FAOWATER

AGWATER SOLUTIONS
Improved livelihoods for smallholder farmers

COUNTRY INVESTMENT BRIEF

Mapping and assessing the potential for investments in agricultural water management

The Federal Democratic Republic of Ethiopia

IWMI International Water Management Institute

IFPRI

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Background

The Agricultural Water Solutions Project

The Agricultural Water Solutions Project aims to unlock the potential of smallholder farming by identifying, evaluating and recommending a variety of agricultural water management (AWM) solutions - including technologies as well as the necessary supporting policies, institutions, financing arrangements and associated business models. This is being achieved through a series of interlinked activities in the seven project sites in Africa (Burkina Faso, Ethiopia, Ghana, Tanzania and Zambia) and in India (Madhya Pradesh and West Bengal). These activities include:

- in-depth case studies,
- mapping areas to identify where solutions are likely to be most viable and have greatest impact,
- discussing AWM solutions and project findings with stakeholders, and
- formulating business models to turn these findings into practical plans.

The national level analysis

This note presents the result of the national analysis. The analysis gathers available thematic maps and district statistics, and combines them with national livelihood maps which have been established through an in-depth consultation process to identify opportunities to invest in AWM in support to rural livelihoods. The suitability of different AWM solutions is then assessed and quantified in terms of investment opportunities and potential number of beneficiaries.

The methodology

Contrarily to classical water investment planning processes, this approach focuses on addressing poor rural people's needs rather than focusing on the development of potentially suitable resources. In so doing, the demand for investments in water is compared to the supply (availability of water). The demand for investments in water varies according to the needs of the population. In order to capture this demand, the project has adopted a *livelihood mapping* approach. This note presents the different steps followed in the national analysis:

1. Map the main livelihood zones, responding to the following questions:
   - what are the different farmer typologies and rural livelihood strategies?
   - what are the main water-related constraints and needs in the different rural livelihood contexts?
2. Map the potential and opportunities to improve smallholders' livelihood through water interventions: estimate the number and percentage of rural households who could potentially benefit from AWM interventions.
3. Map the suitability and demand for a series of specific AWM solutions, showing where they have the highest potential impact on rural livelihoods.
4. Estimate the potential number of beneficiaries, the potential application area and total investment costs for each AWM solution in each livelihood zone.

FAO has conducted and coordinated a participatory AWM mapping process in each project country in close collaboration with national partners. These products have been developed through a stepwise approach including national level data collection and processing, case study analysis, and local consultation. The livelihood map was developed during a participatory mapping workshop which gathered a large number of national experts from different fields (agriculture, water, social sciences, geography, etc.) and institutions (government, universities, NGOs, etc.) as well as farmers groups. This process was organised in two phases: 1) the purpose of a first workshop was to set up the basis for the analysis and start depicting the relationships between rural livelihoods and AWM and 2) a second or series of events - both at national and regional levels - to review the maps and refine the criteria used to define the potential for AWM and the suitability of different technologies. The outputs of the workshop have been enhanced through further consultation with national and international experts and through secondary data analysis using available national and sub-national datasets and statistics.

Mapping the livelihood context

Different people in different places have different needs

The purpose of livelihood zones maps

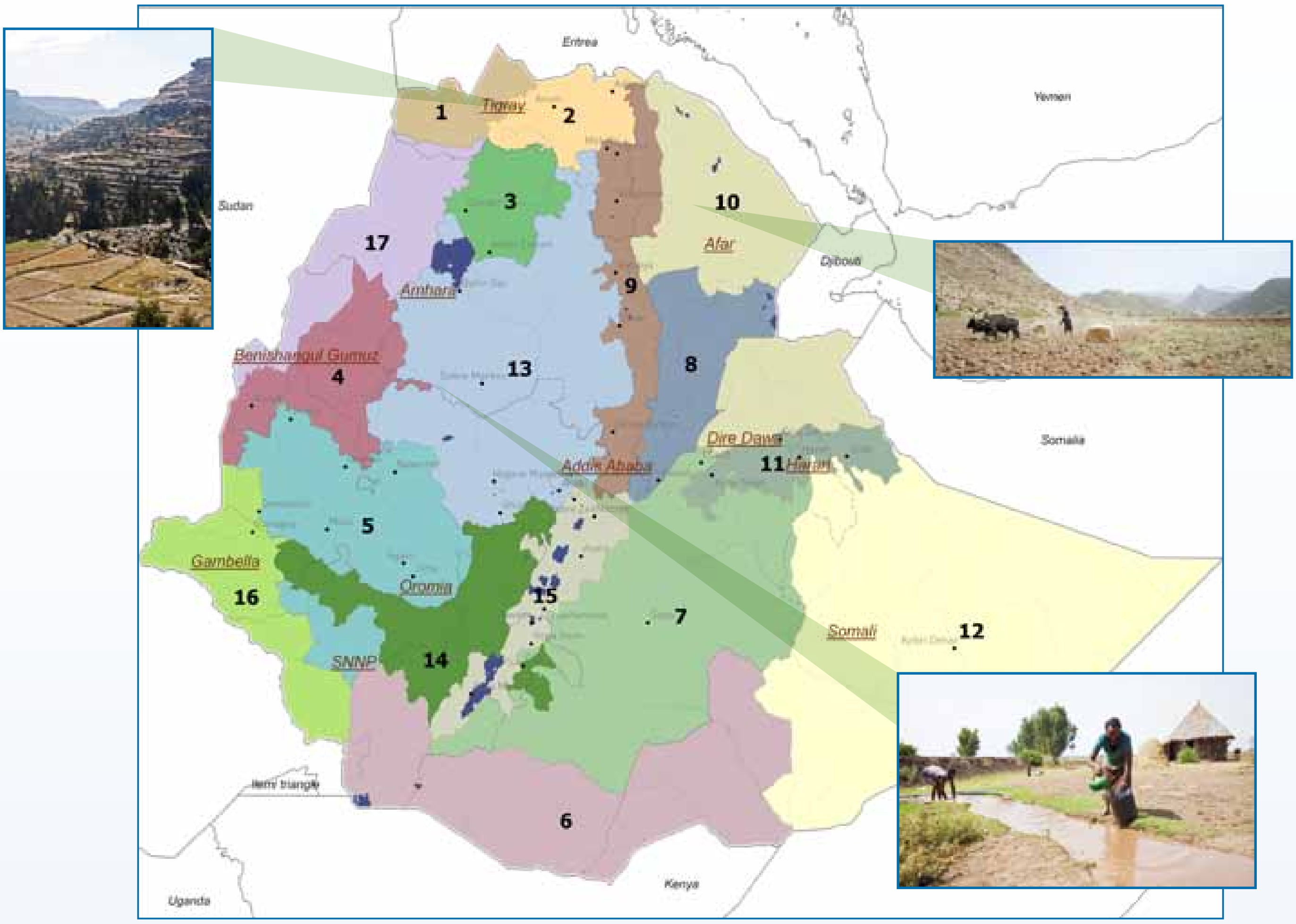
Livelihood mapping consists in identifying areas where rural people share relatively homogeneous living conditions, on the basis of a combination of biophysical and socio-economic determinants. The main criteria to establish livelihood zones are: the predominant source of income (livelihood activities); the natural resources available to people and the way they are used; the prevailing agroclimatic conditions that influence farming activities, and access to markets.

In the absence of detailed local level statistics, the livelihood map is a useful tool to understand rural people dependence to water (access, vulnerability, resilience to shock) and the extent to which investments in water are critical to their development.

The map of livelihood zones is the result of a participatory mapping process involving a wide range of experts, professionals and farmers representatives. Each livelihood zone is described in details in terms of the main smallholders' livelihood strategies, dimensions of poverty, their water-related problems and other constraints for development, and the role agricultural water management plays for their livelihoods. Combined with the map of rural population, the livelihood map makes it possible to assess the demand for water-related interventions in each zone.

Generally, livelihood zone boundaries would coincide with administrative boundaries, but not always. In practice, homogenous agroecological and socio-economic zones often cross larger administrative units. In these cases the delineation is based on other criteria which better capture the delineation between different livelihoods patterns (topography, climatic data, land cover data, etc.).

Livelihood zones of Ethiopia



Describing the livelihood context

Key characteristics of livelihood zones

Zone	Name	Main livelihood sources	Water-related issues	Main constraints for livelihoods
1	Lowland mixed – sesame livelihood system	Mixed system - livestock, crop production livestock dominated by cattle and shoats		Water shortage, erratic rainfall, economic & social infrastructure
2	Northern mixed midlands livelihood system	Moderately productive mixed farming crop production		Shortage of cultivable land, erratic rainfall, shortage of water for agric, land degradation, poor infrastructure
3	Northern cereal pulse mixed livelihood system	Moderately productive mixed farming crop production		Shortage of cultivable land, erratic rainfall, shortage of water for agric, land degradation, poor infrastructure
4	North west lowland sorghum/sesame mixed livelihood system	Farmers, and traders	Scarcity of water, malaria and tsetse fly	Less land ownership, traditional farming
5	Western coffee/maize livelihood system	Coffee, spices , maize, fruits, vegetable major coffee producing area. Cattle and shoats are the main livestock	Poor awareness of natural resources, high cost for infrastructures, harsh topography, irrigation infrastructures, poor extension services	
6	Southern pastoral livelihood system	Mainly pastoralist and small scale agriculture (cattle, goats, camels, sheep, maize, sorghum, (gold),sorghum, maize, teff)	Erratic distribution of water, salinity of groundwater at some places,	Erratic rainfall and poor infrastructure, access to market and roads, low water development
7	Eastern highland mixed livelihood system	Cereals, livestock, spices, fruit and vegetable sorghum, maize and teff are important crops. Goats and sheep, camel and cattle	Poor awareness of natural resources, high cost for infrastructures, harsh topography, irrigation infrastructures	
8	Awash pastoral/ agricultural system	Cattle camel, small ruminants, small/ large scale irrigated and rainfed agriculture, charcoal trading	Soil salinity, flood, malaria	Flooding, salinity, nomadism
9	Meher/belg transition livelihood system	Livestock(cattle sheep and goats), crop production		Shortage of grazing land, erratic rainfall, shortage of water for agric, poor infrastructure
10	North-eastern pastoral livelihood system	Camel, small ruminant	Lack of water, soil salinity	Harsh climate, salinity, volcanic soil, access to market
11	Eastern chat/sorghum highland mixed livelihood system	Commercial agriculture, import-export chat and coffee major commercial crops	Erratic rainfall, flood	Land scarcity, degradation
12	"Ogaden" pastoral livelihood system	Camel, small ruminant, cross-border trading	Lack of water	Water scarcity, insecurity
13	Highland mixed -teff livelihood system	Cereals, pulses, livestock, enset,	Poor awareness of natural resources, high cost for infrastructures, harsh topography, irrigation infrastructures	Land scarcity, degradation
14	Horticultural (enset/ cereal) mixed livelihood complex	Rainfed agriculture	Land scarcity and over population	Rainfall, traditional agricultural system, high population density
15	Rift valley livelihood system	Livestock (cattle, sheep, goats and chicken), vegetable, fruit, cereals	Poor awareness of natural resources, high cost for infrastructures, harsh topography, irrigation infrastructures, localized groundwater and surface water salinity	Drought hazards, poor soil fertility, water quality
16	Gambella agro-pastoral livelihood system	Cross-border trading, fishing, agro-pastoral	Malaria	Erratic rainfall and poor infrastructure
17	Northern pastoral livelihood systems	Farmers, and traders	Lack of capacity and knowledge for water management, extension services	Rainfall, traditional agricultural system, illegal trade

Key typologies of farming population

The analysis of the livelihood context and expert consultations have allowed identifying different categories of farming and rural population. These categories have different characteristics, constraints, priorities and attitudes. In addition different AWM apporaactes and options can impact differently on their livelihoods. Assuming a degree of generalization, it is possible to identify five main typologies:

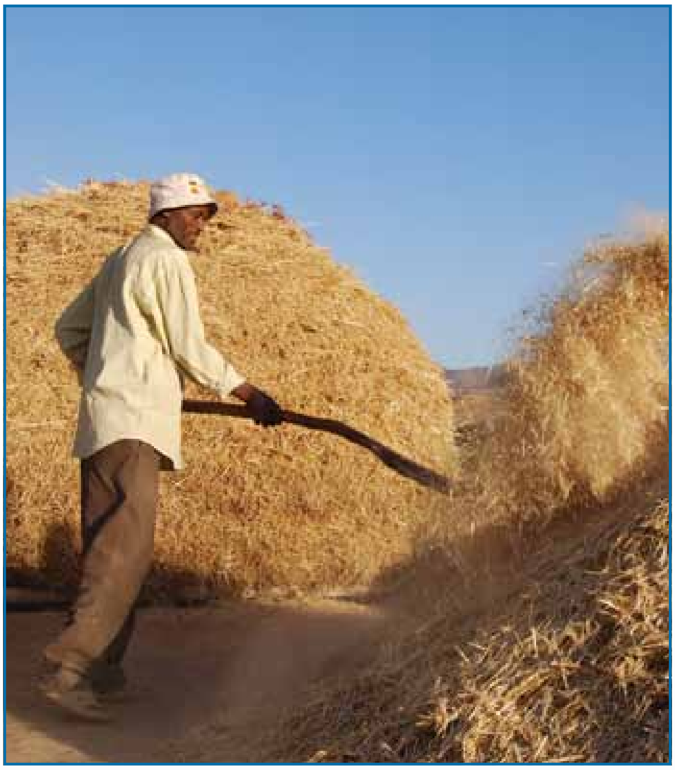
Highly vulnerable people:
this category consists of people having no or very limited access to livelihood assets and resources. They are often widows, families affected by HIV/AIDS or other diseases, etc.

Landless:
These are farmers who does not possess any land, depends on other's land for cultivation by providing their labour

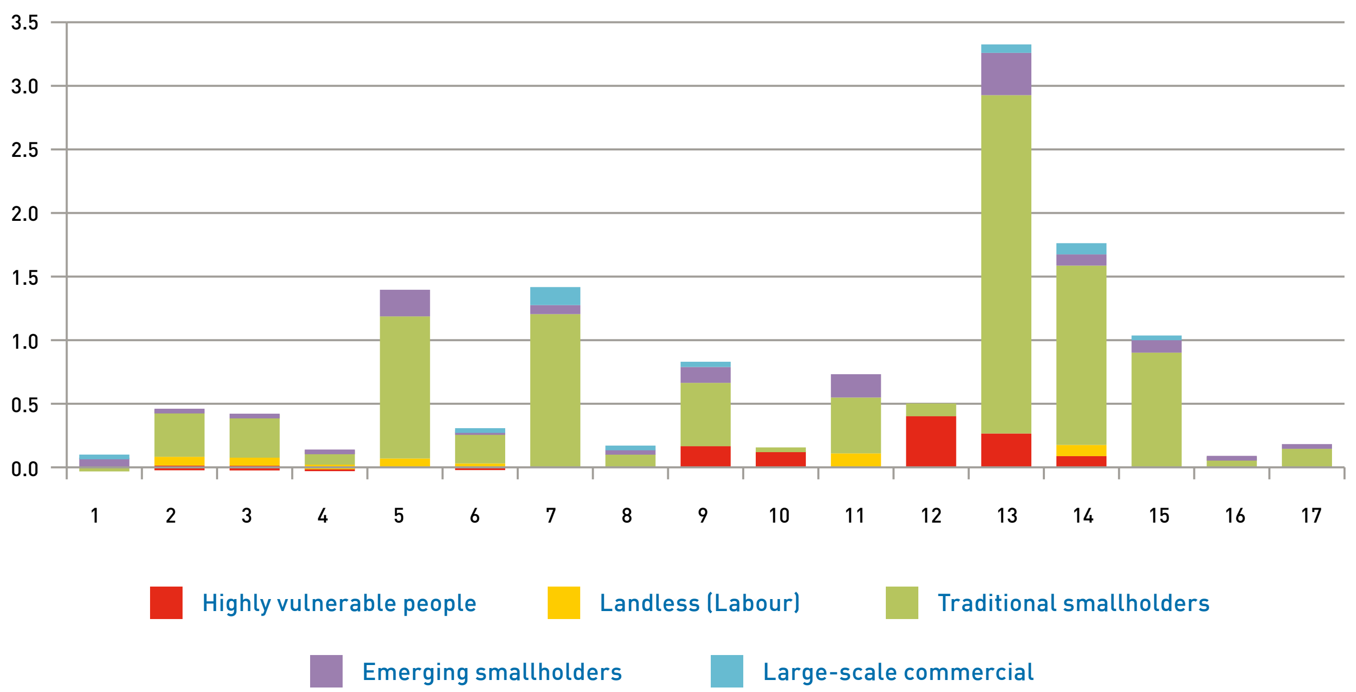
Traditional smallholder farmers:
These farmers produce mainly staple food (both crop and livestock) for household consumption and have relatively marginal connections to markets. The aim at stabilizing production and reduce risks of production failures.

Emerging market-oriented smallholder farmers:
These farmers may partially subsist from their own production but whose principal objective is to produce a marketable surplus

Commercial farmers:
These are large or small-scale commercial farmers and enterprises that are fully oriented towards internal and export markets



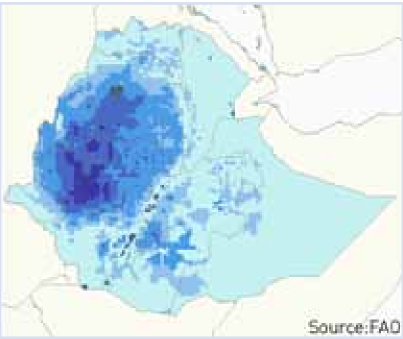
Farming population distribution



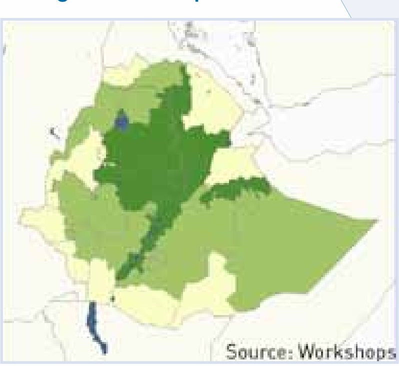
Mapping potential and opportunities for water interventions

Criteria used

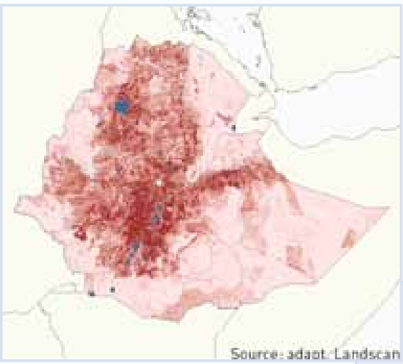
1. Water availability (runoff)



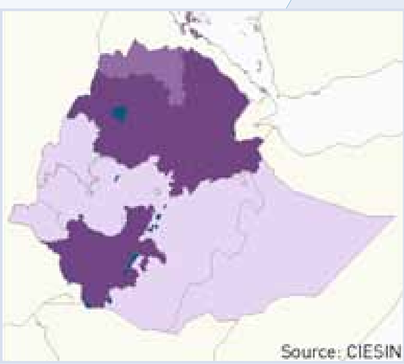
2. Perception of water as limiting factor for agricultural production



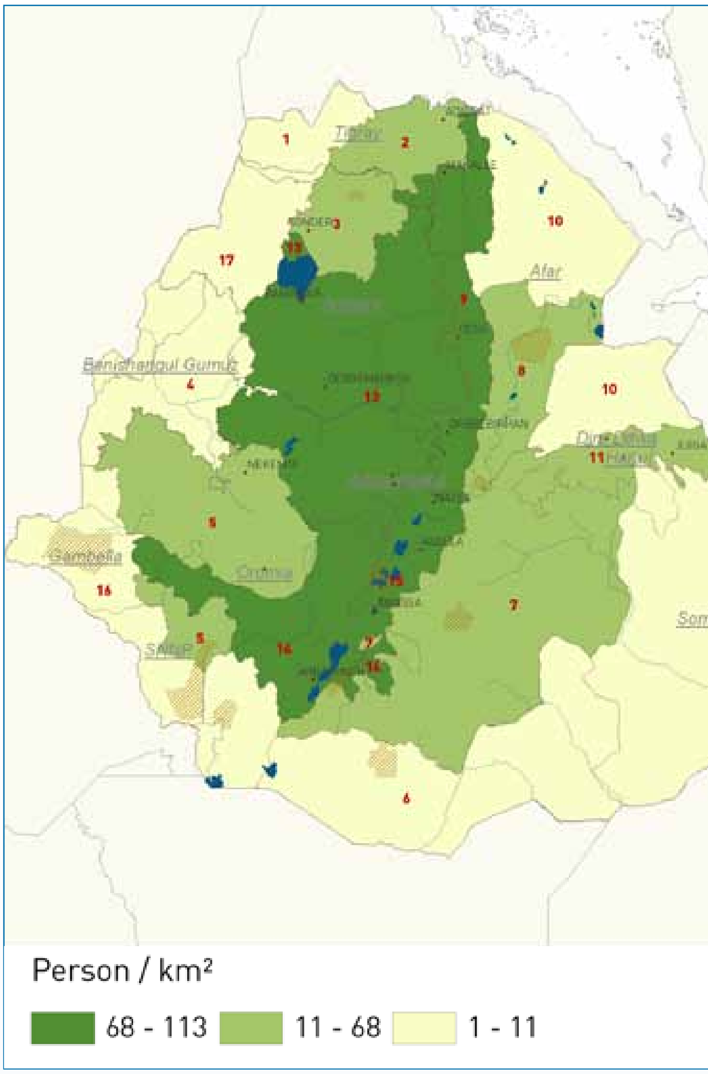
3. Rural population density



4. Poverty (underweight prevalence)

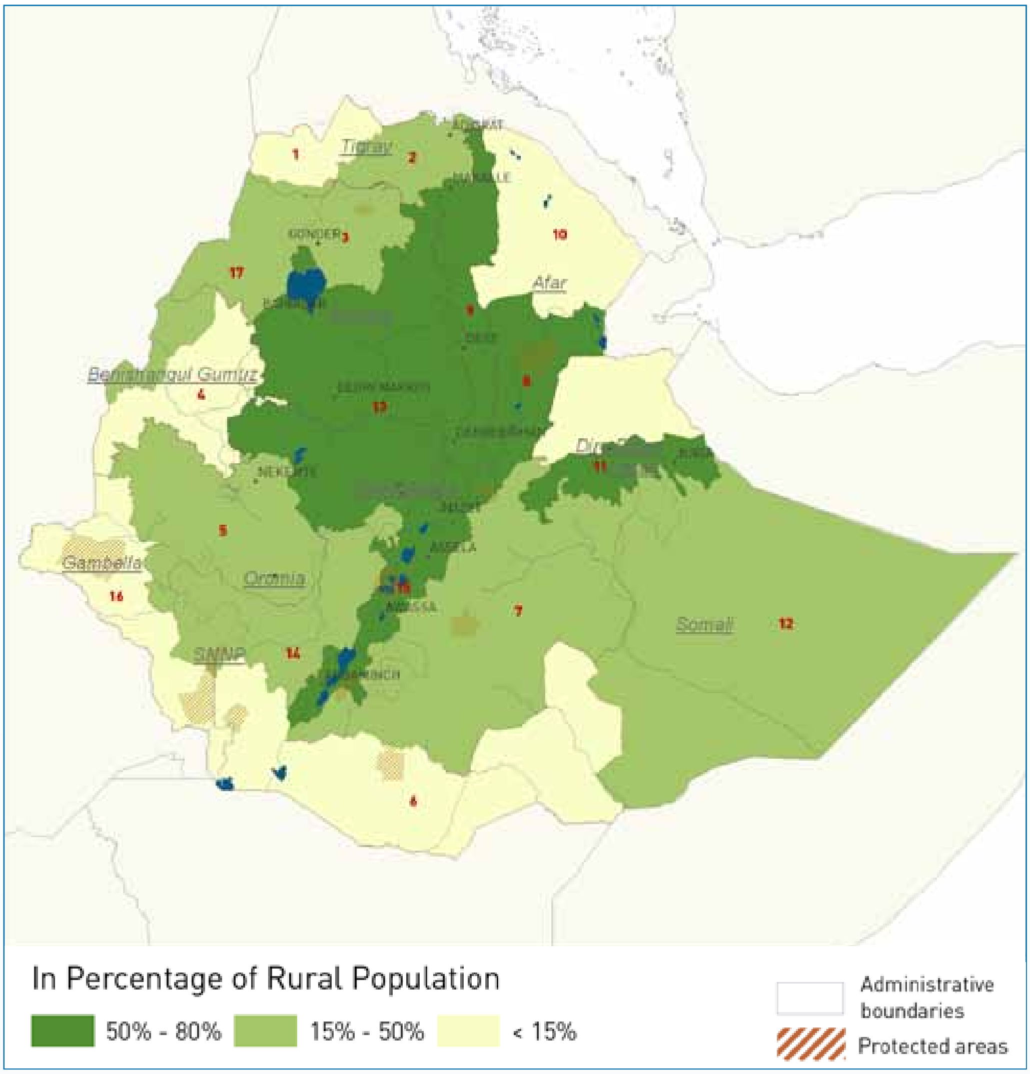


Number of potential beneficiaries



The potential for investment in water in support to rural livelihoods is a function of the demand from rural population and the availability of the resource. The maps below show a distribution of rural population who could benefit from water-related interventions. The level of demand is based on the analysis of the livelihood zones described above, combined with poverty level.

The supply is a function of availability of water, calculated on the basis of well established thresholds of water per person (water development being constrained below 500 m3/pers.). The number of beneficiaries is constrained by water availability and the perception of water as limiting factor. These maps are generic. The following pages show that the potential varies substantially as a function of the proposed technology.



Livelihood zone		Water availability: (m³/p/y)	Rural population			Perception of water as limiting factor for agricultural production	Potential beneficiaries	
No	Name		Total (,000)	Density (p/km²)	% poor (underweight)		Person (,000)	in % of rural population
1	Lowland mixed – Sesame livelihood system	1,085	522	30	48.4	Low	78	15%
2	Northern mixed midlands livelihood system	406	2,397	112	48.0	Medium	1,199	50%
3	Northern cereal pulse mixed livelihood system	1,286	2,194	100	51.5	Medium	1,097	50%
4	North West lowland Sorghum/Sesame mixed livelihood system	16,379	729	19	43.4	Low	109	15%
5	Western Coffee/Maize livelihood system	3,822	7,262	97	44.2	High	3,631	50%
6	Southern pastoral livelihood system	2,517	1,601	13	44.9	Low	240	15%
7	Eastern highland mixed livelihood system	1,379	7,371	56	43.5	Medium	3,686	50%
8	Awash pastoral/agricultural system	787	889	25	50.4	High	705	79%
9	Meher/Belg transition livelihood system	492	4,318	117	50.6	High	2,705	63%
10	North-Eastern pastoral livelihood system	843	814	10	50.3	Low	122	15%
11	Eastern Chat/Sorghum highland mixed livelihood system	184	3,809	179	42.2	High	1,173	31%
12	"Ogaden" pastoral livelihood system	1,178	2,612	12	43.2	Medium	1,306	50%
13	Highland mixed -Teff livelihood system	2,069	17,294	137	48.2	High	13,835	80%
14	Horticultural (Enset/cereal) mixed livelihood complex	994	9,166	187	51.1	Medium	4,583	50%
15	Rift Valley livelihood system	468	5,391	186	46.0	High	3,278	61%
16	Gambella agro-pastoral livelihood system	6,645	470	10	43.8	Low	70	15%
17	Northern pastoral livelihood systems	6,223	951	22	49.0	Medium	475	50%

Mapping the suitability and demand for specific AWM solutions

The AWM options

The project selected a series of promising AWM technologies on the basis of a baseline study, validated by a national workshop. The following solutions were retained and were the subject of in-depth research conducted by the project:

1. **Low-cost motor pumps (for surface water or groundwater abstraction)**
   Motorized pumps up to 5 HP that can lift and distribute water for farming practices. Their cost in Sub-Saharan Africa ranges from 200 up to 500 US$. They can irrigate a few hectares; smallholders in SSA use pump irrigation for high value crops, although they seldom exceed 1 ha of irrigated land per household. Farmers who have access to irrigation have substantially higher incomes and better food security than their neighbors who rely on rainfall. This needs a reliable method of drawing water from an available water source, whether it be a river, a reservoir, a pond, canal or groundwater.
2. **Small reservoirs**
   Small reservoirs are earthen or cement dams that are less than 7.5 meters high. They can store up to 1 million cubic meters of water and sometimes have a downstream adjacent irrigation area of less than 50 hectares. Capital investment is generally externally driven and community management remains the norm.

For the 2 options a biophysical suitability and the potential demand based on livelihood conditions have been assessed and mapped and are presented further down.

Biophysical suitability

The map uses a set of criteria to assess the potential geographical extent of each AWM solution. These criteria represent the distribution of the biophysical conditions under which a AWM solution can have the potential highest impact on livelihoods. The maps show two levels of suitability:

- **High suitability:** areas which present optimal conditions both in terms of biophysical and infrastructure conditions for adoption of a given AWM solution.
- **Moderate suitability:** areas where there are possibilities for application of a given AWM solution, but where conditions are less favourable.

Livelihood-based demand

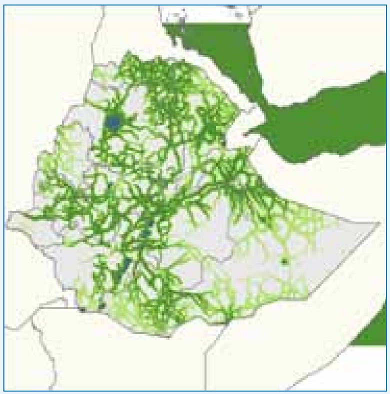
Local consultations and individual expert knowledge allowed expressing the potential demand for a technology among the population living in the different livelihood zone and provided more in-depth information on the potential adopters.

These are for instance: farmer typology, vulnerability to shocks, dependence on water resources, and average landholding size. The resulting map shows distribution of these factors in the different livelihood zones which, in turn, identify areas where livelihoods conditions are more favourable for a given AWM solutions.

Solution 1: Low-cost motor pumps

Biophysical criteria and conditions

Market accessibility (h)



< 4 h   < 8 h   > 8 h

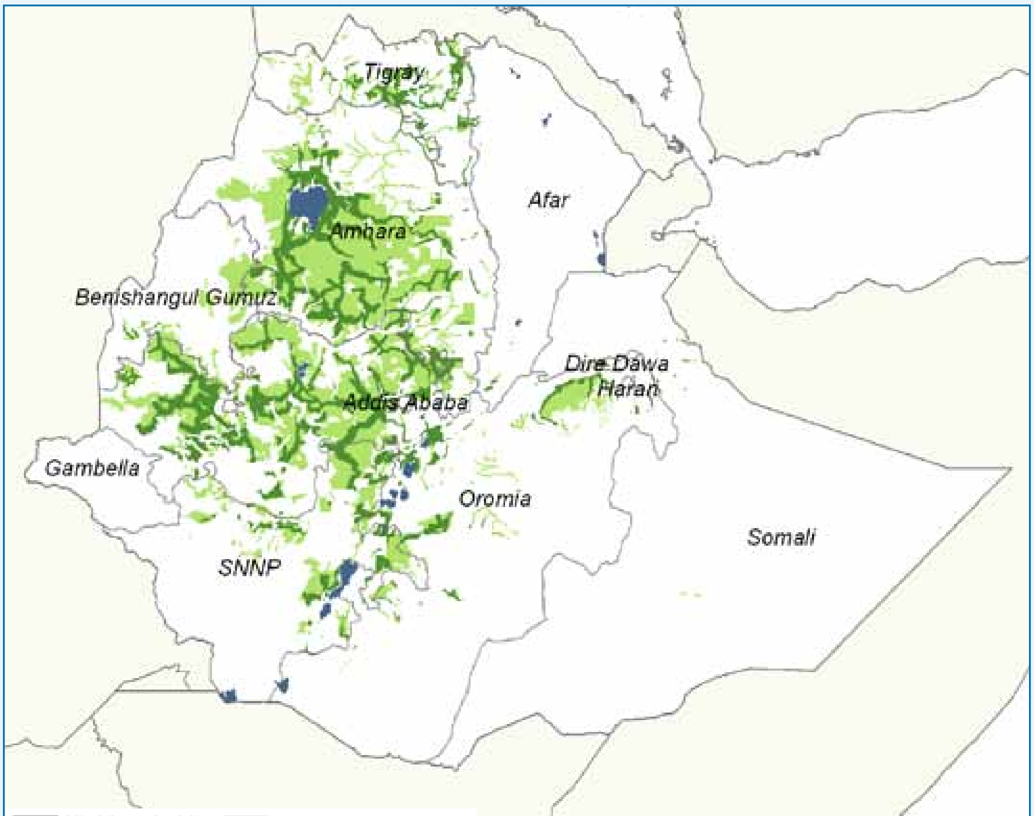
Shallow groundwater

Fluvisols/gleysols

Distance to surface water (km) + Runoff (mm/y)

Distance to sf water	Runoff (modelled)
> 1 km	< 100 mm/y
< 1 km	100 - 150 mm/y
	150 - 300 mm/y
	> 300 mm/y

Biophysical suitability

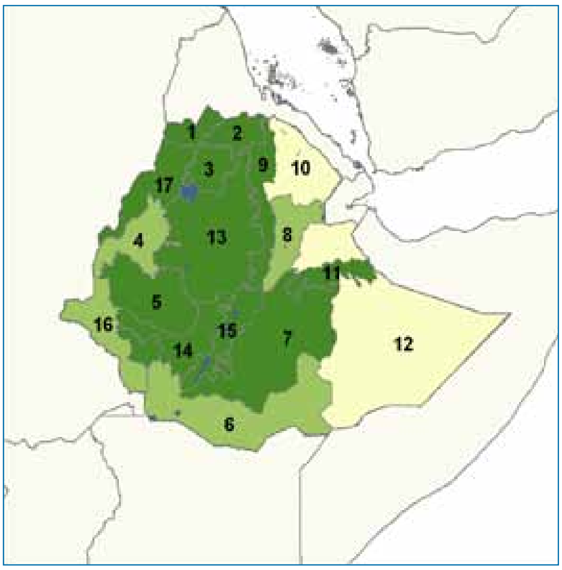


Highly suitable   Moderately suitable

Suitability assumptions	Market accessibility	Surface water	Alluvional soils
Highly suitable	<4 hrs travel time	<1km distance from surface water OR runoff >300 mm/y	Presence of fluvisols/ glevsols/gleyic subunits in soil profile
Moderately suitable	4-8 hrs		
Unsuitable	>8 hrs	>1 km distance	

Physical suitability for small pumps has been assessed on the basis of: travel time to market (defined as centers of 20,000 inhabitants or more), with areas at 4 hours or less considered highly suitable and areas at more than 8 hours excluded, proximity to surface water, occurrence of soils with shallow groundwater potential (fluvisols, gleysols, gleyic subunits).

Livelihood-based demand



Medium-low

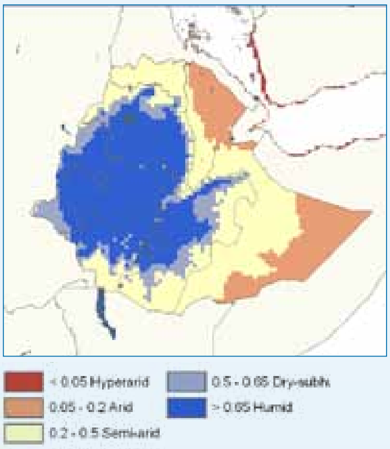
The livelihood-based demand is assessed through the analysis of the livelihood context of the zone. In particular, the context is assumed to be more favorable in zones with relatively higher prevalence of:

- **Market-oriented smallholder farmers**
  This technology would imply higher production of high value crops for market sales. Therefore, this typology of farmers is considered to be more in demand of this technology
- **High population density**
  This indicate relatively higher pressures on natural resources therefore the need for intensification which is associated to this technology

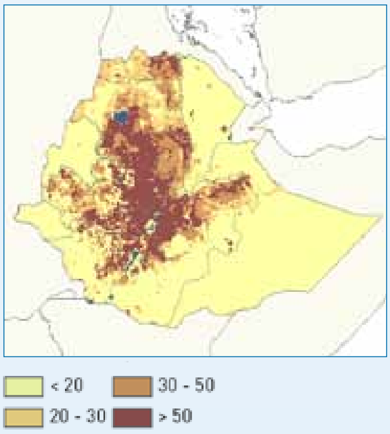
Solution 2: Small reservoirs

Biophysical criteria and conditions

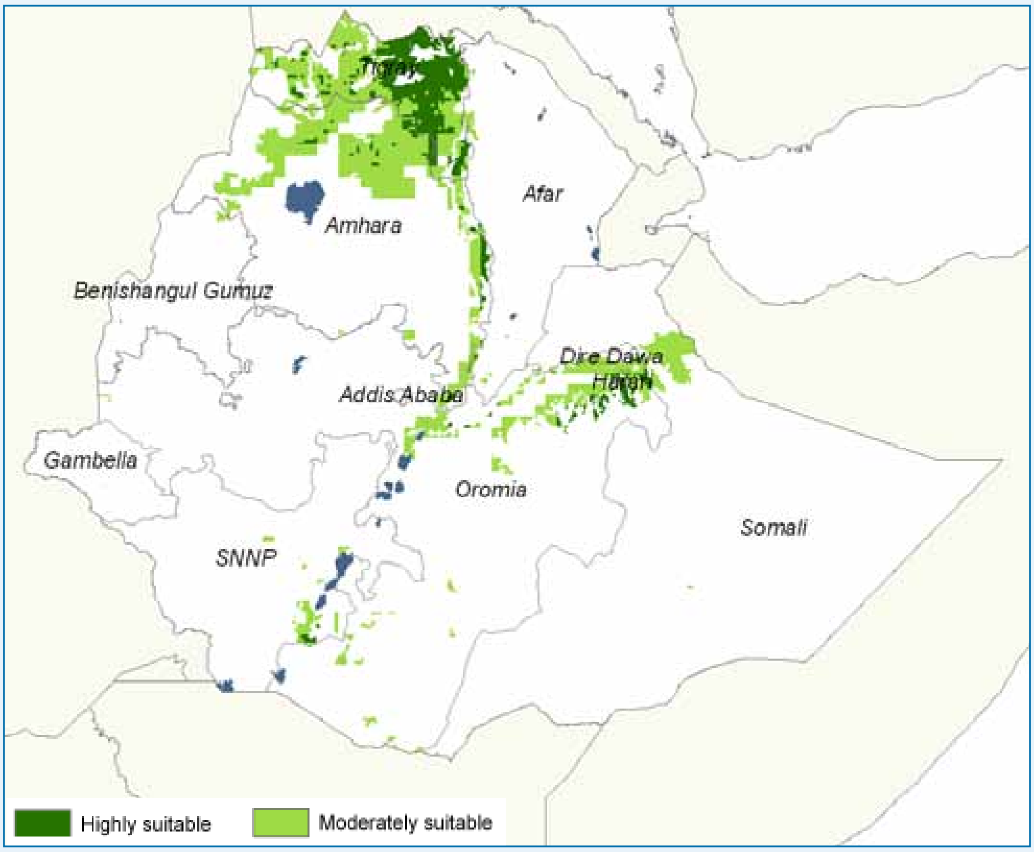
Aridity Index (P/ETref)



Livestock density (Tropical Livestock Unit / km²)



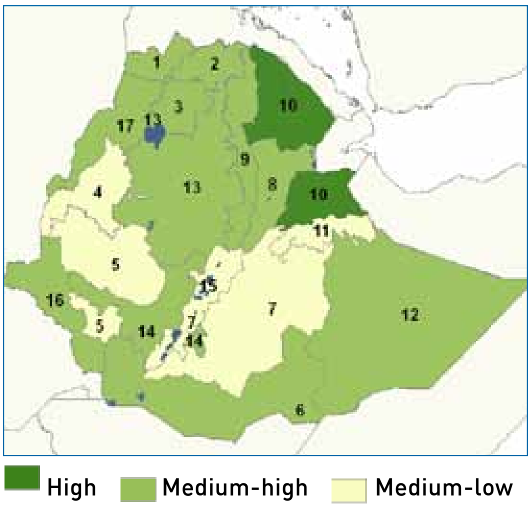
Biophysical suitability



Suitability assumptions	Aridity	Livestock density
Highly suitable	A.I. < 0.65	Density (unit/km²)> =30
Moderately suitable		Density < 30
Unsuitable	A.I. >= 0.65	

Suitable area for small dams is here defined as agricultural area where Aridity Index (yearly precipitation divided by yearly reference evapotranspiration) is between 0.2 and 0.65, semiarid to dry-subhumid; in addition, a higher livestock density is assumed to be correlated with enhanced multiple uses of small dams.

Livelihood-based demand



The livelihood-based demand is assessed through the analysis of the livelihood context of the zone. In particular, the context is assumed to be more favorable in zones with relatively higher prevalence of:

- **Traditional smallholder farmers with relatively higher prevalence of livestock-based livelihoods**
  Small reservoirs are one of the most important water sources for livestock in semi arid areas, particularly for traditional farmers that aim at stabilizing the production and improving nutrition rather than increasing production for sale
- **Higher poverty rates**
  this technology aims at providing water for multiple uses , i.e. cropping livestock water and domestic purposes. This multifunctional nature is crucial to contribute reduce vulnerability to shocks and increase resilience and therefore to alleviate poverty.

Quantifying the potential for investments in AWM

Potential beneficiaries, application areas

Potential beneficiaries (rural households)
(50% of adoption rate)

LZ	Low-cost motor pumps (,000 households)		Low-cost motor pumps (% total househ.)		Small Reservoirs (,000 households)		Small Reservoirs (% total househ.)	
	min	max	min	max	min	max	min	max
1	1	4	1.3%	3.9%	2	29	2.0%	29.1%
2	36	51	7.8%	11.1%	147	196	32.0%	42.5%
3	41	64	9.7%	15.2%	4	86	1.0%	20.4%
4	4	20	2.9%	14.5%				
5	203	308	14.5%	22.1%				
6						2		0.7%
7	35	95	2.5%	6.7%	7	48		3.4%
8	1	1				1		
9	29	46	3.5%	5.5%	38	173	4.6%	20.8%
10		1		0.5%		7		4.7%
11	33	79	4.5%	10.7%	30	199	4.1%	27.2%
12		1			2	9		1.7%
13	522	1 094	15.7%	32.9%	13	58		1.8%
14	124	282	7.0%	16.0%		4		
15	111	141	10.7%	13.6%		59		5.7%
16		2		2.3%				
17	5	21	2.7%	11.6%		22		12.2%
Total	**1 146**	**2 209**	**8.8%**	**16.9%**	**244**	**894**	**1.9%**	**6.9%**

Potential application area (ha)
(50% of adoption rate)

LZ	Low-cost motor pumps (,000 ha)		Low-cost motor pumps (% total agric. land)		Small Reservoirs (,000 ha)		Small Reservoirs (% total agric. land)	
	min	max	min	max	min	max	min	max
1	1	3			2	29		2.9%
2	29	41	1.7%	2.3%	147	196	8.5%	11.3%
3	33	51	1.8%	2.8%	4	86		4.6%
4	3	16		1.8%				
5	162	247	5.4%	8.3%				
6						2		2.3%
7	28	76	1.1%	3.1%	7	48		1.9%
8		1	1.1%	1.5%		1		2.1%
9	23	36	1.0%	1.6%	38	173	1.7%	7.7%
10		1				7		4.3%
11	26	63	1.8%	4.3%	30	199	2.0%	13.7%
12					2	9	1.4%	6.4%
13	418	875	4.0%	8.3%	13	58		0.6%
14	99	226	4.3%	9.7%		4		
15	89	113	4.9%	6.3%		59		3.2%
16		2		2.2%				
17	4	17		1.4%		22		1.8%
Total	**917**	**1 768**	**3%**	**5.7%**	**244**	**894**	**0.8%**	**2.9%**

Note: the above potentials are considered independently for each AWM option. There is therefore a possibility of double counting, i.e. the same rural household benefitting several AWM options. The total investment potential, areas and beneficiaries for the four options is likely to be less than the sum of the options taken separately

Assumptions

The maps are used to assess the potential number of beneficiaries and the extent of land which could benefit from any of the AWM solutions. These calculations represent a 'gross' potential and do not take into account demand-side aspects of agricultural production. Therefore a possible adoption rate is not applied. The calculations are performed as follows:

1. The figures reflect the assumption that 50% of farmers, among those who could potentially benefit from the AWM option, are able or willing to adopt it.
2. The total number of rural people falling into the areas of high or low suitability is calculated on the basis of a rural population density map. These results are then aggregated by livelihood zone
3. The description of the livelihood zones allows for the establishment of a factors that represents the part of the rural population which is likely to benefit from a given AMW solution. The factor reflects the importance of a given solution for the population living in the livelihood zone.
4. A unit area of land per household that can benefit from a given AWM solution is established on the basis of information obtained from the case studies and literature, i.e. 0.8 ha (motor pumps) and 1 ha (Small reservoirs). The number of potential beneficiaries, expressed in number of households, is then used to calculate the extent of land that could benefit from the solution. From national statistics, the country average household size is 5.2 persons.
5. The result is assessed against current extent of cropland in the suitable area, and in terms of its impact on the water balance, and adjusted downwards if needed.
6. The factors derived from sub-national statistics and livelihood mapping exercise (eg. farmers typology, livelihood typology, land holding size etc.) are applied as de-multiplying factors.

Quantifying the potential for investments in AWM

Tentative investment costs

Livelihood Zones	Investment cost (Mln USD)			
	Low-cost motor pumps		Small Reservoirs	
	Min	Max	Min	Max
1	1	2	15	124
2	14	20	225	313
3	16	26	31	657
4	2	8		31
5	81	123		
6				13
7	14	38	35	174
8				2
9	12	18	86	318
10				5
11	13	31	21	134
12			2	7
13	209	438	234	877
14	50	113		28
15	44	56	2	118
16		1		2
17	2	9	2	471
Total	**458**	**884**	**654**	**3 273**

Investment costs

The following assumptions have been made to assess investment cost:

1. The average water amount required for irrigated agriculture is 7 500 m3/ha/yr
2. The potential area for application of AWM options should not exceed an extent which requires more than 30% of the country Internal Renewable Water Resources.
3. 50% of adoption rate by suitable farmers due to market demand
4. For small pumps, the total investment cost is based on the number of households and not on the number of hectares
5. The investment costs only encompass the initial investment for infrastructure development and do not include the running costs and operation & maintenance costs.

Investment costs at country level		
AWM options	Unit cost	Investment costs (min-max) Million US$
Low-cost motor pumps	400 US$/household	458 - 884
Small Reservoirs	750 000 US$/$m^3$ of water stored	654 – 3 273

For more information consult the project website **http://awm-solutions.iwmi.org**
or the FAO Water website **www.fao.org/nr/water/projects_agwatermanagement.html**
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