Socio economic and Environmental Impact Assessment of Community Based Small-Scale Irrigation In the Upper Awash Basin.

A case study of four community based irrigation schemes

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Background and Rationale

- The country has an estimated irrigable land of about 1.5-3.5 billion ha of which only 5% developed
- 55% of the developed area is traditional irrigation(MWR, 2001)
- The National Irrigation Policy
- Environmental Policy in relation to irrigation
- Irrigation has contributed significantly to poverty reduction, food security, and improving the quality of life for rural populations. However, the sustainability of irrigated agriculture is being questioned, both economically and environmentally

SSI development

With the 1975 rural land proclamation, by Derg Government.

- Large irrigated farms nationalized, state Farms.
- Landlord based SSI schemes converted to producer Cooperatives.

In 1980's as a result of the famine of 1984/85, small-scale irrigation schemes were given emphasis.

However, progress was slow.

- Irrigation development did not attempt to involve the farming population,
- The government upgraded several schemes without the consent of the communities concerned

As a result,

Many of the small-scale irrigation projects have been operating below the required economic efficiency

Study objectives:

The overall objective :

Assess the profitability and sustainability of community based small-scale irrigation schemes in the selected study areas.

Specific objectives:

- Assess the benefits, costs and environmental impacts of four small-scale irrigation schemes in the Upper Awash Basin.
- Identify major problems and constraints of irrigation development and propose alternative planning options

Data Sources and collection procedures

1.Household survey

- 240 sample households identified using random sampling techniques.
- Sample populations classified into two groups: irrigators and non-irrigators
- The household survey conducted using questionnaires which cover:

  - ✓ Personal and household information,
  - ✓ Plot characteristics,
  - ✓ Water management,
  - ✓ Cropping pattern,
  - ✓ Agricultural input and yields at plot level,
  - ✓ Marketing and conception of constraints
  - ✓ Water loss during transport, soil salinity, water logging, depletion of soil fertility, water related disease hazards.

2. Community level survey

- Focus group of 5-8 farmers (elders, religious leaders,water users committee members, young people and women) .
- Discussion with Woreda agricultural, irrigation and service cooperatives Bureaus .

3.Irrigation Water Samples:

- for physical & chemical characteristics analysis irrigation water samples were collected from 4 sites (3 samples from each site)

- For bacteriological characteristics analysis of irrigation water samples were collected from four schemes (2 samples from each scheme)

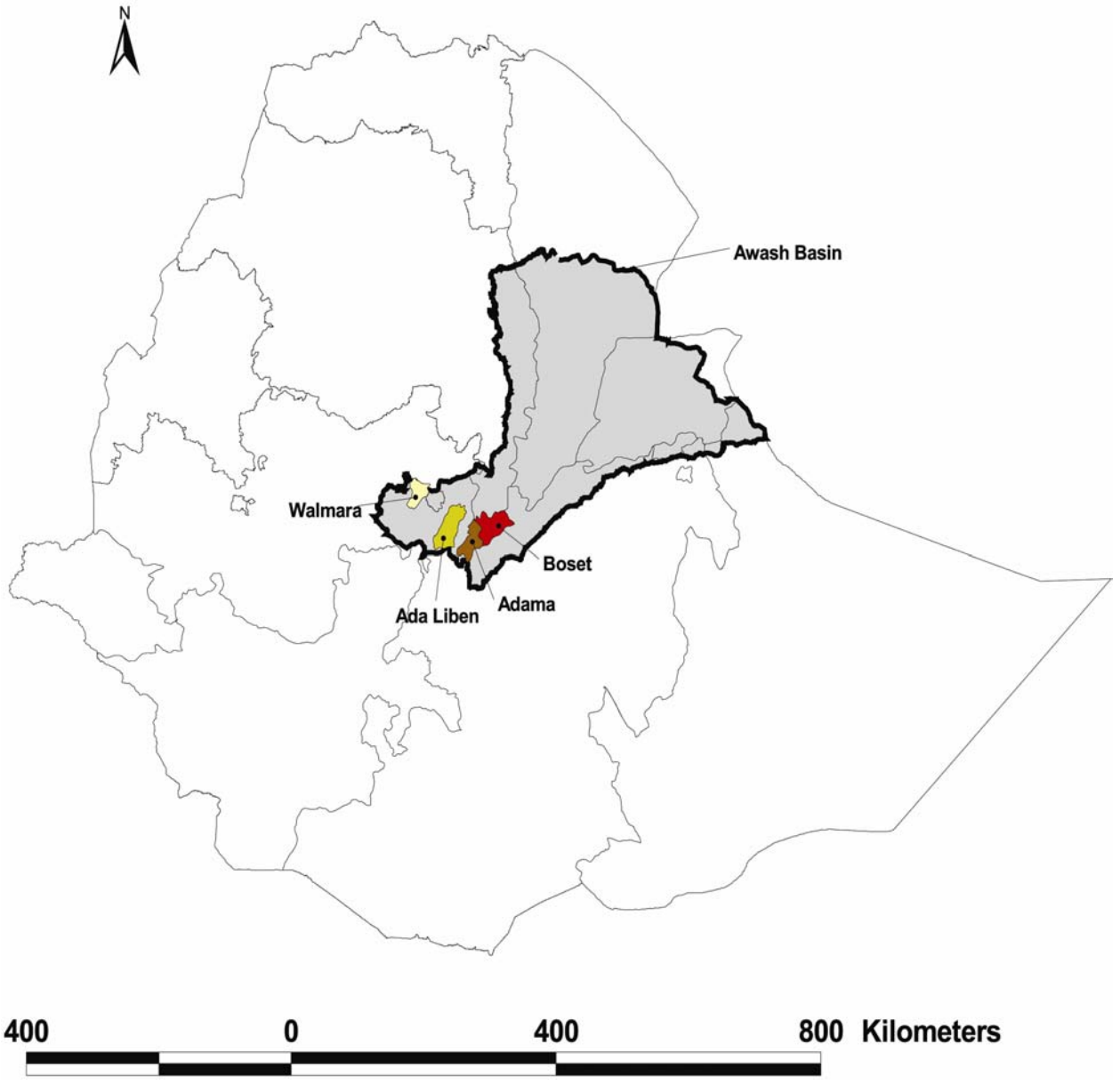
4.Secondary

Maps, baseline information of the schemes , environmental standards and development plans were collected from government office and NGO's who work in the area.

5.Data analysis

- Comparative data analysis between farm types and among schemes were done using SPSS software.

The Study Area



The Study Area continued

Awash Basin :

- The basin has an extensive resource potential in climate, land and water
- Total area- 110,000 km^2
- The Awash River starts from 3000 m to 250 m altitude to lake Abe covering 1200 km.
- Covers-Ethiopian plateau- rift valley- afar triangle.

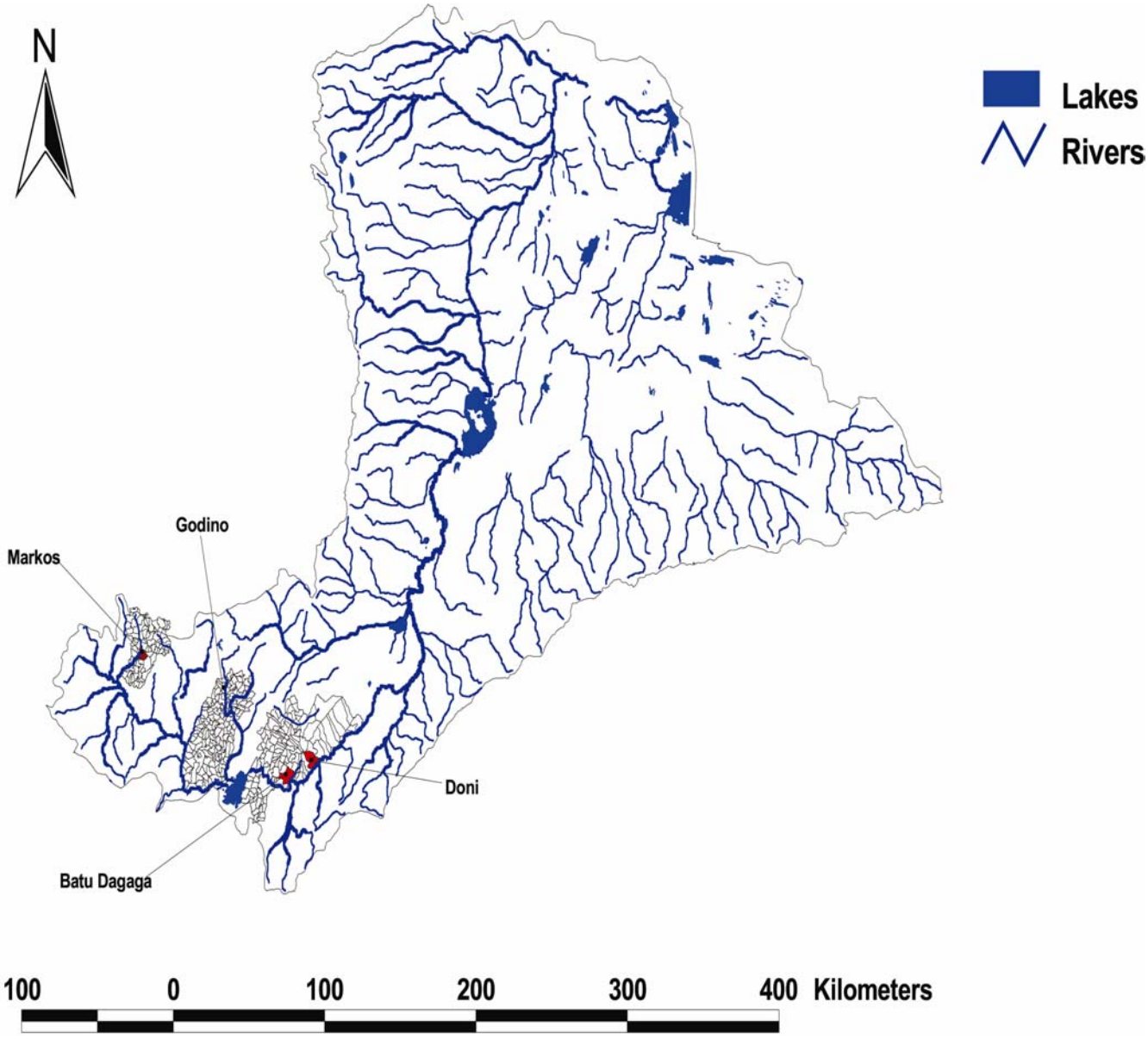
Five major zones (Halcrow in 1989).

- **Uplands** – above 1500 m, mean annual rainfall of 800 mm.
- **Upper Valley** –between 1500 m and 1000 m altitude
- **Middle Valley** –between 1000m and 500 m with a mean annual rainfall 600 mm to 200 mm.
- **Lower Plains** –the Tendaho, Asayita and Dit Bahari areas as well as the terminal lake environs.
- **Eastern Catchments** –the Wabi Shebelle watershed at about 2500 m altitudes down to the desert plains

Study Area (continued)

- Population about 28.5 million,
- Majority lives in upper basin 1500 m a.s.l.
- In the upland, the annual rainfall is adequate for rain fed cultivation
- Below this elevation, the annual rainfall range from 800 mm down to 200 mm, requiring irrigation
- The variation in temperature permit a wide range of crops .
- Potential irrigable land –150,000 ha , Irrigated 69,000 ha
- Mean annual surface water is estimated 3850 –4900 Mm^3
- Currently used for irrigation is estimated to be 44% (MWR, 2002).
- Water quality in the Upper basin is deteriorating due to high waste disposal of Addis Ababa.
- there is a progressive increase in the salinity of the water from the Upper valley to Middle Valley
- Most prevalent disease is malaria

Study schemes



Schemes Distance (KM)	Doni	Batu Degaga	Godino	Markos
Doni	0	18	69	125
Batu Degaga	18	0	62	114
Godino	69	62	0	57
Markos	125	114	57	0

Description of sample irrigation schemes

Parameters	Schemes			
	Doni	**Batu Degaga**	**Godino**	**Markos**
Woreda	Boset	Adama	Ada Liben	Wolmera
Altitude (m.a.s.l.)	1303	1351	2012	2076
Mean annual rainfall (mm)	804	760	816	1187
Mean monthly minimum temp. (^oC)	14	10	8	3
Mean monthly maximum temp. (^oC)	35	35	25	23
Source of water	Awash river	Awash river	Wedecha dam	Markos river
Scheme type	Gravity weir	Electric pump	Gravity weir	Traditional diversion
Method of irrigation	Furrow	Furrow, siphon	Furrow, flooding	Furrow, flooding
Capacity of water (ha)	250	140	1600	130
Current irrigated land	80	60	271	130
Major Cops grown	Onion, tomato, maize, Soya B	Onion, tomato, maize, Soya bean	Onion, cabbage, sugar- cane, potato	Potato, carrot, tomato,
Year started	1973	1995	1965	1885
Upgraded by	CARE, 1995	WVE, 1995	EEC, 1997	-------

Results and Discussion

Tab. 2 Scheme size and number of beneficiaries.

Scheme	Sex	No of HH in PA	No HH in Scheme		PA Cultivated Area (ha)	Scheme Area (ha)	% of scheme area to cultivated area
			No.	%			
Doni	Male	657	62	9.43	1170	85	5.00
	Female	10	10	100			
	Total	667	72	10.8			
Batu Degaga	Male	894	98	11	1340	60	2.41
	Female	90	22	24.5			
	Total	984	120	12.2			
Godino	Male	534	189	35.4	2210	271	8.04
	Female	82	20	24.4			
	Total	616	209	33.9			
Markos	Male	900	200	37.5	2010	130	4.02
	Female	40	26	31.7			
	Total	940	226	36.7			

Source: Peasant Associations and Development Agents at the scheme, 2004.

Tab. 3 Mean comparison of household heads by sex between farm types

Dependant variable (Sex)	Farm type		Person Chi-Square	df	P-value
	Irrigator	Non-irrigator			
Male	112	98	7.47	1	0.006
Female	8	22			

NS=non-significant, *=significant; at p<0.05; **=significant at p<0.01

Tab. 4 Mean comparison of household composition between farm types

Dependent variable	Farm type		Significant
	Irrigator	Non-irrigator	
Household size	7.0	6.0	NS
Male household member	3.0	3.0	NS
Female house hold member	4.0	3.0	NS
Household age <12 years	3.0	2.0	*
Age between 12-17 years	2.0	1.0	NS
Age 18-60 years	2.0	2.0	NS
Age >60 years	3.0	3.0	NS
No of illiterate	0.0	1.0	NS
No of read and write	4.0	2.0	NS

NS=non-significant, *=significant; at p<0.05; **=significant at p<0.01

Tab. 6 Mean comparison of labor requirement between farms.

Dependent variable	Farm type				Significant
	Irrigator	%	Non-irrigator	%	
Family (per ha)	88.0	60	47.0	88	**
Hired (per ha)	69.0	40	29.0	12	**

NS=non-significant, *=significant; at p<0.05; **=significant at p<0.01

Fig. 7 Onion transplanting in Batu Degaga. April, 2004.

Cultivated Landholding and use

Tab. 7 Mean comparisons of cultivated land holding and other parameters between farm types.

Dependent variable	Farm type		Significant
	Irrigator	Non-irrigator	
Land holding (ha)	0.51	0.81	**
Plot distance (km)	0.80	1.35	**
Water distance from homestead (km)	0.90	2.03	**
Plot no per household	5.00	8.00	**
Gully formation on plot	3.40	5.00	NS

NS=non-significant, *=significant; at p<0.05; **=significant at p<0.01

Tab. 9 Comparison of tenure systems among irrigator's farmers in each scheme

Dependent variable (Tenure status)	**Schemes**				**Person chi-Square**	**df**	**P-value**
	Doni	**Batu Degaga**	**Godino**	**Markos**			
Household	55	51	95	65	71.143[a]	6	0.000
Share cropping	1	28	3	0			
Rented	2	1	2	3			

NS=non-significant, *=significant; at p<0.05; **=significant at p<0.01
Note: Means within schemes followed by the same letter aren't significantly different.

Tab. 11 Mean comparison of animal power required between farm types

Dependent variable Oxen days /0.25ha	Farm type		Significant
	Irrigator	Non-irrigator	
Plowing	15.1	10.8	**
Threshing	5.9	6.8	NS

NS=non-significant, *=significant; at p<0.05; **=significant at p<0.01

Tab. 13 Mean comparison of assets ownership between farm types.

Dependent variable	**Farm type**		**Significant**
	Irrigator	**Non-irrigator**	
Farm tools (birr/HH)	427.86	381.23	NS
Livestock (birr/HH)	1104.55	1117.14	NS
Fixed assets (Birr/HH)	4800.11	3481.44	**

NS=non-significant, *=significant; at p<0.05; **=significant at p<0.01

Tab. 15 Mean comparison of net farm income between farm types in 2002/2003 cropping season.

Dependent variable	Farm type		Significant
	Irrigator	Non-irrigator	
Input cost (Birr/ha)	1418.40	596.07	**
Gross farm income (birr/ha)	5135.61	1868.88	**
Net farm income (birr/ha) .	3720.85	1269.98	**

Commercial aspect

- in all the schemes ,there is no organized market for agricultural product

- yields are sold individually

- price variability is high for irrigated crops

- transport cost at time of harvest is high

Input supply and credit system

- more inputs are used by irrigator farmers
- the availability of these input doesn't meet the demand
- private companies supply most inputs
- prices are very high
- farmers don't apply recommended rate
- adulteration of inputs is a problem
- credit facilities are non-existant in all schemes
- one NGO (Gasha) gives short term loan at 16% interest rate at Godino

Fig. 8 Looking for transport at Markos scheme about 35 km from Addis Ababa

Tab. 20 Comparison of cultural practice adopted between farm types

Dependant variable	Farm type		Person Chi-Square	df	P-value
	Irrigator	Non-irrigator			
Erosion on plot					
No problem	89	28	4.016[a]	1	0.134
Mild problem	28	60			
Change in soil fertility					
Highly fertile	64	29	5.978[a]	2	0.050
Moderately fertile	417	334			
Infertile	32	25			
Salinity problem					
No problem	35	15	14.911[a]	2	0.002
Mild problem	18	8			
Severe problem	7	6			
Stone cover					
Low	277	178	11.890[a]	3	0.008
Medium	29	27			
High	1	7			
Very high	0	2			
Stone terrace					
Yes	25	45	14.473	1	0.000
No	485	335			
Drainage ditch					
Yes	136	81	3.382	1	0.066
No	374	217			
Grass strip					
Yes	5	35	34.362	1	0.000
No	505	345			
Clearing stone					
Yes	27	30	2.457	1	0.117
No	483	350			
Planting trees					
Yes	10	14	2.465	1	0.116
No	500	366			
Fence					
Yes	120	65	5.458	1	0.019
No	390	315			

NS=non-significant, *=significant; at p<0.05; **=significant at p<0.01

Positive environmental impacts of small-scale irrigation

- Incomes and food security
- Impact on employment
- Backward and forward economic linkages

Major environmental constraints of small-scale irrigation

- Inefficient use of water
  - Leakage from unlined canals
  - Faulty use of irrigation water
  - Over using water than required
  - Use of flood irrigation
  - Use of extended length of tertiary canals and furrows
- Soil fertility and quality maintenance problem
  - Intensification of agricultural production
  - Without any fertilizer application, yield is very low
  - Nutrients are removed more rapidly than they are replaced
  - All crop residue and green byproducts are removed from the field for livestock feed, fuel and house construction

Fig. 9 Inefficient use of water at Doni scheme

Fig. 10 Organic fertilizer applied at Doni

Soil salinity

- Severe problem in Doni & Batu Degaga schemes
- As a result some farmers have abandoned their fields

Soil erosion

- Heavy grazing from pasturalists camels in Doni &Batu Degaga
- Overgrazing of livestock in the area
- Strong wind causing wind erosion forming rills & gullies
- Furrow & flood irrigation along the slope in Godino & Markos, sheet & gully erosion
- When Awash River overflows its bank ,flooding causes damage to the crop and erosion on the plots.

Fig. 11 Salt affected field at Doni

Irrigation water quality

Four basic criteria for evaluating irrigation water quality:

- Total soluble salt content (salinity hazard)
- Relative proportion of sodium cations (N^{+}) to other cations (sodium hazard-soil permeability effects)
- Carbonate (CO_3^{-})) and bicarbonate (HCO_3^{-}) anion concentration as related to calcium (C^{++}) plus magnesium (Mg^{++}) concentration (alkalinity).
- Concentration of elements that may be toxic (toxicity)

Tab. 21 Physical and chemical characteristics of irrigation water samples collected from the schemes.

Parmeters	Scheme				
	Markos	Doni	Batu Degaga	Godino	Significant
pH	**7.70**	**7.99**	**7.60**	**7.57**	**0.001**
Ecw (µs/cm)	**248.67**	**401.33**	**443.33**	**362.00**	**0.000**
SAR adj.	**2.23^{a}**	**9.93^{ab}**	**10.26^{c}**	**2.78^{cd}**	**0.000**
Bicarbonat (HCO_3) -mg/l	**144.33**	**205.33**	**222.00**	**202.67**	**0.000**
Chloride (Cl)-mg/l	**6.67**	**20.00**	**23.33**	**8.33**	**0.065**
Sulphate(SO_4)-mg/l	**0.93**	**13.00**	**11.97**	**0.90**	**0.000**
Fluoride (F)-mg/l	**0.33**	**2.29**	**2.19**	**0.53**	**0.073**
Nitrate (NO_3)-mg/l	**1.62**	**0.04**	**0.04**	**3.70**	**0.000**
Sodium (Na)-mg/l	**9.50**	**45.67**	**48.67**	**13.83**	**0.348**
Potassium (K)-mg/l	**3.13**	**7.83**	**10.67**	**14.03**	**0.002**
Calcium (Ca)-mg/l	**26.00**	**34.33**	**36.33**	**38.67**	**0.030**
Magnesium (Mg)-mg/l	**10.00**	**8.00**	**8.67**	**10.83**	**0.384**
Boron (HBO_2) mg/l	**0.22**	**0.22**	**0.57**	**1.31**	**0.163**
Carbon Dioxide (CO_2)-mg/l	**6.00**	**4.00**	**10.00**	**12.00**	**0.055**

NS=non-significant, *=significant; at p<0.05; **=significant at p<0.01

Tab. 22 Total Coliform count of water samples collected from the 4 sites, 2004.

Scheme	Temperature (^{0}C)	pH	Coliform count CFU/ 100ml	Ethiopian Standard[1]		International standards (Counts/ 100ml)
				Recommended limit (Counts/ 100ml)	**Maximum allowable limit (Counts/ 100ml)**	
Godino-1	21.49	7.77	150	0	0.05	Nil
Godino-2	22.8	7.57	170			
Markos-1	19.13	7.91	90			
Markos-2	17.2	7.57	20			
Donni-1	21.85	7.91	600			
Donni-2	21.00	7.57	2000			
Batu Degaga-1	21.48	8.47	90			
Batu Degaga-2	22.00	8.29	120			

Source **[1] Environmental protection Authority (EPA, 2003)**

Fig. 12 Water for household consumption from irrigation water at Godino.

Tab. 23 No of treated patients affected by different diseases, at Doni public clinic, 2003

No.	Disease type	Number of Treated patients	Treated patients (%)
1	Malaria	2527	60.00
2	Upper respiratory infection	536	12.68
3	Parasites	246	5.58
4	Diarrhea	207	5.00
5	Wounds	194	4.59
6	Anemia	182	4.30
7	Gastritis	90	2.10
8	Sexual transmitted diseases	88	2.08
9	Rheumatic pain	84	1.99
10	Eye diseases	71	1.68
	Total	**4225**	**100**

***Source*: Doni public clinic, 2004.**

Conclusions

The study of the four small-scale irrigation schemes in the Awash basin has revealed some factors that are important for the successful implementation of small-scale irrigation schemes.

- Irrigation can be comparatively well designed and in a sound technical state but other issues related to land allocation, population pressure, input supply, market situation, health situation can affect the sustainability of irrigation schemes.

- Inefficient use of water, soil fertility and quality maintenance problems, soil salinity, soil erosion, water related disease hazards are considered typical of small-scale irrigation environmental issues which affect the sustainability of the schemes and environment

- The system of furrow irrigation, which is practiced in most of the schemes, has higher labor demands and some farmers practice flooding system. This will aggravate erosion especially in sloppy plots.

Conclusions (continued)

- Marketing, especially through contract farming, has proven to be a problem for smallholder farmers.

- NGO's and government upgraded or new small-scale irrigation projects are handed over to the farmers with out proper completion of construction and technical training and without proper management establishment.

- Lack of technical knowledge among farmers on new technologies and management systems also a hindrance for SSI improvement

- The concept of wealth accumulation is missing among the farming community.

- A major constraint in irrigation development is the top-down approach by the government and NGO's, which took farm population as beneficiaries rather than stakeholders. Technical experts and administrators make decisions on behalf of the farmer.

Recommendations

- Efficient use of irrigation water systems should be practiced to avoid water loss and to control vector breeding and water-related diseases.

- Training in water management, marketing and general crop production is important for new and old irrigation schemes.

- The economics of small-scale irrigation in the Awash Basin is not well understood. Farther economic evaluation of optimal plot size, cropping patterns, technologies, agronomic practices and resources utilized in the irrigation schemes is necessary

- Empowerment of local communities should be given due consideration since they are playing major role in irrigation development in the basin. Awareness of hygienic handling of water should be introduced.

- The NGO's who are involved in irrigation development should come up with a clear, transparent and completed handing over of up-graded or newly developed small-scale irrigation schemes to farmers.

- Rural credit systems should be in place for input supplies and low cost technologies acquirement

- Agricultural product market facilities should be improved

Recommendations (continued)

- Institutional support, monitoring and evaluation of irrigation schemes that is done at present by Woreda Irrigation Desk, woreda Agricultural Desk, Woreda Cooperative Development Desk, and NGOs should be enhanced in an organized way.

- It is necessary to plan agricultural water systems as a whole from drinking water to irrigation water supply. The different sectors should work together at national regional and local level and plan for integrated multi-purpose systems.

- The establishment of a system of water user fees, should be promoted.

- Training of the development agents and water user association officials is essential to building the local understanding, management capabilities and community responsiveness

- Salinity mitigation measures like selection of salt tolerance crops, leaching and drainage, pre-planting irrigation and seed placement techniques are recommended with a proper training of the technique to the farmers and development agents.