# Water for Agriculture in Zimbabwe

## Policy and Management Options for the Smallholder Sector

*Edited by*
mmanuel Manzungu, Aidan Senzanje and Pieter van der Zaag

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CHAPTER 13

# Economic principles and the allocation and pricing of water: A theoretical review for Zimbabwe

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In most of Zimbabwe water sources were widely available with much of the potential runoff and underground water still unexploited. However, in the past two decades water has become increasingly scarce. As water becomes scarce, so it becomes more important to develop institutions which ensure that the available water is allocated to the best uses for the whole society. Economics is the science (or art) of the allocation of scarce resources. In economic terms only commodities which are scarce have value. The air we breathe is probably the most vital resource with respect to life but it has no economic value in Zimbabwe. If good quality air should become scarce then it will start to have an economic value. This is because decisions must be made about how much is used, when and by whom. Costs may be incurred in cleaning, storing and delivering the air and these have to be covered by its "price" but until available air is limited, there is no price or financial value attached to the air itself.

In the past two decades Zimbabwe has faced declining average rainfall. In some parts of the country, the area average over the past century has not been achieved for 15 years. At the same time human and livestock populations have been increasing. This, together with increased economic activity, has seen a significant increase in demand for water. As it becomes scarce, problems arise over the allocation of this water.

It becomes necessary to devise institutions which maximise the benefits to society when using an increasingly scarce resource. It is necessary to encourage behaviour which will result in reduced demand, water conservation and water quality protection. Water is more emotional than most other resources — it is essential to life. Equity and environmental objectives will often take precedence over optimising economic growth.

The best use of water is where it maximises goals. An overriding objective is human, animal, plant and eco-system survival. However, the society also wants to improve living standards and a necessary condition is to increase incomes. For incomes to increase we have to produce more value from our given

resources. It therefore becomes important that, once the basic survival goals are met, water is channelled to those activities which will optimise economic growth. Society may choose to forego some of the growth benefit in the short term in order to enable less privileged members greater opportunities for improving their incomes and thus achieve greater equity.

Where equity or environmental goals take precedence over growth, it is still important for policy-makers and users to be aware of the economic opportunities foregone to achieve these other goals. It is, therefore, important that non-economists are aware of the principles which determine economic optimisation.

## ECONOMIC PRINCIPLES: PARETO OPTIMALITY

As mentioned previously, it is only as a resource becomes scarce that optimal allocation of the scarce resource becomes important. This is in order to ensure that the resource is used in such a way that it provides maximum benefit to society. In economic terms this is where the allocation is Pareto-optimal.

Pareto optimality is determined where marginal benefits in all uses and by all users are equal. It is achieved if it is not possible to rearrange the allocation without resulting in a net loss. Originally stated Pareto optimality is where it is not possible for someone to gain by a rearrangement of resources without someone else loosing. In subsequent interpretation this had been translated to mean that if gainers can compensate the losers and still be left better off, then Pareto optimality has not yet been achieved i.e. it is possible to rearrange how resources are used and consumed and increase their value to society. It may be possible to change the commodity produced and/or the inputs used and/or the distribution to consumers so that the various marginal rates of transformation or substitution are equalised.

An example can be given which illustrates this concept:

> *Available water is allocated on a rationed basis to individual households and to a local leather-processing plant. The water which the individual households require for life, for cooking and even for cleaning has a very high value to the households and it would require very high compensation for them to give up the right to this water. In the extreme instance not even a million dollars a litre would be sufficient to persuade the household to give up the water. However, only about 20% of the water allocated to households is used for primary purposes. The balance is used to irrigate small market gardens. The leather processing plant is doing very well but in order to expand, it requires additional water. The returns to the water used in the leather industry are considerably greater than the returns to water in the market gardens. Pareto-optimality would be achieved if water is reallocated to the leather plant up to the point where the marginal benefits are equal between leather use and household use. The leather plant would be able to pay the households more for the use of the water than the households are able to gain from market-gardening. At the point where the payments from the leather plant can no longer compensate householders for their access to water, then that is the economically optimal distribution of water. The national economy benefits where water is allocated away from inefficient (or lower-return) uses to efficient (higher*

*return) uses since the water will produce greater value added. This economic efficiency refers to returns to resources and is little affected by how technically efficient the market gardeners are. Where market-gardening does produce more value than leather then the leather plant would not be able to pay them for their water since the farmer could earn more by using it to produce vegetables.*

The key to economic pricing of water is that marginal revenue is equal to marginal cost. Marginal cost and revenue refer to the extra cost/revenue incurred/produced when using an extra unit of water. This means that the price should reflect the cost of the last additional unit of water supplied — not the average cost of supplying water. This cost must also include not only the operational costs but also the investment costs and the increasing scarcity value of the water.

In economic theory, provided that the price of the water reflects its true opportunity cost (scarcity value), then the market will maximise growth. The market then maximises social welfare as defined in economic terms. This, however, assumes that income distribution is even (or at least at the point at which society would like income to be distributed) and furthermore that there are no market imperfections. In other words there are no barriers to competition such that prices will continue to reflect changing conditions of supply and demand.

## THE EFFICIENT ALLOCATION OF WATER

As explained above any resource achieves its economically optimum allocation when the marginal benefits and costs between uses and users are equal. However, there is a difference between the costs associated with renewable and non-renewable resources. These costs relate to those where using a resource contributes to its increasing scarcity and thus increases its value and/or to the increasing costs of harvesting the resource as a result of the greater inaccessibility.

The definition of non-renewable depends on the time frame being used and a renewable resource may best be treated as a non-renewable resource if it is being unsustainably used. Surface water is normally considered renewable and underground water non-renewable. The particular circumstances may require that a different approach is used in real life and the analyst will have to use his/her own judgement.

### Surface Water

The main problem faced in allocating scarce surface water resources is that the system must be able to respond to the intra and inter-annual variations in water supplies. In common with other resources, the allocative system must strike a balance between the needs of many different users. Where it is possible to internalise externalities and reduce market imperfections (see below), the market

will ensure that water resources are used in the most economically optimum way. By transferring the water to the users who value the marginal water more, the net benefits of the water use are increased, those losing water are giving up less than those who receive the additional water are gaining. In an efficient allocation, users who can most easily find substitutes or conserve on the use of water receive proportionately smaller allocations when supplies are diminished than those who have few alternatives i.e. the allocation will be Pareto optimal. If the allocative system has flexibility in the exchange of water rights then it will be better placed to respond to intra and inter-annual variation by encouraging water to be used where the return is greatest. It is a system which encourages those who are able to cut back on water use to do so since they can sell their rights to those production processes where it is technically more difficult to change the water use.

## GROUNDWATER

When withdrawals of groundwater supplies exceed recharge, the resource is mined over time. An efficient allocation must take into consideration the opportunity cost of using that water today rather than conserving it for use in the future. There are two factors which need to be considered:

1. The cost of accessing the water will increase as the supply diminishes and the water table drops
2. If the supply of water decreases then the price rises, thus water in the future will be more valuable than it currently is.

It is not possible to determine *a priori* at what point it will no longer be economic to access the water, since this depends not only on the technology and costs of accessing the water but also on the factors affecting demand for water. It is, however, possible to predict that the price of water will rise over time unless new measures are found to maintain the supplies, reduce the cost of access or reduce demand for water. In efficient ground water markets, the water price rises over time. This price rise makes increasing conservation and the development of new technologies worthwhile and is the normal response to increasing resource scarcity.

If the price of water is not allowed to rise over time then society will not be receiving the signal to change use patterns and invest in alternative technologies. Prices play an essential role in encouraging society to use resources to best advantage. Wher e an individual has control over the future of that water, and where that individual expects the price to rise over time, then consideration will be given to the returns from using the water today compared with in future. Where the resource is an "open access" resource then the current user has no incentive to conserve water for the future. In this case society may need to impose a royalty or fee on current use so that the price reflects the opportunity cost of using that water as well as covering the access costs.

## ECONOMIC EFFICIENCY AND MARKET IMPERFECTIONS

This refers to the situation where the market does not result in prices which reflect the true social costs or benefits of resource use. This happens because of market failure. There are a variety of factors which cause markets to fail. The most important of these are "insecure property rights" (lack of tenure, non-excludability) and "externalities" (costs or benefits incurred in the production process which do not affect the producer directly). Lack of tenure will mean that the producer or user will not include the future when s/he is making decisions on resource use. The externalities mean that the user will not take into account those costs (negative externalities e.g. pollution) or those benefits (positive externalities e.g. watershed protection) which they produce. This results in more being produced of goods with negative externalities and less produced of goods with positive externalities than would be the case if the market was able to reflect these values.

Market imperfections are often cited as a major reason why market prices cannot be used to determine user prices and allocation. However, many of the imperfections can be addressed and where this is possible the society will be much better off than they would be if prices are bureaucratically determined. In economic terms we "internalise some of the externalities". This means that institutions are established to ensure that the costs and benefits of the use of water are more closely linked. This is appropriate provided that the cost of correcting the market failure is not greater than the potential welfare benefits from the correction. Inaction is justified if the cost of acting is greater than the presumed benefits.

The industrialised countries have all been active in implementing the "producer pays" principle over the past 30 years. This is an attempt to ensure that the environmental and social costs of a production system are borne by the producers and consumers and not by society as a whole. In this way environmentally damaging activities are discouraged by increasing the cost of supply and lowering the demand by increasing the price. The principle is that if the benefits from that production are greater than the environmental costs imposed then it will continue, but those benefiting directly from it will pay the costs. An example of the polluter pays principle is given below:

> *The leather plant produces effluent which it spills into the stream that feeds back into the river from which the farmers are drawing their water. This causes poor health for farming families and it has a negative effect on crop yields. The leather factory does not consider these costs when it is deciding how to allocate its resources and so these costs are not included in its calculation of profitability. However, from a society's point of view all the costs, even those "external" to the process should be incorporated.* In the past the solution to such a situation would be to have regulations limiting the amount of effluent poured into the river. This would be costly in terms of regulatory staff, it would lay the system open to corruption, and may not work if it is difficult to distinguish who is polluting the water — i.e.

when there are several factories involved. *The leather plant is now required to pay a tax based on the size of the plant or on the amount of effluent produced. This tax is paid into a local community fund or to a Water Purity Board, which uses the funds to clean the water. The decision on how much leather to produce is now affected by the cost of the effluent.* This is known as the "polluter pays" principle. In industrial countries they are finding that wherever possible "tradeable waste permits" are the most efficient mechanism for "internalising externalities".

As this is an important concept, an agricultural example of internalising externalities is also given:

*An agroforestry farm up on an important watershed has just decided to cut down all the trees and to plant cotton instead. This is because the price of cotton has gone up and the cost of transporting the forest products has also gone up. It is no longer rational for the farmer to maintain the trees on the property. This change of land use will, however, have serious effects for the farmers downstream.* These are known as negative externalities. *It is possible to have regulations which prevent the farmer changing the land use but this would require her/him to act against her/his own best interests. Regulations requiring the forest farmer to pay the price of protecting the watershed are inequitable and it may be difficult and expensive to enforce such regulations. All farmers engaged in cotton production which damages the environment could be required to pay a tax, paid into a central farmer-controlled fund used to reduce or reclaim the erosion damage from cotton* i.e. they are made to pay for the extra costs they are causing society. *At the same time, if farmers retaining woodland in areas which have* positive externalities *are paid a royalty for maintaining the tree cover, this may influence the decision to change land use* i.e. they are paid for the extra benefits they are producing for society. *If the returns from cotton are so much greater that they more than compensate for the negative externalities, then it should be possible to use the tax proceeds to reduce the environmental impacts.* As mentioned in the previous example this is known as the "polluter pays" principle and is very important in natural resource pricing and allocation systems.

Property rights and security of tenure are also very important in causing markets to operate in the best interests of society. Where the individual user (as producer or consumer) does not have control over the future use of that water then their decisions will be based on maximising their returns in the short term and this may not be socially optimal. It means that users do not take into account the scarcity value of not conserving the resource for the future. In establishing allocative systems for water rights it is important to recognise the inefficiencies which will result from insecure access.

## REGULATIONS WHICH NEGATIVELY AFFECT EFFICIENT ALLOCATION OF WATER

### 1. Non-transferable water rights

With increasing demand for water and changes in returns to use of water, it becomes very important to have a system which enables the transfer of water

rights. Stimulated by profits, companies, individuals and co-operatives, can be formed to construct irrigation systems and to transport water from surplus to deficit areas (California is an example which owes much of its early development to a change to transferable water rights — Cuzan, 1983). Allowing users to capture the value of water saved by permitting them to sell it stimulates water conservation and allows water to flow to higher value uses.

**2. Water use as a requirement to retaining rights**

A system which requires that the user must use the water or lose the rights to it, discourages water conservation — careful users who use less water find their allocations reduced. An interesting example of this is given in Taylor (1990) which demonstrates the wide benefits from applying a system which encouraged water conservation through a change in use rights.

**3. Pre-determined hierarchy of uses**

This is where government or some other body establishes allocation priorities across and within categories of water. This will result in a situation where net benefits are not equalised. Even if they could be bureaucratically determined at the optimum point initially, a centrally-determined system cannot respond quickly to changes in opportunities. It also reduces investment in the lower priority areas and in high water risk industries. If the market determined the allocation in water scarce years it would allow those most damaged by the shortfall to buy a larger share from those who are not as seriously affected or who can more easily use conservation techniques. This does not happen in centrally-determined priority of uses.

**4. First-come, last out**

The rights allocated according to first user theory are under pressure in a social system which has seen the elite obtaining prior right. The system is also inefficient economically, since it discourages innovation, new investment and is very unlikely to result in a situation where net benefits are equal. A system of transferable rights would enable these to be sold to the best use. Negotiable rights have become increasingly important as a mechanism for "internalising externalities" in industrialised countries and are considered the most likely to have a positive impact on both growth and equity (see Warford, 1976). Preferential access to credit to purchase those rights would assist those who have been marginalised in the past and help to achieve greater equity without affecting growth.

## PRICING SYSTEMS WHICH NEGATIVELY AFFECT EFFICIENT ALLOCATION

### Cheap water policies

Where the opportunity, development and operational costs of water are not reflected in the prices charged, water will be used inefficiently. There may be equity, development or other justifications for low water prices. Society may even decide to forgo the economic growth from market based prices, but the losses must be acknowledged. In some places the same equity or development goals may be achieved at less cost by other means. It is important that the full costs of the water are determined and that the effects of any deviation from efficient prices is made transparent. Low prices increase the demand for water, reduce the incentives to conserve water and the incentives to invest in low-water using industries, water-saving technologies and in the supply of additional water.

### Average pricing systems

These are widespread with water prices established on the average costs of supplying water. These are less efficient than those which are based on the marginal cost of providing the water as explained above. Numerous studies have been carried out, particularly with respect to urban water supplies, on how to apply marginal pricing systems which achieve the efficiency goals but which address other goals, especially limiting profits of the water authorities. Feldman, Breese and Obeiter (1981) and Mann (1987) discuss these issues.

## OTHER GOALS AND WATER PRICING

One aspect of the water allocation and pricing which has not received attention is the aspect of water quality. With low population pressures, limited industry and a natural ability to deal with the levels of erosion and waste polluting the water, it was not rational to have regulations or economic incentives to manage water quality. However, as the pressure on water becomes greater, so too does the need to develop mechanisms to encourage the maintenance and enhancement of water quality. It must be economic to do this. If the water is poor but acceptable for human and animal survival then the society may not be in an economic position to pay for higher levels of water quality and there may be no point in involving costly legislation or payments. Where interventions are designed for the future rather than the current situation, then consideration must be given to the costs involved, especially as it is possible that before the quality became unacceptable, the production systems causing this may change, such that the investment in protection was unnecessary. Where preventive measures are not expensive and/or when the future impact on quality is certain, then it may be economically advisable to implement these measures. Wherever

it is necessary it is essential to try and get the polluter to pay. This reduces pollution by encouraging less damaging approaches, by encouraging investment in alternatives and / or in clean-up.

Equity is a major concern in water allocation and pricing systems. However, it has been found that the severe distortions which arise from not implementing systems which reflect supply and demand, often lead to greater inequities, even when designed to address equity. Where a water allocation system does not use market prices to determine allocation, it is important that the policy-makers are aware of the economic growth foregone as a result of the movement away from market prices. An example follows of what could happen if water were determined by rationing in order to achieve equity:

> *The leather plant owner is wealthy and the households in the area are poor. The District Council, therefore, decide that the poor will have the water and ration it such that 75% goes to the households and 25% to the leather plant with all users paying the same price per unit of water. In doing it this way they reduce the economic potential of the area, they deprive the households from the opportunity of earning more by "selling" the water to the leather plant and they encourage other resources to be allocated to inefficient production thus further exacerbating the inefficiencies. Thus the leather company cannot expand, less is produced, fewer people are employed and equity is not addressed since the households could have made more from selling their water rights to the leather industry. Marketable property rights for the water would better achieve both growth and equity.*

Equity criteria are very important when it comes to water allocation but mechanisms should be found which reduce the negative economic impacts while achieving the equity goals. The basic needs must be met but thereafter water should be allocated to its most efficient use. If certain segments of the population have been disadvantaged in the past then systems to redress this should be implemented. However, it is important that in so doing, the water is directed to where long-term efficiency will be achieved, even if there is a decrease in the short-term. In economics this is referred to as the "infant industry" argument for protection or preferential treatment. It assumes that if favourable access is granted then in the long term that segment or sector will be able to use the water efficiently. One way to redress current inequities but avoid future inefficiencies is to auction allocation rights and to provide the disadvantaged segment with grants or subsidised credit. Where it is a communal property regime then the transfer of these rights would only be saleable within the community.

Studies in India have shown that irrigation can sometimes have negative consequences for women, especially where increased access to water for irrigation reduces access for domestic use or increases health hazards. Women tend to benefit most when the irrigation scheme first reduces the burden of

obtaining domestic water supplies (Agarwal, 1981). A pricing structure and allocative access which ensured that irrigation schemes benefitted all the villagers by access to better domestic water supplies before implementing agricultural uses, would have strong equity benefits. Water provision for social welfare is justified in urban areas, but in many instances, in rural areas, irrigation schemes are considered primarily for their productive potential benefitting only irrigators. Wherever irrigated schemes have the water supply subsidised, there is no justification on efficiency or equity grounds, for not ensuring that the benefits of these schemes are more widespread than just those involved in the irrigation schemes. It is conceivable (particularly if there are many more non-irrigators than irrigators) that the multiplier effects from better access to domestic water by non-irrigators may be as, or more, significant than the gains by irrigators (Agarwal, 1981).

There are a number of other goals which government may be wishing to achieve from a particular water policy, including employment, food security, etc. However, as with equity and gender outlined above, the efficiency costs of any policy which moves water prices away from their opportunity costs, must be estimated and taken into consideration.

Many water pricing systems are based on a hierarchy of uses with some uses paying less for the water. The justification for this is that they cannot afford to pay the full marginal cost of using the water. Unless there are other societal goals which take precedence over economic growth, there is no justification for such a system. If, however, it is decided for reasons of food security or equity that some industries or sections of the population should pay less for their water, then it is important that policy-makers are made aware of the costs involved.

> *In one area 20% of the water is used for drinking and primary use; 40% is allocated at a cheap rate to agriculture and 40% is allocated to industry at full price plus the cost of subsidising primary and agricultural use. The cost to society of this use is the disincentive to industry and the reduced employment and output as a result of forcing up industrial costs. The benefits are the secure access to drinking and the reduced risk of agricultural failure. In a real situation it would be possible to measure how much national income and employment is lost and how much gained. Water pricing policy could then be established with all the facts on the costs associated with using this food risk-minimising strategy. The decision will also depend on whether it is possible and reliable to exchange the industrial output for purchased food. Rural households often opt for self-sufficiency even if they could buy much more food through trade, because of poorly integrated and unreliable markets.*

Centrally determining the allocation of water will always have a negative impact on efficiency. As indicated there are specific times when this may be considered desirable but we must be aware of the costs.

## OPTIONS FOR WATER PRICING POLICY

1. Basic survival level for primary use — set a low price affordable by all. If this was the only use of water then water would not be scarce. It is the use of water for production and leisure purposes which increases the demand, and thus the price of water. If the base price which is affordable is lower than the cost of accessing even those limited supplies of water then it may be possible to rationalise a subsidised price for primary use. Thus if one were pricing supplies of water from a dam, larger volume users would pay more than those using the base rate. This would act as a transfer to primary users and discourage, though not necessarily prevent, the use of water for luxuries e.g. lawns.
2. Once primary use has been addressed, a variety of methods could be used to price the water but if efficiency is to be maximised then the price must be set where it is equal to marginal cost. The marginal cost should include operational costs, replacement costs of both the extraction/delivery equipment, interest on the capital invested and, for underground supplies in particular, a royalty for scarcity. This royalty could be a tax charged by the community to the water agencies (rural/district councils, municipalities or water companies) which would then pass on this tax as part of the price. The community could then use this tax to invest in research into more efficient harvesting and use techniques and into increasing replenishment potential.

All users could be charged the rate appropriate for the use of the last extra unit, but in so doing some producer surplus would be created since everyone would be paying the full cost of using the last unit of water. In the private sector it is the lowest cost producers who benefit from this surplus and competition reduces opportunities to gain from the surplus. The discount coupons proposed by Collinge is one way to reduce producer surplus in state or municipally-owned water supplies. To reduce the producer surplus, and at the same time encourage water conserving technologies and uses, it may be appropriate to use an increasing block rate. This can also be used to subsidise the lowest levels of use.

The OECD (1987), in commenting on water pricing, reaffirm that water should be provided in an economically and environmentally efficient manner so that the net benefits to the community as a whole are maximised. Flat rate pricing systems are very inefficient both economically and environmentally. Increased block systems do not fully satisfy efficiency but go a long way towards it and overcome the difficulties of rents and address equity issues. In an increasing block system, the highest block should be fixed at approximately the marginal cost, with the lower priced blocks set so that full operation and maintenance costs — and where appropriate capital cost-recovery — is achieved. Essentially

the emphasis is that of the user-pays principle which embraces the polluter pays principle in order to reduce waste and encourage incentives for conservation.

The increasing block system is the pricing system which the City of Harare have implemented in response to the recent drought. It takes account of primary use by charging a low rate for essential water supplies. It then increases the rate for each additional block used. This structure encourages conservation by ensuring that the marginal cost of consuming additional water is high. At the margin where the consumer makes the decision of how much extra water to be used, money can be saved by being frugal with water use.

A flat fee, uniform price, is the worst form of pricing. The marginal cost of additional water consumption to the user is zero. In the United States many municipalities still use a flat fee and still others use a decreasing block fee, which is the most inefficient of all. This involves charging higher prices for low use of water and lower prices for larger users. This would only be efficient where water supplies are abundant and where there are large economies of scale to be gained when delivering water.

Another variation on price being set at the marginal cost of supplying all water is that each type of user pays the marginal costs of supplying that market segment i.e. those further from the source or at higher elevations or more widely dispersed etc should pay more because it costs more to deliver the water to them. The current systems mean that higher cost users are being subsidised. Where this coincides with equity it may be acceptable but very often it is the low-density urban and rural areas which benefit.

Whatever the situation, more effective policy decisions can be taken if the cross-subsidisation is made explicit. In terms of efficiency it would mean that people would be encouraged to locate nearer the cheaper water and reduce the overall cost of providing water. Where water costs are too small a proportion of the budget to be considered in the decision, then there is no rationale for having some other sector subsidise the higher-cost water. This principle could also be extended so that as populations increase, forcing increased higher-cost investment in water supplies, these new populations should be required to pay the increased costs their in-migration is causing. It would be useful here if all users paid the marginal cost of supplying their water — heavy users, new users, high-cost users and peak-demand users should all pay differential rates, rather than the average pricing system currently used in most situations.

However, until water resources are scarce and investment in increasing supplies of water are high, it is not worthwhile investing in these more complicated allocation and pricing systems. As water becomes increasingly scarce so it becomes more important to take account of the demand distortions created by inefficient pricing systems.

Another factor which needs to be considered by an optimal pricing and allocation system is supply fluctuations. The system needs to be flexible so that higher prices are charged when water supplies are low and vice versa. If prices were to remain high throughout the seasons and the years, then society would be consuming less than optimal supplies of water. If prices remain low constantly then water will be scarce and rationing will have to be introduced in times of low supply. It is, therefore, important to introduce a system which responds to the supply situation both inter and intra-seasonally. The system could rely on water level indicators and the rating system calibrated to water levels; it could be established for various months at a set rate for seasonal variation and the following year could be based on the previous season's rainfall. This would reduce uncertainty for users and facilitate planning but would also be less likely to match supply and demand.

## WATER PRICING AND IRRIGATION

The principles outlined above all apply to irrigation although much of the literature applies the principles to urban areas. Irrigation is particularly attractive to countries with irregular rainfall. Irrigation in Zimbabwe has been heavily subsidised and it is, therefore, the investment most demanded by smallholders. However, as it is not possible to provide irrigation to all the farmers in the country, careful analysis of both the efficiency and equity impacts of developing irrigation must be undertaken. It is necessary to direct government financial and human capital to those areas of development with the greatest return to both growth and equity. Irrigation can lead to increasing differentiation between the rich and the poor — especially if the price of obtaining water is subsidised but is only available to selected irrigators. Irrigation may therefore only benefit the few at the cost of other development options which would result in greater returns to more people.

It can be difficult to apply marginal cost-pricing methods to irrigation, although a number of options exist. Warford uses a slightly different approach in that he concentrates more on establishing water prices on the basis of opportunity cost. Where it is difficult to establish the marginal cost of water because of the lack of markets, it may be best to consider the next best use and to base analysis and prices on this.

> *Relevant costs are the value of the water resources which are made unavailable for other purposes because of that specific use. Costs of future systems expansion are important while sunk costs are irrelevant. Water pricing policies which reflect real resource costs incurred as a result of additional consumption rather than of historical costs associated with supply of water-related services can prevent wasteful use of scarce water resources. Prices should have low charges when additions to capacity can be provided cheaply. Opportunity cost can sometimes be measured on the basis of*

*an estimation of incremental costs and can be used either to assist in establishing price or as a benchmark to evaluate other social goals* (Warford, 1976, pp 661).

In Zimbabwe the analysis of water and irrigation varies but most analyses of overhead irrigation systems from dams, indicate this to be a highly inefficient and inequitable investment on large state-run projects. In most areas it is only where dams or other water sources already exist that irrigation schemes would be economically viable. In all cases the government has made little attempt to consider the economic implications of its decisions on allocation and pricing of water and water fees to users are not related to any independently determined criteria. The impacts of the subsidised water in terms of opportunity cost of the investment does not appear to have been carried out. Rukuni (1994) showed that government subsidises some 90% of the operation and maintenance costs on 72 irrigation schemes with a standard maintenance fee of Z$145 per ha. Furthermore it does not recover any investment costs from irrigators.

Peacock (1995) showed that the investment costs alone would be in the region on Z$22 000 per hectare per annum (annualised over 20 years) and the operation and maintenance costs would be some Z$4 000 per hectare per annum. The annual irrigation fee is set at Z$145 per ha since 1983 amounting to an annual subsidy in operation and maintenance alone of some $33 million. No attempt was made to consider how many households benefit nor to consider what this money could have done if invested in research, roads, markets, training, credit or resettlement.

Jansen, *et al* (1993) showed that government spends some Z$33 million on annuity and operation and maintenance of irrigation dams but recovers only $3 million. Jansen questioned the equity of investing large amounts to benefit only a few households. She found that none of the schemes investigated showed a positive financial return though some did show a positive economic return. Her findings highlighted that for irrigation to be economically efficient, it needs to be used to produce high-value commodities.

On the other hand Chitsiko (1995) carried out a comparative analysis of three irrigation schemes and found them all to be viable. However, on the evidence in the summary, it was not clear what, if any, charges were made for water and/or for operation and maintenance of the schemes.

There are many analyses on the viability of irrigation schemes, all with different results. There appear to be more which indicate that serious consideration needs to be given to the efficiency of both the investment in, and allocation of, the water resources in this country and how they impact upon all of society's welfare. The numerous studies highlight the fact that it is not possible to make *a priori* judgements on the efficiency of any one scheme and that analyses should be made, taking into account all the externalities involved, of each scheme. It is important to ensure that all the people and activities positively

and negatively affected are incorporated in the analysis, even where the full costs and benefits cannot be reflected in prices. This is known as economic analysis and differs from financial analysis which considers only the costs born directly by farmers/users.

In the light of the theoretical principles outlined earlier it is clear that Zimbabwe's system of country-wide fixed charges for water which bear no relation to scarcity value or supply costs, needs to be urgently addressed. It is time to consider how to establish systems where prices reflect the marginal cost of using water. Rukuni (1988) questions the efficiency, while recognising the easy implementation, of charging blanket fixed fees to all irrigation farmers on all schemes. He considers the necessity to try to devolve responsibility to the local farmers, requiring them to take over operation and maintenance and to collect the fees. In this way efficiency can be achieved since water prices can be related to water use and local institutions can be developed and take responsibility for their resources.

Coward (1976) showed that local irrigation schemes would be more likely to be successful if institutions could be established which would enable more localised control. One way to achieve this is to hand over control of the irrigation to a local authority which is required to charge users and use the proceeds to pay for maintenance. Where there are negative and positive externalities in a scheme, it may be easier to balance these through local taxes and subsidies rather than to try to incorporate them into national level approaches. If Government wishes to encourage irrigation, the subsidies could rather be aimed at training locals in both the technical and managerial skills necessary for successful implementation and providing access to financial resources for investment in water supplies and conservation.

## CONCLUSION

Water, although locally scarce, has only become widely scarce in Zimbabwe during the last two decades. This is the result of increased population growth, increased urbanisation, increased production and unusually frequent and severe drought years. The question of the efficient allocation of water resources is important in response to the scarcity.

Considerable advances in both equity and efficiency can be achieved if more economically rational water allocattion and pricing systems are implemented. There are various studies which could assist in establishing the appropriate principles for water allocation in Zimbabwe, without undermining the important objective of ensuring greater equity in providing access to water resources.

With respect to irrigation Zimbabwe needs to establish more cost efficient systems and increase the output value from these schemes. Where irrigation

schemes are currently resulting in inefficient water use and low water saving, the pricing system has not encouraged efficiency and conservation and this could be relatively easily addressed by using an increasing block scheme where appropriate, or by estimating opportunity costs (Warford, 1976) or by using discount coupons (Collinge, 1992) or some other method which applies the marginal cost pricing principles together with equity measures (Feldman, Breese and Obeiter, 1981).

Public decisions on new investment in providing water supplies must try to take into account those factors recognised in the Irrigation Policy and Strategy for Zimbabwe (1994). The "water pricing policy in future should reflect the scarcity of this valuable commodity . . . its opportunity cost should be taken into consideration in determining price" p.vii and p.19. On delivery costs, the policy concentrated more on cost recovery than on marginal cost pricing "it is the policy that in future, costs of operation and maintenance of irrigation systems be met directly by the beneficiaries. Any subsidies on operation and maintenance should be justifiable and targeted on a case by case basis" (p.vii).

Recognition of the importance of establishing policies which will lead to efficient water use has been given by the Zimbabwe government. Consideration should also be given to concentrating initial investments in rural water on domestic supplies, anticipating economic returns through the multiplier effects from released labour and increased health. This is likely to provide greater returns in terms of both growth and equity than investment in expensive irrigation schemes available only to a few irrigators. However, the multiplier effects of irrigation schemes can also be substantial as was evidenced by the growth of California, which some attribute principally to the irrigation schemes. All these factors need to be considered when the state is investing in water supplies. It is likely to be more efficient and more equitable if the state could find ways of encouraging community and private investment in water supplies. Using the market, with the state playing a facilitative role, should be given serious consideration.

Readers are also referred to a study by Carruthers *et al* on irrigation pricing and management which confirms much of what has been outlined above on the efficiency of relating water use to costs. It also points out that part of the problem of why it is difficult to establish rational pricing systems for irrigation is that benefits from the economic rents do not always remain with the irrigating community and that there may be political pressure from those benefitting from the inefficient system.

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