Performance Evaluation of Community Based Irrigation Management in the Tekeze Basin

A case *study on three small-scale irrigation schemes (*micro *dams)*

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Mekelle University

1. Introduction

1.1 Background

- Irrigation development is one of the most commonly practised strategy to secure food self sufficiency.
- In the period between 1996 and 2001, 46 reservoir dams with a cumulative storage capacity and irrigable area of 46.91 million cubic meter and 3115 ha, respectively, have been constructed (Co-SAERT, 2001).
- Total area irrigated in Tigray (2002) 4773ha, i.e 0.44% of arable land. Source (BoANR, 2003)
- No comprehensive performance evaluation criteria
- IWMI comparative Performance indicators

Introduction cont'd

Features of IWMI comparative indicators are

- ✓ The indicators are based on relative comparison of absolute values, rather than being referenced to standards or target.
- ✓ Data collection procedures are not too complicated or expensive.
- ✓ The indicators relate the phenomena that are common to irrigation and irrigated agricultural systems.
- ✓ These set of indicators are designed to show gross relationship and trends and should be useful in indicating where more detailed study should take place, for example where a project has done extremely well, or where dramatic changes take place.

1.2 Objective

The objectives of this research work are:

1. To evaluate the performance of small scale irrigation schemes
2. To test the comparative performance indicators in the basin
3. To see the conveyance and application efficiency of the irrigation schemes
4. To recommend appropriate strategies that will improve the performance of small-scale irrigation schemes

2. Project Location and Description

2.1 Site Selection

Criteria

- Site accessibility,
- Availability of water in the reservoir, and
- Availability of compiled agronomic and engineering data

Based on the mentioned criteria, Irrigation projects selected for this research work are

i. Haiba Irrigation Project
ii. Meila Irrigation Project
iii. Ma’ynugus Irrigation Project

2.2 Project description

Haiba Irrigation Project

- Geographic location Lat13º19’North, Long 39º22’East
- Altitude2300m.a.s.l. at dam crest
- Zone Southern , Wereda Samre,
- Distance from Mekelle 45Km
- Catchment area39.1km^2 (including Meila, 14.4km$^{2)}$
- Reservior capacity 3.2 million m^3
- Command area 200ha
- Mean annual rainfall 428mm

Project description Cont'd

Meila Irrigation Project

- Geographic location of the catchment, Lat-13°16'- 13°18' North 39°22'-39°25'East. Altitude range of 2340-3000m.a.s.l.
- Zone Southern , Wereda Samre,
- Distance from Mekelle 40Km
- Catchment area 14.4km^2
- Reservior capacity 1.4 million m^3
- Command area 81ha
- Mean annual rainfall 428mm

Ma'ynugus Irrigation Project

- Geographic location :latitude of 14°07'00" and 14°09'20"N and 38°38'00" and 38°49'09"E longitude
- Zone central, Wered Laelay Maichew, Distance from Axum 7km
- Catchment area 13.05km^2, Reservoir capacity 2.38 million m^3, Command area 124 ha.
- Mean annual rainfall 662.7mm

3. Methodology

3.1 Data collection

- Primary Data- respective projects
- Secondary Data- Water Resources Commission, Bureau of Agriculture, Informative discussion

3.2 Data Analysis

- IWMI's comparative performance indicators
- Internal process indicators (conveyance and application efficiency)

IWMI's Comparative Performance Indicators

- Production, Price, Irrigation Infrastructure cost, PET, Crop Water Requirement

$$SGVP = \left[\sum_{i} A_i Y_i \frac{P_i}{P_b} \right] p_{world}$$

Where, A_i is the area cropped with crop i,
Y_i is the yield of crop I,
P_i the local price of crop I,
P_b the local price of the base crop, and
P_{world} is the value of the base crop traded at world prices

Indicators cont'd

- Out put per cropped area (USD/ha) = $\frac{\text{production}}{\text{Irrigated crop area}}$
- Out put per unit command (USD/ha) = $\frac{\text{production}}{\text{Command area}}$
- Out put per unit irrigation supply (USD/ha) = $\frac{\text{production}}{\text{Diverted irrigation supply}}$
- Out put per unit water consumed (USD/ha) = $\frac{\text{production}}{\text{Volume of water consumed by ET}}$
- Relative water supply = $\frac{\text{total water supply}}{\text{Crop demand}}$
- Relative irrigation supply = $\frac{\text{irrigation supply}}{\text{Irrigation demand}}$
- Water delivery capacity = $\frac{\text{canal capacity at the system head}}{\text{Peak consumptive demand}}$
- Gross return on investment (%) = $\frac{\text{production}}{\text{Cost of infrastructure}}$
- Financial self-sufficiency (%) = $\frac{\text{revenue from irrigation}}{\text{Total O \& M expenditure}}$

Indicators cont'd

Internal Process indicators

- Conveyance Efficiency
- Application Efficiency – Gravimetric Analysis

4. Results and Discussion

- Crops grown differs from scheme to scheme

4.1 Input analysis for IWMI's comporative performance indicators

Table Crop type and yield Haiba Irrigation Project (1996EC)

Crop type	Area (ha)	Yield Qt/ha	Yield Qt	Price (Qt/ha)	Revenue (Birr)
(1)	(2)	(3)	(4)=(2)x(3)	(5)	(6)=(4)x(5)
Maize(AS11)	22	74	1628.0	190.0	309320.0
Maize (local)	51.3	70	3591.0	190.0	682290.0
Onion(exotic)	30.9	131	4047.9	200.0	809400.0
Onion(local)	14.5	60	870.0	225.0	195750.0
Tomato	4.9	155	759.5	200.0	151900.0
Potato	0.8	112	89.6	150.0	13440.0
Cabbage	0.4	120	48.0	100.0	4800.0
Abish	1.6	15	24.0	500.0	12000.0
Spices(white)	0.2	10	2.0	700.0	1400.0
Chickpea	3.5	25	87.5	200.0	17500.0
Wheat	1.8	32	57.6	250.0	14400.0
Garlic	6.1	60	366.0	500.0	183000.0
Lettuce	0.1	200	20.0	100.0	2000.0
Spices(black)	0.01	8	0.08	800.0	64.0
"Dimbilal"	0.01	8	0.08	800.0	64.0
Lentil	2.9	25	72.5	350.0	25375.0
"Gaya"	1.68	30	50.4	180.0	9072.0
Total					2431775.0

Results and Discussion cont'd

- Table Crop type and yield Meila Irrigation Project (1996EC)

Crop type	Area (ha)	Yield Qt/ha	Yield Qt	Price (Qt/ha)	Revenue (Birr)
(1)	(2)	(3)	(4)=(2)x(3)	(5)	(6)=(4)x(5)
Onion (local)	26.7	95	2536.5	225	570712.5
Onion	1.1	110	121	200	24200.0
Garlic	0.4	80	32	600	19200.0
Tomato	3.85	200	770	200	154000.0
Potato	3.35	180	603	150	90450.0
Pepper	3.3	70	231	500	115500.0
Carrot	0.1	40	4	150	600.0
Cabbage	0.1	160	16	100	1600.0
Lentil	1.0	30	30	350	10500.0
Maize	30.5	80	2440	190	463600.0
Chickpea	0.1	30	3	200	600.0
Total					1450962.5

Results and Discussion cont'd

- Table Crop type and yield Ma'ynugus Irrigation Project (1996EC)

Crop type	Area (ha)	Yield Qt/ha	Yield Qt	Price (Qt/ha)	Revenue (Birr)
(1)	(2)	(3)	(4)=(2)x(3)	(5)	(6)=(4)x(5)
Onion	9.0	119	1071.0	200.0	214200.00
Garlic	2.35	95.33	224.03	500.0	112016.67
Tomato	2.975	366.67	1090.83	200.0	218166.67
Potato	0.025	95.0	2.38	200.0	475.00
Pepper	8.15	80.33	654.72	300.0	196415.00
Carrot	0.175	316.67	55.42	150.0	8312.50
Cabbage	0.075	415.0	31.13	100.0	3112.50
Maize	25.8	67.5	1741.5	170.0	296055.00
Chickpea	0.55	68.75	37.81	250.0	9453.13
Abish	1.7	125.0	212.5	375.0	79687.50
Lettuce	0.175	336.67	58.92	50.0	2945.83
Total					1140839.80

Results and Discussion cont'd

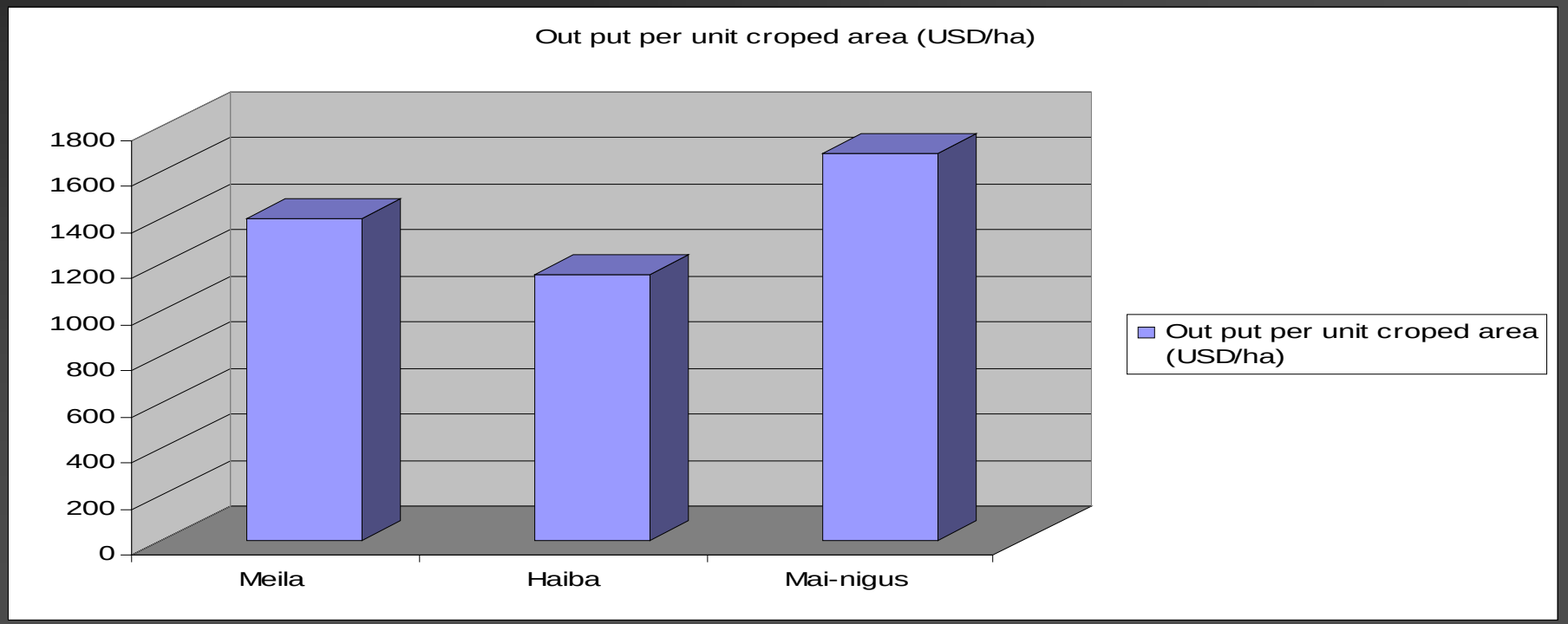
SGVP calculation for the Irrigation Projects

Name of irrigation scheme	Production in Tones of maize (tones)	P_{world} (USD/tones)	SGVP (USD)
Haiba	1279.9479	128.33	164260.0
Meila	763.66447	128.33	98003.61
Ma'ynugus	671.08223	128.33	86122.22

4.2 Agriculture performance Indicators

4.2.1 Out put per unit-cropped area

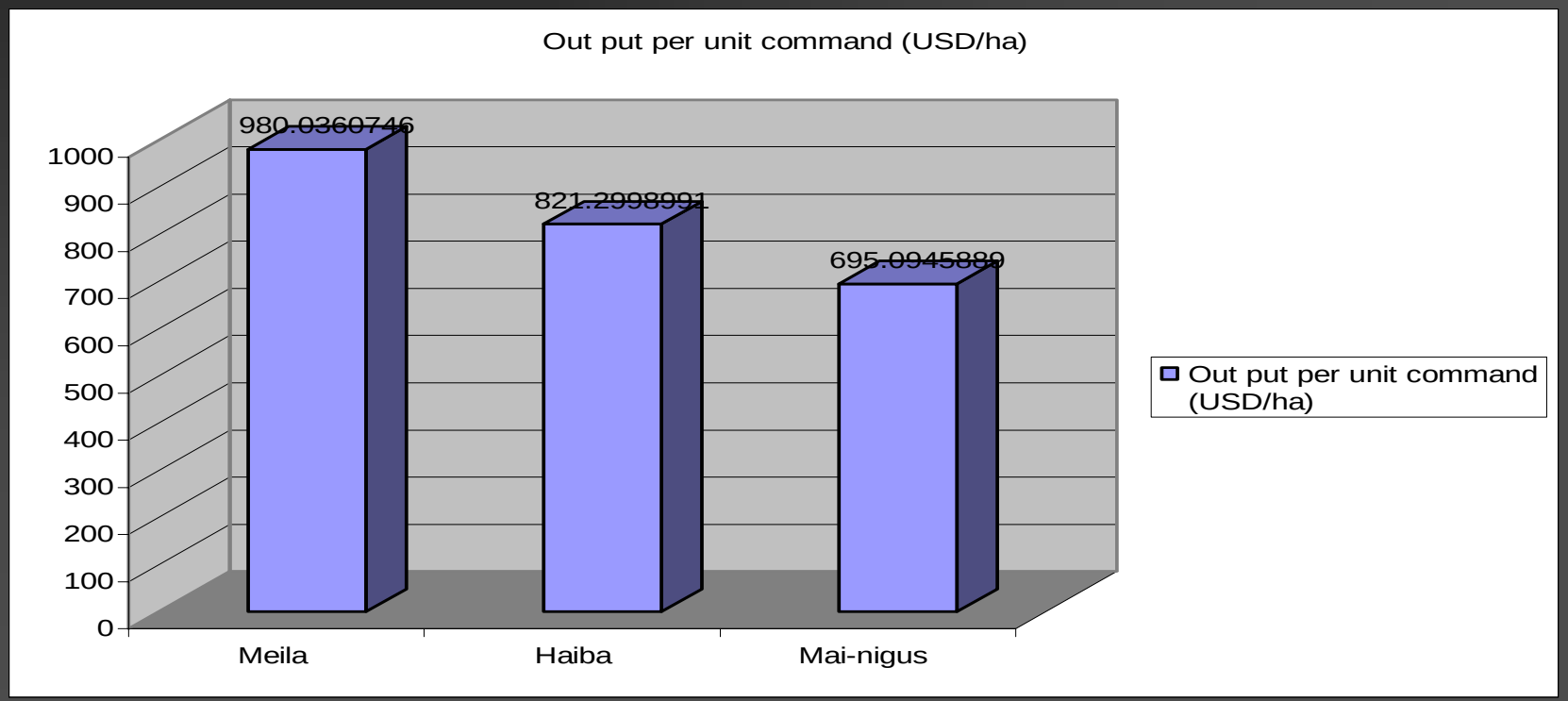
- The output per cropped area shows the response of each cropped area on generating gross return (1399.05, 1151.89, 1682.07).



Agriculture performance Indicators cont'd

4.2.2 Out put per unit of command

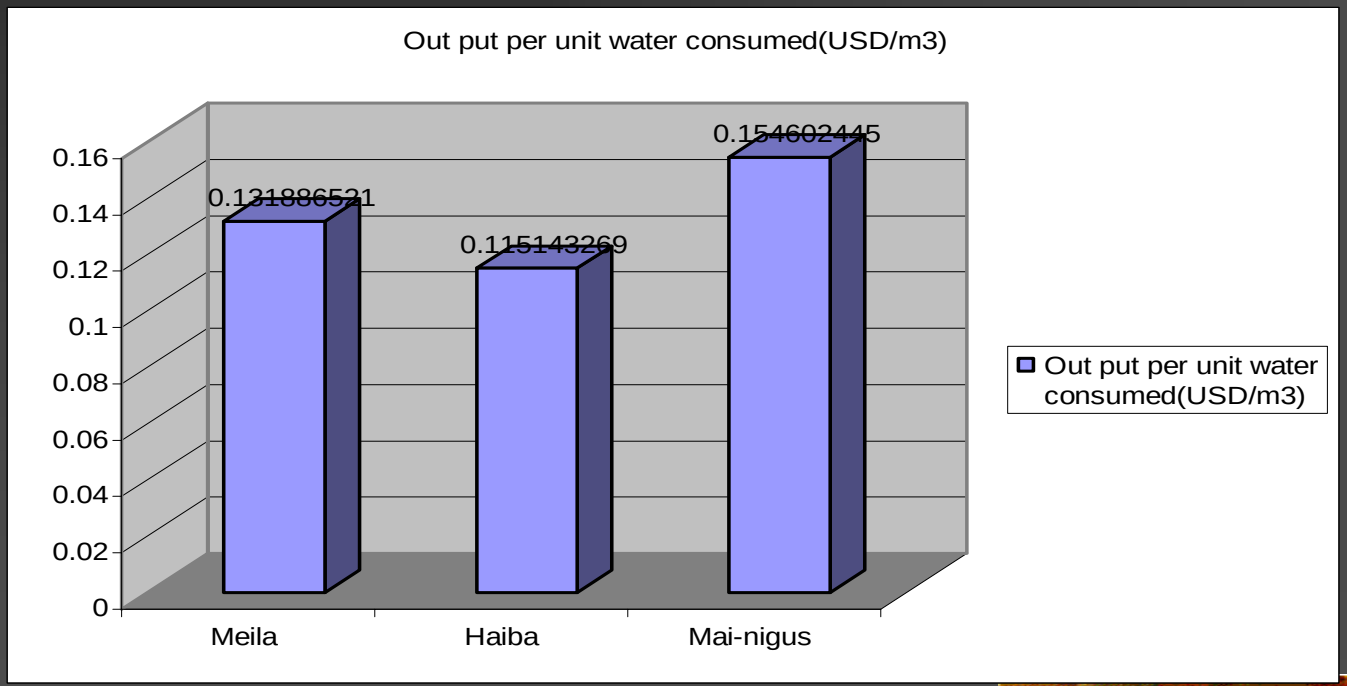
- This indicator expresses the average return of each design command and this is varying from scheme to scheme(irr.are:70.05,142.6&51.2ha)



Agriculture performance Indicators cont'd

4.2.3 Out put per unit water consumed

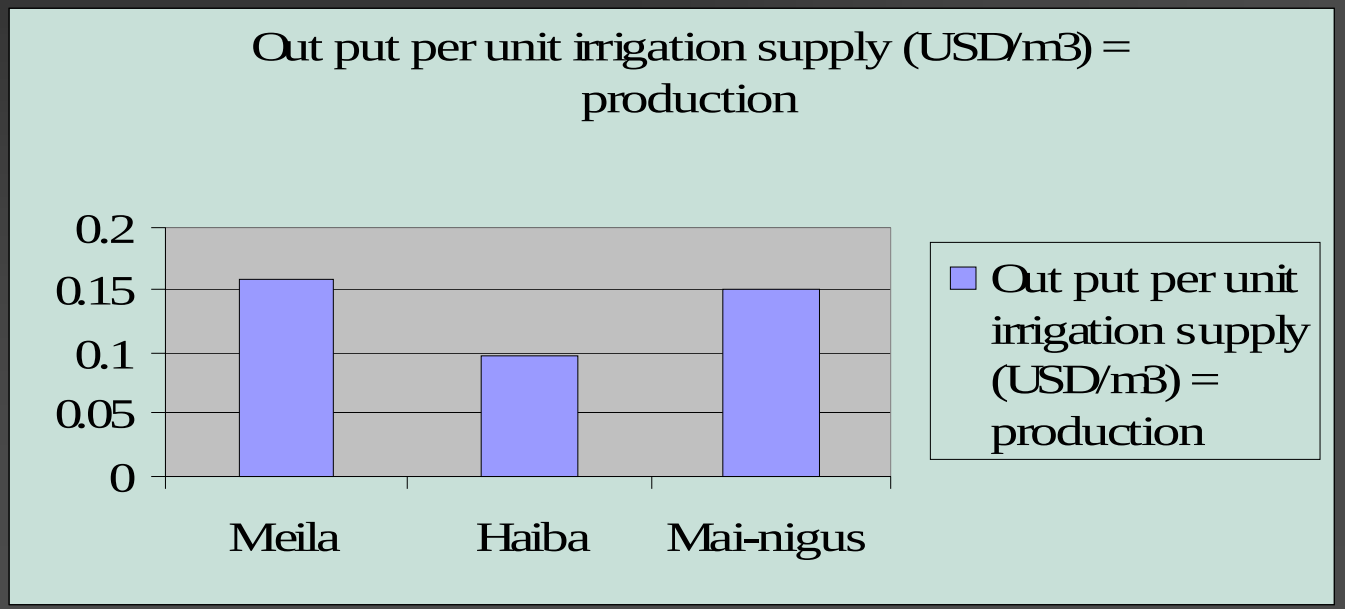
- The output per unit water consumed is used to describe the return on water consumed.



Agriculture performance Indicators cont'd

4.2.4 Out put per unit irrigation supply (USD/m³)

- Out put per Irrigation supply shows the revenue per meter cube of irrigation water in each scheme. US$0.156,US$ 0.096 and US$0.149 in Meila, Haiba and Ma'ynugus respectively.



4.3 Water use performance

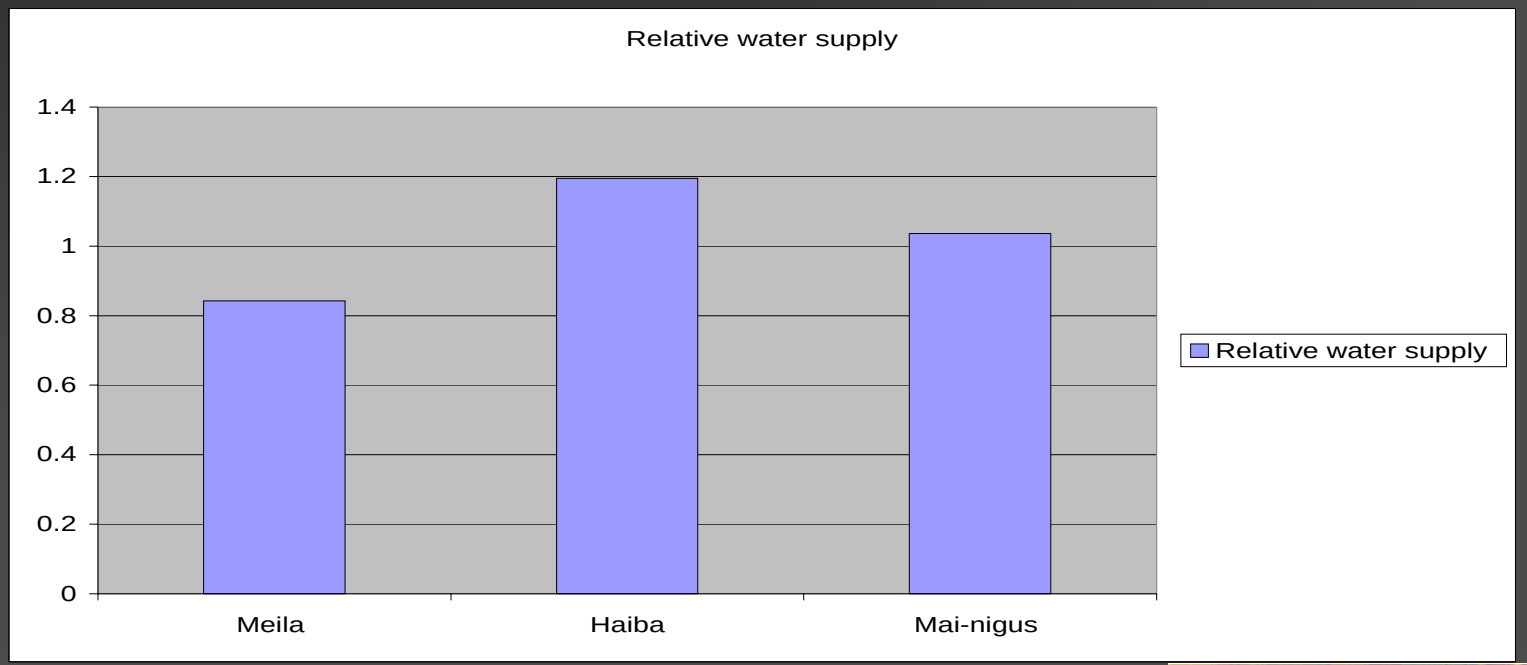
4.3.1 Water delivery capacity (WDC)

- The water delivery capacity of the irrigation scheme shows the capacity of the main canal to convey the maximum peak consumptive demand i.e the ratio of canal capacity at system head to maximum consumptive demand.
- The canal capacity in each irrigation scheme system head is designed base on the maximum peak consumptive demand by considering reasonable freeboard. It is the same for all the schemes since all the dams are constructed for single purpose that is Irrigation.

Water use performance cont'd

4.3.2 Relative water supply (RWS)

- Relative water supply depicts whether there is enough irrigation water supply or not.



Water use performance cont'd

4.3.3 Relative irrigation supply (RIS)

- Relative irrigation supply shows whether the irrigation demand is satisfied or not.
- It is the same with relative water supply

4.4 Financial performance

4.4.1 Gross return on investment

- This indicator considers the production and the total cost of infrastructure for each scheme.

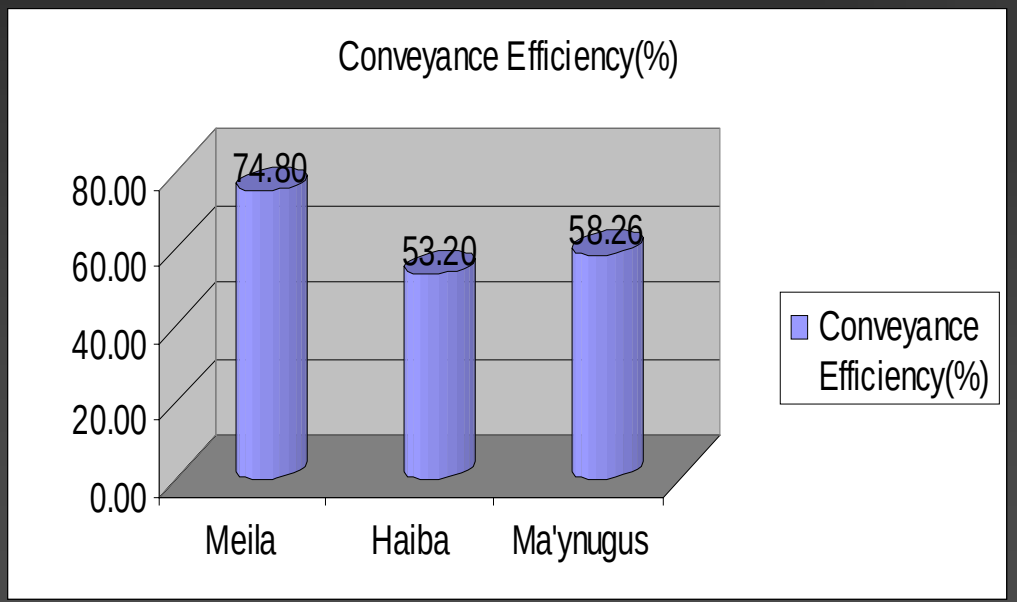
Financial performance cont'd

4.4.2Financial self-sufficiency

- Financial self-sufficiency indicates the revenue from the irrigation over the expenditure for operation and maintenance. The government covers the operation and maintenance of the schemes and it is considered as subsidy. Above and beyond, there is no fee for water it is for free. Therefore it is not possible to compare these schemes based on this indicator.

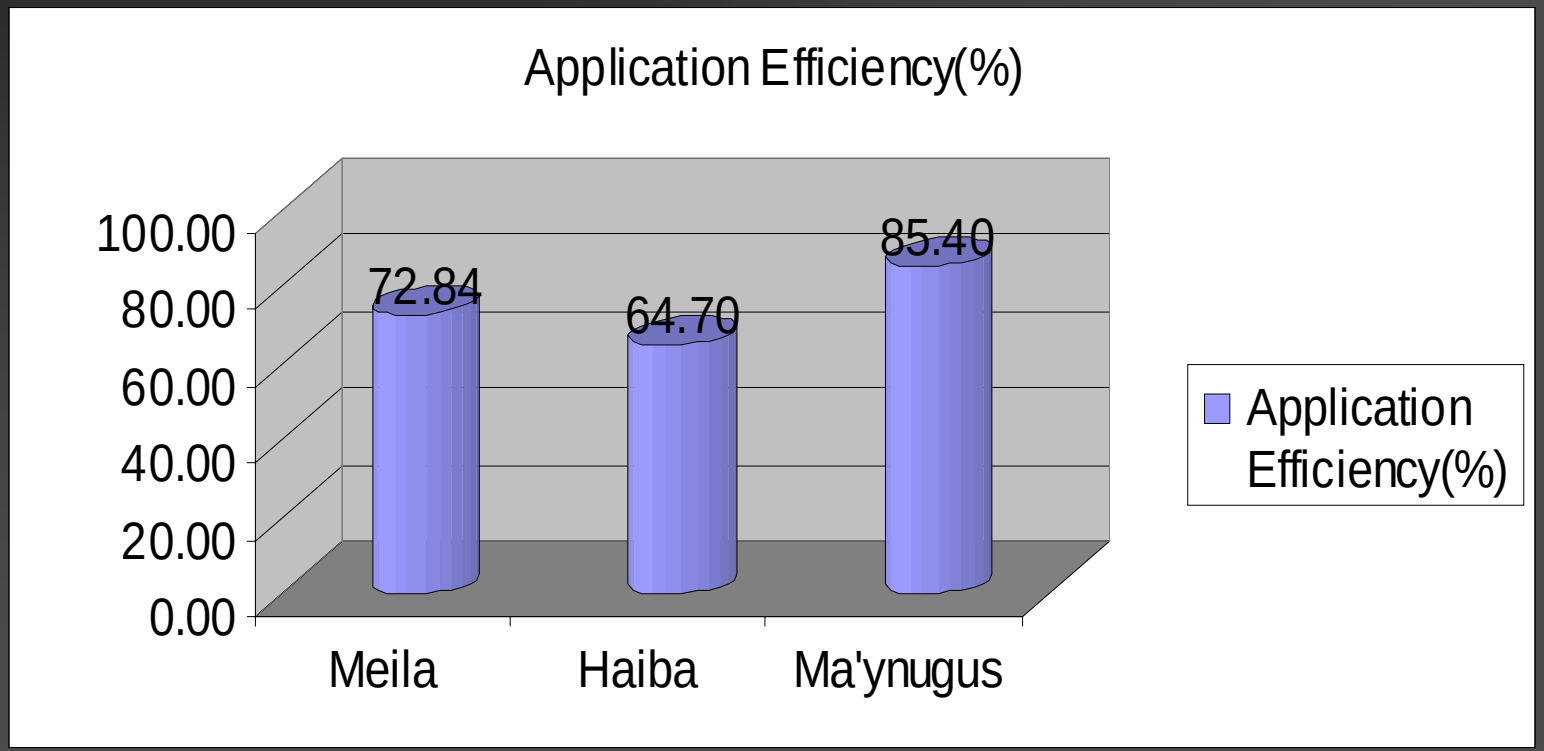
4.5 Internal Process indicators

4.5.1 Conveyance efficiency



Internal Process indicators cont'd

4.5.2 Application efficiency



5. Conclusions and Recommendations

5.1 Conclusions

- The utilization of water harvesting technique like small earth dams has a remarkable turn over in addressing the acute shortage of food production in the basin and in the country as well.
- The comparison of this irrigation schemes indicates the weaknesses and strengths of these irrigation schemes, which are helpful for managerial and technical practices.
- The output per cropped area in Haiba is low as compared to Ma'ynugus, this indicates that the irrigation practice in Haiba is poor and in Ma'ynugus it is good. And the out put per unit command is high in Meila and low in Ma'ynugus this is mainly due to the absence of enough rainfall to fill the reservoir in that season.
- The return from one meter cube of irrigation water is high in Ma'ynugus and low in Haiba, this has an implication on the proper utilization of water, and therefore it is poor in Haiba. In addition the out put per irrigation supply of Haiba is very low as compared to Meila and Ma'ynugus, Meila is the highest this is due to practice of deficit irrigation.

Conclusions cont'd

- The relative water supply is high (1.2) in Haiba and less in Meila, which is 0.8 but this is not considered as a problem rather it improves the return per irrigation water for the scheme. The relative irrigation supply of Meila is smaller than Haiba and Ma'ynugus.
- The gross return on investment of Ma'ynugus is low, and high for Meila this variation is due to high infrastructure cost of Ma'ynugus.
- There is no revenue collected for the operation and maintenance of the system. It is highly assisted by government. There are also beneficiaries' involvements in simple maintenance of canals and clearance of canals.
- The conveyance losses in Meila, Haiba, and Ma'ynugus are 74.48%, 53.2%, and 58.26%, respectively and this is a big loss when we are considering the total investment cost for the development of these water-harvesting systems. And it is also good to lined the canals so that the total water harvested will be used to the intended purpose. Moreover, the farms at lower elevation than these canals suffering from seepage become safe and productive.
- The application efficiency of Meila, Haiba, and Ma'ynugus are 72.84%, 64.7 % and 85.40% respectively. And the field management practice of Ma'ynugus farmers is better than farmers in both irrigation schemes.
- There is no developed soil moisture characteristic curve for these irrigation schemes, which highly assists irrigation scheduling and finally contributes towards the improvement of application efficiency of the system.

5.2 Recommendations

- Frequent performance evaluation is imperative.
- Experience sharing is very important by visiting their sites one another.
- Implementing reasonable irrigation water fee than giving them for free will improve the return from each drop of water.
- practice of deficit irrigation is important for some identified crops.

Recommendations Cont'd

- The introduction of cost sharing will help for operation and maintenance and other managerial activities of the irrigation systems.
- Hydraulic flow metering structures should be constructed at deferent levels of the canals.
- Lining of irrigation canals is very important to reduce conveyance loss.
- Training of farmers is crucial for better application efficiency.
- This paper also calls a proposal to develop a soil moisture characteristic curve of different irrigation schemes in the basin for the major soils.


Thank You!
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