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IRRIGATION WATER PRICING IN ZIMBABWE

by

G.D. Mudimu

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Godfrey D. MUDIMU*

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*G.D. Mudimu is a Lecturer in Agricultural Economics, University of Zimbabwe, P.O. Box MP 167, Mount Pleasant, Harare, Zimbabwe.

Abstract

The Zimbabwe Government attaches great importance to irrigation development to enhance and stabilize crop production which is affected considerably by unreliable seasonal rainfall and periodic droughts. Approximately 150 000 ha of crops are irrigated per year. The Ministry of Energy and Water Resources Development (MEWRD) currently supplies 369 $10^6 m^3$ of water for irrigation

The annual unit cost of supplying water ranges from Z$50 to Z$326 per $10^3 m^3$ for schemes supplied from MEWRD boreholes. For water from MEWRD dams the unit cost ranges from Z$18 to Z$633 per $10^3 m^3$. Government policy up to now has been that commercial farmers and government estates pay water charges that cover capital investment on a historic cost basis amortized at 9,75 percent for 40 years; plus the recurrent cost estimated at 1,0 per cent of total capital costs. Due to increasing investment costs, a proposed approach is to charge a uniform blend price throughout a water region.

Prior to 1983, irrigators on public irrigation schemes paid water charges that covered 10 - 12 percent of the annual O & M costs of a scheme. Capital costs were considered as government grant. Water charges were based on water circulation rotation and crop values. A new payment structure instituted in 1983 was designed to have farmers in the same scheme pay uniform charges based on security of water supply and crop gross margins. A current proposal is to base water charges on average net profitability of the two main crops, maize and beans.

In 1985, the government established a Z$18 million Irrigation Fund to encourage commercial farmers to invest in irrigation development and for the rehabilitation and development of public schemes in the peasant sector.

It is recommended that beneficiaries of irrigation water supplied from public financed water resources must contribute to recovery of initial investment costs and the annual O & M. The water charge has to be uniform for all water users and be based on the farmers' ability to pay.

1. INTRODUCTION

This paper is aimed at discussing the current status of irrigation water pricing in Zimbabwe. This is a timely topic for Zimbabwe which is currently reviewing policies with regard to irrigation development and water pricing. An inter-ministrial sub-committee, the Water Pricing sub-committee, has been deliberating since late 1985 on alternative approaches to water pricing. This has been prompted by government's desire to promote irrigation development through public and private investment.

The paper first outlines why irrigation development is important in Zimbabwe. The current status of irrigation is outlined, including the farming systems, administrative organizations, water resources availability and use. These discussions are intended to give sufficient background for the reader to understand the rest of the paper. Section 3 examines cost of water resource development while section 4 looks at payment for abstraction of surface and underground water. Policy for financing water resource development are covered in section 5, while section 6 examines policies concerning recovery of operating and maintenance expenses in public schemes. Section 7 discusses incentives for irrigation investment by farmers. Conclusions and recommendations are given in section 8.

2. Background Information

2.1 Importance of Irrigation in Zimbabwe

Irrigation development is essential in Zimbabwe because annual rainfall is generally low, unevenly distributed and unreliable. Only 37 per cent of the country receives more than 700 mm annual rainfall which varies between 300 mm in the low lying areas to over 1 000 mm on the central watershed. Monthly rainfall reliability is significantly lower than the seasonal total and rainfall reliability decreases in general from north to south of the country.

Total annual rainfall and its distribution vary greatly from year to year and within the country. It is estimated that 75 per cent of the country is subject to such conditions that make dryland crop production risky. The countryexperiences recurrent droughts and in some parts of the country 'mid-season droughts' are permanent features of the rainfall season.

Maize, the staple diet, is very sensitive to drought, while wheat, grown in the cool dry winter months, is entirely dependent on irrigation. Poor rainfall seasons and/or drought conditions affect water availability for winter irrigation. Therefore, with the bulk of agricultural

production currently under dryland production, reliance on rainfall introduces elements of food security risk. Irrigation is therefore important for crop production stability. It is used to supplement rainfall in order to offset a late start, or mid-season drought or an early cessation of the main rains thus lengthening the growing season. Irrigation is essential for the growing of vegetable, winter and perennial crops (sugar cane, tea, coffee and citrus)

The Zimbabwe government attaches great importance to irrigation development. The first Five Year National Development Plan, 1986 - 1990, envisages that irrigation will play an important role in the transformation of the rural sector. It is planned to increase the irrigation potential by per cent over the planning period. To encourage irrigation development, the government established a Z$18 million National Farm Irrigation Fund from which farmers will borrow at low interest rate to finance investment in irrigation facilities.

2.2 Current Status of Irrigation in Zimbabwe

2.1 Land Under Irrigation

Zimbabwe has an estimated 151 000 ha under irrigation. These are distributed as follows:

Farming Systems Type	ha
Large Scale Commercial Farms	93 000
Plantations and Estates	30 000
Commercial Settler	11 500
ARDA Estates and Settler Schemes	11 000
Communal Area: AGRITEX Schemes	4 400
Private	700
TOTAL	150 600

There are two main farming sub-sectors in the country:

(a) large scale commercial farming by farmers on freeholder land title and

(b) subsistence and commercial farming by peasant farmers residing in areas designated as Communal Farming Areas.

Under the large scale commercial farming sub-sector are individual farmholders, estates and plantations owned by agro-companies. Individual farmholders irrigate from 20 ha to 200 ha. Irrigation is mainly as a supplement to the

normal rainfall in order to extend the crop growing season or offset mid-season drought. Method of irrigation is mostly overhead sprinkler irrigation. Crops grown under supplementary irrigation are maize, soyabeans, cotton, groundnuts, tobacco, tea, coffee, citrus and vegetables. Wheat and barley are entirely grown under irrigation in winter. Crop yields achieved through irrigation are shown in the appendix.

Estate and plantation irrigation is mostly for sugar cane, cotton and citrus production mainly in the low lying south-eastern part of the country. Both flood and overhead irrigation methods are employed.

State farming including irrigation is run by the Agricultural and Rural Development Authority (ARDA). ARDA-run irrigation scheme range from less than 100 ha to over 2 400 ha. Crops grown on commercial basis include cotton, coffee, tea, wheat, barley, rice, beans and tobacco.

ARDA has also the responsibility for developing and managing scheme on which farming families selected from communal areas are allocated plots for purpose of irrigation farming. These are referred to as settler schemes. These range in size from 160 ha per plot to 2 ha per plot. Some ARDA estates have plotholders who are out-growers.

There are some 74 irrigation schemes established in the communal areas between 1912 and 1980, (Blackie, 1984). These are referred to as communal area schemes and range in size from 2 to 400 ha. Individual plot sizes vary from 0,5 to 2 ha. A variety of crops is grown including maize, cotton, wheat, beans, vegetables and others. Production is either for subsistence or marketing. The levels of production and irrigation efficiency range from good to very poor. These schemes are under the supervision of the extension department, AGRITEX. Irrigation method is mostly flood irrigation.

This paper will refer to ARDA, settler and communal schemes as public irrigation schemes. Irrigation by large scale commercial farming units will be referred to as private irrigation.

2.3 Administrative Institutions Involved in Irrigation

Several different institutions are involved in irrigation development and management.

(a) Department of Water Resources Development, in the Ministry of Energy and Water Resources Development (MEWRD), is

Riparian owners must obtain a water right before they can abstract or impound water from a river for irrigation uses. The water right grants permission to abstract a given quantity of water per year. Water rights are granted by the Administrative Court - formerly there was a Water Court.

2.5 Water Resources and Use for Irrigation

Estimates of the surface water resources availability and current utilization in Zimbabwe are (Mitchell, 1986):

Total Surface water run-off per annum	20 000 $10^6 m^3$
Potential water that can be developed after losses	9 580 $10^6 m^3$
Present consumptive use	2 660 "
Balance available	6 920 "

Twenty-eight percent of the potential water available is presently being used. Development of the remaining 72 percent is becoming difficult and costly since the more accessible and economic dam sites have already been constructed.

The Ministry of Energy and Water Resources Development supplies 743 $10^6 m^3$ per year of water for all purposes made up as follows:

	$10^6 m^3$
Mining, Towns and Urban Authorities	374
Large Scale Commercial Farming	136
ARDA, Communal Area Schemes, RWA	233
TOTAL	743

RWA = Regional Water Authority

3. Cost of Water Resources Development

The government finances all public water resources development. Estates and large scale farmers have in the past financed large scale irrigation dams through consortiums.

The theoretical unit costs of producing water, estimated using average figures for dam size, dam construction costs and borehole drilling costs as at March, 1986 are:

Annual Unit Cost of Supplying Water

	$ per $10^3 m^3$
Borehole with handpump	160.00
+ labour	326.00
	$ per $10^3 m^3$
Medium borehole scheme:	
2 x 7,5 m^3/hr - diesel powered	237.00
Large borehole scheme:	
4 x 1 000 m^3/hr - diesel powered	61.00
electrical	50.00

Dams:

Dam Capacity $10^6 m^3$	Storage Ratio	$ per $10^3 m^3$
0,1	1,0	633
0,1	0,1	112
1	0,1	50
10	1,0	75
10	0,1	25
100	1,0	35
1 000	1,0	18

(Source: Mitchell, 1986).

The per unit cost include capital recovery and operations and maintenance costs of the capital works (ie dam or borehole construction, conveyance structures and pumping equipment). Annual capital costs are amortized at 9,75 per cent per year over 40 years which is approximately 10 per cent of initial outlay.

Recurrent costs (operation and maintenance costs) of the capital works (ie dams, boreholes, machinery and conveyance structures) are estimated to be as follows:

		Per Cent of Capital Cost/Year
(1)	Maintenance cost	0,5
(2)	Pumping costs (diesel and electricity)	
(3)	Transport and wages (of Water Baliff and General workers)	0,5
	Total O&M costs	1,0

4. Payment For Abstraction of Surface and Groundwater

4.1 In the Private Commercial Farming Sector

For riparian owners the payment for abstracting or impounding riverflow water is the application fee for the water right. Since the water right is granted to the farm or physical land and not the individual farmer for as long as there is no infringement on the right, it means the application fee is a one time payment. There is no payment for underground water which is regarded as non-public water.

Application Fees for Water Right to Abstract Surface Water

	£/$
Application for use of public water for irrigation	10,50
Application for apportionment or allocation of scheduled irrigable area	10,50
Application for apportionment or allocation on sub-division of land	10,50
Application for revision of water right	10,50
" for extension of time	6,50
" for use of some farm's water right	21,00

These charges have been in existence at the above levels for at least the past 15 years.

4.2 In the Communal Areas

Water rights are invested in the community and held in trust in the name of the Minister of Energy and Water Resources Development. Any individual or organization wishing to abstract water for a private irrigation scheme must apply to the Ministry through the local administrative structures, e.g. District Administrator. However, there is an anomaly with the large scale commercial sub-sector. Communal area farmers on some public irrigation schemes using water abstracted from flowing rivers pay water charges higher than the water right application fee paid by their counterparts in the commercial subsector.

5 Policies with Regard to Financing of Public Water Resource Development

It is government policy that all water consumers pay for the capital and operating and maintenance costs of water

supplies. Urban and industrial consumers purchase their water through the urban and local authorities. Farmers purchase water on individual basis.

5.1 Capital and O & M Costs Recovery in Public Schemes

Until recently capital, operating and maintenance costs for supplying water to public irrigation schemes have been regarded as a government grant or subsidy with no attempt to recover any of these costs from irrigators. The justification has been that most plotholders would not afford to pay for the water. Moreover, irrigation development in Communal Areas was seen as a social investment for rural development and income distribution. Exceptions, however, were plotholders who had purchased their plot but still drew water from the public scheme and plotholders on ARDA co-estate irrigation schemes. These were expected to pay for water at the total recovery per unit cost of supplying water to the schemes.

It is planned that in future all farmers are to pay the total costs so as to reduce government subsidies.

5.2 Cost Recovery From Private Commercial Farmers using Water drawn from Public Dams

For the large scale commercial farmers, government policy have been that they pay a fee that covers capital investment on a historic cost basis plus the recurrent costs (operating and maintenance costs) of government financed water supplies. The water charge, for water supplied from a MEWRD dam, was calculated as follows:

$$\text{Water Charge} = \frac{\text{Amortized Capital Costs}^{*} + \text{O \& M of dam and conveyance}}{\text{Total Water Available for Supply to all Consumers}}$$

Notes Capital Costs amortized at:

(i) 9,75 %/year for 40 years for dams and
(ii) 9,75 %/year for 10 - 15 years for pumps and other equipment.

This method for calculating recovery costs has been used by MEWRD effectively until recently when new major dams have been constructed. Farmers drawing water from public water projects constructed up to 40 years ago have been paying from Z$2,00 to Z$8.00 per $10^3 m^3$. Costs of these old projects were initially low and some have been fully depreciated. Therefore water charges have been low, mostly made up of O & M.

New dams commissioned since 1980 have introduced anomalies. This is as a result of high construction costs. For example per unit cost of water from recently constructed dams range from Z$15.00 per 10^3m^3 to Z$66 per 10^3m^3 per annum respectively. If the principle of having farmers pay for capital and O & M costs is maintained, it means some farmers would be paying very little (those utilizing older water schemes) while others utilizing newer water schemes would be paying high rates.

It was deemed unjustifiable to set different rates for new and high costs water projects. A stage was reached where the MEWRD was having difficulties selling water to farmers for irrigation. Furthermore since the late 1970s there was little invest in irrigation by commercial farmers as irrigation became less viable.

The Irrigation Liaison Committee established a sub-committee, the Water Pricing Sub-committee, to review the situation and make recommendations on how to price water without anomalies. The document being circulated now (details not made available as the document is still confidential) suggests that a uniform price be levied for water. This would be a blend price calculated as follows:

$$\text{Blend Price} = \text{Per Unit cost of Water} = \frac{\text{Summation of Amortized Capital and O \& M costs for All Existing Public Constructed Dams}}{\text{Summation of live yield of water from all Existing Public Constructed Dams}}$$

Using this formula a blend price of Z$11.00 per 10^3m^3 as unit cost of water was obtained. This is to be paid by all farmers irrespective of their location in the country and irrespective of the actual cost of supplying water to them from a given water projects.

A further suggestion is that there be a differential blend price payable by farmers who use water for full irrigation and those who need it for supplementary irrigation purposes only. The latter are mostly in the high rainfall areas located in natural regions I, II and IIIa. The former are in the drier part of the country (natural regions IIIb, IV and V. The rationale for a differential blend price is that farmers in the high rainfall areas use less water and therefore it costs less per total amount used for a given crop per season compared to those who need water for full irrigation.

It is therefore suggested that the country be divided into two water regions for the purposes of differential irrigation water pricing:

(a) Water Region A is that part of the country with rainfall greater than 750 mm per annum. This is mostly in natural regions I, II and IIIa. The blend price for this region is Z$12.00 per 10^3m^3 per year.

(b) Water Region B is mostly natural regions IIIb, IV and V or those areas of the country with annual rainfall lower than 750 mm. The blend price is Z$10.00 per 10^3m^3 per year.

For practical reasons, it has been decided that Water Region A be those farming areas that draw water for irrigation from the Manyame and Mazowe Rivers. The two rivers, located in the northern part of the country, are the major irrigation rivers. The rivers run through the part of the country with annual rainfall in the region of 750 mm and above.

Water Region B is the rest of the country.

It is being suggested that sugar cane be exempted. Sugar cane grown in the low veld, the drier part of the country, is entirely dependent on irrigation. Most water used is from dams constructed 20 to 40 years ago. It is viewed that charging a higher water price would offset the economics of sugar production.

5.2.1 Problems with the above methodology

(1) For new dams being or to be constructed, investment costs are such that it will not be possible to supply water at less than Z$30/$10^3m^3$. This means that each time a new dam is commissioned the cost of water (blend price) goes up. The amount of increase depends on the size and water yield of the new dam. For example the Mazvikadei Dam, presently under construction for Z$25 million, will supply 100 10^6m^3 per year at a cost of Z$30 per 10^3m^3 per year when completed in 1988. It will affect the blend price as follows:

	Water Supply 10^6m^3	Unit Cost of Water		Total Cost $
Current	369	11.00	=	4 059
Mazvikadei	100	30.00	=	3 000
				7 059
		New Blend Price	=	7 059 / 469
			=	Z$15.05

The abilitity of farmers to absorb increasing water cost is being studied by the Ministry of Lands, Agriculture and Rural Resettlement. The government is wary of a situation of increasing irrigation costs for farmers. Apart from discouraging farmers from investing in irrigation it puts the government into two conflicting situations. First, government may have to subsidise irrigation costs. This is unacceptable since the government is trying to reduce subsidies. Secondly, the government will be pressured to raise to raise crop prices to main farm viability. The government has reservation on this alternative as it has adverse effect on consumer prices which the government is not prepared to subsidise.

(2) The second problem is one of cross-subsidization. In a given water region, the water rate would be equal no matter what the actual cost of supplying water to the individual irrigation scheme or farm. This means that there is going to be an element of cross-subsidization among irrigation schemes or farms. Cross-subsidization may also occur between the two proposed water regions.

An assessment therefore needs to be conducted to determine the level of cross-subsidization which may introduce conflicts among users.

6. Policies with Regard to O & M Expenditure within Public Irrigation Schemes

This section refers to irrigation schemes in communal areas and settler irrigation scheme managed by ARDA.

6.1 Prior to 1980/81

Up to 1980/81, irrigators paid the following water charges based on water circulation rotation, value of crops grown and on whether the whole scheme or part thereof was lined or not (Zimbabwe Government, 1983):

Frequency of Water Circulation	Water Rates Per Hectare		
	Crop Growing All Year	Summer Crop Only	Winter Crop Only
	$	$	$
10 days or less	70	40	30
Between 10 and 14 days	35	20	15
15 days or more	6	6	6

The water charges were paid in advance on July 1 of each financial year.

The charges were calculated to recoup 10 - 12 percent of the annual O & M costs of the scheme. The remainder was subsidized by government. Operating and maintenance costs were made up of salaries and wages of extension workers, water baliff, irrigation managers, maintenance of pumping equipment and canals, etc. These varied with schemes.

Capital redemption for the initial investment costs were not incorporated in the charges. These were regarded as government grants. The rationale was that the irrigators would not afford to pay the economic rate for water which was calculated at between Z$50/$10^3 m^3$ to Z$80/$10^3 m^3$. The annual recurrent budget for O & M costs of schemes in communal areas was estimated at above Z$1 million (1983 figures).

6.1.1 Problems arising out of the above methodology

(1) For some schemes, farmers in the same scheme paid different amounts of water charges. This arose from the fact that parts of the scheme fell into different categories in terms of water circulation frequency. There were also cases of arbitrary decisions in the amount levied on individual farmers in a given scheme.

(2) For some schemes, water supply was unreliable resulting in farmers not getting enough water when their irrigation turn came, yet they had paid in advance.

(3) The differential rates paid and unreliable water supply encouraged malpractices such as illegal abstraction upstream of weirs and canals; water piracy; and over irrigation.

6.2 1983 to 1986

In 1983 the then Department of Rural Development proposed a new payment structure for O&M recovery. The overal objective for the new rates were (Zimbabwe Government, 1983):

(a) to improve discipline among irrigators and change attitude towards a limited natural resource.

(b) to provide an incentive for increased production

(c) to raise the proportion contributed by irrigators to running costs to between 20 and 25 percent so as to reduce government subsidies.

(d) to remove the anomaly whereby farmers in the same scheme paid different water charges.

The new payment structure was based on the gross margin principle and took into account the security of water supply to the scheme:

Nature of Water Supply		Water Charges/ha/year		
		Full Year Crop Growing	Summer Crop Only	Winter Crop Only
	Rate	$	$	$
Assured Water Supply	A	145	90	55
Periodic shortages experienced On Sand Abstraction Schemes*	B	72	45	30
	C	30	30	30

* also applied to schemes allowing growing of one crop per year only.

Irrigators in the same scheme were to pay the same rate. The basis for calculating the water charges though based on the ability to pay was literally arbitrary. Gross margin budgets for the various crops and/or crop combinations were developed and a figure for water charges was thrown in. This figure was raised by arbitrary amounts to determine how irrigation costs affected enterprise profitability. Calculations stopped at $145 per ha per year.

An exception was made for those schemes considered to be high risk, mostly located in the drier parts of the country (South-east and south-west). These are mostly sand abstraction schemes. A five day reticulation system is essential and mechanical pumping failure would result in 20 percent or more crop loss. Some of these schemes are in remote and inaccessible parts of the country. They have therefore limited markets for their produce. The recommendation was that such schemes be subsidized to a greater extent.

The Z$145 per ha per year is not an economic rate, neither does it cover all the O & M costs. It was assessed that small scale scheme irrigators were in no position to pay an economic rate due to the following factors:

(1) Most crops grown are not high value crops and therefore do not generate sufficient income to cover a greater portion of O & M costs.

(2) Size of holdings are small (0,1 ha to 1,0 ha) thereby restricting crop choice.

(3) Some schemes being far from markets, transport costs prohibit production of marketable crops, eg green vegetables, tomatoes, green maize etc. As a result irrigators concentrate on subsistence crops whos surpluses would be sold locally.

6.2.1 Current Proposals

The Water Pricing sub-committee has proposed the following:

(i) to maintain the gross margin concept for calculating water charges.

(ii) to incorporate the opportunity cost of labour at either Z$103 per month being the lowest minimum wage in the urban sector or Z$153 per month being the minimum wage for general workers in the agro-industry, eg processing factory, sugar, tea and citrus plantations.

(iii) to base calculation of the final figure on the average net farm profitability of a group of irrigators growing a set of common crops:

$$\text{Net Profitability} = \frac{\text{Average Farm Profitability for Average Farms} + \text{Average Farm Profitability for Better Farms}}{2}$$

(iv) Final payable figure for water charges to be arrived at by sensitivity analysis.

Main crops considered at the moment are maize and beans. Such crops as vegetables, green maize and fruit will be considered once a methodology on how to handle them is established. Data available on level of production of these crops is unreliable. Marketing is also a problem.

6.2.2 Possible Problems

Problems foreseen with the suggested methodology include:

(i) Updating of water cost in an environment of increasing input costs and changing crop prices.

(ii) Having farmers accept increase charges each year or when they increase, and

(iii) In some schemes, the cropping pattern on which the gross margin budgets are based are not those actually practised.

6.3 Farmers Ability to Pay

The gross margin principle is preferred because it provides a framework for evaluating farmers' ability to pay. When water charges were raised to Z$145/ha, the justification was that irrigators were capable of paying. This was assessed from the fact that irrigators were capable of earning net income between Z$1 200/ha and Z$2 000/ha per year or season. This was estimated to be twice the net farm income under dryland cropping.

The gross margin calculations took into account all input costs other than the opportunity cost of labour. It is only now that attempts are being made to incorporate opportunity labour costs. The rationale is that earnings in the irrigation schemes should at least be greater than or equal to government determined minimum wages.

Prices of the main crops are controlled by government which also sanctions increase of input prices. Therefore the issue of maintenance charges is of concern to government. At the current moment government is anxious to reduce the level of subsidies to the agricultural industry. It would welcome reduction in government contribution to O & M within the irrigation schemes.

7. Incentives and Financing of Irrigation Investment in Private Schemes or Farms

It is estimated that the capital cost for installing an irrigation system on a farm is Z$127,36 per 1 000 m^3 of water (for storage, pumps and supply lines). The annual irrigation cost is estimated at Z$20,05 per $10^3 m^3$ per ha (AGRITEX, 1986). As with public water works debt servicing constitutes the major portion of the initial outlay while energy costs form the greater proportion of annual irrigation costs. All these create disincentives for farmers in irrigation development.

In 1985, the government established a National Farm Irrigation Fund (NFIF) to encourage farmers in all subsectors to invest in irrigation development on their properties. The fund is worth Z$18 million of which Z$12 million is earmarked for the large scale commercial farmers and Z$6 million is for rehabilitation and development of smallholder irrigation schemes in Communal Areas.

Farmers borrow from the fund at 9,5 percent per year interest rate. This is 50 percent lower than the interest rate charged by commercial banks for irrigation finance.

A proviso by government at the moment is that the large scale commercial farmers, who make use of the Fund, allocate water use to wheat irrigation. This is aimed at increasing wheat production in order to reduce wheat imports.

It is expected that in future smallholder farmers in public schemes in Communal Areas would borrow from the Fund to construct on-farm works.

Conclusion and Recommendations

Investment in irrigation development is costly. In Zimbabwe, it costs between Z$15 and Z$100 per 1 000 m^3 to supply water from dams recently constructed or to be constructed. The government's policy is that farmers and users of water pay the full cost of water to cover initial outlay and operating and maintenance costs. In addition farmers pay operating and maintenance for on-farm irrigation facilities. Irrigation investment by farmers and government in public irrigation schemes is therefore unattractive. This has prompted government to review irrigation development policy, examine water pricing policy and establish a national irrigation fund.

There is dilemma regarding how much of the cost of irrigation is desirable or possible to recover from the farmers. Conflict arises from the need to have beneficiaries contribute to recovery initial and O & M costs. The charge should be large enough so that the irrigation system is self-financing but small enough so that farmers have the ability to pay it.

From Zimbabwe's experience, the recommendations for tackling the dilemma are:

(a) Beneficiaries must contribute to recovery of water resources development costs, including the operating and maintenance costs. Therefore water charges must be fixed at a level sufficient to cover these costs.

(b) The rate should encourage economics in water use but should not act as a disincentive to farmers to use or invest in irrigation. Therefore water charges have to be related to farmers' ability or capacity to pay.

(c) A uniform rate should be levied for all water users with subsidies for those farmers in irrigation schemes that need government support to be viable.

(d) Appropriate level of water charges in public schemes should be based on a certain percentage of the gross value of the farmers' increased production attributable to irrigation.

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APPENDIX 1

Table A.1 PUBLIC IRRIGATION SCHEME DEVELOPMENT COSTS (1984 Estimates for Mushandike Settler Irrigation Scheme).

		Per Hectare (Z$)
A. WATER SUPPLY		
Main Canal lining		408
Secondary canal lining		41
	Sub-total	449
B. IN-FIELD COSTS		
Tertiary Canals		1 423
Canal Gates		16
Canal formers and templates		5
Measuring flumes		1
Roads		6
Access road bridges		1
Fencing		25
Demarcation		18
Land preparation		36
Blair toilets		8
	Sub-total	1 539
C. SERVICE DEVELOPMENT COSTS		
School buildings		318
Irrigation Officer's house		25
Clerical Assistant's house		11
Extension Worker's house		22
Water Guard's housing		44
Telephone installation		2
Administrative centre		82
	Sub-total	504
D. CONTIGENCIES (price, planning and physical - 10%)		249
TOTAL DEVELOPMENT COSTS (A + B + C + D)		2 741

(Source: Rukuni, 1984)

APPENDIX 2

Table A.2 Operating and Maintenance Costs Per Type of Scheme, 1984.

	Type of Scheme	Per Hectare (Z$)
(a)	Gravity with no pumping	153
(b)	Pumping from source then gravity	384
(c)	Pumping from source then sprinkler	462
(d)	Sand Abstraction then gravity	738

(Source: Rukuni, 1984)

Table A.3 Average Operating and Maintenance Costs on Various Irrigation Schemes, 1984

Scheme	Per Hectare (Z$)
ARDA Schemes	10 000 - 15 000
Communal Schemes	271*
Commercial Farming Unit	145

(Source: Rukuni, 1984)

APPENDIX 3

Table A.4 Zimbabwe: Average Dryland and Irrigated Crop Yields, 1970 - 1979.

(kg/ha)

	Communal Farming Areas		Commercial Farming Areas	
Crop	Irrigated	Dryland	Irrigated	Dryland
Maize	5 494	656	7 000	4 732
Wheat	2 256	n/a	4 700	2 025
Cotton	1 887	822	3 500	1 650
Groundnuts	1 687	581	2 500	1 710
Sorghum	2 020	516	2 700	1 854
Soyabeans	2 036	n/a	2 000	1 601
Potatoes	4 183	n/a	30 000	n/a
Beans	1 200	800	n/a	n/a

(Source: Central Statistical Office, 1970 - 1979).

Notes: (1) n/a = not available

(2) There is no dryland wheat production.

APPENDIX 4

Table A.5 Returns and Costs of Summer and Winter Irrigated Crops at Sanyati Irrigation Scheme, 1984/85.

	Per Hectare Figure		
	Summer	Winter	
	Cotton	Maize	Wheat
Yield kg/ha	2 520	5 494	3 330
	Z$	Z$	Z$
GROSS OUTPUT	1 890	989	942
CASH COSTS			
Land Preparation	72	32	57
Seed	5	20	55
Fertilizer	190	216	289
Insectides	99	-	-
Water Charges	90	55	55
Hired Labour	10	-	-
Marketing	2	1	74
Other	46	41	32
Total Cash Costs	514	365	562
Gross Margin	1 376	624	380
Average Area (ha)	0,65	0,65	0,65
Crop Gross Margin (Z$)	894	406	247

Whole Farm Gross Margin

Summer Crops	Z$ 894
Winter Crops	653
Farm Gross Margin	1 547

(Source: AGRITEX Farm Management Data)

APPENDIX 5

Table A.6 Returns and Costs of the Main Irrigated Crops on Large Scale Commercial Farming Units, 1984/85

	Per Hectare Figures		
	Cotton	Maize	Wheat
Yield (kg/ha)	3 000	6 500	4 700
	Z$	Z$	Z$
GROSS OUTPUT	2 250	1 170	1 330
VARIABLE COSTS			
Labour	167	68	62
Fuel	148	131	130
Seed	27	36	56
Fertilizer	245	292	384
Herbicides	57	28	21
Insecticides	132	28	5
Irrigation	91	101	150
Insurance	3	6	84
Harvesting & Marketing	377	218	158
Other	27	18	20
Total Variable Costs	1 274	926	1 072
GROSS MARGIN	976	244	258

(Source: Agritex Farm Management Data 1986).

Notes

	Cotton	Maize	Wheat
Price	Z$0,75 kg	Z$180/tonne	Z$283/ tonne
Irrigation water ($10^3 m^3$/ha)	4,5	5,0	7,5
Water cost/$10^3 m^3$	Z$20,25	Z$20,25	Z$20,25