1681	75	1308
2. Fair control (public tubewell supplies)	33	1868	13	1775
3. Good control (purchase from private tubewell)	133	1962	35	1962
4. Very good control (tubewell owners)	42	2242	9	2148
TOTAL:	378		132	

*From Lowdermilk, M. K., A.C. Early and D.M. Freeman. Farm Irrigation Constraints and Farmers' Responses: Comprehensive Field Survey in Pakistan. Water Management Research Project Technical Report 48. Fort Collins, Colorado State University, Sept. 1978.

channels in tank commands. In the latter, as a team from Anna University observed, farmers need the flexibility to manage channels using alternative water supplies from the several wells in the command when water is short in the tank. More importantly, in water-logged areas of large gravity systems it may be advisable to deliver less water from canals, (perhaps extending the area served by canals) and to encourage the use of groundwater to improve drainage. (IIMI Pakistan may develop a research programme in this area). There are so many issues to be raised concerning conjunctive use of canal and well water that this deserves a separate paper. We would welcome contributions on this topic, but will not treat it further here.

S. P. Sangal, Deputy General Manager of the National Bank for Agricultural and Rural Development, reported at the Roorkee Workshop that it is now estimated that 39.4 million hectare/metres are available for groundwater development in India, of which only about one quarter is so far utilised. He also said the available resource might be revised upwards substantially. These figures indicate the important potential contribution of groundwater to Indian production. However, in some countries in the Middle East and in parts of India, farming is drawing down aquifers faster than they can be recharged, which will lead eventually to a decline in the area utilised. In still other areas, agricultural productivity is threatened by rising water tables.

3. VARIATIONS IN GROUNDWATER AVAILABILITY, ACCESSIBILITY AND QUALITY

Groundwater resources vary greatly in terms of their accessibility and ease of recharge. The first depends both on the structure of rocks and aquifers and the cost and availability of different water-drawing technologies in relation to local incomes and opportunities. The second also depends on the physical characteristics of the water table and on its relation to other bodies of water from which it could be recharged, such as from rivers or canals and from surface irrigation. Quality may be affected where there is danger of saline intrusion.

Differing combinations of access and rechargeability provide a variety of situations in which different groundwater policies are appropriate. For example, concern will be much greater regarding the mining of an aquifer for which recharge is very limited where the means of groundwater extraction are readily available than where high costs of exploitation greatly limit actual offtake. In this latter case, the long-term consequences of groundwater mining may outweigh the adverse distributional impact of having groundwater available only to those able to mobilise the high investment cost needed. By contrast, where groundwater is in plentiful supply and particularly where its extraction would improve farm productivity due to water-logging, policy can be oriented towards maximising access to this resource and spreading the benefits of its use amongst the rural population. Shah 86 classified 4 main situations, shown in Table 2. Workshop participants began to work on a more elaborate matrix on appropriate policies and technologies for *the poor to gain from groundwater*.

The depth at which the groundwater lies is a crucial parameter, since it affects the expense of tapping it, the type of pump required, and the discharge rate. With deep wells it becomes necessary to make economies of scale by extending the command area as far as possible and intensifying cropping, so that the capital equipment is used for as many months as possible. Further investment is required for channels, underground pipes, etc. In these circumstances, more farmers are served, and management becomes a more complex affair than with a single hand pump or small mechanised unit serving one owner or a small group. In some cases, there is no choice: there is only one available aquifer and the

Table 2: Policy options for groundwater management*

Policy options	Water-logged area	Good ground-water area	Poor ground-water area	Risk of saline intrusion area
Likely impact of sustained withdrawal	++	+	-	--
Power pricing				
a) flat component	nil	high	high	high
b) pro rata component	nil	low	low	high
Power supply regulations	very liberal	liberal	limited	very stringent
Siting regulations	very liberal	liberal	stringent	very stringent
Capital cost subsidy (+)/ tax (-) on wems	++	+ to resource poor	-	--
Surface water irrigation	Strongly discourage	discourage	strongly support	strongly support

* Table presented by Shah at Common Property Resource Workshop on Groundwater, WRDTC, University of Roorkee, February 1987.

depth and its consequences must be accepted. However, in other cases, as in parts of Bangladesh, there may be a choice between deep and shallow tubewells. There are social, economic and technical pros and cons to be considered in choosing between deep and shallow wells (DTWs and STWs) when both are technically feasible. Because of this, it is important that research into these issues is carried out on an interdisciplinary basis: the Workshop at Roorkee was fruitful because it included both social scientists and engineers. In addition, there may be agronomic considerations; in the case of the first DTWs in Bangladesh, there were unappreciated agronomic reasons why the recommended crops and cropping intensities could not be adopted by many farmers, affecting the economics of the wells (P.Smith, personal communication).

4. MEANS TO MAKE GROUNDWATER ACCESSIBLE TO POOR FARMERS

As the title of the Roorkee workshop indicates, groundwater is usually regarded as a common property resource. However, unlike the case of common grazing grounds, it requires investment by a particular individual, group or institution to tap it. Therefore, it is right that the investment should give some return to the investor, who will also expect to cover his running costs, and in the case of an individual or group, make some profit as a reward for management skills and time inputs. Further, the well has to be sited on a particular piece of land, which is often individually owned. If channels or pipes are necessary to distribute the water to parcels of land owned by different persons, individuals may have to be compensated for loss of land or disturbance. Thus, there is a complex of private and common property rights involved.

There is generally an interest to see that the rural poor are able to get access to groundwater, and that this resource is not exploited and used solely by those who have above-average access to capital and land. Attempts to improve access to the groundwater resource by the rural poor can operate through several mechanisms:

a. helping poor people develop their own water supplies by credit programmes, which may be addressed to individuals or groups. Additional assistance may be provided through programmes to educate them in the technical and financial requirements of managing the group asset.

b. providing publicly-run DTWs which either
   - pump additional water into canal systems, providing water on identical terms to canal water.

   or - sell water direct from the well, at a small profit, at cost or on subsidised terms.

c. Government installation of DTWs or STWs which are subsequently sold or rented to groups of farmers to manage themselves, at cost or subsidised terms.

d. affecting the terms on which groundwater is sold from private wells, by encouraging as many farmers as possible to invest in wells (thus increasing competition) and by manipulating the electricity tariff in the case of electric pumps so that a flat rate makes it attractive to sell water at cheap prices (see Shah 1985).

A number of government agencies and NGOs have been active in pursuit of a. above while writers like Shah have argued that major improvements in rural welfare can be attained by means of d.

In Pakistan, Bangladesh and also in India, the State through the Department of Irrigation, or special parastatals or District Councils, has intervened to provide DTW's capable of irrigating large areas at costs lower than would be possible with many small STW's. In many cases running costs have been higher than expected, costs have proved difficult to recover from farmers, and because of inefficiency, shortage of spare parts or interruptions in the supply of fuel, farmers have not received water in a timely and reliable fashion.

5. POLICY AND PRACTICE ON GROUP OWNERSHIP OF WELLS

a. Formal groups (co-operatives)

In view of the current movement of opinion in favour of privatisation, it is particularly important to understand how privately-controlled wells operate in considering the options for a transfer of state wells into other hands. Where such transfers have taken place, as in Bangladesh, it has often been stipulated that the recipient farmers should be organised into a formal cooperative. However, it has often not been tested whether formal cooperatives work either more efficiently or more equitably than the more informal management systems found in the private sphere. First results from a research project based at Bangladesh Agricultural University indicate that there are no significant differences in levels of productivity and efficiency between wells operated under different systems of management (Mandal & Palmer-Jones 1987). Comparative research in other areas would be useful.

b. Informal groups

Within informal groups, we can distinguish between those initiated by outside organisations and those developed by farmers themselves.

Several programmes have been set up to help marginal farmers and the landless cope with financial constraints and to develop their own water supplies both for their own use and for sale of water to other farmers, such as that run by the Grameen Bank and Proshika of Bangladesh. These are discussed by Wood (1984), Mandal & Palmer-Jones (1987) and Nagabrahman & Vengamaraju (1987). There are also cases where small farmers have been able to gain access to groundwater supplies by cooperating with others to raise the funds needed to dig a well. These informal coops then operate like a water company, the well supplying water not only to the joint investors but also to neighbouring farmers. Successful water coops are usually formed by close relatives and neighbours, and those of similar caste and social class (Nagabrahman & Vengamaraju 1987, Shankar 1987). Shah's material from the water-scarce village of Anklav in Gujarat provides examples of complex water supply companies with up to 150 customers (Shah & Vengamaraju, 1986).

A feature of the groups studied in India was the wide range of patterns in regard to ownership of the WEM and payment for the water. Because farmers had several plots, not all of which were within the command area, they might well be sharers in one well, or sellers of water from their own individual well, and at the same time, buyers from another.

One of the interesting things to emerge from the Palmer-Jones and Mandal paper was that in many cases in Bangladesh the groups managing and selling the water had become smaller over the years, in some cases reducing to one person or two or three relatives. This did not necessarily mean that the command area had shrunk, as the sellers supplied other farmers. The Workshop members became conscious that there could be high transaction costs to farmers in belonging to a cooperative or group owning a well, if this meant they had to take an active part in management decisions, solving problems and quarrels, etc. In some cases farmers actively prefer to specialise in farming, and to buy water from a professional manager. Provided there are many wells in the area, with overlapping command areas, so that the seller does not have monopoly power, prices for water tend to stabilise round a common and reasonable average. Chambers, after his further explorations in UP after the Roorkee Workshop, enquires "Is it really worthwhile trying to form groups, given the equity of the market with saturation?" This leads him on to a second policy question: "How can saturation (with pumps) be achieved rapidly in unsaturated areas?" This last question leads us back to questions of credit and subsidisation.

Saturation and competition also bring us back to the STW versus DTW argument. A monopoly situation is much more likely to arise where a government-operated DTW sells water at a cheaper price than is possible from privately-operated STWs with smaller commands. Chambers recently visited an area of Eastern UP where World Bank tubewells with large commands were being installed in an area where there were many group and private wells. It is worth noting that the Bank wells received a dedicated power supply for 22 hours a day, whereas other pump owners got electricity for 6 - 8 hours. Of the 4 visited, only one was in commission, and it had put out of business several private and group wells. In view of the record of state wells elsewhere, the fear expressed by one farmer seems reasonable:

> All the group and private wells will fail because of the World Bank well, and then it will itself fail.

(Chambers 1987)

On the other hand, if the Bank tubewells are efficiently operated, then farmers will benefit from cheaper water. We need more investigations into how things work in practice. Swaminathan was not too hopeful about the performance of 96 Panchayat (Rural Council) wells installed in 1969 in Coimbatore. When he looked at these recently many were not functioning at all because they had no energy. Others were suffering from disputes about who would be served, problems over rights of way for channels, pressures against using a DTW that might affect the operators of STWs, etc. (Swaminathan 1987)

The solution is not necessarily, or not only, to sell DTWs into private ownership. In Bangladesh farmer groups generally preferred STWs to DTWs where they had a choice, because they could be managed by smaller and therefore more cohesive groups. The difficulties farmers sometimes experienced in managing large command areas with numerous farmers led to various special programmes such as the Irrigation Management Training Programme in Bangladesh to give farmers management training, and to organise them into more cohesive sub-units, by dividing the command into blocks. This claims to have succeeded in doubling the command area of assisted DTW's (Baset 1986), but some investigators have doubted the durability of the effect, and questioned if intensive training can be replicable on a large scale.

6. FORMS OF PAYMENT FOR WATER AND ENERGY

We need to distinguish between economic efficiency (maximising returns to the scarce resource) and other types of efficiency such as water efficiency (preventing waste, maximising returns to water) and energy efficiency (maximising returns per unit of power). The three forms of efficiency may coincide, but do not always do so. In Network Paper 86/2b Svendsen argued that farmers should face a water charge more closely related to actual consumption and to the costs of supply if greater water-use efficiency is to be achieved and if the financial viability of irrigation projects is to be assured (1986). In the case of groundwater, water may be paid for on the basis of quantity supplied, by an hourly pumping charge or by the farmer himself providing the diesel fuel required for pumping, or by a metered electricity supply. In other cases it is paid for by an area charge, sometimes differing for different crops. This variety provides an opportunity for research work to test the efficiency of water use under different charging systems.

The use of electricity prices for promoting rural equity has consequences for levels of economic activity and welfare within both the irrigation and other sectors. Shah argues that groundwater markets exhibit a strong responsiveness to intervention and that policies should be designed to work through these markets (1986). For areas where groundwater is relatively abundant, he favours flat-rate power tariffs to lower water prices and expand groundwater sales. This should benefit poorer sections of the community, since they can then afford to use more irrigation water on their own land and there will be increased demand for labour due to the adoption by all farmers of more water-intensive crops.

The main disadvantage to use of a flat-rate power tariff is that it will encourage inefficient use of power and water supplies, with adverse distributional consequences for other actual and potential users of electricity and water in agriculture and elsewhere. This is important in areas where groundwater is short in relation to demand. From his work in Tamil Nadu, Copestake estimates that a farmer with a 3hp electric pump, run for 400 hrs/year, pays only one quarter of the charge that would be levied on an electricity user outside the agricultural sector, giving an implied subsidy more than 3 times the actual rate paid by the pump owner of Rs. 225 (1986). As a result, demand for power far exceeds supply, leading to the rationing of power by, for example, limiting the number of new connections available. Alternatively, there may be frequent power cuts, leading to uncertainty and loss of output (Chawla et al. 1987, Shankar 1987). Outside the farming sector, enterprises are discouraged which themselves use electricity, such as rural industries that could provide valuable employment to the local economy.

With a flat-rate power tariff, pump owners have no incentive to avoid wastage of power and water, since each additional unit is of negligible cost to them. Most studies of tubewell development find high levels of wastage due to low levels of pumping efficiency, attributable either to negligence or to deliberate tampering with the pump; for example, by partially closing the valves and thus reducing greatly the water pumped per unit of electricity (Copestake 1986). Charging for power on a high pro rata basis, such as happens in Anklav, a water-scarce village in Gujarat with a very deep water table, can generate high levels of water-use efficiency; here, for example, many pump owners have invested in canal linings and the installation of pipelines to conserve water. (Shah and Raju, 1986).

The use of pro rata power tariffs does not always guarantee efficient use of power. Copestake's own material shows diesel pumps to be operated at efficiency levels equal to or even lower than those for electric pumps, a surprising finding given that diesel pumps have a non-negligible marginal cost.

Low pumping efficiency has been attributed to a variety of causes: reducing the pump's flow means the farmer does not have to maintain such close supervision of the irrigation operation and thus saves him time, and pump owners may also not be clearly aware of how far efficiency falls (and costs rise) as a result of certain practices. Widespread pump inefficiency would suggest that power costs are relatively unimportant in determining water prices. If this is so, then policies aimed at affecting groundwater markets that act through power prices should not have much effect. Alternatively, perhaps a certain level of inefficiency must be assumed as a given and about which little can easily be done.

Pro rata power tariffs are likely to be a necessary condition for greater water and power efficiency, but what are the other conditions sufficient to achieve this? Would the spread of smaller scale pumps prevent wasteful practices, such as closing the valves as described above? Do programmes of technical advice have a significant impact on levels of efficiency? Is the reason why farmers use pumps of greater horsepower than necessary because they believe them to be more durable and reliable? Is it because the smaller pumps and their spares are not yet so readily available? If the latter is the case, the situation may be changing in India. S. P. Sangal in his report to the Roorkee Workshop said 3 hp units are now more available and .75 and 1.75 hp pump sets are coming on to the market and farmers are using them with their domestic electricity supply.

It has also to be realised farmers are not always concerned to get the cheapest water or energy. They may put a premium on reliability or convenience. In some areas Chambers and Pant noted a gradual switch from electric pump sets to diesel, preferred as more reliable and moveable from tube to tube. (Chambers 1987)

Pump owners may themselves charge farmers using their water in a variety of ways. In the Indian and Bangladesh case studies, examples were cited of flat charges per hectare, a charge per hour of pumping, or a share of the crop being irrigated. It is to be expected that each of these modes of charging will have different effects on the behaviour of both buyer and seller - an area of investigation in which Palmer-Jones is particularly interested, and on which he invites correspondence.

The consequence for efficient use of resources of sharecropping contracts for land use has been under study for some years, the general conclusion being that sharecropping represents a second-best solution given the prevailing constraints, such as risks to crop production, and absence of insurance markets and risk aversion amongst both tenants and landowners. Information is much more limited on sharecropping where water rather than land is the resource being shared, although it has long been common in the Middle East and North Africa. Shah's study of groundwater markets in India describes a contractual form for Anklav, where the water-seller provides water and half of the fertiliser, the water-buyer proves labour, land and the other half of the fertiliser and the final crop is shared on terms varying from 33% - 60% (1986). Mandal and Palmer-Jones found typical shares for water supplies were 20% to 30%.

There is mixed evidence on the actual efficiency of resource use under water sharecropping systems. From Palmer-Jones' work in Bangladesh, cropshare systems seem to exhibit significantly lower crop yields and smaller command areas than where a fixed charge per unit area is charged on water delivery (1987). One reason for this may be that the water-buyer has reduced incentive to purchase complementary inputs, such as fertiliser and pesticide, since the cost of these is borne by him whereas the benefit from their use is partially appropriated by the water-seller. Secondly, the effective charge per unit area under the cropshare payment system may be substantially higher than under other charging systems, making water far more costly in the former case and thus reducing demand for this input. However, the water provider shares the risk of a poor crop. Wood's survey of group-managed wells under the Proshika landless credit programme in Bangladesh provides a contrasting case in which wells performed relatively better where a cropshare system was in operation (1983). However, in the cases described, the agreement between water-seller and -buyer usually specified a given package of cultivation practices to be followed by the water-buyer, thus reducing the disincentive to use other inputs noted above.

As far as rural equity is concerned, Palmer-Jones concludes that the spread of sharecropping "is likely to be adding considerably to rural inequality" the advantage of cropsharing to the water-seller being to allow "appropriation of income streams by WEM owners at the expense of productivity of the unit" (1987, p.34).

Little comparative material on sharecropping where water is the only input shared is as yet available from elsewhere; it would be interesting to get network members to pool their experiences on the existence of such contracts in other contexts, their operation and effects on equity and efficiency of resource use. In particular, it would be useful to focus on questions such as the following:

- what seems to be the incidence of sharecropping with water and with what particular factors is it associated?

- is the inefficiency associated with sharecropping found by Palmer-Jones also found elsewhere? Is it common for water-sellers to prescribe a particular input package to the buyer, as noted by Wood?

- are there not significant benefits to be derived by the water-buyer from sharecropping with water by, for example, creating an incentive for the well-owner to maintain reliable supplies of water, as the assurance of his getting paid depends on continued irrigation of the share plots?

- is the high implicit charge per unit area under sharecropping a function of the well-owner's monopoly power or a function of the cost of bearing the risk of failure of essential supplies (fuel, spare parts, etc.)? Palmer-Jones notes some downward pressure on the size of crop share, in some areas from 33% to 20-25%. This could be caused either by reduced perception of risk or increase in the number of competing water suppliers.

7. WELL-SITING CONTROLS, GROUNDWATER REPLENISHMENT AND EQUITY

In many areas, attempts to control groundwater extraction rates have been made by limiting the number of new wells that can be dug in a particular zone, by imposing minimum spacing requirements between new and existing wells, by restricting the number of new electrical connections, by refusing credit to those in certain zones, or by licensing well digging.

Sound arguments usually underlie the imposition of these controls, such as to prevent interference between wells and to limit over-use of an aquifer; but they also have distributional implications for incomes. For example, in some countries spacing norms apply only to modern wells, so that while a new WEM cannot be established next to another modern WEM, there is no bar to it being dug next to traditional shallow wells which will suffer substantially from reduced draft. (In some Moslem countries, all wells traditionally have their own protected area). Similarly, "spacing regulations create and strengthen the monopoly power of existing owners of WEMs" (Shah, p.11) protecting them from competition from other suppliers of water and keeping water prices higher than would otherwise be the case. To the extent that spacing controls are only enforceable through institutional credit channels, they also will mainly affect only the resource-poor farmer.

As it is difficult to limit extraction rates some writers have proposed that more attention be paid to replenishing groundwater supplies. Various techniques have been developed to promote artificial recharge and greater natural recharge of aquifers by limiting runoff, terracing and reafforestation of slopes (Vohra, 1986, 1987). Such policies have obvious attractions, but there are considerable difficulties due to overall cost of implementation and to the inequitable allocation of costs and benefits between different populations. Typically, the costs of promoting greater natural recharge are borne by one group of people, as for example where those in the hills making up a catchment area are involved in reafforestation, while the benefits are reaped by those downstream who get improved water levels in local aquifers, lesser siltation of dams, etc. Do network members know of cases where large-scale watershed management has been successful in significantly improving rates of recharge? What system has been developed to compensate those investing effort in improving recharge? Is this explicitly related to the level of benefits reaped by those downstream or more generally provided from government funds?

8. POLICY AND GROUNDWATER DEVELOPMENT: EQUITY, FEASIBILITY AND SPILL-OVER EFFECTS.

A variety of policy choices are available to control levels of groundwater use according to groundwater conditions and administrative capacity. Some of these choices are presented by Shah (1986), from which Table 2 is taken, for a range of situations. We would be interested to receive from network members comparative material on the operation of these different policies from a variety of contexts, in particular in relation to their consequences for equity, their feasibility and their spill-over effects.

Equity: In India, rural equity and the improvement of the position of small and marginal farmers have been identified by policy makers and researchers as important policy targets. Irrigation development has been seen as particularly relevant in promoting greater welfare amongst the poor, due to its being a "livelihood intensive" sector, providing incomes and employment not only to farmers directly involved in irrigated agriculture but also to those in a wide range of associated activities (Chambers, 1986). The government has a massive credit programme, and the National Bank for Agricultural Development lends to small and marginal farmers in zones where it is judged there is undeveloped groundwater potential. For this purpose almost all States now have Groundwater Boards which categorise blocks as dark (no institutional credit), grey or white.

How far equity should take precedence over issues of productivity is still subject to dispute; Carruthers maintains a sceptical position on the extent to which "poverty planning" is likely to succeed (1984). Chambers however takes the view that while it may be difficult to incorporate equity considerations into planning tools in practice, nevertheless a shift is required in the way by which policies and projects are assessed so that explicit account is taken of the effects on poor people. In choosing alternatives, Chambers considers that increased production in itself should be given less weight than the provision of secure and viable incomes to vulnerable groups (1986).

Do network members have clear examples of cases in which equity objectives have been explicitly incorporated into project selection procedures? Are there identifiable productivity losses associated with the emphasis on equity in such examples?

Feasibility: Discussion of the means to attain a certain goal needs to consider the feasibility and cost of alternative policy measures. Thus, for example, an ideal policy for controlling groundwater use, in theory, might involve the licensing of all forms of extraction so that levels of exploitation can be controlled. This solution may not be feasible in practice because of the difficulty in establishing a system for such licensing and the very high costs in administration and manpower required to make such a system truly effective. Similarly, some pricing policies may involve very high collection costs that outweigh their potential benefits from more efficient resource use. For example, if electric power is to be charged on a pro rata basis, this involves the use of metering and the employment of meter readers at considerable cost to the electricity supply company and with risk of corruption. It is unclear whether any country has devised an effective means to control groundwater extraction rates in practice. Control through the supply of institutional finance is only partially effective where farmers can raise their own resources to pay for the investment. Could network members contribute their own experience with alternative groundwater extraction controls, their relative costs and efficacity?

Spill-overs: Alternative policy measures also need to be considered in relation to the wider economy and an assessment made of their probable spill-over effects. In the case of groundwater exploitation using modern WEMs, an important issue relates to the level and structure of power costs in the agricultural sector as against power costs to other parts of the economy. In many parts of India, electric power to the farm sector is subsidised with a number of consequences for other potential users of power, some of which were considered earlier. Policies to subsidise agriculture have also led to over-extraction from aquifers in many parts of the world; as Peterson notes, "the great social diseconomies" resulting from large-scale aquifer mining in the US "are imbedded in the farm pricing and agricultural subsidies of the US Government" (pers. comm., 1987).

A complex web of policies exists in many countries, each policy aimed at a particular goal but with substantial side-effects; thus, for example, there may be, on the one hand, siting restrictions to control over-use of groundwater while, on the other, farm price support and cheap farm power encourage high levels of groundwater use. Are such conflicting situations inevitable or could a more rational system of policies towards irrigated farming be derived?

9. CONCLUSION

We hope we have said enough here to stimulate further research and discussion. We will hope to have articles on specific issues or case studies in future issues. If many comments are received, we can put together another discussion paper. In the meantime, Network members interested in the work going on in India can write direct to the coordinators of the groups there:

Dr Tushaar Shah, Institute of Rural Management, PO Box 60, Anand 388 001, Gujerat, India

Dr A S Chawla, Professor and Head, WRDTC, University of Roorkee, Roorkee 247667, India

Please note, however, that some of the papers given at the workshop are still in draft form and final versions may not yet be available.

Those interested in the effects of water contracts, may also like to correspond with Dr. Richard Palmer-Jones. He is at the Institute for Agricultural Economics, Dartington House, Little Clarendon Street, Oxford OX1 2HP, United Kingdom.

REFERENCES:

Baset, M. System performance: a case study of a deep tubewell under the Irrigation Management Programme. In Methodologies to evaluate performance of irrigation systems. Papers from a workshop. Bangladesh Agricultural Research Council & Winrock International Institute for Agricultural Development. Dhaka 1986.

Carruthers, I. *Public sector opportunity and limitations in groundwater* development. Agricultural Administration, vol. 16, no.4, 1984, pp.169-180.

Chambers, R. Irrigation against rural poverty. Paper presented at the INSA National Seminar on Water Management - the Key to Development of Agriculture, held at INSA, New Delhi, January 1986.

Chambers, R. Notes and Reflections on a visit to Eastern UP 26-28 February 1987. Mimeo, Institute for Development Studies, Sussex, 1987.

Chawla, A. S. et al. Access of small and marginal farmers to groundwater - a field study. Paper presented at the Workshop on Common Property Resource - Groundwater, held at the Water Resources Development Training Centre, University of Roorkee, February 1987.

Chisholm, N. Socio-economic change in irrigation pumpgroups in NW Bangladesh, Irrigation Management Network Paper 10b, pp.2-7, ODI, London, November 1984.

Copestake, J. Finance for wells in a hard-rock area of southern Tamil Nadu. Research report no. 11, ODA/NABARD research project "Credit for rural development in southern Tamil Nadu", Madurai, June 1986.

Dhawan, B. D. Management of groundwater resource in India: direct versus indirect regulatory mechanisms. Paper prepared for the Seminar "Evaluation of People's Participation in Development" held at the Institute of Economic Growth, November 1986.

Mandal, M. A. S. & Palmer-Jones, R. W. Access of the poor to groundwater irrigation in Bangladesh. Paper presented at the Workshop on Common Property Resource - Groundwater, held at the Water Resources Development Training Centre, University of Roorkee, February 1987.

Nagabrahman, D. & Vengamaraju, K. Poor and groundwater: some institutional alternatives. Paper presented at the Workshop on Common Property Resource - Groundwater, held at the Water Resources Development Training Centre, University of Roorkee, February 1987.

Palmer-Jones, R. W. Share-cropping with water. mimeo, Queen Elizabeth House, Oxford, 1987.

Shah, T. Externality and equity implications of private exploitation of groundwater resource. *Institute of Rural Management*, Anand, October 1986.

Shankar, I. Working of private tubewells in Phulpur Tehsil of Allahabad District, UP. Paper presented at the Workshop on Common Property Resource - Groundwater, held at the Water Resources Development Training Centre, University of Roorkee, February 1987.

Svendsen, M. Meeting irrigation system recurrent cost obligations. ODI/IIMI Irrigation Management Network Paper 86/2b, August 1986.

Swaminathan, C.P. Performance of Community Wells for Irrigation in North Arcot District. Wamana April 1987, pp 13-16.

Vohra, B. B. Management of natural resources: urgent need for fresh thinking. mimeo, August 1986.

Vohra, B. B. When "minor" becomes "major": some problems of groundwater management. mimeo, December 1986.

Vohra, B. B. Issues in water management. mimeo, January 1987.

Wood, G. The socialisation of minor irrigation assets in Bangladesh. ADAB News, vol.X(1), January - February 1983, pp.2-20.

Wood, G. Provision of irrigation services by the landless: an approach to agrarian reform in Bangladesh. Agricultural Administration, vol.17(2), 1984 pp.55-80.

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