Smallholder irrigation: Zimbabwe

ABSTRACT

Smallholder farmers in Zimbabwe suffer from low incomes and living standards, poor nutrition, housing and health and are unable to send children to school. They are extremely food insecure, particularly in low rainfall areas, where rainfed agriculture is almost always a failure. Irrigation, however, can make agriculture successful, as had been recognized by 1932, when the government set up the Mutema irrigation scheme in Manicaland.

Sixty years later, during the devastating drought of 1992, the Hama Mavhaire Irrigation Scheme was commissioned, affecting 96 families each with 1 ha of land. Built for slightly less than US$l million, the Hama Mavhaire dam was filled in one go by a flash flood. The surrounding area was completely dry but the irrigation scheme was a green oasis of life, visible for miles. The only maize of the year grew here and was followed by crops of beans and other vegetables.

The scheme was a hive of commercial activity. People from surrounding communal lands and towns visited the scheme to order green mealies, grain and vegetables. Orders for farm produce were received from as far afield as Bulawayo and Hwange, 250 and 500 km away respectively.

Implementation involved planning with farmers. An interim Irrigation Management Committee (IMC) formed at the outset enabled farmers and planners to share their views. Technology options were discussed and selections made. Unskilled labour for the surveys was recruited among potential beneficiaries. This enabled farmers to understand the technical aspects of the scheme, which would help them with subsequent management.

Farmers were allocated plots prior *to* implementation and it was their responsibility to dig pipe trenches, clear bush and fence the scheme. Field equipment, provided initially through a government grant, belonged to the irrigators, who operated, maintained and if necessary replaced it. Management created a sense of responsibility and ownership and farmers now run a sustainable scheme, averaging **US$2** 000 a year each. Plot allocation took into account households headed by women, who participated in the scheme as equals to men. Environmental issues were prominent in scheme implementation.

INTRODUCTION

Smallholder farmers in Zimbabwe, particularly in the low rainfall areas, are extremely food insecure. They suffer from low incomes and living standards, poor nutrition, housing and health and cannot send children to school. This is aggravated by the fact that there is usually very little rainfall, especially in agro-ecological zones IV and V. Annual rainfall is 450-650 mm/year in zone IV and less than 600 mm/year in zone **V,** concentrated in a few isolated storms.

Under these climatic conditions, rainfed agriculture fails four years out of five. With irrigation, however, successful cultivation of crops becomes a possibility. This had been recognized by the government in the 1930s; the Mutema irrigation scheme in Manicaland was introduced in 1932.

Such schemes were constructed without the participation of farmers, however. The government surveyed sites suitable for irrigation and, without consulting would-be beneficiaries, designed and constructed irrigation schemes. The government would select irrigators from communities and where there was no local interest, farmers would be brought in from other areas. Farmers at Chilonga irrigation scheme, for example, came from Chivi and Masvingo to irrigate in Chiredzi district.

The schemes belonged to the government, not the farmers, and irrigators had no responsibility for them; they merely grew and sold crops. Repair and maintenance were the responsibility of the state. Canals breached, roads eroded, fences broke and irrigators would wait for the government to repair its scheme. As the number **of** schemes increased, so did repair and maintenance budgets. Schemes that fell into disrepair gradually became unsustainable.

This was the situation addressed by the innovative approach in the Hama Mavhaire area in Mvuma district during development of an irrigation scheme in 1992 as part of the Hama Mavhaire Irrigation Scheme.

The United Nations Development Programme (UNDP) funded the project, which was executed by the Food and Agriculture Organization of the United Nations (FAO). The objective was institutional strengthening and capacity building for the Irrigation Branch in the Department of Agricultural Technical and Extension Services (Agritex), a department of the Ministry of Lands and Agriculture. Agritex offers extension services to farmers in Zimbabwe and is responsible for smallholder irrigation schemes.

In September 1997, **following a** one-year preparatory phase under FAO's Technical Cooperation Programme (TCP), the project became effective. The programme seconded to Agritex three irrigation experts and an agro-economist, who trained Irrigation Branch staff. Fieldwork followed in planning, designing and constructing on-farm water management of sustainable smallholder irrigation schemes. The experts were available for technical backstopping until Agritex engineers and economists had acquired sufficient competence and self-confidence, at which point staff worked on their own, with occasional back-stopping when the need arose. Several smallholder irrigation schemes were implemented under this project, including Hama Mavhaire.

The planning, implementation and management of Hama Mavhaire Irrigation Scheme are typical of the approach adopted for development **of** sustainable smallholder irrigation schemes in Zimbabwe. The Hama Mavhaire project illustrates innovative experiences that may be replicated in other developing countries.

PRE-INNOVATION

The area before the irrigation scheme was implemented is described as follows:

"A poorly maintained gravel road takes off at the 256 km peg on the Harare-Masvingo highway and winds due west through Mushagashe West Small Scale Commercial Farms. After 18 to 19 km on this road, you come to a hill overlooking the Mavhaire River Valley, a sprawling stretch of barren land. The reddish brown soils are sun-baked, gravelly and generally shallow. Trees do not grow and thorny bushes and shrubs thrive in their place. On the few patches of arable land, there is very little evidence to suggest any meaningful harvest. The farmers get one meaningful harvest in five years. A few poorly conditioned animals roam the countryside in search **of** grazing. **A** kilometre into the valley brings **you** to a village consisting mainly of pole and ***daga*** huts. The inhabitants greet you with faces that are highly expectant of some food aid, either in the form of a food-for-work scheme or actual food handouts. This is how they have come to survive over the years, as a result of the now persistent droughts in Zimbabwe. The children look poorly nourished, poorly dressed and their faces show general sadness. There is no evidence of alternative employment opportunities in the area. The only obvious pastime for the men is beer drinking. The women try their luck by forming a club where they exchange skills in cookery, sewing and general family care. However, these noble efforts soon come to nought as lack of funds pulls the noose on these efforts. The women need opportunities to generate their own funds.

Lying idle in the area is the Mavhaire dam, capable **of** irrigating approximately 100 ha, which provided the opportunity for the innovative approach."

The work of the Agritex irrigation economist was adopted in its entirety in an effort to give a comprehensive picture of the situation prior to project implementation. **A** socio-economic baseline survey was carried out in 1988 by the Agritex team ***to*** establish the "without project" situation. A sample of 24 of the

TABLE 1
Dryland cropping pattern and input use for 24 households, 1995

Crop	Area	% of total area	Average yield (tonnes)	Average fertilizer (per ha)	Average chemical use (per ha)
Grain maize	38 8	49	2 4	Compound D – 115 kg Ammonium nitrate – 89 kg	Thiodan – 0 50 kg
Rapoko	13 4	17	0 74	Compound D – 21 kg	–
Sorghum	7 5	10	2 5	Compound D – 47 kg	–
Groundnut	7 4	9	0 43	Gypsum – 54 kg	–
Sunflower	4 0	5	0 80	Compound D – 50 kg Ammonium nitrate – 25 kg	–
Fallow	7 6	10	–	–	–
Total [a]	**78.7**	**100**	–	–	–

[a] Obtained after multiplying average dryland holding (3.26 ha) by number of households (24).
Source: Analysis of the Agritex socio-economic survey data.

TABLE 2
Total dry land cropping areas, yields and input use for 96 households, 1995

Crop	Area	% of total area	Total yield (tonnes)[b]	Total Compound D (kgc	Total Ammonium nitrate (kg)d	Total Thiodan (kg)e
Grain maize	153 35	49	368 04	17 635 30	13 648 19	76 68
Rapoko	53 20	17	39 37	111727	0	0
Sorahum	31.30	10	78.24	1470.91	0	0
Groundnut	28.17	9	12.11	1 520.99	0	0
Sunflower	15.65	5	12.52	782.40	391.2	0
Fallow	31.30	10	–	–	–	–
Total	**312.97**	**100**	–	–	–	–

[a] Result of multiplying average holding (*3.26* ha) by number of households (*96*).
[b] Result of multiplying average yield per ha in Table 1 by total area per crop in Table 2
The same reasoning is applied to c-e.
Source: **Derived** from Table 1.

96 farmers, randomly selected and interviewed by means of a questionnaire, captured information on land use, employment and dryland incomes, set out in the following paragraphs.

Land use

Land use data **refer** to dryland holdings, cropping patterns and use **of** inputs. The average holding was 3.26 ha, with a cropping pattern of 49 percent grain maize, 9 percent groundnuts, 10 percent sorghum, 17 percent rapoko and 5 percent sunflower; average yields are shown in Table 1. Results are used to estimate the areas, yields and inputs for the households participating in the two alternatives.

TABLE 3
Total dryland cropping areas, yields and input use for 92 households, 1995

Crop	Area	% of total area	Total yield *(tonnes)*	Total Compound D *(kg)*	Total Ammonium nitrate *(kg)*	Total Thiodan *(kg)*
Grain maize	146 96	49	352 71	16 900 49	13 079 51	73 48
Rapoko	50 99	17	37 73	1 070 71	0	0
Sorahum	29 99	10	74 98	1 409 62	0	0
Groundnut	26 99	9	11 61	1 457 61	0	0
Sunflower	14 99	5	11 99	749 80	374 90	0
Fallow	29 99	10	–	–	–	–
Total	299.91	100	–	–	–	–

Source: As for **Table** *2*.

TABLE 4
Available labour per household per month, 1995

Month	Adult labour	Child labour	Total
January	40	30	70
February	40	–	40
March	40	–	40
April	40	–	40
May	40	60	100
June	40	–	40
July	40	–	40
August	40	60	100
September	40	–	40
October	40	–	40
November	40	–	40
December	40	30	70
Total	**480**	**180**	**660**

Table 2 gives total dryland holdings, yields and inputs for alternative 1; Table 3 those for alternative 2. Levels of inputs and yields are far below the national average.

Labour availability and use

Labour requirements are calculated for dryland cropping patterns. The Farm Management Branch of Agritex provides estimates of labour requirements for dryland crops by operation and on a monthly basis per hectare. Labour for off-farm activities such as cooking, firewood collection, cattle herding and leisure have not been captured. The Farm Management Branch gives guidelines on labour requirements and availability for such activities by not counting children

TABLE 5
Crop and input prices, 1995

Item	Price (Z$)
Grain maize	1 050 00 (per tonne)
Rapoko	650 00 (per tonne)
Sorghum	650 00 (per tonne)
Groundnut	4 100 00 (per tonne)
Sunflower	1 154 65 (per tonne)
Compound D	1 064 (per kg)
Ammonium nitrate	1 795 (per kg)
Gypsum	0 23 (per kg)
Thiodan	7 28 (per kg)

Source: Project area prices.

below the age of 18 as available for labour during the academic year. A labour day of only six hours and 20 working days per head per month are assumed, although farmers normally would be able to work more.

For the Hama Mavhaire project, average family size was two adults and three children between 9 and 18. Farm Management Branch guidelines indicated the adults would provide 20 hours of labour per month each. The children would provide labour during the May, August and December/January school holidays (see Table 4). Children younger than nine do not provide labour. Labour for the two alternatives is worked out from Table 4.

"Without project" income

The "without project" income is derived from the dryland cropping pattern in Table 1. Crops, fertilizers and chemicals are valued at 1995 prices (see Table 5), with gross margins calculated for the two alternatives.

INTRODUCING INNOVATION

Irrigation scheme development, with full farmer participation in planning, implementation, operation and maintenance was a new approach in Zimbabwe. Farmers at Hama Mavhaire were involved from the outset, providing guidance on land for the irrigation scheme and supplying unskilled labour for bush clearing, pipe trenching and soil and topographic surveys. This allowed them to become familiar with scheme planning and engineering, preparing them for future operation and maintenance. Farmers felt involved and responsible for the success or failure of the scheme, which was theirs.

The engineering design was selected from options prepared by an engineer after discussion of advantages and disadvantages with the farmers. Farmers were exposed to different technologies through visits to other irrigation schemes and discussions with the participants.

On the basis of information gained, the farmers selected a drag-hose sprinkler system. Each farmer owned, operated, repaired and maintained his/her set of six sprinklers and hose and was responsible for replacing the equipment when it wore out. The government was responsible only for the headworks and the supply pipeline. The drag-hose sprinkler irrigation system incorporated built-in management elements, making it easier to use and permitting more efficient irrigation. Irrigation efficiency on smallholder schemes in Zimbabwe is about 45 percent or lower for surface schemes and 65-70 percent for sprinkler schemes.

Besides introducing innovative irrigation, the project dealt with environmental management and conservation. The soil was often bare for seven to ten months of the year, a result of overgrazing and low rainfall, effects **of** which became apparent during occasional storms. Sediment loads in the tributary streams of the Save river were high, with gullies forming everywhere. Over time, streams and rivers would fill up with sand, seriously reducing their water storage capacity. Under the irrigation scheme, livestock were not allowed to roam, thus relieving the land of grazing pressure and giving vegetation a chance to recover, which reduced soil erosion. Year-round crop production in the scheme further increased vegetation cover.

Ownership **of** an irrigation plot in Zimbabwe had always been a preserve of men, often a source of problems when husband and wife did not share the same level of commitment in the venture. Some husbands even destabilized management of the plot or misused earnings to discourage their wives. At Hama Mavhaire, however, about 50 percent of the plot holders are women.

The scheme has seen farmers move from near zero incomes to annual gross margins of about US$2 772/ha, since two to three crops can be grown each year. New houses built of burnt brick and corrugated roofing are being built and the general appearance of farm families suggests they enjoy good nutritional status. Livestock *are* in good condition because of the stover coming from the scheme.

Key features

Government practice had been to develop irrigation schemes without beneficiary participation, with the result that schemes were viewed as government owned. The schemes were financially unsustainable, since the government had to bear the cost of all operations, maintenance and equipment. Management was also the responsibility of government. The innovation was to chart a new partnership

[48] Crop residues and stubble.

TABLE **6**

"Without project" incomes for alternative 1, 1995 *(96 households)*

Crop	Gross income	Compound D total cost	Ammonium nitrate total cost	Thiodan total cost	Total variable cost	Gross margin (28
Grain maize	38644301	2828701	2449849	55820	53 343.70	333 099.31
Rapoko	25 590 74	1 792 10	0	0	1 792.10	23 798.64
Sorghum	50 856 00	2 359 34	0	0	2 359.34	48 496.66
Groundnut	49 657.36	2 439.66	0	0	2 439.66	47 217.70
Sunflower	14 446 23	1 254.90	702 20	0	195717	1248906
Total	**526 993.34**	**36 133.01**	**25 200.69**	**558.2**	**61 891.97**	**465 101.37**
Hired labour						226 9fi4
Without project net benefit						**238 137.367**

[a] Total yield in Table 2 multiplied by unit price in Table *5*. The same approach is applied on inputs.

TABLE **7**

"Without project" incomes for alternative 2, 1995 *(92 households)*

Crop	Gross income	Compound D total cost	Ammonium nitrate total cost	Thiodan total cost	Total variable cost	Gross margin (Z$)
Grain maize	370 341 22	27 108 ***39***	23 477 72-	-53494-	31-12' 05	319 220 17
Rapoko	24 524 46	1 717 43	0	0	1 71743	2280703
Sorghum	48 737 **00**	2 261 04	0	0	2261 04	4647596
Groundnut	47 588 31	2 338 01	0	0	233801	4525030
Sunflower	13 844.31	1 202.68	672 95	0	1 875 62	11 96868
Total	**505 035.30**	**34 627.55**	**24 150.67**	**534.94**	**59 313.15**	**445 722.14**
Hired labour						211 017
"Without project" net benefit						**234.705**

Source: As for Table *6*.

between government and farmers, who were to share the cost of development. The farmers were to decide on which technology to use and were to own the scheme and manage its affairs. All farmers, regardless of gender, participated fully.

Implementation involved planning with the farmers. An IMC was formed at the inception of scheme planning **so** that farmers and planners could share their views. Technology options were discussed and selections made. Unslulled labour for the surveys was recruited from the potential beneficiaries. This helped the farmers understand the technical aspects of the scheme, which would help them later in scheme management. The farmers were allocated plots prior to implementation and it was their responsibility to dig pipe trenches, clear bush and provide fencing.

Field equipment, provided initially through a government grant, belonged to the farmers, who operated and maintained it, replacing it as necessary. Plot allocation took into account households headed by women. Scheme management created a sense of responsibility and ownership among farmers, who now run a sustainable scheme averaging US$2 500-2 700 gross margin per hectare per year. The scheme is user-friendly, especially for women, since they do not have to move pipes, except for small hoses and sprinkler tripods. The pipe system is environmentally friendly and healthy, with no runoff to cause water logging that can be the source of malaria and bilharzia.

POST-INNOVATION

Annual fixed costs for the 96-ha Hama Mavhaire Irrigation Scheme work out at US$1 518/ha and operating costs are US$1 654/ha.

The scheme was commissioned during the devastating drought of 1992, the worst in living memory. Built at a cost of slightly less than **US$1** million, the Hama Mavhaire dam was filled in one go by a flash flood. While most of the surrounding area and the hinterland was completely dry, with leafless trees and dry grass, the greenery of the irrigation scheme could be seen from a distance. The only maize of the year grew in the area, followed later that year by beans and other vegetables.

Commercially, the scheme was busy: people from surrounding communal lands and towns came to order green mealies, grain and vegetables. Orders for farm produce were received from as far afield as Bulawayo and Hwange.

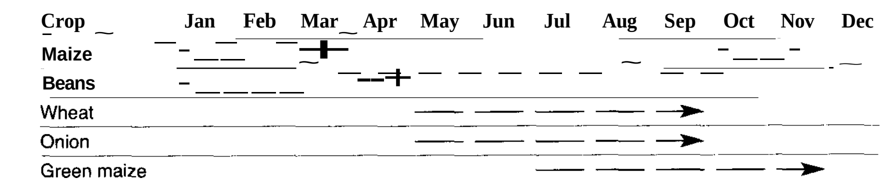
Work by the Agritex agro-economist illustrates the “with project” situation. Agritex looked at costs and benefits of the Hama Mavhaire scheme on the basis of two mutually exclusive designs, with the objective of maximizing incomes. For the Hama Mavhaire farming community, the objective is to maximize family income from the project – the net benefit increase. The resources used consisted of land, labour and inputs. The tools to evaluate them were cropping patterns, labour requirements and crop budgets.

Resource use differs in the two alternatives. In alternative 1, 96 ha of land are irrigated by 96 farmers using six sprinklers each at the same time for six days at peak demand. In alternative 2, 46 ha are irrigated by 46 farmers for the first three days and the other 46 hectares are irrigated for the next three days, requiring 12 sprinklers operating at the same time to enable a three-day cycle at peak demand. Investment, operation, maintenance and replacement costs and the areas irrigated are different in the two alternatives.

TABLE 8
Hama Mavhaire cropping pattern *(years 1-20 of operation)*

Crop	% of total area	Area for alternative 1 *(96 ha)*	Area for alternative 2 (92 *ha)*
Grain maize	50	48	48
Beans	50	40	48
Wheat	50	48	48
Onion	25	24	24
Green maize	25	24	24
Total	200	192	192

TABLE 9
Cropping calendar *(years 1-20 of operation)*



Note: The lines and arrows show the time the crop is planted, until it is harvested

Cropping patterns

To estimate benefits from the Hama Mavhaire Irrigation Scheme, a cropping pattern has been proposed (see Table **8).** The following factors were taken into account:

- farmers' aspirations
- agronomic factors
- soils
- crop water requirements
- rotational considerations
- marketing aspects
- labour requirements

The cropping calendar is given in Table 9. The lines and arrows show the time from planting to harvest.

Yield levels are based on experience from similar irrigation schemes **and** figures from the Farm Management Branch; input levels are recommendations based on soil analysis by the Department of Research and Specialist Services (DRSS) in the Ministry of Agriculture. It is assumed that farmers can obtain good maize yields from the first year of operation, since the crop is well known. For other

TABLE 10
Yields for irrigated crops (years *1-4* of *operation)*

Crop	First year *(tonneslha)*	Second year *(tonneslha)*	Third year *(tonneslha)*	Fourth year *(tonnes/ha)*
Grain maize	6.00	6.00	6.00	6.00
Beans	1.4	1.6	1.8	2
Wheat	3.5	4.00	4.5	5
Onions	12 314	14 074	15 833	1593
Green maize	40 000	40 000	40 000	40 000

[a] Yield expressed in bundles.
[b] Yield in cobs.

crops, a learning process has been assumed, with yields increasing from 70 percent of target in year 1 to 100 percent from year 4. Yields are given in Table 10.

Labour requirements

Labour requirements were based on the sum of individual requirements for each crop minus the family labour contribution. The Farm Management Branch of Agritex provides estimates on a monthly basis by hectare, crop and operation. Available labour is the same as for dryland.

"With project" income

Project income is derived from crop budgets. Crops are valued at after-gate sales prices. Yields in Table 10 multiplied by prices in Table 11 give gross values per hectare for each crop.

Investment costs

Investment costs include construction, field edge conveyance and headworks and in-field works. Figures for the two alternatives are given in Table 12.

Energy costs

Energy costs are for electricity used to pump water, derived from the energy used in irrigation and the charge per kWh. Energy use depends on the size **of** electric motor and pumping time required, which depends on the cropping pattern. The cost per kWh is provided by the Zimbabwe Electricity Supply Authority **(ZESA).** Annual electricity costs at *200* percent cropping intensity are estimated at Z$151 665 for alternative 1 and Z$145 367 for alternative 2.

Repair and maintenance costs

Annual repair and maintenance costs are estimated at 5 percent **of** the capital

TABLE 11
Irrigated crop prices, 1995

Crop	Price (Z$)	Comments
Grain maize	1 050 00	G M B price c
Beans	5 000 00	estimated farm-gate price
Wheat	1 450 00	G M B price
Onion	0 60"	estimated farm-gate price
Green maize	0 30b	estimated farm-gate price

* Price per bundle.
b Price per cob.
c G.M.B. stands for the Grain Marketing Board of Zimbabwe

TABLE 12
Investment costs for the two alternatives, 1995

Item	Alternative 1 (Z$)	Alternative 2 (Z$)
Pipes	689 240	822 739
Hoses and valves	103 718	212 284
Sprinklers and skids	193 443	371 323
PVC fittings and steel pipes	282 509	244 423
Gates and tools and barbed wire	76 294	76 294
Cement for 4 reservoirs, manholes and fencing	30 518	30 518
Pumping unit	498 047	498 047
Sub-total	**1873770**	**2 255 630**
10% contingencies	187 377	225 563
Skilled labour	89 427	108 590
Unskilled labour	178 855	217 181
Total	**2 329 429**	**2 806 964**

Source: Estimated by the Irrigation Branch of Agritex.

cost of equipment, which works out at Z$116 471 for alternative 1 and Z$140 348 for alternative 2.

Replacement costs

Replacement costs are based on manufacturers' recommendations that hoses and valves should be replaced every 4 years, sprinklers and tripods every 10 years and pumping units every 15 years.

Production costs

Production costs are variable. Input rates recommended **by** the Department of Research and Specialist Services and Agritex are valued at 1995 prices to obtain the variable costs.

TABLE 13
Replacement *costs* in Z$ *(years* 7-20 of *operation)*

Item	Replacement costs Alternative 1	Replacement costs Alternative 2
Hoses and valves (4 years)	103 718	212 284
Sprinklers and skids (10 years)	193 443	371 323
Pumping unit (15 years)	498 047	498 047

Source: Taken from Table 12.

TABLE 14
Measures of financial viability

Alternative	Net present value *NPV*	Internal rate of return *(IRR)*	Benefit/cost ratio
1	510 000	10 53%	1 23
2	1 103 000	16 07%	1 11

TABLE 15
Measures of economic viability − Hama Mavhaire project

Alternative	Net present value *INPV)*	Internal rate of return *(IRR)*	Benefit/cost ratio
1	3 054 000	27 50	1 94
2	7 028 000	55 43	1 77

Cash flows

Cash flows indicating "with" and "without" project situations for the two alternatives have not been indicated here. Gross values of production are the project inflows. There are no salvage values for equipment. Outflows include costs of production, repair, maintenance, investment and replacement. Depreciation has been excluded. Inflows minus total outflows give net benefit, which, less "without project" income, gives the incremental benefit or net cash flow. This is used to calculate project worth. The time-adjusted cash flow approach has been followed. The analysis is conducted at constant prices, ignoring inflation over time.

Measures of project worthiness

To assess financial viability, the internal rate of return, net present value and benefit-cost ratio have been calculated. The discount rate used is 9.75 percent. Instead of granting Hama Mavhaire farmers funds for development of the scheme, the government may charge this interest rate under the National Farm Irrigation

Fund. By giving the project such funds, the government forgoes the opportunity, thus 9.75 percent is the opportunity cost of capital.

Economic analysis

Economic analysis of the Hama Mavhaire scheme judges how the two alternatives would contribute to social and economic growth. Since the two alternatives compete for Zimbabwe's scarce capital resources, care is necessary to select the better options. Economic analysis follows the same procedure as financial analysis but goes beyond analysis of tangible costs and benefits by taking into account secondary and intangible costs and benefits to society as a whole.

The prices of the starting point for economic analysis are then adjusted to reflect the value to Zimbabwean society of the two alternatives. The main elements of distortion in the Zimbabwean economy are:

- premiums on foreign exchange;
- transfer payments;
- price distortions in traded items;
- price distortions in non-traded items;
- distortions in wage rates.

These need to be corrected to arrive at shadow prices. The relationship between the financial price and the shadow price is:

SP=(FP)x(CF) (SPxCF)

Commodity conversion factors are obtainable from the Planning Commission of Zimbabwe.

Based on financial and economic analysis, both alternatives are viable under the assumptions. Alternative 2 is better than alternative 1 if only IRR and NPV are considered. The B/C-ratio makes alternative 1 the better choice. Analysis results are of course only as accurate as the data used to calculate them and there are uncertainties in estimating costs and benefits.

Farmers now grow at least two crops per year, managing their own scheme with backstopping from government extension and technical staff and enjoying the possibility of growing a wider range of crops, for example paprika for export. Leaders and members of the scheme have taken into account the need for women to participate fully, both in plot ownership and decision-making. All 17 irrigators in Block C, for example, and 70 percent of plot-holders are women. Brick houses are being built in the village and electricity has been brought to the scheme's administration centre. Women have started savings clubs and farmers have been trained in simple on-farm repair and maintenance of irrigation equipment. Food handouts from the government are a thing of the past. Cattle feed on stover and farmers employ local people. The scheme is a green spot all year round. The nearby rural service centre has new shops, grinding mills and a butchery. **A** clinic has been built as a result of the scheme.

LESSONS LEARNED

In the past, international opinion regarded smallholder irrigation development schemes as expensive to construct and maintain and therefore uneconomic and unsustainable, a false assumption that lacks a technical basis. Wrong approaches to development coupled with wrong choices of technology are largely to blame for the establishment of unsustainable smallholder schemes.

The other assumption is that smallholders are not able to use and benefit from advanced technologies. Properly modified and packaged, these technologies can improve scheme performance through their management features. The move from surface irrigation with about 45 percent efficiency to a drag-hose sprinkler system with about 70 percent efficiency is an example.

Sharing costs between government and farmers relieves financial pressure on the government, which can then concentrate on new areas of development.

Farmers are always willing to take charge of their own development as long as the right approaches are used. Farmers do not have money and should contribute through their labour during project planning and implementation. When the scheme becomes operational, farmers need a period of financial grace, except for seasonal loans.

There are also benefits for the wider community. Successful irrigation development has brought with it electrification, roads, growth in service centres and an enhancement of rural livelihoods.

REFERENCES

- Hama Mavhaire scheme design report.
- Hama Mavhaire operational records.

General Information

Title of innovative experience: **Hama Mavhaire irrigation development**
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