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Awash Basin Authority



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# ***The Study of Water Use and Treated Wastewater Discharge charge***

## **Report on Charge System for Irrigation Water Abstraction and Use**

### **Final Report**

**Submitted to**

**Federal Democratic Republic of Ethiopia**

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## **ABBREVIATIONS AND ACRONYMS**

ABA/AwBA	Awash Basin Authority
ABHC	Awash Basin High Council
CF	Crop Factor
DMD	Dam Management Directorate
ETB	Ethiopian Birr
ETc	Crop Evapotranspiration
FAO	Food and Agricultural Organization
FDRE	Federal Democratic Republic of Ethiopia
GIR	Gross Irrigation Requirement
GIS	Geographical Information System
Ha	Hectare
IRRT	Irrigation Technology
ISF	irrigation service fee
KII	Key Informant Interview
LP	Land Productivity
MoA	Ministry of Agriculture
MoWIE	Ministry of Water, Irrigation and Electricity
O&M	Operation and Maintenance
OWWE	Oromia Water Works Enterprise
RBT	Rising Block Tariff
ToR	Terms of Reference
WP	Work Package
WRM	Water Resources Management



WSAM	Water Source and Abstraction Method
WSM	Water shade Management
WUA	Water User Associations
WTP	Willingness To Pay

# **1 Introduction**

## **1.1 Background**

Water scarcity is now a global phenomenon which makes the management of water resources a complex task. Coping with water scarcity requires the development of comprehensive framework including technical, political and institutional dimensions. Ethiopia is facing a growing challenge in maintaining water quantity as well as quality and meeting the rapidly growing demand for water resources.

Ethiopia has a water resources management policy and a number of proclamations and regulations to ensure the implementation of Integrated Water Resources Management (IWRM) at basin scale by acknowledging that water is an economic and a social good. The Ethiopian water resource policy (MoWIE, 2001) states that water should be recognized as a natural resource with an economic value and ensures that charges are paid for services rendered. Accordingly, water is recognized as a vulnerable and scarce natural resource and it ensures that all charging systems and mechanisms should be geared towards conservation, protection and efficient use of water as well as promotes equity of access. The river basin has been acknowledged to be the appropriate unit of analysis to address these challenges facing water resources management; and water charging at this scale can provide essential information for policy makers in their decisions on allocation of resources.

Awash River Basin is one of the most utilized river basins in the country. It serves as a source of drinking water, hydropower, industrial consumption, irrigation and disposal of waste water. A major user and consumer of the surface water in the Basin is irrigated agriculture through numerous private and government irrigation farms and small holders. The Basin has more potential for further irrigation development owing to suitable topography and ease of diversion of water along the river, if water availability is not going to constrain this development. Water charging is seen as a key economic and policy instrument to improve the sustainability of water management, to encourage conservation and improvement of quantitative and /or qualitative status of water. Additionally, irrigation water pricing has an important role in revenue generation

for basin authorities, improve efficient water use, increase water productivity, equity, and fairness among water users.

## 1.2 Problem

Coping with water scarcity requires the development of comprehensive framework including technical, political and institutional dimensions. The recurrent droughts coupled with erratic water supplies in Ethiopia, particularly in the Awash Basin, is a reminder that water is a limited resource which must not be taken for granted. As population grows and economy develops, the country will be facing water scarcity in general, and inadequate water availability in many river basins including Awash Basin. Despite the presence of enabling policies, proclamations and regulations there is no clear national guideline to charge water for irrigation use. Thus, it is the appropriate time to consider the introduction of reasonable and affordable water use tariff for irrigation and other uses as one of water management and conservation strategies.

In general, there is a low productivity of water and a high water application rates compared to irrigation water requirement of crops in Awash Basin irrigated farms. Low water management levels and excess irrigation water application rates in turn created the problems of water logging and salinity in some of the farms in Basin.

Despite the fact that irrigation water pricing is considered as an important tool to improve efficiency in resources utilization, it is not commonly practiced in Ethiopia. However, there exist some experiences in charging for irrigation water use in Awash River basin. The irrigation water users in the basin are charged for their water consumption on volumetric basis using a fixed rate. However, the effectiveness and impacts of this irrigation water pricing system has not been studied well. Few studies(Ayana et al 2015) revealed that the irrigation water tariff in Awash basin is very low and as a result water users are not encourage to consider water charges in their irrigation scheduling, water application rate, crop selection, change in cropping pattern, area expansion, and water productivity. The study concluded irrigation water pricing in Awash basin seems to be low and does not encourage individual users in improving water productivity; and recommends the charge of irrigation water use in Awash basin should have to be optimized with a well specified and revised pricing objective(s) if it has to influence the water productivity. On

the other hand, Ayana et al (2015), clearly indicated that both the authority and water users see the irrigation water use charges paid as a nominal contribution than as water demand management tool.

Capacity building is required for organizations in order to manage the complicated issue of water pricing with all its stakeholders. Management of irrigation and other water systems entails a context of human resources, water control works, appropriate policies, legal frameworks and institutions to support irrigators and farmer organizations, markets, supply chains for irrigation technologies and support services for farmers and other users. This requires an enabling social and economic environment in which these crucial elements can be developed through human and institutional capacity building. Thus, in this study, a capacity building activity for the Basin Authority staff and other stakeholders will be provided continuously in a form of technical assistance to fill the skills gap and to transmit the know-how on pricing irrigation water use.

### **1.3 Understanding the ToR**

The Terms of Reference (ToR) states that the main reason for Awash Basin Authority (ABA) to undertake this study is the unavailability of the water tariff in the country which highly affects the water resource by over abstraction and unwise use. As a way forward to overcome this challenge, ABA prepared the TOR in collaboration with the Ministry of Water irrigation and Electricity (MoWIE) to study the water tariff in detail and implement on different water uses like irrigation, industries, hydropower, domestic and livestock water supply, treated waste water discharge, tourism and fisheries.

Suitable, appropriate and implementable irrigation water use charge guideline for different water uses are needed which are consistent with the national water resources management policy, proclamations and laws and regulations of the Country.

The introduction of a water charging policy is, therefore, likely to be part of a larger package of measures designed to move to a virtuous circle where water users are willing to pay for water, with the revenue being invested in sustaining the resources and improving service delivery. In this WP, a focus is made on the objective that the introduction of irrigation water tariff serves as

an incentive for efficient water use and benefiting the society. Assessment on the irrigation water abstracted by different type of users and the related costs are undertaken in the basin. The affordability and willingness to pay of the different users in the basin is also assessed. Appropriate water tariff is set based on the existing situations and considering future scenarios. Experiences and best practices from the other countries served as inputs when setting the tariff. The charge setting takes into considerations principles of affordability and willingness to pay, fairness and equity, transparency and feasibility and sustainability and resource conservation.

## **1.4 Objective of the study**

The main objective of the WP2 is to set an appropriate irrigation water use charge for irrigation water abstraction in the Awash Basin considering the different irrigation schemes with different technologies, farm types and socio-economic conditions.

The specific objectives to be addressed in WP are:

- To set an appropriate irrigation water use charge for irrigation water abstraction at abstraction points including dams, diversions, pumps, and ground water supplies
- To estimate the cost of abstracted water from the water bodies
- To estimate cost of maintenance and weed control of main delivery systems.
- To estimate water and land productivity
- To study the willingness to pay and to accept (socio-economic analysis)
- To undertake cost-benefit analysis
- To estimate the irrigation water use charge per unit hectare of irrigated area and crop for large, medium and small scale governmental, private schemes, horticulture (flower farms) and for small farmers except those which are exempted from permit with Ethiopian water resources management proclamation number 197/2000.
- To develop a framework for guidelines and systems that enable implementation of irrigation water tariffs.

## 2 Literature Review

### 2.1 Definitions, theories and principles of water charging

A wide range of terms and definitions are used in the literature to describe payments made for irrigation water services, and the costs incurred in providing such services. The following paragraph will explain the different terms and definitions for irrigation water tariff setting.

#### **Water charges**

The term “water charges” includes the totality of payments that a beneficiary makes for the irrigation service – volumetric, crop-based, area-based etc. A water charging system embraces all of the policies, practical actions and mechanisms required to set the level of recoveries, decide the basis on which a charge will be levied, levy the charge, and collect the revenue (Molle, et al 2008).

In some cultural or political contexts, it is unacceptable to place a charge on water and therefore other terms such as **irrigation service fee (ISF)** are used, with the emphasis being that the charge is made for the service of supplying water to the user, not for the water itself.

Water pricing is used in the literature to be synonymous with charging. More commonly, as here, it has the restricted connotation of charge per unit quantity of irrigation water used. The concept is clear in the case of volumetric charging but where charging is non volumetric; an implicit charge can be derived by dividing the charge by the volume of irrigation water delivered.

Therefore, users to access water can define irrigation water charge as an actual (financial) payment and the term “irrigation water use charge” is adopted in this study. It is equivalent to Irrigation water tariff. All the discussion in this study uses the term *irrigation water use charge*, focusing on how irrigation water charges are reasoned, justified, determined, enforced, recovered and eventually expended.

#### **Cost of water**

The cost of water must be carefully distinguished from the charge. Cost tends to relate to the direct expenses incurred in providing for example, the cost incurred to irrigation service. It is

important to emphasize that the costs to an individual farmer will be very different from the total costs to society based upon a total economic valuation. This more general basis for establishing the ‘cost of water’ is set by the Global Water Partnership (GWP, 2000).

It includes a full analysis of the different cost elements that may be factored into a calculation of the cost of supplying water - operation and maintenance, capital depreciation and replacement, opportunity costs (that is, benefits foregone when water is not applied to its most beneficial use); social costs; and environmental costs. The Global Water Partnership identifies three components of irrigation water costs that are important related to irrigation water use. These are full supply cost, full economic cost and full cost. The following table presents the clear explanation of each cost.

Table 1. Components of irrigation water cost (FAO, 2004)

No	Components of irrigation water cost	Description
1	Full supply cost	Operation and maintenance, capital depreciation and replacement, opportunity costs
2	Full economic cost	Opportunity cost, economic externalities and full supply cost
3	Full cost	Environmental externalities, full supply cost and full economic cost

## 2.2 The need for irrigation water charging

Water charge serves as signals of the value of the scarce resource and induces users of various sectors to utilize water accordingly. Yet, it is not always clear what is the “right” charge and how pricing is to be implemented (FAO, 2015 and Molle, F & Berkoff J. 2007).

There could be large differences in charges and charging mechanisms within a single country reflecting different objectives, different water sources, and different degrees of water scarcity and irrigation schemes with different technologies, farm types or socio-economic objectives.

Clarity of objectives in formulating water charges is essential: some objectives are in direct conflict (high charges to discourage waste will impact heavily on the poorest farmers; sophisticated charging systems based on volumetric measurements are expensive to introduce

and operate, increasing bureaucracy). Thus a clear definition of what tariffs are designed to achieve is essential.

The three most common objectives for introducing water charges in irrigation are (Cornish et al, 2004):

- To recover the cost of providing the service (either the full cost, including capital expenses, or the ongoing Operation and Maintenance (O&M) cost, or some intermediate level
- To provide an incentive for the efficient use of scarce water resources
- As a benefit tax on those receiving water services to provide potential resources for further investment to the benefit of others in society.

Each of these three objectives requires specific levels and structures of pricing to be achieved. Although the available literature identifies a number of theoretical objectives of irrigation water pricing, in practice just two objectives dominate: (i) to achieve some level of cost recovery, and (ii) to bring about a reduction in irrigation consumption. The target level of cost recovery, or the magnitude of any reduction in consumption, will vary between schemes and countries (Cornish et al, 2004).

## **2.3 Irrigation water charging methods**

This section addresses the practicalities and modes of charging for irrigation water. The following are the most common ways of defining charges and their differentiation according to uses and users (Easter and Liu, 2005).

Irrigation services can be charged for in various ways. Sometimes a combination of charges is applied. The different systems discussed below provide different levels of incentive to irrigators to reduce consumption, and different structures of income to the service provider (Cornish et al, 2004).



### 2.3.1 Area-based charge

Area-based irrigation water use charge is not only simple to calculate and easy for farmers to understand but it also has lower implementation costs. The implementation cost is lower than volumetric charge because water deliveries need not be measured. Also, assuming 100 percent collection rates, charges per hectare, based on average direct cost, result in full recovery of direct costs. Although it gives farmers no incentive to reduce water use per hectare, it is still widely used in many systems throughout the world due to the simplicity of its implementation. In Haryana, India, irrigation water is priced at US\$2.50 /ha (Cornish and Perry 2003), while in Pakistan, charges range from \$2 to \$8/ha but are set to cover only part of the O&M costs (Ahmad 2000). A fixed rate per hectare of farm, where the charge is not related to the area irrigated, the crop grown or the volume of water received (except that a larger irrigated area implies a greater volume of irrigation water). It is usually designed to cover the fixed costs of the service. Different charges may be used for gravity and pumped supplies.

### 2.3.2 Crop-based

A variable rate per irrigated hectare of crop, i.e. different charges for different crops (as some crops have higher water requirements than others), where the charge is not related to the actual volume of water received, although the type of crop and area irrigated serve as proxies for the volume of water received.

### 2.3.3 Volumetric

Volumetric charges assess a per unit charge for each m<sup>3</sup> of water delivered. Volumetric charges can be organized into different water rate structures from uniform rates to increasing/decreasing block rates or tiered rates, to seasonal rates, as described below (Wichelns 2010).

**Uniform rates/fixed rate:** The unit charge for water is constant, or flat, regardless of the amount of water consumed.

**Increasing block rates:** The unit charge for water increases as the volume consumed increases. This structure consists of a series of charge blocks, where the unit charges for each block

increase as the block volumes increase. Those who use low or average volumes of water will be charged a modest unit charge; those using excessive volumes will pay higher unit charges. A variety of approaches can be applied to setting each block volume. This method is referred sometimes as a Rising Block Tariff (RBT).

**Decreasing block rates:** The unit charge for water decreases as the volume consumed increases. Similarly to increasing block rates, the structure consists of a series of “charge blocks,” which are set quantities of water sold at a given unit charge. The unit charges for each block decrease as the block quantity increases.

**Seasonal rates:** The unit charge for water is set to vary from season to season. For instance, “Bega” or dry season water rates are set higher than “Kiremit” wet season rates in order to reflect the fact that water is more valuable. Seasonal rates can be flat, uniform, increasing or decreasing

#### 2.3.4 Tradable water rights

The entitlements of users in an irrigation project, or more widely, other users, are specified in accordance with the available water supply. Rights holders are allowed to buy or sell rights in accordance with specified rules designed primarily to protect the rights of third parties. Sales require authorization by a licensing authority or court approval.

#### 2.3.5 Area-season-based charge

Some countries also use area-season-based charges. For example, a higher price is charged during the dry season, when water is scarce, and a lower charge is levied in the monsoon or wet season, when water is relatively plentiful. If the charge is set high enough in the dry season, it will help limit the number of hectares irrigated in that season. In France, the pricing structure was based on different costs for off-peak and peak water use. The peak season lasts five months in the summer, and the water charge reflects the long-run marginal cost of supplying water. During the off-peak seasons, France includes only operating costs. This pricing structure has helped reduce water use during summer when demand is high compared to supply (Johansson et al. 2002).

### 2.3.6 Area-Technology-based charge

This charging method is not received much attention; theoretically, it should promote selected irrigation technologies. The basic idea is similar to area-crop-based charges, with farmers using water-saving technology paying lower per hectare water charges. For example, drip and sprinkler irrigation generally allow better water control and more output per unit of water delivered than flood irrigation. Therefore, a higher per hectare charge could be levied on farmers not using these technologies to encourage them to switch.

If area-based charges can be established that reflect differences in water use by season, crop, or irrigation technology, area pricing would have some of the benefits of volumetric pricing. This would be the case if, after controlling for crop, irrigation technology, and season, there was little variation in water uses per hectare. Problems are still likely to exist because farmers at the head of the canal tend to over irrigate their fields when water charges are based on area. However, if farmers can be assured that each scheduled water delivery will be on time and in the quantity demanded, they will have much less incentive to over irrigate than with irregular deliveries (Yacov, 2005).

**Table 2.** Bases for three identified key irrigation water charge methods and their description (FAO, 2004)

No	Type	Description of the irrigation water charging methods
1	Area-based	(a) A fixed rate per hectare of farm, where the charge is not related to the area irrigated, the crop grown or the volume of water received. It is usually part of a “two-part” tariff designed to cover the fixed costs of the service. Different tariffs may be used for gravity and pumped supplies.
		(b) A fixed rate per hectare irrigated. The charge is not related to farm size, type of crop grown or actual volume of water received (except that a larger irrigated area implies a greater volume of irrigation water).
2	Crop-based	A variable rate per irrigated hectare of crop, i.e. different charges for different crops, where the charge is not related to the actual volume of water received, although the type of crop and area irrigated serve as proxies for the volume of water received.
3	Volumetric	(a) A fixed rate per unit water received, where the charge is related directly to, and proportional to, the volume of water received.
		(b) A variable rate per unit of water received, where the service charge is related directly to the quantity of water received, but not proportionately (e.g. a certain amount of water per hectare may be provided at a low unit cost, a further defined quantity at a higher unit cost, and additional water above this further quantity at a very high unit cost). This method is referred

		to as a rising block tariff.
<b>4</b>	<b>Tradable</b>	The charge of water is determined in a market where allotments can be traded (within season, seasonally or permanently). If the market is regulated, the regulator set the charge limits.

## 2.4 Comparison of the different types of charging systems

Under area-based pricing systems, which are most commonly used, farmers pay a fixed charge per unit of land, assessed either on the basis of their total holding, the irrigated part of it or the actual crops irrigated. This charging structure is adequate where the sole objective is cost recovery, a fixed cost per hectare. In some cases, this may vary according to crop type, with higher charges for more water demanding crops. The system is relatively easy to administer, but is open to abuse, particularly through collusion between the farmer and the assessor to reduce the scale of the charge. Assessment based on irrigated area would appear to be the fairer method, but it requires considerable resources and effort.

Volumetric water pricing or tradable water allocations (quotas) are used where the objective is to reduce or limit water use in the agriculture sector. Where volumetric pricing is proposed to limit consumption, delivery must be measured and controlled to the individual user. This method may not be feasible in large parts of the developing world because of the costs and complexity of installing large numbers of measuring devices on the supply to small farmers, and the vulnerability of available devices to accidental and malicious damage. The challenge to administration and management would be unrealistic in the short to medium term. However, there is little practical evidence from the field to support the view that volumetric pricing has a significant effect on farmers' water consumption patterns (Cornish et al, 2004).

Non-volumetric water charges are simpler to administer than volumetric pricing as there is no requirement for extensive measurement infrastructure and continuous field recording. Any charge structure that contains a volumetric element is impractical where there is no infrastructure to routinely measure the volume used. Where this infrastructure does exist, a two-part tariff (with a fixed element to cover O&M costs and a variable element to reflect consumption) offers the

benefit of assuring a more predictable basic income stream. RBT pricing depends on volumetric measurement and so is not common in irrigation, particularly in the developing world.

Irrigation water charging systems broadly classified as volumetric and non-volumetric water charging. Volumetric water pricing is used where the objective is to reduce or limit water use in the agriculture sector. Metering is necessary but volume can be represented by time or the number of ‘turns’, provided discharges are more or less stable and predictable. It is proposed to limit consumption; delivery must be measured and controlled to the individual user. Volumetric irrigation water charge methods conserve irrigation water (Wichelns 2010). Practical evidence is recorded from the field to support the view that volumetric pricing has a significant effect on farmers’ water consumption patterns (Ariel and Jyothsna 2004). Moreover, they explained that, irrigation water pricing is expected to enhance water conservation and thereby reducing demand (Ray 2002).

Challenges of volumetric irrigation water charges are listed as follows:

- Volumetric method may not be feasible in large parts of the developing world because of the costs and complexity of installing large numbers of measuring devices on the supply to small farmers, and the vulnerability of available devices to accidental and malicious damage (Cornish et al, 2004).
- Volumetric measurement of irrigation water may not be practical for technical, financial and managerial reasons. In some cases (e.g. for paddy), measurement at the farm level is unworkable without major structural investment and installing functional devices in flat gravity systems is impracticable.
- Require extensive measurement infrastructure and continuous field recording.
- Impractical administration and management follow-ups of irrigation water for each irrigated farms.

Non - volumetric methods charge for irrigation water bases on a per output basis, as per input basis, a per area basis, or based on land values. This method of irrigation water charges are simpler to administer and manage than volumetric pricing, as there is no requirement for extensive measurement infrastructure and continuous field recording. Any charge structure that

contains a volumetric element is impractical where there is no infrastructure for frequent measurement of the volume of irrigation water used.

Non- volumetric water charge is again classified broadly as:

**Area-based charge:** under Area-based charge – the irrigator is charged according to the area irrigated, based either on: (i) the area owned; or (ii) the area cropped

**Crop-based charge** - the charge is based on area and type of crop. Differentials may be justified by crop priority.

Challenges of Non-volumetric water charges are listed as follows:

- Non- volumetric water charges is relatively easy to administer, but is open to abuse, particularly through collusion between the farmer and the assessor to reduce the scale of the charge.
- Assessment based on irrigated area would appear to be the fairer method, but it requires considerable resources and effort.
- This charging structure is adequate where the sole objective is cost recovery, a fixed cost per hectare/crop. Over consumption of water is highly applicable.
- In some cases, this may vary according to crop type, with higher charges for more water demanding crops – this in turn makes the irrigators to shift to less water demanding crops.

In conclusion, each method has its advantages and disadvantages, notably the ease with which charges can be calculated, justified, administered and implemented. Additional modalities may also vary: for instance, charges may vary by season, be paid before or after cropping, in one or more installments, in cash or in kind, etc.

## 2.5 Existing irrigation water Charing in the Country

Despite the fact that irrigation water charging is considered as an important tool to improve efficiency in resources utilization, it is not commonly practiced in Ethiopia. However, there exist

some experiences in charging for irrigation water use in Awash River basin. Awash basin is one of the basin that operates with the concept of river basin management and irrigation water pricing in Ethiopia (Ayana et al 2015).

### **2.5.1 Experience of Awash River Basin**

In Awash River Basin irrigation water users are charged for their water consumption on volumetric basis using a fixed rate. The volumetric method of irrigation water charges collection that required continuous recording of flow rates at each abstraction point, which is expensive, difficult to monitor and open to abuse. However, the effectiveness and impacts of this irrigation water pricing system has not been studied well. As the GIRD consultant (2010) study shows, the charge was ETB 3.0 per 1000m<sup>3</sup> and this charge can't cover even the O&M costs. Similar studies (Ayana et al 2015) revealed that the irrigation water tariff in Awash Basin is very low and as a result water users are not encourage to consider water charges in their irrigation scheduling, water application rate, crop selection, change in cropping pattern, area expansion, and water productivity.

The study concluded irrigation water pricing in Awash Basin seems to be low and does not encourage individual users in improving water productivity; and recommends the cost of irrigation water in Awash basin should have to be optimized with a well specified and revised pricing objective(s) if it has to influence the water productivity. On the other hand, Ayana et al (2015), clearly indicated that both the Authority and water users see the charges paid as a nominal contribution than as water demand management tool. Hellegersetal (2005)study proposed a new more equitable system of water allocation based on flow rate, which is easier to administer. The new system would give users the right to a specified flow rate and charges would be based on the allocated flow. A charge of ETB 50,000 per m<sup>3</sup>/s equates to the current charge of ETB 3 per 1,000m<sup>3</sup> and thus the large users would pay no more than at present.

### 2.5.2 Experience of Koga Irrigation Project

Koga irrigation project is a large scale (7000 ha) project with expected beneficiaries of about 10,000 households. The project is expected to be managed by the community through the already established Koga irrigation cooperative. Irrigation water users are recommended to pay for O&M cost from the beginning. A grace period of three years is recommended to individual water user and repayment of capital cost is to be started on the fourth year from the time a farmer has started using irrigation water.

The water charge on Koga irrigation project is established based on area-crop-based approach. The main challenges in this project while setting water charging were crop selection, method of water pricing, level of cost recovery, billing and collection mechanisms and institutional setup (GIRD, 2010).

In Koga irrigation project, farmer's ability to pay was estimated under three farm models with three approaches. These are:

- a- Typical farm house holds will be able to pay 33% of the economic rent for water charge
- b- A farm household will be able to pay 25% of the economic rent for water charge
- c- Based on farmers willingness. Household survey shows that farmers are willing to pay 10% of their net income for irrigation water.

### 2.5.3 Experience of Tendaho Irrigation Project

Volumetric irrigation water pricing methods is proposed for the cost recovery of irrigation water service to be delivered from Tendaho dam and irrigation project. The unit charge of one m<sup>3</sup> of water for full cost recovery of all investment and O&M costs including interest repayment is estimated to be Birr 0.31. On the other hand, excluding the interest repayment, the unit cost of one m<sup>3</sup> of water is estimated to be Birr 0.18 under 30 years of cost recovery.

In order to recover the dam and irrigation investment and O&M costs within shorter period time, 20 years repayment periods were considered as alternative. Under this alternative the unit charge of water is estimated to be Birr 0.43 and Birr 0.26 per m<sup>3</sup> of water, where interest repayment on loan is included and excluded, respectively, for 20years of cost recovery option. The final



decision on the unit charge of one m<sup>3</sup> of water should consider the affordability of water service payers and international experiences. The result of the analysis shows that Tendaho Sugar Project affords to pay the highest charge estimated among the four options. These are, irrigation water charge of Birr 0.43 is 2.01% of the net income of the sugar industry which is by far below 5%.

## **2.6 Irrigation water charging practices, international experience**

### **2.6.1 South Africa**

The main criteria underlying the pricing of any scarce resource is efficiency. However, water pricing is often perceived as a policy intervention that negatively affects poor farmers and small holds. Thus, for water pricing, the efficiency criteria alone may not be always appropriate. Similar pricing policies may have very different impact under different conditions. Moreover, farmers responses to water pricing depends on a variety of endogenous (crop mix) and exogenous conditions (soil type, water supply reliability, existing water institutions, charges of other inputs and outputs etc) (Yacob et al).

While pricing is a useful tool , it is not always easy to implement and rising charges can sometimes have the effect of increasing overall water use. Moreover, the financial cost recovery for irrigation provision is gaining more widespread acceptance, though such cost recovery is not always based on economic pricing principles (Ariel and Jothisna, 2004).

South Africa is a water scarce country where water demand is greater than the available water in river basins. About 70% of the cities of the country are dependent on rain-fed agriculture (Joe and Barbara, 2015). The country is divided in to 19 management areas and the water charge amount is highly dependent on the management areas and type of water abstraction sectors (South Africa department of water affairs and forestry). In the country, the agricultural sector pays a row water charge (includes: OM charge, charge for depreciation of government schemes and catchment management costs) since 1999 and water resources management costs are introduced in 2002.

The foundation of water allocation and pricing in South Africa is the national water act of 1998. The government is the custodian of water and is to manage it for the benefit of the all persons in sustainable and equitable manner. Equity and environmental sustainability are the two major policy goals in South African system.

Once these reserve volumes are established for a specific water resources, the right to use water for other purposes can be authorized through license that is limited in time, requires registration and that can be transferred permanently or temporarily. Licensed rights will be further only be given to users that are in the public interest, and will be charged the full cost for water supply, including infrastructure cost development and river basin management.

In South Africa, there is a concept of Free Basic Water, which ensures all users had free access to a minimum amount of 6m<sup>3</sup> per household per month. The cost of this water is covered by higher income users. At a system level, South Africa aims to take a national wide, holistic perspective on water pricing through a water pricing strategy applied at the points of abstraction and discharge.

The country repeatedly revises the water use policy for better reflect the desired policy goals, specifically social equity and environmental goals. The final tariff will reflect the hybrid approach with some charges levied uniformly on a national, regional, scheme or project basis; and specific types of charges also allowed. In the country, the irrigation water charge considers both water resources management charge and water resources structure charges. However, the water resources structure charge is capped (SIWI, Working paper 28).

In 2003/04, the maximum cost for water management was 3.16 cents/m<sup>3</sup> and the minimum was 0.27 cents/m<sup>3</sup>. The cost of irrigation water didn't exceed 1.07 cents/m<sup>3</sup>. The cost is highly dependent on the water management area and water abstraction sectors (South Africa department of water affairs and forestry).

Gill et al (2010), studies the impact of increasing irrigation water charge in South Africa by considering two scenarios (the first is when all water is fully utilized in agriculture and the second scenario is when water is not fully utilized). In both cases, increasing water tariff by 50%

risks the risk profile of agriculture, threatens food security, reduces national welfare, increases import of staple foods and their price will be increased, and decreases employment in agriculture

### 2.6.2 India

In India, pricing of irrigation water has been debated since long. Various committees and commissions have examined the issue from time to time and have given their recommendations. Irrigation commission (1972) recommended that the water rates should be 5% - 12% of the total value of farms produce, the lower percentage being applicable to food crops and higher for cash crops (Kulkarni, 2007).

In the country, most of the operation and maintenance work of the large and medium scale irrigation schemes is handled by the state irrigation department; although there are few instances where the users manage such kind of schemes. The allocations for O&M for the Irrigation or Public Works Department as a whole are determined as part of the State budget. However, the fund allotted for O&M is not sufficient and that the allocations for particular projects often do not meet their needs in terms of either magnitude or timeliness (planning commission government of India, 1992). To solve this problem the committee recommends a two-part tariff comprising a fixed charge applicable to entire command area as a membership charge, a variable charge based on area irrigated to recover annual operation and maintenance (O & M) cost, and 1% interest on the capital cost. That means, the National Water Policy Statement of 2002 advocates for “the water charges for various uses and should be fixed in such a way that they cover at least the O&M charges of providing the service initially and a part of the Capital Costs subsequently. Thus, full cost recovery was recommended to be the ultimate goal.

To achieve this ultimate goal, India follows a step by step eventually leading to pricing on volumetric basis supported by improvement of existing activities systems, creations of autonomous, financially self-reliant entities at the system level with participatory management by users.

The National Water Policy of India (MOWR, 2002) emphasizes that allocation of irrigation water should be done with due regard to equity, social justice and that the supply of water should

be made on volumetric basis. Now many States have adopted Participatory Irrigation Management (PIM) approach, where irrigation water is supplied to the Water User Associations (WUAs) (Kulkarni, 2007). To assure sustainability of water resources, water charge is imposed by the government and it comprises of one or more of the following elements (COMMISSION, 2017)

- (i) Water rates depending in the kind of crop
- (ii) The area irrigated,
- (iii) Number of irrigations of each crop
- (iv) The total volume of water used by the farmer

The assessment and the charge collection in the country is handled by the irrigation department and in some cases the collection is handled by the Revenue department while the assessment is handled by the irrigation department. However, there are some states where there is no irrigation water rates and no mechanism of water charge collection.

For levying water rates, the irrigation sources are classified into two categories. Any source of irrigation coming under Major & Medium Irrigation Projects is designated as Category– I source. Sources of irrigation other than Major & Medium Irrigation Projects are classified under Category-II source. Further, the crops are classified as Wet crops, Dry crops and Double crops. Different water rates are charged for (a) first or single Wet crop, (b) second or third Wet crop, (c) first irrigated Dry crops, (d) second or third irrigated Dry crops and (e) Double crops. For each of these types of crops, water rates are different for category-I and category–II sources of irrigation. Karthikeyan et al (2009) conducted a research on farmers willingness to pay on South India and found that most of the farmers are willing to pay for irrigation water charge equivalent to O&M cost. The main reason for their positive response is the malfunctioning of the irrigation systems and reduction of yield following this problem (Karthikeyan et al, 2009)

The National Water Policy of India emphasizes that allocation of irrigation water should be done with due regard to equity, social justice and that the supply of water should be made on

volumetric basis. Now many States have adopted Participatory Irrigation Management (PIM) approach, where irrigation water is supplied to the Water User Associations (WUAs). States where PIM has been adopted on a significant scale are Andhra Pradesh, Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Orissa and Tamil Nadu. However, excepting the States of Maharashtra and Gujarat, the volumetric allocation and supply is yet to be adopted in other States.

Volumetric method of pricing irrigation water has always been advocated as the better approach to induce water savings by farmers. However, owing to seemingly technical and administrative complexities in adoption of the volumetric method - especially in large public canal irrigation systems, the area based pricing method is widespread in most countries. In India, during the last decade, there has been significant development in adoption of the volumetric supply and pricing through participatory irrigation management.

In Maharashtra for example, the volumetric charges for bulk water supply have been so fixed that the assessment on the volumetric rate and the prevailing crop-area-season rate almost matches. The volumetric rates vary as per the season – low in monsoon (kharif) season and high in summer (hot weather) season. The present volumetric rates in the State are Rs. 47.6/103 m<sup>3</sup> for kharif season (1 July to 14 October), Rs. 71.4/103 m<sup>3</sup> for rabi season (15 October to 28 February), and Rs. 144.8/103 m<sup>3</sup> for hot weather season (1 March to 30 June). These volumetric rates are applicable until the next revision of the crop area rates.

### **Flow measuring devices in canals**

In India, the tradition of flow measurement in canals is in vogue since more than a century, and the conventional measuring devices like Standing Wave Flume (SWF), Parshall Flumes, Orifices and V notches are generally used. In some States, the measuring devices are not constructed separately, but only the gauges are installed in the canals. The discharges are then computed by using Manning's or other empirical formula.

In most of the irrigation projects, the discharge measurement data of main canals, branch canals /distributaries is routinely maintained. A SWF was installed on Mutha canal in 1928. Since then

the SWF is normally provided on all canals and distribution system having discharging capacity more than 0.15 cumecs. Later in 1970s, under the World Bank and USAID assisted programs, Parshall and Cut-Throat Flumes were introduced for measuring flow below 0.15 cumecs. Manuals and Standards on design and construction of measuring devices have been prepared by the Department. Irrigation engineers are trained in the subject at the State's Water and Land Management Institute (WALMI) on regular basis.

### 2.6.3 China

China feeds 22% of the world population with 6% renewable water resources and the country is undoubtedly facing a serious water shortage problem. The country is currently using a mix of volumetric based, area based and quota allotment water pricing systems. For irrigation use, water pricing varies in different provinces and the pattern turns out to be somewhat random. How to charge water for irrigation is largely a decision of the province and the local governments. The country uses the area based and quota allotment pricing methods concerning irrigation water (Xizi, 2010).

The price that Chinese farmers are charged for the water they use on their farms typically combines a resource charge and an infrastructure charge. A resource charge seeks to capture the opportunity cost of water in a river in its best alternative use (which may include environmental flows). An infrastructure charge is the fee charged for delivering water from the river to farmers' fields, including the capital cost of constructing, operating and maintaining an irrigation system. In China, actual prices charged for irrigation water are thought to be well below levels that are efficient (i.e., that markets would set). Charges do not even cover the full costs of operating and maintaining irrigation systems. Moreover, the charge of irrigation water varies across the country, being generally lower in the south (RMB0.02–0.03/m<sup>3</sup> in provinces like Guangdong and Chongqing) than in the north (RMB0.10–0.14/m<sup>3</sup> in provinces like Gansu and Shanxi) but is generally one half-one third of the cost of supply (Michael et al, 2008). Even though there is steep increase in irrigation water charge in some basins, it is still not sufficient even to satisfy the OM. Following this problem, irrigation facilities are aging and the water use related efficiency problem is becoming worst (Liao et al , Discussion Paper 6).

Moreover, the discussion paper explains what will happen if the current irrigation water charge is increased considering the recovery of water supply system. As per the paper, the current irrigation water charge is fixed based on the farmer's willingness to pay and still the ability of the farmer's to pay for irrigation water is low. Thus, it is very difficult to increase the water charge to fully recover water supply system costs, but also to cover the OM costs. In addition to this, the main challenge country in relation to irrigation water use is farmers are not participating in irrigation water management practices even in field canal level. Because of this reason, over irrigation is a common practice and even on some areas yield reduction is become a serious problem. On this specific area, the irrigation water charge is increased to improve the water use efficiency. However, the result is not only encouraging the farmers to reduce water use, but also force the farmers to decrease their grain production, which in-turn increases the social inequities.

As discussed in Xiaoliyu Yan (2011) the number of small holders (small abstractions) are so many, and it is patchy to monitor, report and collect water abstraction charges. Thus, China use a levy for the village as a whole and then recharged to the farmers bundled in with other local service charges many months later and often pro-rated by land area, thereby breaking the link between water use and charge. This introduces a free-rider incentive for both the well operator (who is not responsible for the sustainability of the common aquifer but only for his own infrastructure assets) and the farmer, who can benefit by taking more than his share of the commonly administered water supply to boost yields while sharing out the additional costs. To avoid these problems, Collection of abstraction charges and the allocation of water rights are reformed.

Following the abolishing of agricultural taxes in 2005, China now has a greater flexibility to implement more effective irrigation pricing. In most of the cases, fees charged to farmers are much less than the cost of providing the water. Moreover, as most of the irrigation supplies are not gauged, the management systems are vulnerable to abuse of commons, with these who take more than their share benefits without sanction. To avoid these problems, water users associations are widely established and these are responsible for setting and collecting user charges and owning of the assets.

The main challenges mentioned as “the three red lines” of China in relation to water are, red lines for total water use, water use efficiency and water pollution . To reduce these challenges the country has working on controlling total water use, improving water use efficiency and controlling. To achieve these goals, the country is doing many things including preparation of water use guide/principles pollution (China’s water resources management challenges, Global water partnership, 2015).

Studies show that, the extensive agricultural land reclamation in combination with unreasonable water use in recent years declines the water potential of the country. One of the measures planned by the government to protect the water sources is irrigation water charge and about 128 farmers were interviewed about the impact of increasing irrigation water charge on water use efficiency. The result shows that about one-third of the farmers select drilling well (even there is released ordinance on restriction of ground water sources), one third adopt improved irrigation technologies and only few farmers opt for shifting crop pattern (Yusuyunjiang et al, 2014]. In general the research concludes that, the sole increase in irrigation water charge would have little prospect of success to increase water use efficiency at substantial degree. Some of the parameters that influence farmer’s response against increase in irrigation water charge are total land area, age, total farm income, water shortage, education level, location and others.

It is becoming increasingly clear, however, that a supply-side only approach is not sufficient to deal with the growing water scarcity. Gradually China’s leaders have started to recognize the need to stem the rising demand for water from all sectors (Boxer, 2001). For example, since the early 1990s, leaders have encouraged households to adopt water saving technologies (Lohmar, et al., 2003). Unfortunately, most of their efforts to encourage the use of modern water-saving technologies, such as drip irrigation and sprinkler irrigation, have failed. In more recent years water officials also promoted water management reforms by providing canal managers with better incentives to save water (Wang, et al., 2005). However, these reforms have not been effectively implemented across wide regions across China .

Under these circumstances, China’s water officials and scholars have begun to consider reforming the pricing of irrigation water as an important policy instrument for dealing with the water scarcity problem (e.g., Wang, 1997; Wei, 2001). When trying to explain the low adoption



rates of water saving technologies and the limited success of water management reforms, researchers invariably have speculated that one of the reasons for the failure was the absence of economic incentives facing water users (Lohmar, et al., 2003; Yang, Zhang and Zehnder, 2003).

Similar to the situation in many places around the world, the cost of water is low in China. Groundwater users only need to pay for the cost of energy to pump water out. No extraction fees are charged. Surface water also was charged much lower than its maintenance cost (Zheng, 2002). Despite the fact that agricultural sector is the main water-using sector in China (68% in 2001, Ministry of Water Resources, 2002), charges for irrigation water have not been raised much.

Furthermore, inside most irrigation districts, water charges are assessed based on the size of irrigated area. When the cost of water is low or not related to the quantities demanded, the benefit from saving water also is low. As a result, the current water pricing policy in the agricultural sector (as opposed to the industrial and residential sectors) has not been effective in providing water users with incentives to save water. Reform is needed to make the charge of water reflect the true value of water so that agricultural users will have incentive to save water.

While there is increasing consensus that reforming water pricing is necessary, two basic issues need to be addressed before any new policies can be made. The first issue is the effectiveness of increasing the cost of irrigation. Previous economic studies in a number of developed countries have shown that demand for irrigation water inelastic (e.g., Moore, Gollehon and Carey, 1994; Ogg and Gollehon, 1989). If water users in China are not responsive either, raising the charge of water will not be an effective mechanism to reduce demand. If water users do respond to charge changes, it is important for policy makers to learn about the nature of the responses when planning charge interventions. This is because water use reduction could reduce crop production and thus affect China's food security.

The second issue is the welfare impact of higher irrigation costs on producers. In the political-economy environment that dominates policy making in China today, it is absolutely imperative to assess how much producers would be hurt should pricing policies be effectively implemented. The current government is intent on reducing farmer burdens and raising incomes even if other

long term problems (e.g., the unsustainable tapping of groundwater resources) are undermined (Lohmar, et al., 2003).

**Table 3.** Water charge for Irrigation- experience from different country (FAO, 2005)

<b>N o</b>	<b>Country</b>	<b>Method of water abstraction</b>	<b>Charge per 1000m<sup>3</sup>(US\$) Volumetric</b>	<b>Charge per ha (US\$) Area</b>	<b>Crop type</b>	<b>Efficiency</b>	<b>Technology</b>
1	Israel		180-290				
2	Spain		27-133	90-129			
	Water Assoc. (spain)		8-160*	60-1200 (equivalent charge per ha per year)			
3	Australia		8				
3	Netherlands	Surface + ground water	1440				
4	Tanzania		420				
5	Brazil		3 - 33.84	3.69 (ha/month)			
6	Japan			246			
7	Greece			92-210			
8	China		27- 49.5	50-150			
9	Bangladesh			150			
10	Zimbabwe			22.3			
11	Sudan	Area + crop		15.8 - 28.1 11.8-21.1	Cotton other*		

## 3 Methods

### 3.1 Description of the Awash Basin

Awash River Basin is one of the 12 basins in the country. The total catchment area of the basin is about 115,523 square kilometers and is divided into a number of sub-catchments. The basin is characterized by wide-ranging agro-climatic zones with extreme ranges of topography, vegetation, rainfall, temperature and soils. Among others, the basin extends from both semi-desert lowlands to cold high mountain zones (Gedion, 2009).

The Awash basin is the most utilized in Ethiopia. It serves as a source of drinking water, hydropower, industrial consumption, irrigation and disposal of waste water. A major user and consumer of the surface water in the Basin is irrigated agriculture through numerous private and government irrigation farms and small holders. The Basin has more potential for further irrigation development owing to suitable topography and ease of diversion of water along the river. But as the population and the economy grow rapidly, water is becoming increasingly scarce resources. In Awash Basin, many industries and major cities abstract water from Awash River. This creates a risk as growing volumes of industrial effluent and urban wastewater are contaminating the water and causing scarcity by reducing the quality of surface water available for downstream users.

The Awash Basin is characterized by a number of small, medium and large scale irrigation schemes; According to the irrigation survey conducted by FAO (2012), Oromia irrigation survey and data collected by the Addis Ababa university team in the Basin(2016), the total irrigation area of the basin is found to be more than 200,000 ha. The irrigation practice in Awash River basin is dominated by surface irrigation which is the least efficient irrigation practice. Figure 1 shows the location of all irrigated areas in the Basin.

In general, there is a high water application rates compared to irrigation water requirement of crops in most irrigated areas. Low water management level and excess irrigation water application rate in turn created the problems of water logging and salinity in some of the farms in the Awash Basin.

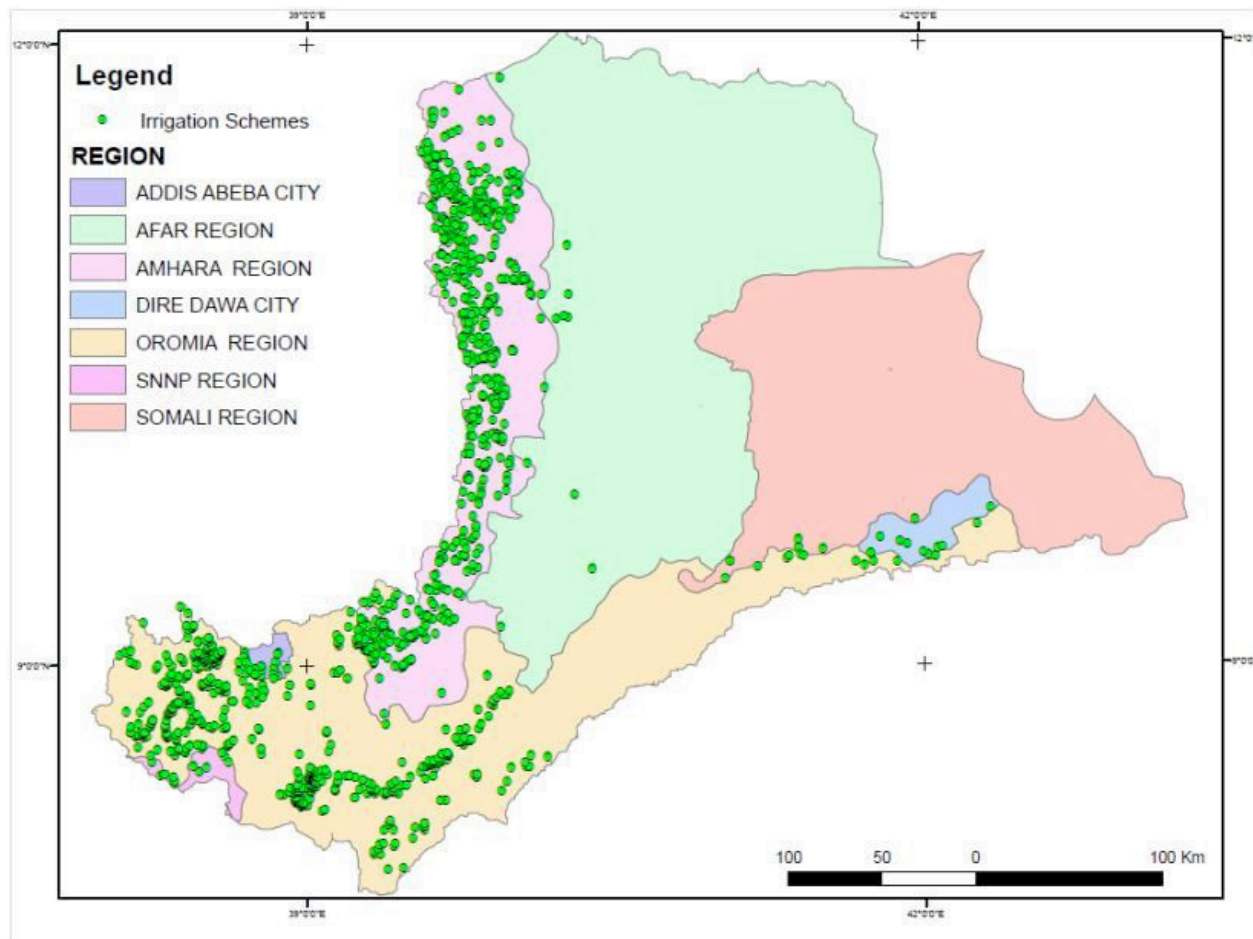


Figure 1 : A map of the Awash Basin with irrigated areas (AAiT study, 2016)

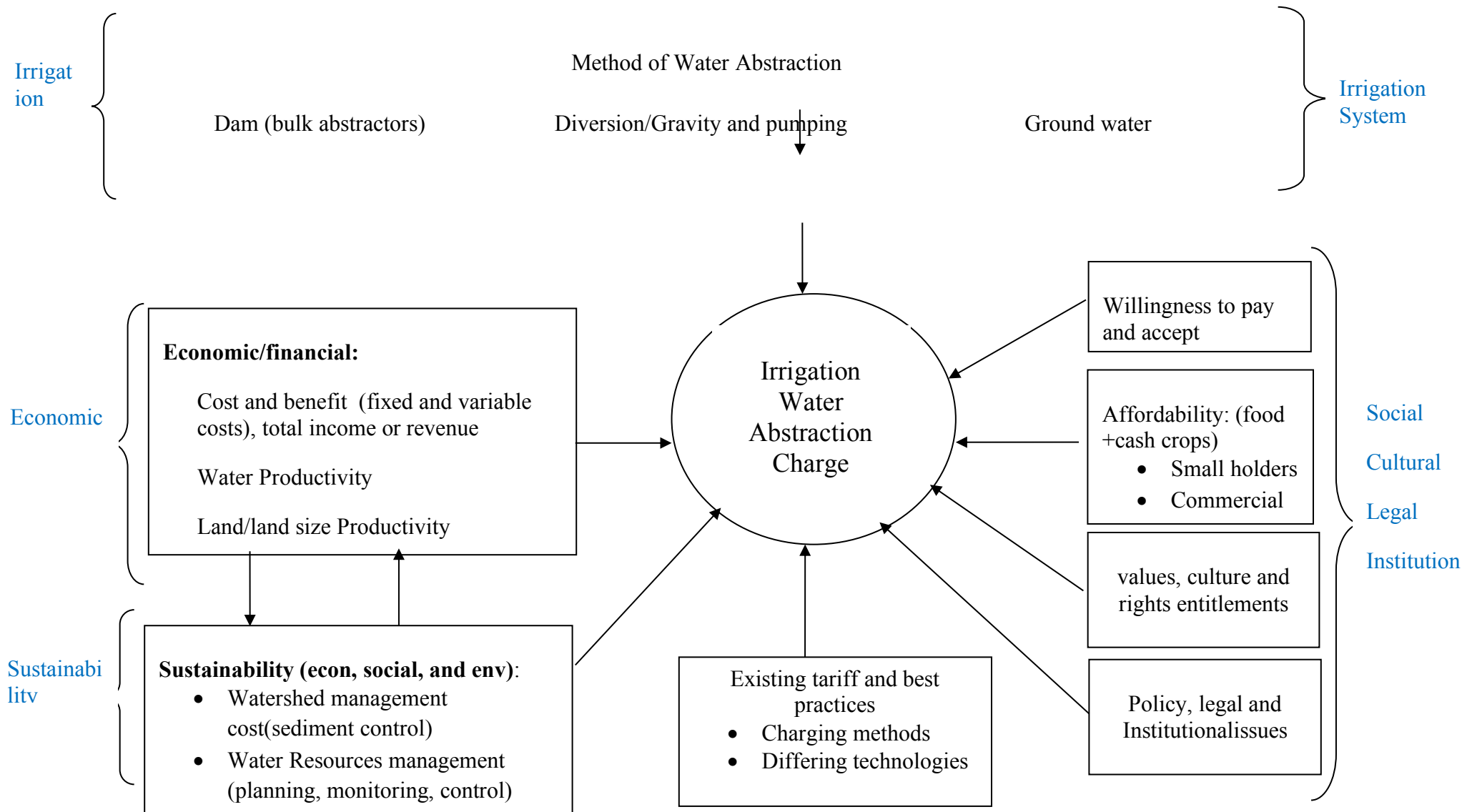
### 3.2 Conceptual Framework

The following conceptual framework is suggested for setting irrigation water abstraction charge based on the literature review, best practices and the findings of the field visit. The framework includes various components: irrigation water abstraction types, irrigation technologies, financial and economic analysis, water resources and watershed management costs, best practices, willingness to pay, affordability, legal and institutions, socio-cultural contexts that influence irrigation water charges. Figure 1 shows these different variables affecting the irrigation water charge and their relationships.

WP-2 team members together with others have conducted field visits to Awash Basin from May 29, 2017 to June 03, 2017 and from June 18, 2017 to June 23 2017. . The main objective of the visits is to collect preliminary data and information to be used in drafting the early

conceptualization of the water charge system. The WP-2 team members had interviews with 17 stakeholders/institutions (Annex 4 lists the institution visited) and visited irrigation infrastructures at Tendaho, Werer and Wonji areas. The findings of the field visits together with the review of past studies/experiences is used to conceptualize the water abstraction charge for irrigation use.

**Figure 2 : Conceptual framework for irrigation water charge**



The various variables and factors affecting irrigation water charge abstractions are discussed in the following section. These factors are:

- Irrigation system and water abstraction types
- Irrigation efficiency and technology
- Economic and financial aspects
- Sustainability
- Existing water Tariff and Best Practices
- Social and cultural
- Legal and institutional

### **3.2.1 Irrigation Systems and Water abstraction method**

The irrigation system consists of a (main) intake structure or (main) pumping station for water abstraction, a conveyance system, a distribution system, a field application system, and a drainage system. All these components play a significant role in terms of volume of water diverted from the source and the actual water applied to the field to enable crop growth. There are three forms of abstraction of water for irrigation use from surface and ground water resources in the Basin. These are discussed as follows:

#### **Method of Water Abstraction**

##### **1. Bulk Abstraction using Dams**

One way of abstraction is by constructing a dam on the main Awash River or the tributaries. The Tendaho dam on the main River and the Kesem Dam on a tributary of Awash are the cases in this category. The two dams are newly constructed for the purpose of providing water for sugar cane irrigation farms. The Dam Management Directorate (DMD) is currently in charge of managing these dams and is mandated to recover the cost of the infrastructure from the irrigation users/sugar factories. DMD is considered as bulk abstractor of water using reservoir and has to pay the water charge to ABA.

## **2. Diversion using weirs/barrages or pumps with flow measurements**

There are large scale irrigation farms abstracting water from the main River using properly designed and constructed diversion weirs. Metehara, Amibara and partly Wonji farms are abstracting water using weirs and pump stations. They have also flow measuring structures at the abstraction point and in their conveyance and distribution systems. One problem is that the flow measuring structures provided at the intake structures may not functioning properly. The amount of flow diverted and distributed to the off-taking canals may not be known accurately. This problem has been raised by users at Werer irrigation schemes. Area/crop based irrigation water charges may be appropriate in this situation.

## **3. Diversion or pumps without flow measurements (traditional ways)**

Small farmers abstract water from the river and its tributaries through various mechanisms such as pumping and diverting traditionally. Many farmers located in the upstream side abstract water from the river system using simple diversion techniques. The volume abstracted is not known at all because it is not measures. Area/crop based method of irrigation water charge may be appropriate in this case.

## **4. Groundwater Abstraction**

In some areas, groundwater can be the only major water resource for irrigation. A differential pricing structure would be required to control groundwater pumping and reduce over-abstraction above the safe yield or withdrawal exceeding certain volume of abstraction. But in this study, no differentiation is made between surface and ground water abstraction.

### **3.2.2 Irrigation Efficiency and Technology**

One of the main objectives of introducing water charges is to provide an incentive for efficient use of scarce water resources. “Water use efficiency” is a common phrase in the literature, often meant to convey two quite different concepts: the first relates the volume of water diverted from a source to the volume consumed in the target activity – with “losses” such as seepage counting as inefficiency in the system. The second meaning of “water use efficiency” is actually a



productivity concept – how much is produced per unit of water Consumed. (Bosworth et al, 2002, ODI 145).

There are many methods of applying water to the field. There are three basic methods: surface irrigation, overhead/sprinkler irrigation and drip irrigation. Surface irrigation has the lowest application efficiency compared to sprinkler system or drip systems. Comparing the three systems, higher application efficiency is obtained in drip followed by sprinkler. Technological improvements can improve irrigation efficiency. Moreover, even if there is potential for increased scheme-level and on-farm efficiency, this can require expensive investments in drip or sprinkler systems that may not be justified either financially or economically.

The Basin Authority needs to find ways of adapting modern water-use technologies so as to spread the available resource more widely, and to enhance the productivity of the water. The charge system should be designed to serve as an incentive to users to shift to water-saving technologies and to shift to crops that need less water. This works only if alternative crops and technologies are available and can be adopted without a significant drop in net farm income.

### **3.2.3 The economic and financial analysis**

The economic/financial variables to be used in irrigation water change can be viewed as component of the specific economic approaches to be adopted in setting irrigation water tariffs. The basic economic approaches or considerations include land productivity, water productivity, cost and income approaches.

#### **Cost and income approaches**

Identification of cost is an important component of irrigation water change. In this regard, we can group costs can be viewed from two perspectives. These are, 1) cost from production side and 2) cost from water management side. The cost of production has to do with costs to be borne by irrigators (large, medium, small scale, governmental, private investment schemes, Horticulture (flower farms), Identification of investment costs is important in many cases as it is difficult to collect income or profit data from firms/establishments. They assume that they will be taxed more if they provide their income statement or profit data. Thus we can use costs as

indirect measure of income in case of missing income data. Generally, we can divide cost items in to two:

- Fixed costs (FC): Fixed costs are costs that are independent of output. These remain constant throughout the relevant range and are usually considered sunk for the relevant range (not relevant to output decisions). Fixed costs often include rent, buildings, machinery, etc.
- Variables costs (VC): Variable costs are costs that vary with output. Generally variable costs increase at a constant rate relative to labor and capital. Variable costs may include wages, utilities, materials used in production, etc.
- Total cost is the sum of total fixed costs and total variables cost. I.e.  $TC = TFC + TVC(Q)$ .

### **Income consideration**

The income approach considers the total profit or total revenue generated from producing goods and services using the irrigation schemes. The total revenue components constitute of charge of the product and the quantity of goods/ services. However, the measurement of output depends on the specific sector. Thus as a general principle, a certain level of income or profit generated from the use of water in a given irrigation scheme can be objectively deducted. However, the irrigation charge should consider certain principles including but not limited to affordability and willingness to pay, fairness and equity, transparency and feasibility etc.

### **Land productivity:**

Land productivity refers to the ratio of farm output (Y) measured in value (birr) or volume (kg) to cultivated (irrigated) area measured in hectare or any another standard/ local measurements. In order to collect land productivity data, we can use either cross sectional or time series data (successive production years) from irrigation schemes in a given basin system. The productivity performance of irrigated crops can be measured using indicators such as yield or monetary value of the total produce per unit of area. On the other hand, one can use hedonic charge method to reveal the implicit value of irrigation water by analysing agricultural land values. The method

can be applied to a sample of both irrigated and non-irrigated properties and the value of irrigation water can be estimated by disaggregating the total charge of each parcel of land, to be obtained through a local survey (Madison, 2001).

### **Water productivity: WP**

This is another method that can be used in determining irrigation water charges. Water productivity can be expressed in terms of physical water productivity, that is, the ratio of agricultural output to the amount of water consumed. Whereas economic water productivity means the value derived per unit of water used (Ali and Talukder, 2008). WP was measured in terms of harvested crop yield per unit of water diverted or supplied (kg/m<sup>3</sup>). Three methods can be used to derive water values in agricultural sector in general and irrigation in particular, these are: Water values based on the Gross Value Added (GVA), Water values based on the Net Value added (NVA), and Water values based on the Net Profitability (NP).

### **3.2.4 Sustainability**

One of the objectives of introducing the water charge is to bring a sustainable use of the water resources. The Awash water quality is showing deterioration and huge amount of sediment from the watershed find their ways into the reservoirs and irrigation canal. To maintain the quality and control the quality, ABA has to monitor the River water at different points in a regular manner. Watershed management programs have to be carried out on areas where water is generated.

### **Watershed Management Practices**

The objectives of watershed management programs are to protect and enhance the water resource originating in the watershed and to check soil erosion and to reduce the effect of sediment yield on the watershed. WSM practices help in increasing the life of the downstream dam and reservoirs. WSM practices in general serve the purposes increasing infiltration and water holding capacity and prevent soil erosion. There are several types of interventions known as agronomic/vegetative and engineering/structural measures. The watershed management costs are analysed from some implemented projects in Awash Basin and they are considered in irrigation water charge.

## **Water resources management cost**

To manage water resources properly, a water resource management charge should be introduced which will contribute amongst others towards:

- water abstraction control to ensure that all get their fair share of water,
- monitoring of quantity and quality of water and pollution control
- planning the future river basin development activities and schemes,

### **3.2.5 Social and Cultural issues**

**Affordability:** This is another important factor to be considered in determining irrigation water tariff. Wang et al (2010) claimed that affordability is measured in terms of the ratio of household's water expenditure to income. The levels of charges for use of water for irrigation as a percentage of gross income estimated to be around 5 percent for food crops, and 12 per cent for cash crops in India.

**Willingness to pay:** willing to pay is important variable in determining irrigation water charge. Data were collected from water users the willingness and total amount of money they plan to pay. Logistic regression is used to assess the behavior and water tariff pricing of irrigators.

**Rights and entitlements:** The other component of the framework under mediating factor is water right systems. In Ethiopia, both indigenous (traditional) and formal or legal systems of water rights coexist. The two are functional and strong in rural areas of the country simultaneously. Pricing policy should take into account different rights and entitlements. It is a mediating variable that constrain or create favorable condition for irrigation water pricing.

### **3.2.6 Legal and institutional issues**

Non-traditional farmers with traditional irrigations are exempted from permit with Ethiopian water resources management proclamation number 197/2000.

Irrigation water use services could also be provided through private investments in the development of irrigation and related water works construction (Regulation No. 162/2009).

Investors in Ethiopia are allowed to engage in “irrigation development” “covering more than 50 hectares of land” (Art. 2(3)). This legal framework is designed with “the objectives of providing incentives to investors engaging in irrigation development to bring about an accelerated economic development of the country by increasing the role of private sector in developing irrigation through utilizing the huge available irrigable land and water resources of the country” (Art. 4). In order to benefit from irrigation development incentives, it is a mandatory requirement to obtain investment permit as required under investment proclamation and water use permits in accordance with Proc. No. 197/2000 and Reg. No. 115/2005. Regulation No. 162/2009 stipulates incentives to be granted to include “exemptions from water use charges and making available for further development major irrigation structures such as dams, main canals and access roads at government cost” (Article 6 (1) (3)). The period of exemptions from water use charges for an investor who engaged in irrigation and related water works construction development lasts “until the actual investment cost is recovered” (Article 7(1)). The period of exemption from water use charges shall begin from the date of commencement of use of water resources as may be appropriate (Article 7(2)).

Recently, the Irrigation and water users’ association proclamation No. 841/2014 is enacted to govern farmers’ management of irrigation and drainage system “which are formed on irrigation infrastructures constructed by the federal government throughout Ethiopia” (Article 3). This proclamation envisages that irrigation water users that are not less than five may form association (Art. 10(1)). Irrigation water users association may be formed through two procedural mechanisms. First, those persons who possess land on the basis of landholding system and uses such land with water supplied from a traditional and drainage system may form water users association with a fulfilment of minimum requirements of membership through their own initiation. Second, the Ministry of Water, Irrigation and Electricity may form irrigation water users associations using irrigation water from a modern irrigation and drainage systems or traditional irrigation and drainage systems upgraded to modern irrigation and drainage systems (Arts. 11 and 12).

The water users association among other things shall have the objectives to manage, operate and maintain irrigation and drainage system in its service area and provide equitably to its members

for agricultural purpose; undertake construction and reconstruction works and issue internal rules for consumption of irrigation water and collect charges from its members for the services provided (Art.4)

### **3.3 Method of Data Collection and Analysis**

#### **3.4 Data Types**

Two groups of data are collected to determine an appropriate water charges for irrigation water abstraction and use. Technical data related to irrigation systems were collected to determine various cost items and value of the water. The other data is socio economic data and the analysis helped to assess the social and environmental viability and sustainability of the irrigation water tariff system. Conducting socioeconomic assessment on different irrigation water users was used to determine their willingness to pay (WTP) and accept using various techniques.

##### **3.4.1 Technical data**

Representative samples from all types of irrigation water users: large, medium and small scale governmental, private schemes, horticulture (flower farms) and for small farmers except those which are exempted from permit with Ethiopian water resources management proclamation number 197/2000 are included in the study.

The following irrigation schemes specific data were collected and analyzed based on sample size which is determined based on standard scientific procedures.

- Water abstraction method (dam, diversion, lift)
- Water source used (dam, diversion of surface water , or ground water)
- Type of ownership (Government, private, small holders)
- Water application methods/technologies used
- Total area irrigated, type of crops grown, growing seasons
- Yield of different crops
- Volumetric water diverted/abstracted each month/year
- Existing water charge and service charge

- Operation and maintenance cost for primary irrigation canals, weed control
- Infrastructure cost at abstraction point and the downstream costs, if any
- Climatic data such as Rainfall, Max and Min Temperature, Relative humidity, Sunshine hours and wind speed were collected.
- etc

### **3.4.2 Socio-economic data**

Using appropriate sample sizes socio economic data were collected. Details of these data are presented in section 5. 2 and 5.3 of this report or in Work Package 1 report.

## **3.5 Method of data collection**

### **Technical Data**

The Study team has developed data collection instruments for the baseline data collection both at the abstractor as well as household level. . The instruments developed in this study have sections on technical, social, economic, and institutional aspects. The technical and economic baseline data are collected on scheme levels while the social group are collected at household level. The data collection instrument for the technical section only is presented in the Annex 1.

Since a large number of irrigation schemes (large, medium and small) exist in the Awash Basin, selecting irrigation schemes as samples is a necessary step where baseline data should be collected. The selection of irrigation schemes is based on the minimum criteria adopted for this study.

In selecting irrigation schemes for data collections, criteria based on location of the schemes, size, irrigation methods used, ownership , abstraction type and regional representations were adopted.

A stratified sampling strategy is followed in this study. A trade-off between generating a large enough sample size to make a valid generalization to the population and the many constraints that appear with increasing sample size has to be made. Considering all the above mentioned

factor, our sample size is selected to be 31 and the Table 4 below listed the visited irrigation schemes.

**Table 4** : List of irrigation schemes visited which are considered as samples for the study

No.	Name of Scheme	Location in the Basin (U,M,L)	Adm. Region	Scheme type (SH,P&C, G, Asso)	Size irrigated area (ha)	Crop types	Irrigation method/technology
1	Wonji area sugarcane growers cooperative union, LTD	U	Oromiya	Assoc	7000	Sugarcane	Overhead (about 80%) and furrow irrigation
2	Wonji Sugar factory	U	Oromiya	G	5700	Sugarcane	Furrow Irrigation
3	Africa Juice	U	Oromiya	P&C	560	Papaya, Orange, Mango, Citrus, cash crops	Furrow and drip irrigation
4	Upper Awash Agro Industry Enterprise	U	Oromiya	P&C	3900	2700ha (Papaya, Orange, Banana and mango), and 900ha cotton, Bean and Tomato	Surface irrigation (basin)
5	Awash Winery	U	Oromiya	P&C	Total 570ha. 193 ha is developed	grape wine, cash crops (like Maize)	drip and furrow irrigation methods.
6	Metehara Sugar factory	U	Oromiya	G	13,333	sugarcane, and 132 ha fruits	Furrow irrigation method (about 90% of the area is covered by hydroflumes)
7	Red Fox Ethiopia PLC	U	Oromiya	P&C	100ha and 44ha is developed.	Cutting industries	Drip
8	Trisol PLC	U	Oromiya	P&C	52.3	Orange, Tomato, green paper, Onion (about 24 ha), Mango	Furrow irrigation



No.	Name of Scheme	Location in the Basin (U,M,L)	Adm. Region	Scheme type (SH,P&C, G, Asso)	Size irrigated area (ha)	Crop types	Irrigation method/technology
9	TigilFriw water users association	U	Oromiya	Assoc	38.5	Onion	Furrow
10	Florensis Ethiopia	U	Oromiya	P&C	Total 23 ha , 15 ha is developpe	Cutting industries	Drip
11	Vegpro Agriculture PLC	U	Oromiya	P&C	20	Roses with different varieties	Drip
12	Mahdi Abdi Farm	M	Somali	P&C	Total 20 ha and out of which 8ha is developed.	Papaya, Orange, Mango, Lemon, Coffee	Flooding
13	Tony Farm	U	Diredawa	G	Total 39ha out of 20 ha is developed	Orange, Citrus, Maize and vegetables	Furrow and drip irrigation
14	Shinile	U	Somali	SH	300ha	Onion, Orange, Mango, Tomato	Surface irrigation
15	Amibara	M	Afar	G	160ha	Cotton, Wheat, Animal food, Rice, and permanent fruits	Furrow irrigation system
16	Sunta Irrigation project		Afar	Asso	2000ha		
17	Chifra	L	Afar	SH	74ha	Maize	Furrow, Sprinkler
18	Elfora			P&C	Total 1774 ha , 77ha is developed	Tomato, Onion, Pepper, Cabbage, Banana, Mango, Avocado,	Furrow Irrigation

No.	Name of Scheme	Location in the Basin (U,M,L)	Adm. Region	Scheme type (SH,P&C, G, Asso)	Size irrigated area (ha)	Crop types	Irrigation method/technology
						Papaya	
19	Amibara irrigation development	M	Afar	P&C	6017	sugarcane	furrow
20	Kesem sugar farm	M	Afar	G	2700+1400	sugar cane	furrow
21	Demilew	M	Afar	P&C	54	cotton	furrow
22	Werer research center	M	Afar	G	180	cotton, maize, sesame, rice	furrow
23	Haji Ahmed mehamed	M	Afar	P&C	1254	cotton	furrow
24	Hameditabot a	M	Afar	P&C	2.5	cotton	furrow
25	Kalid farm	M	Amhara	P&C	15.3	papaya, water melon	furrow
26	Tendaho sugar farm	L	Afar	G	11300	sugarcane	furrow
27	Shewarobit Prison farm	M	Amhara	G	130		furrow
28	Gewanewer eda	M	Afar		3812	cotton, maize, tomato, onion	furrow
29	Kaluwereda	M	Amhara		7236.5	chat, coffee, apple	furrow, flooding
30	Kewetwereda	M	Amhara		6347	20% tobacco, tomato, cabbage	floodings, furrow
31	Dubtiwereda	L	Afar	Assoc.	400	onion, tomato, maize, pepper	furrow
					1700	maize	
					505	onion, tomato, maize, pepper	
					402	sugarcane	
					460	onion, tomato, maize, pepper	

(U,M,L) : Upper, Middle and Lower

(SH,P&C, G, Assoc): Small holder farmers, Private and Commercial, Government, Associations

In order to collect data and information which were used for the determination of irrigation water abstraction charge, field visits were arranged from 7th May to June 5th 2018 covering irrigation schemes in the lower, middle and upper Awash Basin

Irrigation schemes specific data such as area cultivated, volumetric water diverted each year, type of crops, water charge, service charge, operation, and maintenance cost etc. were collected from field visits and visual observation in the sampled irrigation schemes. Wherever possible, direct field measurements were carried out using simple methods. In some cases, where it is difficult to get the above data, estimation is made by the technical team.

Field discussions were held with irrigators and technical staff to get more information on irrigation schemes and their views on irrigation water charges. Discussions were also held with officials and experts from Ministry of water resources, irrigation and Electricity (MoWIE) and Awash basin authority (ABA) about irrigation water pricing experiences and its impacts in Ethiopia and Awash River basin respectively.

Technical data were collected from 31 irrigation schemes in total based on the sampling techniques. In addition to the technical data, social data were collected from 165 irrigators. 14 in-depth interview, 19 key informant interview, three focus discussion (consisting of six members each) and observation of water use on the farm land have been conducted. The summary of the collected data is presented in Annex 2.

### **Socio-economic data collection**

Primary and secondary data socio-economic data were collected using field visits and surveys, key informant interview, focused group discussion, meetings and workshops with irrigation water users and published and unpublished materials related to water charge and charge setting. WP 1 report has provided detailed discussions on socio-economic data collection methods and analysis and the various instruments used in the Study.

### **3.6 Data analysis**

The collected technical data from irrigation water users found in the Awash basin river basin (upper, middle and lower Awash) were analyzed. The sample size is determined by combining both systematic and stratified sampling techniques. Accordingly, 32 samples were selected based on the three irrigation land scale classifications : small-scale (command area less than 200 ha), medium-scale (command area of 200 to 3000 ha) and large-scale (command areas of greater than 3000 ha) , type of crop grown, farm size, location of the firm in the basin and ownership

#### **Background to data type and data collection methods**

The irrigation team applied various data collection mechanisms to understand the willingness, affordability and irrigators conditions. As indicated in the inception report, the study team is expected to use both primary and secondary data. The primary data collection was generated using key informant interview, filed observation and stakeholder's discussion and analysis at the farm level.

For this particular study data was collected from irrigation water users at different level (large scale , medium scale , small scale , governmental owned , private investment schemes). The major targets of the study were irrigators who owned more than two hectares of land and irrigators with less than two hectares of land were excluded from the study.

#### **Primary data and secondary data**

The primary data were generated using structured questionnaires and interviews. About 32 irrigators were systematically selected. Out of which about 14 small-scale (command area less than 200 ha), 7 medium-scale (200 to 3000 ha), 10 large-scale (greater than 3000 ha) and OIDA. Thus, for this data analysis OIDA is ignored and the rest 31 are considered.

#### **Quantitative data analysis**

In addition to the land size distribution; the owners of irrigation land are classified in to four major categories. As presented in the following chart the majority of them 17 (54.8%) are under private and commercial ownership (P&C) type and 9 (29.1%) are owned by the government (G).

Moreover, 4 (12.9%) are under water users association (Asso) and the remaining 1 (3.2%) is classified as small holder (SH).

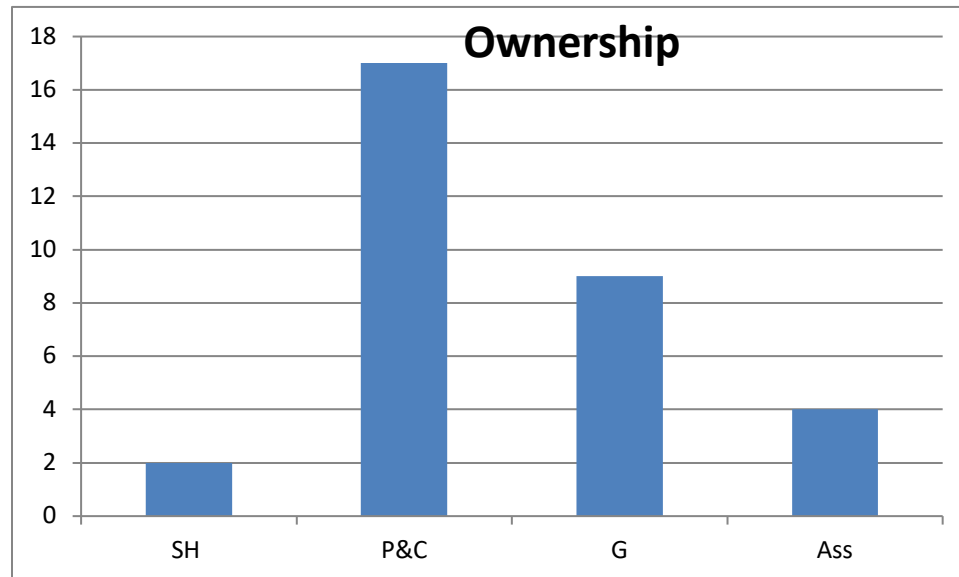


Figure 3 : Bar graph showing ownership of irrigation schemes of the samples

Considering the samples of this study, irrigators use different water source and different abstraction systems. As indicated in the chart below, the majority of the considered irrigators, Ten (32.2%), uses Awash water source and gravitational systems (A,G) to abstract water. Six of them (19.3%) use the same source but pumps to abstract water (A,P) and Two (6.5%) use the same source and combination of abstraction methods (A,G&P). Moreover, Two (6.5%) are using both Awash River and ground water sources (A&GW) and Seven (22.5%) uses ground water source (GW) for their irrigation purpose. In addition to this, Two (6.5%) have Dam and the remaining Two (6.5%) use other sources, like springs.

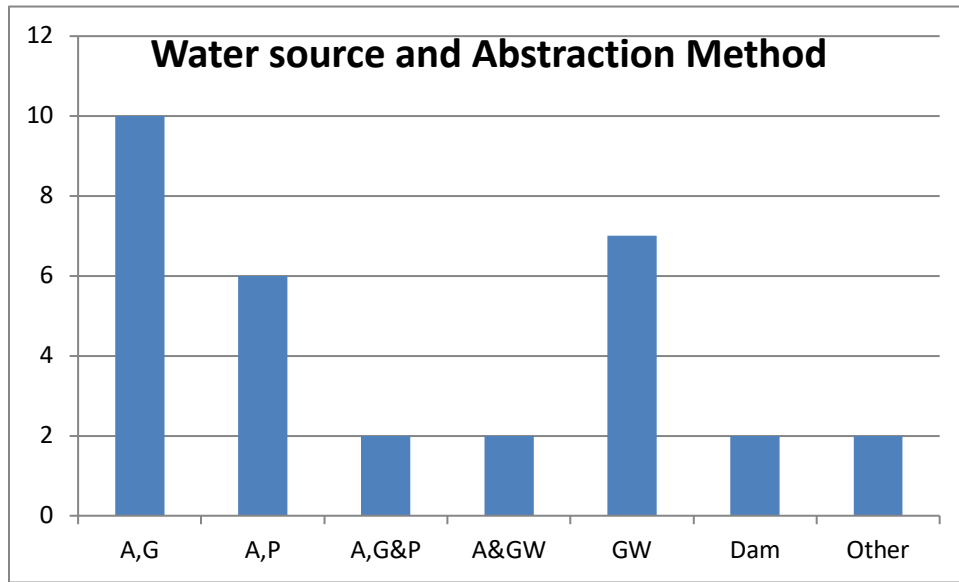


Figure 4 : Bar graph showing water source and abstraction methods of irrigation schemes of the samples

In addition to this, there are at least four irrigation water application techniques used in the basin. The total area covered by the considered 31 samples is about 71,957ha. As indicated in the chart below, the majority, 67,191ha (93.38%) is covered by furrow irrigation system and about 3900ha (5.42%) is by basin irrigation system which is also a surface irrigation method. On the other hand, small portion of the considered area, 866ha, is covered by pressurized irrigation systems: is drip system and sprinkler irrigation system.

### 3.7 Irrigation Water Use Charge setting

Area-crop based model is formulated to set the charge for irrigation water abstraction and use. In this study, the following model is adopted for irrigation water charge estimation. The model is based on the conceptual framework which is already discussed. The model contains arameters and factors are considered in setting the charge. The model adopted in this study:

$$IWAC(ETB/ha-crop) = A * (WSM_c + WRM_c) + A * EF_f * WAM_f * IRRT_f * CF$$

where :

IWAC = Irrigation Water abstraction and use Charge

$WSM_c$  = Watershed management charge

$WRM_c$  = Water Resources management charge

$CF$  = Crop factor

$EF_f$  = Economic and Financial factor

$IRRT_f$  = Irrigation Efficiency factor

$WAM_f$  = Water abstraction and irrigation sytem factor

$A$  = Net area of land irrigated (ha)

The above equation can be easily converted to charge per volume of water used based on the specific crop water use values.

The field data collection for this study reveals that the majority of the schemes don't have flow measuring structures at the abstraction points. Even the irrigation schemes where they use pumps to abstract water from the ground water don't have flow measured records. Hence, the irrigation water abstraction charge should be Area/crop based system. But, in the future only the volumetric method of water charge should be practiced and there should be an incentive for schemes introducing flow measuring structures.

Area based water charge seems easier in terms of administration. But In the area/crop based method, one cannot be sure that the actual demand of the crop has been supplied and exact area under a given irrigated crop may not be known and may varies from season to season.

The model assumes also that there is a uniform charge for different seasons and locations. The water charge should be uniform throughout the year (no seasonal variability) and also throughout the basin (no spatial variability).

## 4 Charge Setting

To achieve the primary goal of reduced water use per unit of output in irrigation water management, two key issues must be addressed: first, to design an effective pricing mechanism based on local conditions and, second, to develop a strategy for obtaining high rates of collection. In this section, we focus on the first key issue, water pricing mechanism which is area-based pricing.

Area-based water charges are fixed charges, based on the area irrigated. The main problem is irrigated area varies from year to year and season to season. For example, the area irrigated during the wet season is usually much larger than during the dry season. In addition, the project area is usually larger than the area actually irrigated. Therefore, the Basin Authority will need to estimate the area actually irrigated each season, which requires additional effort and capacity.

Other disadvantage of this pricing method is that, once the irrigated area decision is made, the water charge will have no effect on farmers' water consumption, because the marginal cost of applying additional quantities of water per hectare is zero. Thus, the demand for water is usually higher than it would be under a charge that varied by the quantity of water used, and it is likely to lead to overuse of water by farmers near the head of the canal.

The advantage is that it is simple to calculate, easy for farmers to understand, and the implementation costs are lower than for volumetric pricing because water deliveries do not have to be measured. Although it gives farmers no incentive to reduce water use per hectare, it is still widely used in many systems throughout the world due to the simplicity of its implementation.

Area-based pricing is appropriate in places where water is not scarce, where crops are not varied, and where meter installation is difficult or costly. However, area-based pricing systems are becoming less and less popular, and in this study the designed area-based pricing systems are adopting new features. The extensions of area pricing include area-crop (the most widely used modification), area-irrigation, area-season, and area-technology-based pricing.



Some countries also use area-season-based charges. For example, a higher charge is levied during the dry season, when water is scarce, and a lower charge is levied in the rainy or wet season, when water is relatively plentiful. If the charge is set high enough in the dry season, it will help limit the number of hectares irrigated in that season.

The area-crop based model formulated in the previous chapter is used to set the charge for irrigation water abstraction and use. The calculations of the various factors used in the model are described below.

#### **4.1 Watershed and Water Resources management charge**

The management of watersheds is most commonly thought to involve the hydrological, physical, biological and engineering sciences. However, economics also has a role in watershed management planning. Cost-benefit analysis is the most common type of economic analysis used for watershed planning. Cost benefit analysis measures, in monetary terms, a project's inputs and outputs over the service life of the project. Cost benefit analysis is a useful decision method when the watershed manager must make a decision based solely upon economic efficiency.

However, watershed managers frequently must deal with multiple decision criteria.

Unfortunately, there is no available data to estimate these charges directly. To estimate the costs incurred by AwBA for watershed and water resources management, monitoring Supervision activities, cost breakdowns from other projects outside the Basin are used (i.e. Hawassa and Ziway areas). Assuming a 15 % management, monitoring, supervision cost, annual watershed development and management cost is estimated to be 132,637,750 ETB for Awash Basin. Based on Strategic plan of AwBA, there are ten active regional and federal stakeholders and it is assumed that these stakeholders share the cost equally. Accordingly, the share for AwBA will be 13,263,75 ETB. This amount in turn is apportioned among various uses of water: irrigation, water supply, hydropower, fisheries, recreation, and waste water, based on volume of water consumption and income generated from each use. Based on the above assumption, it was calculated that irrigation users will pay a charge of 50% of the total 13,263,75 ETB. Therefore, irrigation water users will be charged an annual amount of ETB 6,631,875 as contribution for

watershed and water resources management cost of the Awash Basin. Assuming that there are 100,000 ha of irrigation users that will have permit and pay irrigation water abstraction and use charge, this amount will be 66.32 ETB per ha of irrigated land annually.

## **4.2 Water Abstraction and method factor**

Three types of water abstraction methods are considered in this study:

- Bulk abstraction using dams,
- Water abstraction from river using pump or diversion structures, and having flow measurement at the abstraction point and in their conveyance and distribution systems.
- Water abstraction from river using pump or diversion structures, without flow measurement at the abstraction point and in their conveyance and distribution systems.

Irrigation water use through construction of dams should be encouraged in the basin, as the amount of water for allocating among various user is getting scarce. Construction of dams requires a huge capital investment. Dam developers or owners should recover their investment costs from irrigation users downstream. In addition to paying cost recovery for investment and operation and maintenance costs, users should also pay charges for irrigation water use. This will increase the charge for users downstream of dam. This study has taken into account this fact and a lower water abstraction and use factor is recommended for bulk abstractors.

Volumetric method of pricing irrigation water has always been advocated as the better approach to induce water savings by farmers. To impart significant development in adoption of the volumetric supply and pricing, irrigation schemes with flow measurement structures should receive some forms of incentives. A lower water abstraction and use factor is recommended for users in this category compared to those abstractors without measurement.

Water abstraction from river using pump or diversion structures, without flow measurement at the abstraction point and in their conveyance and distribution systems should be discouraged. Therefore, a water abstraction and use factor of 1.0 should be applied for users in this category.

Table 5 : Recommended factors for water abstraction method:

Type of water abstraction	Factor
Dam abstraction with measurement	<b>0.75</b>
Abstraction with measuring	<b>0.85</b>
Abstraction without measuring	<b>1.00</b>

### 4.3 Economic factors

Economic analysis results based on 2% profit or elasticity value are tabulated below (Detail of the calculation will be discussed in the economic aspects section). The crops are categorized in to eight different groups (cereals, vegetables, pulses, root crops, cotton, sugar cane, permanent, flower) .

Table 6 : Economic analysis results for different crop categories

	Crop Group	ETB/ha
<b>1</b>	Cereals	162.40
<b>2</b>	Vegetables	371.45
<b>3</b>	Pulses	170.33
<b>4</b>	Root Crops	202.50
<b>5</b>	Cotton	234.80
<b>6</b>	Sugar Cane	481.80
<b>7</b>	Fruits (permanent crops)	274.93
<b>8</b>	Flower	19133.33

## 4.4 Crop factor

Area-crop-based pricing systems vary the charge per hectare irrigated by type of crop. The water charge variation among crops depends on the water consumption of the crops. To encourage efficient use of water, the high water-consuming crops such as sugarcane, should have higher charges per hectare. If the charge differences are large enough, farmers are likely to switch to alternative crops. In contrast, if the government is pursuing a low food price policy or wants to encourage production of commercial crops, the water charge for these crops could be set lower than for other crops.

The water abstraction charge should vary along geographical location (upper, middle, lower). Thus, climatic factors need to be taken in setting the water charge. The actual irrigation water use depends on the kind of crop, the net irrigated area under that crop and number of irrigation of each crop which varies from season to season and from location to location. The crops are categorized in to different groups (cereals, vegetables, pulses, root crops, cotton, sugar cane, permanent, flower) as shown in the table below.

Table 7: Crop categories and crops included in the category

	<b>Crop Category</b>	<b>Crops included in the Category</b>
<b>1</b>	Cereals	Barely, Maize, Milet, Sorghum, Teff, Wheat, etc.
<b>2</b>	Vegetables	Cabbage, Carrot, Cucumber, Garlic, Lettuce, Onion, Pepper, Tomato, Beet roots, etc..
<b>3</b>	Pulses	Bean (dry), Groundnut, Pea, Lentil , Chick pea, bean, etc.
<b>4</b>	Root crops	Potato, Sweet Potato
<b>5</b>	Cotton	
<b>6</b>	Sugar cane	
<b>7</b>	Permanent	Banana, Citrus, Mango, Papaya, Guava, Coffee, Chat, , Grapes, etc.
<b>8</b>	Flower	

**Source: FAO I & D paper 24 (1977) and paper 33 (1979), FAO 56**

Based on the above shown crop categories and their respective characteristics, ETC values are estimated using CROPWAT. The different crop water use under different climatic conditions obtained from different sources and by running the CROPWAT model and using selected climatic data are calculated. The net irrigation requirement is estimated by considering effective rainfall. Finally, the gross irrigation requirements (GIR) is estimated for the eight crop categories by averaging the values for upper, middle and lower basin and assuming an overall efficiency value of 50% and the results are tabulated below.

Table 8: Estimated Gross Irrigation Requirements (GIR) for the eight crop categories

<b>Crop category</b>	<b>GIR (mm)</b>
Cereals	916
Vegetables	1287
Pulses	608
Root crops	964
Cotton	1518
Sugar cane	2795
Permanent	1929

The crop factors are calculated considering the cereal water consumption as a reference and by dividing the other crop categories GIR values by the reference. The calculated crop factors values used in the model are tabulated below

Table 9: Estimated crop factors for different crop categories

<b>Crop</b>	<b>cereal</b>	<b>vegetable</b>	<b>pulses</b>	<b>Root crops</b>	<b>cotton</b>	<b>Sugar cane</b>	<b>Permanet</b>	<b>flower</b>
<b>CF</b>	1.0	1.4	0.7	1.1	1.7	3.1	2.1	1.0

## 4.5 Irrigation Technology factor

A growing population and maybe changing food consumption patterns are expected in the Awash Basin, thus water demand will increase in the future. Thus increase in food production is a must and this increase would need to come from higher crop yields and greater crop intensity given limited scope for agricultural land expansion. Expanding the use of efficient irrigation and agricultural water management technologies is a key part of the solution to increasing yields in a sustainable manner. Investments in efficient irrigation can also lead to major improvements in the standards of living of small farmers who produce the majority of food in the basin.

Improved irrigation technology and advanced farm management practices offer an opportunity for agriculture to use water more efficiently. Farmers may install new equipment, such as sprinkler or drip irrigation systems, or adopt advanced water management practices to conserve water without sacrificing crop yields. While farmers' decision to adopt water-saving irrigation technology responds to the cost of water, physical properties of the land such as topography or soil texture dominate the choice of irrigation technology.

Thus, in setting the irrigation water charge we consider a technology factor to reflect this reality mentioned above is introduced (see table below). We considered surface irrigation method, overhead (sprinkler) and drip irrigation methods.

For example, drip and sprinkler irrigation generally allow better water control and more output per unit of water delivered than surface irrigation. Therefore, a higher per hectare charge could be levied to surface than drip.

Table 10 : Irrigation technology factor

Type of irrigation method	Technology Factor
Surface	1.0
Over head	0.7
drip	0.6

## 4.6 Irrigation water abstraction and use charge

The irrigation water use charge setting should take into account all the variables that are explained in the section above. One major issue is what should be the method of irrigation water abstraction charge. As discussed in the literature review part, volumetric and Area/crop based systems are used in many places. Both methods have advantages and disadvantages as discussed previously. For this study, both methods will be considered as measurement unit for the water charge. The volumetric method of water charge can be applied on schemes where functioning flow measuring structures are installed and area based method where flow measuring structures are lacking. But, in the future only the volumetric method of water charge should be practiced and there should be an incentive for schemes introducing flow measuring structures.

Area based water charge seems easier in terms of administration. Some stakeholders said that Area-based water charge method is better in a system where illegal users have control of the water distribution structures. But they expressed their concerns about area-based method. If water demanded is not supplied, area based payment is not appropriate. In the area based method, one cannot be sure that the actual demand of the crop has been supplied or not. Exact area under irrigation maybe not known or it may varies from season to season. For example, Tendho and Wonji sugar Factories said that volumetric system are the most appropriate since they have a good infrastructures/flow measuring structures and a good water management system.

The envisaged water charge should promote the use water-saving technologies in irrigations and it should serve as an incentive to shift from low water use efficiency systems to high water use efficiency systems. As the main aim of setting irrigation water charge is to promote fair water allocation of water at each levels of irrigators and to optimize irrigation water productivity (water use) shifting from furrow irrigation to pressurized irrigation at all scales levels is important. Government should prepare an incentive mechanism such as preparing a loan and/or leave the payment for the new water charge for a certain period, as the initial cost is high to shift from furrow irrigation to pressurized irrigation. Irrigation water use charge for different crop groups are calculated and tabulated below. Table 11 provides a summary of irrigation water use charge for different crops, irrigation systems and factors that help reduce water use per hectare.

Table 11 : Irrigation water abstraction and use charge for different crop categories

**1. Cereal**

Crop Type		Cereal		
Crop Factor (CF)		1.0		
Economic value (ETB/ha)		162.40		
Crop water use (m <sup>3</sup> /ha)		9160		
Water resource and watershed management cost (ETB/ha)		66		
IRRT factor	WAM factor	Crop area (ha)	Charge (ETB / ha)	Charge (ETB/1000 m <sup>3</sup> )
1.00	1.00	1	228.40	24.93
0.70	1.00	1	179.68	19.62
0.60	1.00	1	163.44	17.84
1.00	0.85	1	204.04	22.28
0.70	0.85	1	162.63	17.75
0.60	0.85	1	148.82	16.25
1.00	0.75	1	187.80	20.50
0.70	0.75	1	151.26	16.51
0.60	0.75	1	139.08	15.18



## 2. Vegetables

Crop Type		Vegetable		
Crop Factor (CF)		1.4		
Economic value (ETB/ha)		371.45		
Crop water use (m <sup>3</sup> /ha)		12870 (two harvest is assumed)		
Water resource and watershed management cost (ETB/ha)		66		
IRRT factor	WSAM factor	Crop area (ha)	Charge (ETB / ha)	Charge (ETB/1000 m <sup>3</sup> )
1.00	1.00	1	586.03	45.53
0.70	1.00	1	430.02	33.41
0.60	1.00	1	378.02	29.37
1.00	0.85	1	508.03	39.47
0.70	0.85	1	375.42	29.17
0.60	0.85	1	331.22	25.74
1.00	0.75	1	456.02	35.43
0.70	0.75	1	339.02	26.34
0.60	0.75	1	300.01	23.31

### 3. Pulses

<b>Crop Type</b>		<b>Pulses</b>		
<b>Crop Factor (CF)</b>		0.7		
<b>Economic value (ETB/ha)</b>		170.33		
<b>Crop water use (m<sup>3</sup>/ha)</b>		6080		
<b>Water resource and watershed management cost (ETB/ha)</b>		66		
<b>IRRT factor</b>	<b>WSAM factor</b>	<b>Crop area (ha)</b>	<b>Charge (ETB / ha)</b>	<b>Charge (ETB/1000 m<sup>3</sup>)</b>
1.00	1.00	1	185.23	30.47
0.70	1.00	1	149.46	24.58
0.60	1.00	1	137.54	22.62
1.00	0.85	1	167.35	27.52
0.70	0.85	1	136.94	22.52
0.60	0.85	1	126.81	20.86
1.00	0.75	1	155.42	25.56
0.70	0.75	1	128.60	21.15
0.60	0.75	1	119.65	19.68

#### 4. Root Crops

Crop Type		Root crops		
Crop Factor (CF)		1.1		
Economic value (ETB/ha)		202.50		
Crop water use (m <sup>3</sup> /ha)		9640		
Water resource and watershed management cost (ETB/ha)		66		
IRRT factor	WSAM factor	Crop area (ha)	Charge (ETB / ha)	Charge (ETB/1000 m <sup>3</sup> )
1.00	1.00	1	288.75	29.95
0.70	1.00	1	221.93	23.02
0.60	1.00	1	199.65	20.71
1.00	0.85	1	255.34	26.49
0.70	0.85	1	198.54	20.60
0.60	0.85	1	179.60	18.63
1.00	0.75	1	233.06	24.18
0.70	0.75	1	182.94	18.98
0.60	0.75	1	166.24	17.24

## 5. Cotton

<b>Crop Type</b>		<b>Cotton</b>		
<b>Crop Factor (CF)</b>		1.7		
<b>Economic value (ETB/ha)</b>		234.80		
<b>Crop water use (m<sup>3</sup>/ha)</b>		15180		
<b>Water resource and watershed management cost (ETB/ha)</b>		66		
<b>IRRT factor</b>	<b>WSAM factor</b>	<b>Crop area (ha)</b>	<b>Charge (ETB / ha)</b>	<b>Charge (ETB/1000 m<sup>3</sup>)</b>
1.00	1.00	1	465.16	30.64
0.70	1.00	1	345.41	22.75
0.60	1.00	1	305.50	20.12
1.00	0.85	1	405.29	26.70
0.70	0.85	1	303.50	19.99
0.60	0.85	1	269.57	17.76
1.00	0.75	1	365.37	24.07
0.70	0.75	1	275.56	18.15
0.60	0.75	1	245.62	16.18

## 6. Sugarcane

<b>Crop Type</b>		<b>Sugarcane</b>		
<b>Crop Factor (CF)</b>		3.1		
<b>Economic value (ETB/ha)</b>		481.80		
<b>Crop water use (m<sup>3</sup>/ha)</b>		27950		
<b>Water resource and watershed management cost (ETB/ha)</b>		66		
<b>IRRT factor</b>	<b>WSAM factor</b>	<b>Crop area (ha)</b>	<b>Charge (ETB / ha)</b>	<b>Charge (ETB/1000 m<sup>3</sup>)</b>
1.00	1.00	1	1559.58	55.80
0.70	1.00	1	1111.51	39.77
0.60	1.00	1	962.15	34.42
1.00	0.85	1	1335.54	47.78
0.70	0.85	1	954.68	34.16
0.60	0.85	1	827.73	29.61
1.00	0.75	1	1186.19	42.44
0.70	0.75	1	850.13	30.42
0.60	0.75	1	738.11	26.41

## 7. Fruits and other permanent crops

<b>Crop Type</b>		<b>Fruits</b>		
<b>Crop Factor (CF)</b>		2.1		
<b>Economic value (ETB/ha)</b>		274.93		
<b>Crop water use (m<sup>3</sup>/ha)</b>		19290		
<b>Water resource and watershed management cost (ETB/ha)</b>		66		
<b>IRRT factor</b>	<b>WSAM factor</b>	<b>Crop area (ha)</b>	<b>Charge (ETB / ha)</b>	<b>Charge (ETB/1000 m<sup>3</sup>)</b>
1.00	1.00	1	643.35	33.35
0.70	1.00	1	470.15	24.37
0.60	1.00	1	412.41	21.38
1.00	0.85	1	556.75	28.86
0.70	0.85	1	409.53	21.23
0.60	0.85	1	360.45	18.69
1.00	0.75	1	499.01	25.87
0.70	0.75	1	369.11	19.13
0.60	0.75	1	325.81	16.89

## 8. Flower

For the crop flower, a crop factor of 1.0, an irrigation technology factor of 0.6, and water abstraction method factor of 0.8 5 are assumed. Considering the economic factor ETB 19133.33 per ha for flower, the irrigation abstraction and use charge for flower farms is set to be ETB **9,824.00 per ha**.

#### 4.6.1 Projected Amount of Charge to be collected

Currently there is a total irrigation area of 200,000ha and 125,000 is assumed to be able to pay the irrigation water charge. Based on an average area coverage by each crop (vary from year to year) in the Basin and by assuming an average irrigation charge for each crop, an estimated amount of 77 million ETB can be collected annually from irrigation water users. The assumption here is that there will be 100% collection efficiency. The Table below shows the details of the calculations.

Table 12 Annual estimated charge collected amount from irrigation abstractors and users

No.	Crop Type	Area irrigated (ha)	Average Charge value Birr/ha	Total value (birr)
1	Cereals	30,000	200	6,000,000
2	Vegetables	30,000	450	13,500,000
3	Pulses	2,000	150	300,000
4	Root Crops	5,000	225	1,125,000
5	Cotton	15,000	350	5,250,000
6	Sugarcane	30,000	1200	36,000,000
7	Fruits and other permanent crops	10,000	500	5,000,000
8	Flowers	1000	10,000	10,000,000
<b>Total</b>		<b>125,000</b>		<b>77,175,000</b>

#### 4.6.2 Charge Comparisons

Comparison of the calculated irrigation water charge in this study with the existing, other studies and African countries is presented in the below.

	Comparison with	Developed irrigation water charge in this study
1	<b>Existing AwBA charge:</b> the charge is 3.0 ETB per 1000m <sup>3</sup> for all crops	The developed charge vary with crop, technology, abstraction and the range is : Min value is for cereal : a charge of 15.18 ETB per 1000m <sup>3</sup> and the max value is 55.8 ETB per 1000m <sup>3</sup> for sugarcane
2	<b>Tendaho Project study :</b> The charge vary between 260 ETB and 430 ETB per 1000 m <sup>3</sup> of water for sugar cane depending on %ge of cost recovery	For sugarcane, our study showed a range between a min value 26.41 ETB per 1000m <sup>3</sup> of and the max value is 55.8 ETB per 1000m <sup>3</sup>
3	<b>ARBA: Abay Basin Team water charge:</b> The charge for large scale irrigation Sugarcane is 615 ETB/ha and for other crops on large scale irrigation 64.8 ETB/ha	For sugarcane, our study showed a range between a min value 738 ETB/ha and the max value of 1559 ETB /ha and average for other crops is about 300 ETB/ha
4	<b>South Africa:</b> The cost is highly dependent on the water management area. The minimum cost of irrigation water is 2.0 ETB/m <sup>3</sup> .	Min value is for cereal : a charge of 0.016 ETB/m <sup>3</sup> and the max value of 0.068 ETB/m <sup>3</sup> for sugarcane
5	<b>Sudan :</b> They use Area +crop based method , the water charge for cotton varies between 330 ETB/ha to 786 ETB/ha	For cotton our study yields value ranging between 245 ETB/ha and 465 ETB/ha
6	<b>Zimbabwe :</b> 602 ETB/ha as irrigation water charge. No crop is specified	Without flower and sugarcane, our study gives an average charge for other crops of about 300 ETB/ha



## **5 Institutional and legal, Economic, Social Aspects**

### **5.1 -Irrigation Water Charge Setting and Implementation (Institutional and Legal)**

#### **5.1.1 Introduction**

Water institutions are expected to measure and record effectively the parameters on which charges are based and collect the charges; and also identify areas where legal code is lacking for enforcement (FAO, 2004). The existing institutional framework, as stated in Ethiopian Water Resources Management Proclamation No. 197/2007 (Articles 20-22) empowers Awash River basin Authority and Ministry of Water, Irrigation and Electricity to set water abstraction/use price and treated wastewater discharge charge. However, research shows that if water use charges are too low they may lead to non-viable institutions, sub-optimal water resources services and overall deterioration of the water resources (DWS, 2015).

The study team conducted a comparative study of water institutions and their impact on water sector performance in all regions in the basin. Accordingly, the team consulted with all relevant Federal, Regional Institutions; Water User association; visited key institutions dealing with water, environment, industry, agriculture, and investment bureaus such as Awash Basin Authority, Abay Basin Authority, and regional representative bureaus located in Amhara, Oromia, Afar, Somali Diredawa and Addis Ababa Regional administrations.

The findings reveal that there are many ways of water charge settings. The two fundamental units of analysis for water charge applied were (1) the physical water resources, and (2) the national and the abiding principles and regulations of the country. However, as water supply and demand varies from one area/basin to another, the water pricing should also consider local characteristic and be calculated locally.

The Bonn International Conference on Freshwater (December 2001) however de-emphasized the possible contribution of water pricing to water management and rather underlined on the recovery of operational and financial costs. It contended that such cautious approach emanated moderately from the debate on “water as a human right” in the previous international water conferences, which advocated that no one should be denied access to water. This suggests that

agricultural water users should be charged fully for operational and financial costs, whereas financial support to poor domestic users could continue in form of government subsidies.

### 5.1.2 Gaps identification matrix

The emerged legal and institutional gaps identified in implementing the irrigation water use/abstraction charge categories are mainly related with irrigation water use permit systems, water use registration systems, water charge payment system, monitoring and evaluation systems, and information management systems.

In implementing effective water charge systems in the areas of irrigation sector at different levels the core structural gaps identified were highly linked with inadequate, overlapping, conflicting or no structural units in the areas of water use permit system, water use registration system, water charge payment, monitoring and evaluation, and water information management system.

### 5.1.3 Possible Structural Challenges

- Lack of Awash Basin High Council (ABHC) structure required to strengthen collaboration among the basin stakeholders
- Limited AwBA structures (Head office, Upper, Middle & Lower Basin levels only)
- Overlapping of water permit mandates (Federal, Basin, Regional, Zone, Wereda)
- Although, AwBA has adequate number of Water Use Permit staffs working at main and branch offices, there is no particular section that deals with this task (fragmented water charge and permit structural arrangement)
- The Water Charge (technical - analytical) related tasks are incorporated with in Water Permit (administrative - legal) tasks.

The following table shows list of water charge implementation identification matrix along with main institutions dealing with irrigation.

**Table 13** : Irrigation Water Use charging System Gap Identification Matrix

<b>Responsibility Category</b>	<b>AwBA</b>	<b>Regional Bureau</b>	<b>MoWIE (Federal/Ministries)</b>	<b>Awash Basin High Council</b>	<b>Water Users Associations (WUAs)</b>
Irrigation water use permit	Water use permit only	Water use permit only	Water use permit only (large scale)- MoWIE		
Irrigation water use registration	There is a regulation to have water use registration but inadequate implementation				
Irrigation water charge payment	☑	☑	☑		☑
Monitoring, evaluation and Learning system	Available but inadequate	Available but inadequate	Available but inadequate		
Information management system	Available but inadequate	Available but inadequate	Available but inadequate		

#### 5.1.4 SWOT Analysis on Existing situations

Under this section, SWOT analysis of legal and institutional arrangements of the existing situation on water use and treated waste water management practices in Awash River basin, based on the trend and historical development of institutions in the basin were conducted. This has enabled us to clearly understand the existing challenges/problems in relation to water charge setting and management institutions.

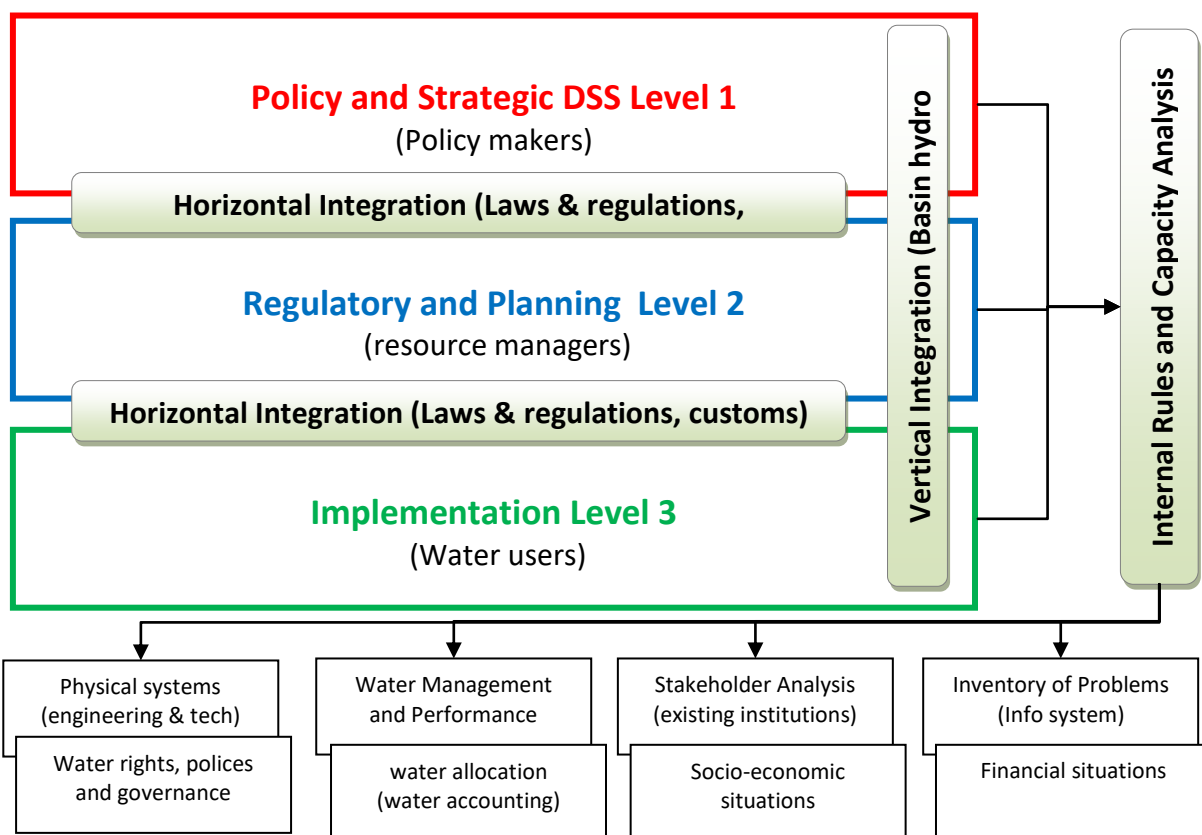
The following are examples of SWOT conducted on the basin requiring further inputs and improvement based on field trips.

**Table 14 :** SWOT Analysis on Existing Legal and Institutional Situations

Strengths	Weaknesses
<ul style="list-style-type: none"> <li>– AwBA has a legal mandate to undertake activities related to charge setting and management.</li> <li>– Irrigation water users are highly motivated and ready to pay water charges, as a grant/acceptability for ensuring water abstraction permit system (e.g. Amibara areas, Upper Awash Agro Industry)</li> <li>– Transparency on water use as compared to land size used for irrigation (transparency based on the customary business principle of large land size means access to more water)</li> </ul>	<ul style="list-style-type: none"> <li>– Fragmented institutional capacity to implement water charge management in the basin</li> <li>– Weakness in organizing and managing GPS related information captured to improve irrigation water users</li> <li>– Lack of integrated water charge management systems</li> </ul>
Opportunities	Treats
<ul style="list-style-type: none"> <li>– Water users in the upper Awash basin are relatively willing to pay if they have got adequate and quality water supplies.</li> <li>– Under normal weather conditions, pastoralists do not have shortage of lands and water supply problems.</li> <li>– AFDRA Salt water treatment factory discharges treated wastewater, exemplary activities in lower Awash requiring further field visit for analysis.</li> <li>– Availability of awareness in protecting Awash river in its natural course and water quality</li> <li>– Afar Regional government promised to Awash Municipality to provide them safe water tanker (2 year ago, false promise)</li> <li>– Adama Urban Water Supply Information System (nationally can be considered s one of the best)</li> <li>– Silvia Private limited bottled water supply company showed a great interest to support AwBA's water resources management and development activities.</li> </ul>	<ul style="list-style-type: none"> <li>– Lack of accountability over stakeholders in the basin</li> <li>– Over lapping and conflicting responsibilities on implementing charge structures in the basin</li> <li>– Inadequate understanding on the importance of strengthening and supporting River Basin Authority (mainly by Regional Water Bureaus).</li> <li>– Inadequate support from Regional Water Bureaus in the basin</li> </ul>

### 5.1.5 Conceptual and Legal Institutional Framework

The importance and interconnectivity of each of the three core water institution components (policy, regulations and administration) discussed in the previous sections, together with their vertical and horizontal relationships are illustrated in the Figure below. The legal framework and institutional arrangement will help as a roadmap for further evaluating and developing possible institutional arrangement scenarios useful to carry out all implementation tasks related to water use and treated wastewater charge setting and management systems.



**Figure 5 :** Conceptual Legal and Institutional Framework and Elements in Institutional Arrangement

### 5.1.6 Institutional Arrangement

Improvement of water governance system is not just about government systems and capacities; it is about a range of non-state agents and their interaction with government institutions. In fact, Effective water governance requires laws and institutions to balance the multiple dimensions of sustainable water resources development.

Water laws without governing institutions can be considered as a tree without roots, which shows that both are inseparable entities. Institutions can be both formal (based on written rules) and informal (rules derived from traditional practices). According to Bandaragoda (2000), the institutional arrangement for water resources development and management must have inter-linked structure that consists of the following three components:

- a. Policies (national, local and organizational)
- b. laws (formal laws and regulations, informal practices, and internal rules of organization)
- c. Administrative structures (organizations for resource management and implementation)

The importance, the vertical and horizontal relationships among each components of water institutions are discussed in the separate report of this study.

### 5.1.7 Recommended Awash Basin Water Charging System

The identified legal and institutional gaps regarding the water use/abstraction and treated wastewater charge tasks/categories are related to water use permit systems, water use registration systems, water charge payment system, monitoring and evaluation systems, and information management systems.

The recommended duties and responsibilities for these systems are:

**Table 15** : Recommended Operational duties and responsibilities on water Charging system

Category	Water charge collection	Water use permit system	Water use registration system	Monitoring and evaluation	Hydro informatics
Irrigation	<b>AwBA</b> - main river & canals <b>Regions-on</b> tributaries	<b>AwBA</b> - main river & canals <b>Regions-on</b> tributaries	<b>AwBA</b> - Basin wide, <b>Regions</b> - Region wide	AwBA, Regions	AwBA, Regions
Water supply	Regions/City Administrations	Regions/City Administrations	AwBA - Basin wide, Regions - Region wide	AwBA, Regions	AwBA, Regions
Treated wastewater	Regions/City Administrations	Regions/City Administrations	AwBA - Basin wide,	AwBA, Regions	AwBA, Regions

Category	Water charge collection	Water use permit system	Water use registration system	Monitoring and evaluation	Hydro informatics
discharge			Regions - Region wide		
Hydropower	AwBA	AwBA	AwBA - Basin wide, Regions - Region wide	AwBA, Regions	AwBA, Regions
Recreation	AwBA	AwBA	AwBA - Basin wide, Regions - Region wide	AwBA, Regions	AwBA, Regions
Aqua culture	AwBA	AwBA	AwBA - Basin wide, Regions - Region wide	AwBA, Regions	AwBA, Regions

### 5.1.8 Legal Framework

The legal frameworks for water resource administration in Ethiopia generally reflect the federal arrangement of the country with a shared responsibility for governance between federal and state governments. The FDRE Constitution, which lays the primary legal foundation for federal and state governments' power, has several provisions that have direct legal and institutional significance for the management of the water resources of the country. Article 40(3) of the Constitution exclusively vests the rights of ownership of both rural and urban land as well as all natural resources in the state and peoples of Ethiopia.

Issues to be incorporated during implementation of irrigation water charge:

- Consolidating existing fragmented water charge system through harmonized Awash basin water charge system by establishing immediate Water Use Registration Database System in the basin
- Considering harmonization of the federal and regional states laws on water resources management with the view of avoiding conflict over the mandate to administering the resources. This could be done either by amending either of the two laws or by issuing

guidelines for interpretation and harmonization of the laws for the proper implementation.

- The need to assign the power of collecting water charge system to regional water resource bureaus in order to address local realities and legal issues of states water resource administration power
- Reforming the legal and institutional basis of existing water charge collection system to ensure effective compliance mechanisms for defaulting water users
- Establishing a water stakeholder's forum constituting concerned organs of both federal, regional governments and local communities to address water charge related concerns.

Conduct a regular study of water governance efficiency performance factors due to the fact that the basin water abstraction and wastewater discharge charge setting will be influenced by water governance performance factors determined by how effectively a regulatory system responds to challenges, and institutional performance enhancer elements such as accountability, policy coherence, stakeholder participation, transparency, and the capacity for information management.

## **5.2 Economic and Financial Aspect**

Worldwide, irrigation water consumes the bulk of renewable fresh water resources. As water demand increases with rising living standards and population growth, and as prospects for water diversion (extraction) are limited in some regions and nonexistent in others, the course of water policy left open is to increase efficiency of water use. This requires taking account of the full cost of water and the way to achieve this goal inevitably leads to some form of water pricing. Yet, water policy makers and economists are far from agreeing on what constitutes the “right” charge of water in any given circumstance and how this charge is to be charged. This paper aims to clarify and reconcile some of the conflicting views by discussing the economic aspects underlying irrigation water pricing and their implementation in practice.

### **5.2.1 Data type and source**

The primary data was generated using structured questionnaires and interviews conducted with irrigators located in Awash River basin system for different production activity. The study



collected both quantitative and qualitative data. The quantitative data constituted detail information on production, water use, land size, location, type of crop grown, cost of production, irrigation type, irrigation technology used etc. The collected qualitative data was used to substantiate the quantitative data.

### 5.2.2 Population data and sampling

The study population was constituted registered irrigation water users found in the Awash basin river system (upper Awash, lower Awash and middle Awash basins). Once the sample size is determined the next step was to select the final sample of irrigators. In this regard, the study used a systematic and stratified sampling approach. Thus irrigators were systematically selected / stratified from legally registered irrigation water users in Awash basin. Following Ayana et al, (2015) the criterion used to classify sample irrigators are amount of irrigated land coverage (small-scale (command area less than 200 ha), medium-scale (command area of 200 to 3000 ha) and large-scale (command areas of greater than 3000 ha) irrigation), type of crop grown, farm size, location of the firm in the basin (upper awash, lower awash and middle awash).

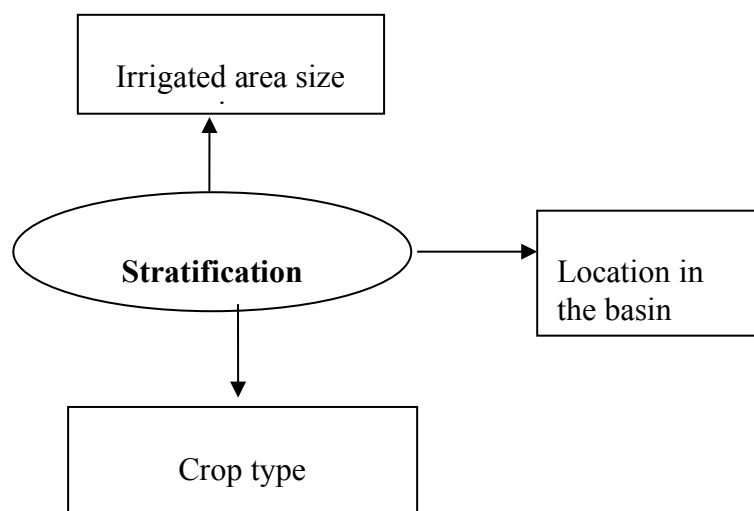


Figure 6: Systematic and stratified sampling approach for sample selection

### 5.2.3 Data type and data collection methods

The irrigation team applied various data collection mechanisms to understand the willingness, affordability and irrigators conditions. As indicated in the inception report, the study team is expected employed both primary and secondary data. The primary data collection was generated

using key informant interview, filed observation stakeholders analysis and firm level data. The secondary data (financial and administrative data) was collected from different sources including but not limited to irrigators reports (both private and public) Awash basin Authority and other regional water bureaus.

For this particular study data was collected from irrigation water users at different level (large scale , medium scale , small scale , governmental owned , private investment schemes). The major targets of the study were irrigators who owned with more than two hectors of land and irrigators with less than two hectares of land were excluded from the study.

#### **5.2.4 Primary data and secondary data**

The primary data were generated using structured questionnaires and interviews. About 16 irrigator's were systematically selected from legally registered irrigators (the list was obtained from ABA). Generally, about 6 small-scale (command area less than 200 ha), 3 medium-scale (200 to 3000 ha) and 7 large-scale (greater than 3000 ha) irrigation schemes were included in the assessment. The willingness to pay for irrigation, water was assessed using structured questionnaires. The interview was done using two different "bidding games". The bidding processes well informed the respondents maximum WTP for a 1000 m<sup>3</sup> of irrigation water which is currently costing only 3 Birr over years. Getting water without price was given as a starting bid and the initial bid was set 10 Birr per 1000 m<sup>3</sup> (considering the average price for developing countries) . Then the respondents were allowed to select the final price they would like to pay and if no asked respondent's willingness until response is yes. A total of 16 irrigators were interviewed to collect information relevant to willingness to pay for irrigation water.

In order to generate qualitative data, several techniques were applied, including filed observation, and key informant interviews (KIIs) and stakeholder analysis. The data was collected from 7 to 25 many February 2018. A total of 9 KII and four stakeholder's analysis were held. The study team members have also collected additional data using a quantitative survey on firm specific data such as area cultivated, amount of water diverted to each scheme each year, water fees, service charges, operation and maintenance fees collected for five consecutive

production years were collected. However, most could not provide the financial data which of grate use for cost benefit analysis.

### 5.2.5 Data analysis

The respondents were asked to report their level of education. As presented in the following table the majority of them 14(87%) have at least 1<sup>st</sup> degree. In this regard, we can conclude that the respondents can provide the required information.

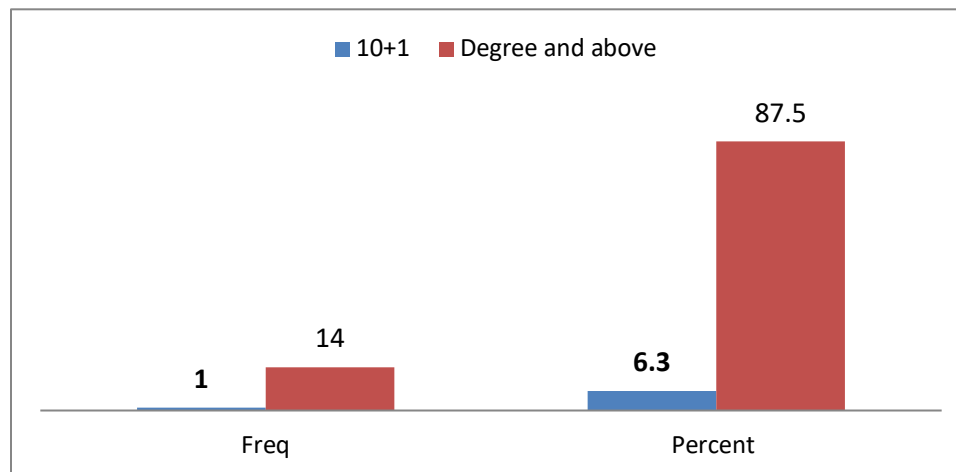


Figure 7: Level of education of the respondents of the economic and financial survey

The distribution of type of crop or the type of irrigators covered in the sample shows that at least eight types of irrigators were covered. These are cotton producers, cotton and high breeding seed, flowers, grape, sugarcane, sugarcane and cotton, vegetable and vegetable table and fruits. As the following table indicates the majority of them are flower growers and sugarcane producers.

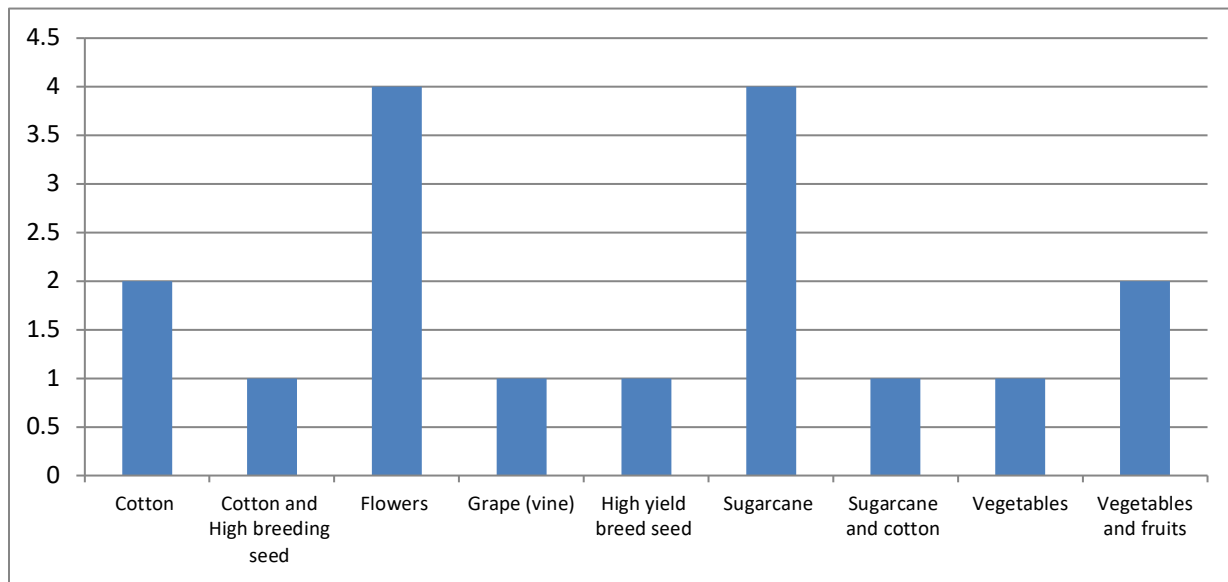


Figure 8 Type of crop covered in the sample of the economic and financial survey

As presented in the following table, the respondents composed of managers, accounts, sales managers and public relation and owners.

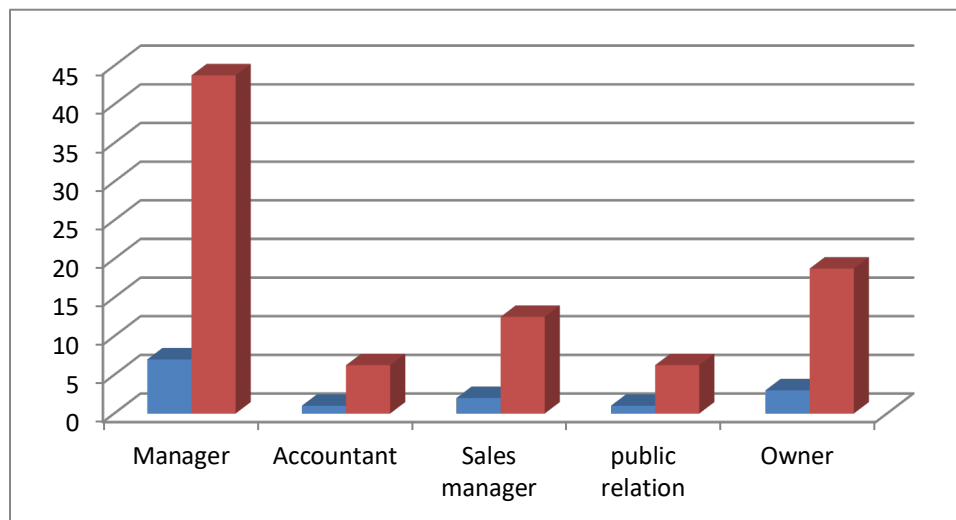


Figure 9 : Composition of the respondents for the economic and financial survey

The response on the type of ownership indicate that while 4(25 %) of them are from public farm the remaining 12 (75%) are from private firms. Thus, the number private operators are greater than the number of public operators.

The respondents were also asked to report the source of water for irrigation. As presented in the following table the major source of water for irrigation comes from river 9(56%), ground water 4 (23%) and rain water harvesting 2 (12 %). As the KII and the stakeholder analysis indicted those who use ground water as source for irrigation, argued that though the introduction of irrigation water is important for the sustainable development of the river basin they should not be equally taxed as they have already invested huge sum of money for the development ground water scheme. This signals that there could probably certain a misunderstanding about the introduction of water tariff. The implementation of an effective water price would require a good knowledge of irrigators to water pricing policy (and the reasons of introducing new water tariff).

Table 16 Source of water for irrigation of samples for the economic and financial survey

<b>Source of water for irrigation</b>					
		Frequency	Percent	Valid Percent	Cumulative Percent
	Ground water	4	25.0	25.0	25.0
	River	9	56.3	56.3	81.3
	Rain water harvesting	2	12.5	12.5	93.8
	other source	1	6.3	6.3	100.0
	Total	16	100.0	100.0	

In relation to the respondents were also asked to report the type of irrigation to produce their outputs. As presented in the following table, the while the majority of them reported that they are using traditional 8 ( 50%) and modern irrigation systems 5(31.3%) only a few of them reported to used mixed irrigation systems.

Table 17 Type of irrigation used of samples for the economic and financial survey

### Type of irrigation used

		Frequency	Percent	Valid Percent	Cumulative Percent
	traditional	8	50.0	50.0	50.0
	modern	5	31.3	31.3	81.3
	Mixed	3	18.8	18.8	100.0
	Total	16	100.0	100.0	

The major variable which would explain the income level of the respondent was also included as key variable. As presented in the following table the annual income greatly vary where the minimum was found to be 11400 and the maximum being 472, 00000 million. The implication of this is that the price should consider the annual income level of irrigators.

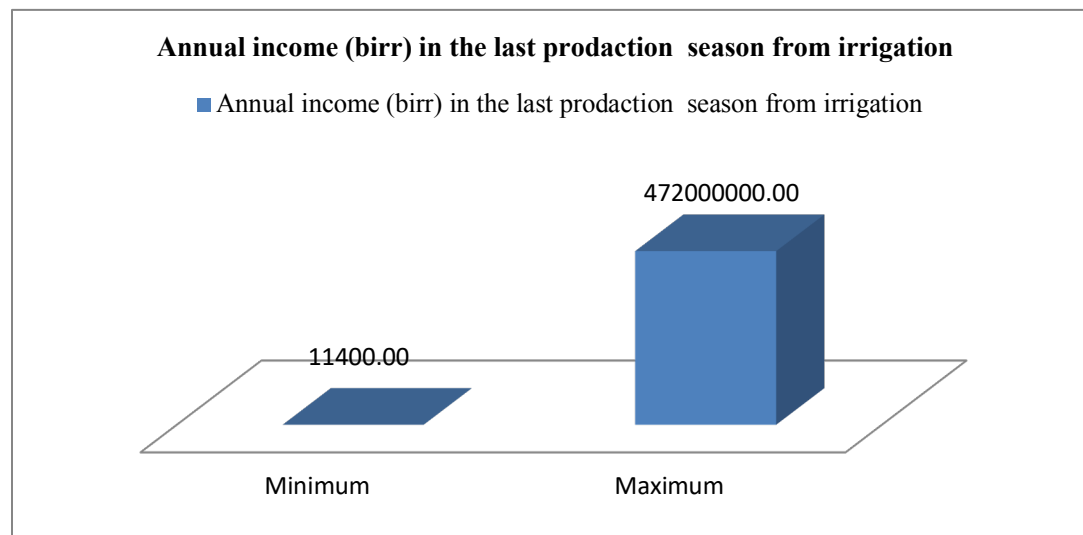


Figure 10 : Annual income range of samples for the economic and financial survey

### 5.2.6 Willingness to pay for irrigation water use (WTP)

One of the most prominent issues in the process of price adjustment is to understand the willingness of the clients or beneficiaries involved in the new tariff setting. This is highly dependent on the nature the farm and its location. The study indicated that are three types of farms involved in the study; small holders, medium and large government owned farms. In terms of payment all the study participants indicated that the amount of tariff set in the past was very small i.e. 3 birr for 1000m<sup>3</sup>.



Figure 11: Furrow irrigation on the farm (*Methehara*)



From the field observation we can clearly understand that drip<sup>1</sup> and sprinkler irrigation systems are the most preferred irrigation systems to systematically manage the water as compared to furrow irrigation system.



Figure 12 : Flora farm that used drip irrigation

Here the main argument of the above explanation on the adjustment of water tariff is that informants indicated that people carelessly used the river water in the case of furrow irrigation is because of the cheap availability/ payment of water. So, when the price of water increased people become more conscious on economically use the water and most people continued to argue that if we continue to use the river water like this then the scarcity or extinct of the river will be inevitable.

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<sup>1</sup>A winery farm manager indicated that for a single drip irrigation structure installation it costs 50,000 US Dollar. The price issue is also one of the factors that prevents the widely expansion of drip irrigation. This is a clear indication that drip irrigation needs more financial input.



When we come to the results of the study we can associate willingness to pay issue it on three main important strands: the location/region of the farm, types of the farm and accessibility and cleanness of the water.

**Location/region of the farm :** Starting as a small stream from the western part of Oromia the Awash River crosses the boundaries of three major regions in the country; Afar, Amhara and Oromia. Among the three regions, the majority or all clients or payers of water fee to Awash Basin Authority was found in Oromia and Afar regions. The system of payment has been more practical in the upper stream and middle stream users than the lower stream<sup>2</sup> of the two regions. When it comes to the lower stream of the Awash Basin (starting from Gewane to Kesim) as well as Amhara region the payment system were not yet started and in some cases people didn't have the knowledge about the existence of Awash Basin Authority (this was happened in the Amhara region<sup>3</sup>). This has its own implication on increasing the number of clients of ABA. In other words, people who know about the payment issue of the river water have been more willing than those who have little or no information about the water tariff in previous years. This was become clearer when we had a discussion with small-scale farms found in the lower stream.

**Type of farm:** Notwithstanding with the willingness of informants participated in the research to subdue to the new price adjustment, the study also revealed that all types of farms were not paying fee for ABA. This was mainly connected to the source of water used by the farm. In this regard, we can site two examples, one from the flora farm and the other from the state farm. We also found out that other than the Awash River the flora farms used ground water as a source of water for their farms.

Yalcana<sup>4</sup> is one of the flora farms found in the Oromia region used a borehole besides Awash River as a main source of water. During our interview, the farm manger informed us that he got

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<sup>2</sup>During the time of field visit WEfound that ABE employees were afraid to discuss openly about the payment issue of the Awash River to the local community because they thought it may trigger conflict. Among the Afar population there is a perception of saying that "Water is a gift of God".

<sup>3</sup>In the absence of the AWBAthe farmers were organized under association or union and use the tributaries of the Awash River for irrigation. The case of *KemiseWoreda* can be mentioned here as an example, there was also the called *Yeweha Abate* who coordinated the use of water and collects some amount of fee from its members for maintenance and administrative purpose. WEwas also witnessed to see the Audit report of two unions in the *Woreda* and their commitment of keeping the solidarity of the water users.

<sup>4</sup> This was the farm manager who abused the research team by releasing a dog.

the permission to dig the borehole from Oromia Water Works Enterprise and they provide him a permission to dig a borehole and since then the flora farm used the water without any control. Plus he openly indicated that he didn't pay a penny for the water use till now but he paid a small amount of money for Oromia Water Works Enterprise for permission. This shows that ABA has been out of the game and the flora farm used the water without any payment. From the point of the farm manager he argued that we were covered all the expenses for digging the hole and without reimbursing our expense how can it be possible to ask water fee? This also connected to the rules and regulation or legal framework of ABA (it could be discussed by the legal team of experts).

The second case was associated with the state sugarcane farm located in the Afar region. According to a respondent at finance and planning position of a certain farm, farms were not paying anything for the use of water. This is evident as the state farms use water from a dam constructed by the Federal Water Construction Authority and during that time the responsible body for the dam was not clearly identified by the government. On the one hand, they informed that a responsible body for dams and canals will be established by the federal government and it will control the administration of the dam<sup>5</sup>.

**Accessibility and Cleanness:** the flow of Awash River is not uniform throughout the year, the volume become very high during the rainy season and gradually decreased towards the summer. This brought a serious complain from the lower Awash River users. Most informants underscore that even though the payment for irrigation water use might not be expensive, the issue of accessibility and provision of clean of water should be addressed. In the second case for example, most flora farms complied about the quality of the irrigation water.

### **The average willingness to pay of irrigators**

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<sup>5</sup>Informants in the sugarcane factory told us that the constructions of the two dams were below the standard and full responsibility was taken by METEKE.

The survey data also indicated and collected data on the willingness to pay (WTP) of the study farmers. Following (Hussain<sup>6</sup> , 2007 and<sup>7</sup>, Molle and Berkoff,2008 ), assuming that the probability of irrigator's willing to pay for irrigation water supply is a linear function of an initial bid value; the following simple probit model is specified to determine the average WTP of irrigation users in the Awash basin .

$$Y = 1 / \text{the amount of initial bid level} = \gamma_0 + \gamma_1 \text{Bid} + \varepsilon$$

Finally, by dividing the intercept ( $\gamma_0$ ) by the coefficient associated with the bid value ( $\gamma_1$ ) of the above equation. Thus using this approach the average willingness to pay for irrigation water can be determined using the following estimable model. The results of the model are presented in the following table. The result from the profit model shows that the average willingness to pay for irrigation water is 120 Birr per hectare of land served per year.

A farm manager from Red Fox mentioned that *“if you maintain the cleanness of the river water we don't complain about the increasing of the water tariff because we are working on a very lucrative business”*.

In addition, the quantitative firm level survey data reveals that the majority of the industries are willing to pay for irrigation water use. About 14 (87.5 %) of the respondent have indicated that they are willingness. However the result for the Key informant interview indicated that the irrigators have concern over the supply and quality of irrigation water. They have stated that the current price is very low that it could not help to maintain that sustainability of the Awash basin river. Moreover, the KII indicated the readiness of willingness varies depending on farm size and income level.

### 5.2.7 Affordability of irrigation water price

The price of water may reflect different considerations, such as reducing the amount of water used and saving, demand management, the financing of irrigation institutions, cost recovery and

<sup>6</sup> Hussain I, Hanjira MA (2007). Irrigation and poverty alleviation: Review of the empirical evidence. Irrigat. Drain. 53:1-15. Jensen

<sup>7</sup> Molle F, Berkoff J (2008). Water Pricing in Irrigation: Mapping the Debate in the Light of Experience, in: Molle, F., Berkoff (eds), Irrigation water pricing. CAB International, pp. 21-93.

repaying those who have invested in irrigation. Most importantly, the price should not exceed the users' ability to pay. In this regard, the study team members collected cost and revenue data to estimate the affordability of irrigation water price or tariff. This helped to conduct the cost benefit analysis that would help to estimate the affordability irrigation water tariff. However, it should be noted that some firms did not report their financial data. In addition, the qualitative data analysis indicated that respondent suggested awareness creation, income level, farm size and type of business should be considered while setting the new price.

**Awareness creation among various stakeholders:** the discussion with stakeholders revealed that awareness creation should be given top priority. This can be done at different level. For example, at firm level, regional level and other local arrangement found across at the different administrative parts.

**Income of the farm:** the respondents also indicted that farm size, income and type of crop or should be used to while setting irrigations tariff. This is an interesting point to consider for example we found that flora business is very lucrative but the amount of land required is relatively small.

### 5.2.8 Economic estimation of affordability

The profitability index /cost benefit analysis was used to calculate the profitability index of the sample irrigators/ farmers. In this regard, we tried to collect detail cost (initial, investment cost, operating cost, total variable cost etc) and revenue data (price, amount or quantity sold etc) from the sample farmers. This analysis was conducted in order to check the affordability of the new proposed price by the study group of farmers. In this regard we tried to collect five year financial statement data from the respective sample firm to check the trend. However, only few firms provided the data considering it as confidential data. The profitability index was calculated by dividing the sum of discounted benefit by discounting cost for each type of crop.

$$\sum \frac{B_t}{(1+r)^t} \dots \dots \dots 1)$$

$$\sum \frac{C_t}{(1+r)^t} \dots \dots \dots 2)$$

The following table summarizes the profitability index by crop type. The result revealed that cotton, flowers, sugarcane and vegetable were found to have a profitability index greater than one indicating that almost all firms have a good profit return both in trend and time.

**Table 18 :** The profitability index by crop type

Crop type	Profitability index
Cotton	2.51
Flowers	2.32
Fruit	NA
Sugarcane	1.87
Vegetable	2.30
Pulses	NA
Cereal	NA

### 5.2.9 Profit based analysis

In order to estimate the economic factor for irrigation we chose to use the revenue or profit based analysis. In this approach firms were categorized in six category based on their crop type (cotton, Flowers, fruit, sugarcane, vegetable, cereals, pulses, root crops). As presented in the following table the economic factor was calculated based on share of profit and model based estimation. The share of profit suggest that farmers should pay at least 1- 5 % of the total profit per hectare. This is somehow some international experience but lacks objectivity. Thus, we also estimated a simple regression model to calculate the elasticity of profit to water and land. The estimate from of the model is stated as follow;

$$\ln AR \text{ or } \pi = \alpha_0 + \ln \alpha_1 Q + \ln \alpha_2 \ln Land\_irrigation + \ln \alpha_3 Wper A + e_0$$

Where AR; is average revenue / or profit

Q; is output in value of production

Land \_irrigation; amount of land allocated for irrigation

Water \_per A; amount of water used per hectare

E; is the error term

Even though the R square of the estimated model is low (as there could be omitted variables) still the result indicates that there is a positive and significant effect of both land and water in revenue function. The result of the estimation also shows that elasticity of water to profit per hectare is about 0.028.

On the other hand, the following table indicates that the economic factor is presented in two options. These are as percentage share from profit per hectare and base on calculated the elasticity. In this regard, we consider the minim amount i.e. 1 percent of the profit per hectare per crop (based on 1%-5 % profit criterion) which can be estimated simply by multiplying 0.01\*profit per hectare. On the other hand, we consider 0.028 \*profit per hectare for the model based analysis. the result is summarized in the following table.

Table 19 The economic factor is presented in two options (percentage share from profit per hectare and base on calculated the elasticity)

<i>Number of firms</i>	<i>Type of crop</i>	<i>Cost per Ha</i>	<i>Revenue per Ha</i>	<i>Profit (Ha)</i>	<i>Share from per Ha profit (1%)</i>	<i>Model Elasticity</i>
	Cotton	1045.5	13227	12182	121.81	341.092
	Flowers	383863	1052632	956667	9566.60	26786.6
	Fruit	3632.0	17378	13746	137.46	384.899
	Sugarcane	7544.5	25976	24090	240.89	674.520
	Vegetable	4071.8	19930	18572	185.75	520.026
	Cereals	4800.0	10600	5800	58.00	162.400
	Pulses	4500.0	10583	6083	60.833	170.333
	Root crops	2307.7	7846	5538	55.38	155.077

### 5.2.10 Conception

The study finds out that there is a clear difference on the conception or fear of price increase of water among the stakeholders. This becomes very clear when we see the local and foreign users of Awash River. There were some doubts among the users of river Awash on the implication of increasing of the water tariff, particularly on the revenue of the farms. So, they underlined that the price increasing must consider the payment ability of the farms and shouldn't be exaggerated (Interview made with employee of Wonji out growers scheme sales man). The foreign investors who own the flora farm express their worries mainly on wise management of the Awash River. Their doubts mainly focused on the flow of water will diminish in the future because the following reasons: primary furrow irrigation system waste a great deal of water. Secondly, there is pollution of river water because of toxic materials including plastics were dumped on the river increased from time to time. Thirdly, the climate changes observed at the global level aggravate the situation. Finally, the addition of all these factors will decrease the amount of water for all. So, the fear comes on because people are afraid on the sustainable use of river water.

### 5.2.11 Challenges

There were various challenges mentioned by informants:

- Lack of installed water meter that measures the flow of water
- Lack of partnership among stakeholders including ABA
- The mixing of lake *Beseka* with Awash river has been not favorable by local people in the Afar region and during the stakeholders analysis participants of the study stated that due to this more people were affected water born disease such as diarrhea
- Sudden flooding of the Awash River during the rainy season when dikes couldn't be able to block the river .
- No peaceful or healthy relationship between the upper and lower stream irrigation water users when there was scarcity of water. In order to ease the tension between them there was a committee established on temporary bases but once the problem solved then the committee was not functional or dissolved.

- As indicated in our former discussion, most farms used furrow irrigation and when excessive water overflows on the farm the salinity of the farm increased and which in turn damages crops or plants grown on the farm. .
- Even in the future the practicality of water tariff in the lower Awash stream will be questionable unless the scarcity of water avoided

### **Expectations from ABA**

The study participants also forward their expectations from ABA. This includes, provision of clean water, maintain the quality and quantity, regular maintenance of the canal and cleaning the silt from the main canal. This has been identified as the most pressing challenge.

**Awareness creation and experts' assistance on the cost-effective irrigation schemes:** The key informant interview indicated that there has been knowledge gap on irrigation skim and this needs to be addressed by the ABA through awareness creation as well as technical assistance

### **Measures to be taken**

The findings of the study indicated that are some steps to be taken in to consideration prior to setting the new tariff. First and foremost people need to know about the purpose of setting new tariff. This gives more confidence on the side of clients to be on the comfort zone in accepting the new tariff. One of the mechanisms of doing this is public consultation which can serve as best platforms for discussion.

Informants in the large-scale state farms who provide water for other small holders (out growers) claimed that there were illegal water users from the main canal. The same kind of complain was raised from the other private farms and to avoid this problem the stakeholders has been tried different mechanisms:

- There is a committee which establishes to redress the grievance created between the upper and lower Awash River users but this committee was active when there was a problem and it would be better to make if permanent.
- Some informants raised/stated that managing and controlling of the Awash River is a precondition for its effective use. Particularly maintaining the cleanness of the river water



is also the responsibility of the three regions which crosses the boundary and not only ABA. In this regard, Farm managers that come from other countries share their experience for example, farm make of Red and Florence (flower farms) in formal as the examples of Europeans countries and Rank and Mass and two rivers that cross bounding and those countries are responsible for these rivers (Germany, France, Netherlands, Belgium and Luxemburg). In this case the ABA needs to include the regional government in the management and control of the river.

- Country to this payment of the Awash River the flowers farms use borehole without paying water fee for ABA.
- The ABA mainly concerns for the main river but the contribution of tributaries was immense ,the case of *Bulga* River can cited as an example. Along the river a dam was built by *Metek* but the employees of farm/firm has a concern on the standard of the construction, mainly at the gate of the dam didn't properly function and if something is wrong with at the gate the employee of the farm indicated that the factory as well as the plantation is still in great danger.
- ABA needs to install gage in order to know the exact amount of water used by the firms accountably. Currently the use a long estimation by taking the type of crop cultivated in the farm.
- The ABA should keep in mind that the expectations from its clients must be fulfilled as per the rules and regulation of the authority. For instance, to alleviate this problem canal need to be cleaned twice a year (before and after New Year) because this helps the proper flow of water from the main canal to each farm.

### 5.2.12 Conclusive Remark

There are some points that need to be taken into consideration by ABA before it the new tariff is implemented. As it is presented in previous discussion some of the issues raised were technical while others were more administrative. In terms of technicality, the ABA needs to solve problems associated to dams, the case of Koka and Kesem dames can be cited as an example. When it comes to more practical aspect we can mention lack of fair distribution of water to farms, regular cleanness of silt of the main canal etc. Furthermore, there has been lack of

awareness on the existence and duties and responsibilities of ABA among various stakeholders across the three regional states, particularly in the lower stream of Afar and Amhara region. In relation to the above mentioned points there was lack of communication among stakeholders in different aspects of providing permission to dig borehole (the case of *Yalcana* or other similar flora farms can be a very good point) which is played by enterprises like Oromia Water Works Enterprise (OWWE). In this regard, there are two main important points to be taken into consideration. The first one is the duties and responsibilities of the ABA and other regional offices with similar objectives needs to be clearly defined. Secondly, the roles and responsibilities of ABE and other regional offices should be announced to their clients in a very understandable way. So, there has to be a link between these agencies with that of ABA because once they got the permission to dig borehole then it will be easy to make a registration by ABA and facilitate the payment process. In this regard, cooperation among stakeholders could be the best mechanisms of creating a link.

## **5.3 Social Aspects**

### **5.3.1 Introduction**

The findings of this study are based on data collected using survey, in-depth interview, key informant interview, focus group discussion and non-participant observations. The finding of the study showed that irrigators' were water consciousness on the basis of perception of irrigation water as scarce resource, water quality and willingness to pay. There is a general consensus among irrigators that water is a primary resource for irrigators and government in the Awash Basin. The livelihood of smallholder farmers and business firms are dependent on water and land in the Basin. Government's plan in realizing food security, promoting agricultural investment and socioeconomic development depends on the availability and accessibility to the water. Thus, water security and sustainability are the concern of all stakeholders in the basin. To secure the benefit of irrigation water on sustainable manner, investment in the service, environment and water conservation are compulsory. This depends on irrigators' conscious of the benefit of water, willingness to pay for the irrigation water charge and the necessity of water conservation participation.

### 5.3.2 Methods of Data Collection

Survey, key informant interviews, in-depth interviews, focus group discussions and observations were used to collect data from irrigators (large, medium, and small scale), governmental, private investment schemes, horticulture (flower farms) and nontraditional farmers except traditional irrigations which are exempted from permit with Ethiopian water resources management proclamation number 197/2000. Data were collected on irrigation water consciousness, willingness to pay irrigation water charge, factors affecting willingness to pay, social equity and fairness, impacts of introducing irrigation water charge and environmental concern of irrigation water use.

Survey questionnaire were administered to a total of 165 irrigators (small, medium and large scale) in the Awash Basin of three regions (Oromia, Afar and Amhara National Regional States). In addition, 14 in-depth interview, 19 key informant interview and 3 focus group discussions were held in collecting data. Concurrent data collection method and analysis were employed in this research.

### 5.3.3 Results and Discussion

#### Water Consciousness

Water consciousness were addressed by assessing perception of irrigators on irrigation water (values of water), knowledge of irrigators on availability of irrigation water (scarcity) and manner of its utilization, irrigators experience and willingness to conserve water, irrigators willingness to pay for irrigation water charge and the link between water and the livelihood of people living and making their livelihood in the Awash River Basin. The first factor used to measure water consciousness is irrigators' perception of water scarcity. Water is a scarce production resource for 79.9% (131) respondents. Informants (both experts and company representatives) view irrigation water resource in Awash Basin as a precious resource. An expert from East Shewa Zone Irrigation Development Authority equates water from Awash Basin with petroleum. Generally,, irrigators aware that the water from Basin is the source of livelihood for many smallholder farmers and small, medium and large scale investment.

In addition, five item Likert scale (strongly agree=5, agree=4, neutral=3, disagree=2 and strongly disagree=1) were used to measure water consciousness of irrigators. The overall score ranges from 5 to 25. The mean, median, standard deviation of score of the Likert scale are 18, 18 and 2.9 respectively. The mean and median score are above the value of neutral. Using neutral score as dividing line, the score were divide into two: water conscious and unconscious. Based on this criteria, 77.4% of the respondents are conscious of social, economic and political value of water in the basin. The other factor used to measure water consciousness is irrigators' perception of status of current irrigation water availability. It is adequate for 52.3% and very adequate for 12.6% irrigators. On the other hand, informants in indicated that water scarcity is seasonal. Furthermore, Water security and sustainability is another indicator of water consciousness. This is dependent on willingness of irrigators to invest on environmental and water conservation and efficient use of irrigation water. Survey conducted showed that 92% of irrigators are willing to participate in water conservation activities.

### **Irrigators Willingness to pay Irrigation water charge**

Irrigation water charge is not a new phenomenon in Awash Basin. Commercial irrigators' and cooperative unions in the Awash Basin have been paying 3 birr per 1000m<sup>3</sup> irrigation water charge for the past two decades. However, not all irrigators in the basin are paying irrigation water charge. Regarding payment, there are two categories of irrigators:

- A. **Currently Irrigation Water Charge Payers:** including Commercial farms, some flower farms and legally established water user cooperatives/unions
- B. **Unlicensed irrigators:** including smallholders, agro-pastoralists, pastoralists and illegal "water users/irrigators"

However, majority, 80.6% (129) of respondents, are willing to pay irrigation water charge for the water they have been using for irrigation. Unwilling respondents attributed their unwillingness to pay to water is God's gift (30.3%), can't afford (28.8%), payment for other inputs (25.8%) and small size of irrigable land (15.2%) respectively. Informants from commercial farms raised adverse impacts of addition of cost on companies operating in a loss in the basin. Even though, there is a general consensus that the amount of money they have been paying for the irrigation

water they have been using is less than the value of the water for social, economic and political developments at individual, local and national level. The existing water charge is considered by respondents and informants as low compared to the water value such as source of life, income, and wellbeing of people living in the area, both directly and indirectly. However, irrigators demand services such as canal maintenance and clearing services, sharing information on release of water from dams, designing and implementing flooding, siltation and salinity control mechanisms, construction of reservoirs to realize water security/sustainability and establishment of measurements for the charge they are going to pay.

The amount of charge to be introduced or reformed is also the concern of irrigators. Irrigators expected fair charge that encourages efficient water use and investment in agriculture. They claimed that irrigation is a tiresome activity that requires huge investment. Thus, addition of high water charge discourages irrigators and agricultural investment in the Basin. A foreign working in foreign agricultural company in the basin said that irrigation water charge is low in many countries as compared to other sector water abstractors. Irrigation is also high priority area for Ethiopian government in realizing food security and improving living conditions poor smallholders in the country (MoA, 2011). The Growth and Transformation Plan of the country also provided emphasis for irrigation. Thus, realizing fair use of irrigation water is the concern of different categories of irrigators. Thus, the irrigation water charge to be introduced/modified should not be exclusionary or designed in a way that benefits one and disadvantaged other.

### **Environmental Concern**

Water quality is the major worry of irrigators in the Awash Basin. Urban and industrial wastes are polluting, as to the perception of respondents, water of Awash. In addition, Beseka lake is seen as a serious threat by people downstream of the lake. In addition, water use, management and saving are perceived poor throughout the Awash Basin. Irrigators' use of water saving technologies except flower and fruit farms are low or absent among smallholders, cooperatives or commercial farms. Furrow irrigation is the dominant irrigation system in the Basin. Siltation, flooding and salinity are the main threats for irrigators. However, there are attempt made to reduce the impacts of those factors in the Basin. Irrigators are participating in afforestation and watershed development programs the government is running each year in their area. This plays a

key role in reducing siltation in the Basin. Organizations (private) in the Basin are also providing social services such as constructing schools, provision of health services, provision of potable water, supply of energy related materials and engage in environmental protection as social corporate responsibility of the company. All informants believe that the reforming the existing water tariff system and licensing irrigation water use positively contributes to water saving and reduces adverse effects of careless use of irrigation water.

### **Conflict Among users**

Conflict is common among irrigation water users in Awash Basin. The instigating factors are water shortage during dry season, interruption of water abortion time by power/electricity interruption and water theft (illegal water use. However, irrigators developed various systems to manage conflict over water use and allocation and sanction those who breach the rule. Irrigation water is allocated to members for specific date and time in a week. Violation of the time of allocation results in financial punishment in the area.

Survey conducted showed that the introduction/modification of irrigation water charge can cause conflict for 49.4% in the basin. The main factors indicated for the conflict include accessibility (36.5%), purpose of water abstraction (16.5%), amount of payment (13.5%), water apportion (11.8%), inability to create ownership rights overland (10.6%) and others (9.4%). Furthermore, 15.5% and 8.5% expect tension between government and users and between users themselves. These indicates that conflict and tension with government and among users is expected to be minimal.

### **Impacts of Introducing/ Modifying Irrigation Water Charge**

The introduction or modification of irrigation water charge has both positive and negative impacts. The positive impacts mentioned include promotion of water saving, realization of water security and sustainability and improve in the Authority service giving capacity. However, introducing high and attempt to implement without consultation with irrigators may cause loss among irrigators operating in loss by increasing cost, raise cost on irrigators, resistance and

tension, tension between government and irrigators and low investment in agriculture. Thus, advocacy, offering or facilitating service needed by irrigators, working to improve on water quality and security, constructing reservoirs to realize water security and working on siltation, salinity and flooding.

#### **5.3.4 Conclusive remarks**

Irrigation water charge is a sensitive issue that involves political, historical, social, religious and economic dimensions throughout the world (Abu-Zeid, 2003). Water is linked with improvement in the living conditions of smallholders and agricultural investment in the basin. But water security and sustainability are the concern of irrigators in the Basin. Thus, irrigators are willing to invest and pay for the water they are using in irrigation. However, irrigators demanded many services such as canal maintenance, sustainable access to irrigation water in quality and quantity, and investment in irrigation infrastructure. The amount to be introduced shouldn't discourage but rather promotes investment agriculture, environmental protection and realization of food security in the basin and national level.

On the basis of study conducted and conclusion, the following are recommended for smooth implementation of irrigation water charge:

- Control of illegal water use in the basin by registering and licensing all irrigators (smallholders, pastoralists, agro-pastoralists, small, medium and large scale farms)
- Helping and facilitating for the formation of irrigation water users Associations in the Basin
- Provision or helping/facilitating the formation of company that offers canal maintenance and clearing services
- Provision services such as water quality control, flood, siltation and salinity control
- Creation of strong linkage between Awash Basin Authority and irrigators and local level officials at various parts of the country
- Conducting awareness raising and consultation meetings with stakeholders (irrigators, regional and local level officials).

## 6 Conclusions and Recommendations

### Conclusions:

To achieve the primary goal of reduced water use per unit of output in irrigation water management, one key issue is to design an effective pricing mechanism based on local conditions. In this study we developed an area-based water charging mechanism with fixed cost from watershed and water resource management and a variable cost with the following attributes: Crop factor, Economic factor, Irrigation technology factor and factor for water abstraction method.

The field data collection for this study reveals that the majority of the schemes don't have flow measuring structures at the abstraction points. Even the irrigation schemes where they use pumps to abstract water from the ground water don't have flow measured records. Hence, the irrigation water abstraction charge should be Area/crop based system. But, in the future only the volumetric method of water charge should be practiced and there should be an incentive for schemes introducing flow measuring structures.

To estimate the costs incurred by ABA for watershed and water resources management, monitoring supervision activities and cost breakdowns from other projects outside the Basin are used with the following assumptions: a 15 % management ,monitoring, supervision cost, there are ten active regional and federal stakeholders and these stakeholders share the cost equally. Total cost of watershed and water resource management further apportioned among various users of water in the basin: irrigation, water supply, hydropower, fisheries, recreation, and waste water, based on volume of water consumed and income generated from each use (thus, 50% share for irrigation). Additionally, it was assumed that, traditional irrigation farmers were exempted from paying for watershed cost. Based on these assumptions a fixed cost of 66.32 ETB per hectare will be levied on irrigation water users.

The next attributes in the model is crop factor. For this we grouped the crop in to eight groups (Cereals, vegetables, root crops, cotton, sugarcane, pulse, permanent (fruit), flower) and the water requirement of each group is calculated to come up with the crop factor. The Economic



factor is estimated based on 2% profit or elasticity value. To account for improved irrigation technology and advanced farm management practices the model also includes Irrigation Technology factor. The last attributes is the Water abstraction method factor: here three types of water abstraction methods are considered (Dam, abstraction by pumps and diversion structure and having measuring device, and finally the same abstraction but without measuring devices). The model encourages irrigation water use through construction of dams and a lower water abstraction and use charge is recommended for bulk abstractors.

Area-based water charges are fixed charges, based on the area irrigated. The main problem with this approach is when irrigated area varies from year to year or season to season. For example, the area irrigated during the wet season is usually much larger than during the dry season. In addition, the projected area is usually larger than the area actually irrigated. Therefore, the basin authority will need to estimate the area actually irrigated each season. In this study, the water charge is assumed to be uniform throughout the year (no seasonal variability).

The irrigation water use charge setting, taking in to account all the variables that are explained above, concluded the following charges for each groups of crops: Irrigated area covered with Cereals will pay 148 to 228 birr/ha, Vegetables will pay (assuming two harvest) 300 to 596 birr/ha, Pulses will pay 119 to 185 birr/ha, Root Crops will pay 166 to 289 birr/ha, Cotton will pay 245 to 465 birr/ha, Sugarcane will pay 738 to 1560 birr/ha, Fruits and permanent crops will pay 325 to 643 birr/ha, Flowers will pay 9,824 birr/ha.

### **Recommendations:**

- To encourage farmers to use less irrigation water per hectare, water charges have to be related to the amount of water that farmers abstracted. Disadvantage of area based charging method is that, once the irrigated area decision is made, the water charge will have no effect on farmers' water consumption, because the marginal cost of applying additional quantities of water per hectare is zero. Thus, the demand for water is usually higher than it would be under a charge that varied by the quantity of water used, and it is likely to lead to overuse of water by farmers near the head of the canal. Thus, volumetric pricing system with proper flow measuring

structures will have to be considered in the future by the Basin authority, if reducing water use per hectare is the major concern.

- Area based water charge seems easier in terms of administration. But in the area/crop based method, one cannot be sure that the actual demand of the crop has been supplied and exact area under a given irrigated crop may not be known and may varies from season to season. There is a need to monitor crop and area on a seasonal basis. The ABA should have a unit to monitor the crop types and area covered under each crop using emerging technologies such as remote sensing, satellite imagery and Geographical Information System (GIS).
- The various factors used in the model in setting up the charge such as crop factor and irrigation technology factors are estimates based on literature values supported by some field observations. These factors should be revised periodically based on the actual data collected from the Basin.
- One of the main objectives of introducing water charges is to provide an incentive for efficient use of scarce water resources. Technological improvements in irrigated agriculture can improve irrigation efficiency. Thus, the Basin Authority needs to find ways of adapting modern water-use technologies so as to spread the available resource more widely, and to enhance the productivity of the water.
- To achieve the primary goal of reduced water use per unit of output in irrigation water management, two key issues must be addressed: first, to design an effective charging mechanism based on local conditions and, second, to develop a strategy for obtaining high rates of collection. In this study, we focus on the first key issue, water charging mechanism which is area-based pricing. But, the second requirement, high rate of collection must be considered by the Authority from the very first day of implementing water charge.
- One way of abstraction is by constructing a dam on the main Awash River or the tributaries. The Dam Management Directorate (DMD) is currently in charge of managing these dams and is mandated to recover the cost of the infrastructure from the irrigation users/sugar

factories. DMD is considered as bulk abstractor of water using reservoir and has to pay the water charge to ABA but the Abstraction method factor may need modification in the future.

- In some areas of the Awash Basin, groundwater can be the only major water resource for irrigation. A differential pricing structure would be appropriate in the future to control groundwater pumping and reduce over-abstraction above the safe yield or withdrawals exceeding certain volume of abstraction.
- The economic/financial variables used in irrigation water charge can be viewed as component of the specific economic approaches to be adopted in setting irrigation water charge for certain period. Designing and implementing water charges is a long-term exercise, which will take different shapes depending on the social, hydrological, environmental and economic characteristics of a country. The water charging mechanism reform has to go through several iterations, revision of price set up cycle.
- The introduction and use of water charging instruments is unavoidably and strongly influenced by the political and economic interests of the society, as well as the current water governance situation. We encourage high levels of transparency, accountability and participation to increase the effective contribution of water charging instruments to sustainable water management. We encourage the Basin authority to involve in a constructive and open dialogue on water policy goals, the role of water charging in combination with other policy instruments, and the surrounding institutional framework.
- One of the objectives of introducing the water charge is to bring a sustainable use of the water resources. The Awash river water quality is showing deterioration and huge amount of sediment from the watershed find their ways into the reservoirs and irrigation canal. To maintain the quality and control the quantity, ABA has to monitor the river water at different points in a regular manner. Watershed management programs have to be carried out on areas where water is generated.
- The objectives of watershed management programs are to protect and enhance the water resource originating in the watershed and to check soil erosion and to reduce the effect of

sediment yield on the watershed. The watershed management costs have to be analyzed from some implemented projects in Awash Basin and they will be considered in irrigation water use charge.

- There is large scale irrigation farms abstracting water from the main river using properly designed and constructed diversion weirs. One problem is that the flow measuring structures provided at the intake structures may not functioning properly. The amount of flow diverted and distributed to the off-taking canals may not be known accurately. This problem has been raised by users and needs solution in the future.
- Finally, instead of using spreadsheet, the irrigation water use charge needs to be fully modeled and full-fledged application program must be developed in the future.

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## **Annexes**

Annex 1: Irrigation Technical Data Collection Instruments

Annex 2: Summary of Field data collected /Irrigation Technical

Annex 3: Maps of routes and samples for data collection and Pictures

Annex4 : List of Institution consulted by WP-2 team during the first field visit:



## Annex 1: Irrigation Water Charge Data Collection/Instruments

### 1. Background information

Code \_\_\_\_\_

#### Study Area/Catchment Location

1.1. Name of River/Lake Basin:		1.2. Catchment/Sub basin name	
1.3. Water system /catchment location in the basin within the Basin:	<input type="radio"/> Upstream =1 <input type="radio"/> Middle-stream =2 <input type="radio"/> Downstream =3	1.4. Geographical location (NE):	
1.5. Administration (Region)	Region=1: Wereda=3	Zone=2: Kebele/Village=4	
1.6. Water Irrigator extractor/user category:	<input type="checkbox"/> Institutions extractors=1 <input type="checkbox"/> Institution user=3 <input type="checkbox"/> Individual extractor=2 <input type="checkbox"/> Individual user=4		
1.7. Water and land use/cover	Monthly volume of water abstracted (at least one year)		
	Size of irrigated land in hectare =2 (net, gross)		

#### Legal and Institutional Information

1.8. Institutional contact Person:	Name=1:		Position=2	
	Phone Number=3:		Email=4:	

## Irrigation Technical

### General

6.1. Type of Irrigated Farm:

- ☐ Government (state farm) =1
- ☐ Cooperative Farm (WUA's) =2
- ☐ Private/commercial=3
- ☐ Small holders=4
- ☐ Other (specify)

6.2. What type of irrigation methods/technology do you use to irrigate your farm?

- ☐ Furrow irrigation =1
- ☐ Sprinkler irrigation =2
- ☐ Drip irrigation =3
- ☐ Flooding=4
- ☐ Center pivot =5
- ☐ Others (specify): \_\_\_\_\_

**Please include here net irrigated areas for each irrigation method in a separate table with volume of water abstracted for each area.**

6.3. Do you have flow measurement method at the abstraction point?

- ☐ Yes=1
- ☐ No=0

6.4. If yes please describe which method you are using? \_\_\_\_\_

**Please include here in a separate table with monthly volume of water abstracted at the diversion point for some years.**

6.5. Sources of Irrigation water (If the source is dam please fill section 8.4)

<input type="checkbox"/> River=1	<input type="checkbox"/> Rain harvesting=4	<input type="checkbox"/> Lake=7
<input type="checkbox"/> Dam=2	<input type="checkbox"/> Spring=5	<input type="checkbox"/> Shallow well=8
<input type="checkbox"/> Ground water (deep) =3	<input type="checkbox"/> Pond=6	<input type="checkbox"/> Flood water=9
<input type="checkbox"/> Other (specify)	<input type="checkbox"/> Deep well	

6.6. Method of water abstraction:

- ☐ From Dam/bulk =1  
☐ Pump=2  
☐ Diversion=3  
☐ Other (specify)

**Pump related data should be included here (please refer section 8.3)**

6.7. Types of crops grown:

**Please insert a table with types of crops grown /seasons/ area and so on**

**Existing irrigation practices:**

6.8. Fill in the table below with respect to irrigation water and land use

**A. Irrigation water use**

6.8.1. Quality	<input type="radio"/> Excellent=5	<input type="radio"/> Very Good=4	<input type="radio"/> Good=3	<input type="radio"/> Poor=2	<input type="radio"/> Very poor=1
6.8.2. Availability	<input type="radio"/> Plenty=3 <input type="radio"/> Dry season stress=2 <input type="radio"/> Always short=1				

**B. Irrigated Land use**

Salinity	<input type="radio"/> Plenty of unproductive land =1	<input type="radio"/> Some sign of salinity problem=2	<input type="radio"/> No salinity problem at all=3
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6.9. Measuring irrigation practices of the farmer (the level of farmer make scheduling of irrigation, uses discharge measurements, runoff control methods, etc)

	Very good=5	Good=4	Poor=3	Very poor=2	Not available=1
6.9.1. Practices	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6.9.2. Irrigation scheduling	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6.9.3. Runoff handling	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6.9.4. Measuring device	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6.9.5. Reuse of runoff	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

6.9.6. Water saving  
practices

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

6.9.7. Overall efficiency

6.10. How do you decide when and how much to irrigate your crops?

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6.11. Number of harvests per year, length of irrigation season, number or interval of irrigation per season for each crop grown in the scheme? )it is good to put the data in tabular form)

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6.12. Irrigator (farmers) insert scale

	Very good=5	Good=4	I don't know=3	Poor=2	Very poor=1
6.12.1.Irrigation skill knowhow (the level of knowing irrigation practices, good knowledge of plane, soil and water interaction)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6.12.2.Willingness to shift to new technology	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6.12.3.Ability to shift	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

6.13. Expansion plans: Do you have any plan to increase or decrease the amount of water withdrawn from your groundwater and/or surface water source in near future? ☐ Yes=1, ☐ No=0

6.14. If yes (above) please explain

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6.15. Water distribution infrastructure is in line with design ☐ Yes=1, ☐ No=0

### **Distribution systems:**

- 6.16. Please describe the irrigation system here: how water is abstracted, transported /conveyed and distributed. Types of conveyance and distribution and their respective lengths as it affects the irrigation efficiency which is important variable for water tariff.

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- 6.17. Please fill in the table below with regard to water distribution infrastructure

	Length (km) =1	Capacity (m <sup>3</sup> /sec =2	Leakage/ breakage=3	Maintenance (who is responsible)? =4	Other
6.17.1.Main Canal					
6.17.2.Secondary Canal					
6.17.3.Tertiary canal					

	Controlled/ gated=1	Lined (km) =2	Unlined (km) =3	Flow measuring device=4	Other
6.17.4.Main Canal					
6.17.5.Secondary Canal					
6.17.6.Tertiary canal					

- 6.18. Fill the table below regarding irrigation pump.

6.18.1.Irrigation pump type	<input type="radio"/> Centrifugal=1 <input type="radio"/> Other _____	
6.18.2.Capacity (l/s)		
6.18.3.Maintenance	<input type="radio"/> Yes=1, <input type="radio"/> No=0	If yes go to Q. no. 8.5.4
6.18.4.Frequency of maintenance	<input type="radio"/> Once=2, <input type="radio"/> Seasonal=3, <input type="radio"/> Yearly=4	

6.18.5.Power sources	<input type="checkbox"/> Diesel=1	<input type="checkbox"/> Electric=2
6.18.6.Water table	<input type="checkbox"/> shallow (0-10m) =3	<input type="checkbox"/> medium (10- 30m) =2 <input type="checkbox"/> deep (>30m) =1

6.19. Please answer the following question with respect to irrigation dam (if exists)

6.19.1. Storage capacity of the dam: \_\_\_\_\_ (m<sup>3</sup>)

6.19.2. Height of the dam: \_\_\_\_\_ (m)

6.19.3. Controlled by: \_\_\_\_\_

6.19.4. Other features \_\_\_\_\_

### **Water tariff related general part**

6.20. What are the challenges in irrigation agriculture related to your scheme: some of them are listed here

- ☐ Salinity
- ☐ Water logging
- ☐ Drainage water
- ☐ Water scarcity
- ☐ Water quality
- ☐ Damage on irrigation infrastructures
- ☐ Marketing
- ☐ Supply of agricultural inputs
- ☐ Corruption (related to water supply and delivery)
- ☐ Skill of operators
- ☐ Operation and maintenance
- ☐ Imposition in crops to be grown

6.21. Please explain the challenge:

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6.22. How do you evaluate the current irrigation water pricing practices in Awash basin and its challenges

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6.23. What improvements should made in the future? some of these are:

Quantity (canal capacity) ,Quality, Rate, Reliability, Billing system, Service quality Maintenance, or others

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## Annex 2 :Summary of data and information collected /Irrigation Technical

N o.	Name of Scheme	Location in the Basin (U,M,L )	Adm. Region	Scheme type (SH,P &C, G, Asso)	Source and method of water abstraction	Size net irrigated area (ha)	Crop types, growing season, irrigation interval, and area	Irrigation method/technology	Flow measurement and availability of flow amount abstracted	Conveyance system (distance from the source)	Distribution system	Irrigation practices (scheduling, water saving , reuse)	Major challenges in irrigation	Awareness and opinion on the existing water pricing	Remarks	Persons contacted and address
1	Wonji area sugarcane growers cooperative union, LTD	U	Oromiya	Asso	Awash river, pump	7000	Sugarcane	Overhead (about 80%) and furrow irrigation	measurement is taken at diversion structures			there is scheduling (I), no water saving (than using overhead irrigation methods) and reuse practice	water shortage, spare part , Management from AwBA,	If the service increases, the price is very small.	They are willing to pay based on the services.	AtoMulugetadagne, General manager (
2	OIDA	U	Oromiya											They don't know whether water fee is required or not.	They only provide the infrastructure and not participated in crop production	AtoKefyalewLema, D. Manager, 0923205124
3	Wonji Sugar factory	U	Oromiya	G	Awash river, pump	5700	Sugarcane	Furrow Irrigation	Measurement is taken at the pump		MC= 480m, SC=77120 m, TC= 198000m, all are not lined	There is Plot level schedule decided based on the soil type	water logging problem, water scarcity, EEPKO	current water fee is very small.		AtoAsres (0911853279) AtoTekeste H/mariam, (0930293044)
4	Africa Juice	U	Oromiya	P&C	Awash River, pump	560	Cytrus and cash crops	Furrow and drip irrigation	There is no flow measuring instrument	5km	All earthen canals and they don't have any other data about the distribution systems	They have technical personnel to do this	Pollution, loss in the canal (about	are ready to pay, every body using the river should pay.		Ato Tufa, crop protection manager (0930292037); Mr. Bel, Production manager



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5	Uppr Awash Agro Industry Enterprise	U	Oromiya	P&C	Awash River, gravity system	3900	perennial crops cotton. Bean and Tomato	Surface irrigation (basin)	The canals are agatedbu there is no measurement	18km			Soil salinity, water scarcity, turbidity, canal maintenance	They are willing to pay.	there should be enforcement mechanism to adopt better technology,	AtoChalchisa, Upper Awash Technical manager (0910098687); AtoMenkir (0910037604)
6	Awash Winery	U	Oromiya	P&C	Awash river, deep well	193 ha, plan to add 80 ha of Wine farm	wine, cash crops	drip and furrow irrigation methods.	There is automated flow measuring device for drip systems only (they use about 150 m <sup>3</sup> /ha water per week).	5km (unlined canal)	They don't have information about this	There is no any practice. Rather, they decide based on their experience	water loss, water scarcity	The current water fee is very small.	the payment should be volume based not area based,	Mr. Johan, Agronomy manager (0935409504)
7	Metehara Sugar factory	U	Oromiya	G	Awash river, pump	13,333	sugarcane & fruits,	Furrow irrigation	There is staff gauge and data is collected three times per day	main canal is 18.94km	47.66km secondary canal, 67.29 km lateral and 11.925 km sub laterals	They use cropwat (they estimate that 64 ha land should be irrigated within 12 days).	siltation, water logging, beseka lake, EEPCO, Kokareservoir management, water scarcity	They are paying	The price should consider the location of farm lands,	AtoTofikJemal, senior irrigation specialist (0911318166); AtoDerejeGirma (0939769263)

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8	Red Fox Ethiopia PLC	U	Oromiya	P&C	Awash river	44 ha	Flower epicotyl	Drip	They have flow measuring device and they use about 1500m <sup>3</sup> per day			they decide based on the standards in relation to light intensity	Flood, pollution, salinity	The current water fee is very small.	relative fee based on water use amount and quality, enforcement to use better technologies	Mr. Serawit Eshetu, Irrigation manager (0912811343)
9	Trisol PLC	U	Oromiya	P&C	Awash river	52.3	Orange, Tomato, green pepper, Onion, Mango	Furrow irrigation	No flow measurement	15m away from Merti-Jeju canal	No data	soil moisture inspection	Flood and market problem,	paying for water and canal maintenance	canal should be maintained periodically.	Ato Michael Solomon, General manager and owner (0947882888)
10	TigilFriw water users association	U	Oromiya	Asso	Awash river, Pump	38.5	Onion	Furrow irrigation	no measurement	No data	No data	No data	No water shortage and the main problem is EEPCO.	They are paying 1554 ETP per annum for the whole area.	AwBA have no power to manage the basin although authorized to act as owner of the basin. "fee for water is not the issue, rather it is better to give value for water"	Ato Kumlachwe Akewak, General Manager (0911536243)

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11	Florensis Ethiopia	U	Oromiya	P&C	GW, Awash river	15 ha	Cutting industries	Drip	On the pump	they use green houses	they use green houses	They have climate controlling boxes to fix schedule and irrigation water requirement	Tele (in relation to network for climate control boxes)	They are okay if the fee is reasonable	The government should work on watershed management, infrastructure construction (like road) should consider flow direction of their drainage systems	Mr Erik Westerman, general manager (0911490173); Mr. Netsanet, Agronomy and product manager; Mr. H/Maryam, Irrigation department head
12	Vegpro Agriculture PLC	U	Oromiya	P&C	GW	20	Roses with different varieties	Drip	Yes and they use 750m3 water per day	they use green houses	they use green houses	The irrigation interval and irrigation water amount is decided based on visual inspections	Salinity (the Ph is around 8), water scarcity	They believe that the current fee is very small	If the fee is increased by 5% to 10% in annual basis, I will be fair.	

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13	Mahdi Abdi Farm	M	Somali	P&C	Shallow well	8ha	Papaya, Orange, Mango, Lemon, Coffee	Flooding			secondary canals	Irrigate once per week based on crop sign	water shortage	No triff at the moment. But they are willing to pay if the service is improved		BeshirHassen, Mager (0915752149)
14	Tony Farm	U	Diredawa	G	Deep well	20 ha	Orange, Citrus, Maize and vegetables	Furrow and drip irrigation		The main line is pipe		by plant sign, soil and others	Salinity, water scarcity, water quality, marketing, O&M	They don't have a problem on water charge		915402699
15	Shinile	U	Somali	SH	Spring	300ha	Onion, Orange, Mango, Tomato	duged well		2km main canal		Irrigate based on crop sign	Salinity, water scarcity, water quality, marketing, O&M	They are paying 10% for the canal		
16	Amibra	M	Afar	G	River	160ha	Cotton, Wheat, Animal food, Rice, and permanent fruits	Furrow irrigation system	No	2km main canal		By looking the plants and soil test	Salinity, water scarcity, damage on irrigation infrastructures	As it is non-profitable, it is hard to pay for water		Nurehussen, representative (0919633535)
17	Sunta Irrigation project		Afar	Asso	Well	2000ha										Mohammed Seid (0920543893)

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18	Chifra	L	Afar	SH	Shallow Well	74ha	Maize	Furrow, Sprinkler	No			Crop sign				
19	Elfora			P&C	Groundwater, pump	77ha	Tomato, Onion, Pepper, Cabbage, Banana, Mango, Avocado, Papaya	Furrow Irrigation	Yes, but no for canals	600m main canal	there are secondary canals of 600m length each		Salinity, Water logging, Drainage water, water scarcity	They believe that there should be payment if there is service for that		Endris Abdu, Farm supervisor (0910442090)
20	amibara irrigation development	M	Afar	private	river, Diversion	6017	sugarcane	furrow	measurement is taken at diversion structures			the quality of water is poor and the availability of it is stressing in dry season.	shortage of water is the major problem.	Our agreement is to pay per CWR but the delivered amount of water is too small due to upstream users hence the process of payment is not fair but the pricing is amll.	they are ready to pay if the requested water is delivered to them even the price if modified or not.	Mr. Assefa, human resource . Mob.0911347777

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21	kesem sugar farm	M	Afar	gov't	dam, Diversion	2700+1400	sugarcane	furrow	measurement is used at each intake, and flow mass curve is used.			the quality of water is good and plenty of water is available.	the main problem administration to enhance land since the place is in afar region ruled by the clan system the gov't had not an opportunity to push the community to get land. At the dam gates are non functional hence excess water is flowing.		the dam is under attack there is no any one responsible for it. Either AwBA or the factory should take the responsibility.	AtoMollaRedaFarmer engineer Mob. 0936046364
22	demilew	M	Afar	private	river, Diversion	54	cotton	furrow	flow is measured at intakes.			quality of water is poor and there is 76 ha of unproductive land due to salinity.	salinity and scarcity of water is the main problems.	the price is very small hence if there is a fulfillment of all operation they are willing to pay.	maintenance of the main canal should be undertaken by the Authority, the rate and quality of water should be increased.	AtoDemilew Owner mob. 0930072522

N o.	Name of Scheme	Locati on in the Basin (U,M,L )	Adm. Regio n	Schem e type (SH,P &C, G, Asso)	Source and method of water abstract ion	Size net irrigate d area (ha)	Crop types, growing season, irrigatio n interval, and area	Irrigation method/techn ology	Flow measure ment and avaialbilty of flow amount abstracte d	Conveyan ce system (distance from the source)	Distribution system	Irrigation practices (scheduli ng, water saving , reuse)	Major challenges in irrigation	Awarenes s and opinion on the existing water pricing	Remarks	Persons contacted and address
23	werer research center	M	Afar	gov't	Awash river, Diversio n & Pump	180	cotton, maiz, sesame, rice	furrow	flow is measured at intakes.			both model based and soil moisture capacity test are used.	scarcity, water quality, and damage on the infrastructu res are the main problems.	the level of knowing the irrigation practices is good and work with a good plan.	regulators should be functional.fu rther investigation should be taken to know the effect of lake Beseka to Awash River.	AtoFikaduRobi, assistant researcher Mob. 0910156312
24	haji Ahmed mehamed	M	Afar	private	river, Pump	1254	cotton	furrow	measur ment is used at the intake to the main canal from the weir.	the main canal ranges from 4 to 5 km.	water from main canal to secondary to tertiary then psyphons are used at the field to take water to each furrow.	their practice is based on soil type, wheather condition and schedule d system.	due to scarcity of water there is unirrigated land of 500ha. The main canal is below its capacity due to sedimentati on it should be maintained. There is also slinity of soil.	the price is fair, but they are willing to pay if there is a good mechanis m to maintain the canal and if there is possibility to deliver the requested water.	the canal should be maintained.	AtoDemisshWegaye hu Farm Manager mob. 0910066011

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25	hameditabota	M	Afar	private	river, diversion, & Pump (Dry Season), Diversion	2.5	cotton	furrow	there is no flow measurement device.	during high flow they use traditional canal and diversion is used but during low flow pump is used.		irrigation practices is based on physical inspection	salinity, scarcity, flooding are the main problems.	there is no any payment till now. But if the infrastructures are built we are willing to pay.	main canal should be constructed, and river training works should be built.	AtoMoyaleKedir Owner Mob. 0911817282
26	kalid farm	M	Amhara	private	ground water	15.3	papaya, habhab	furrow	no.	from the well water conveyed through plastic hose to the distribution system.		the overall efficiency of the field is poor.	electricity, road access and water supply is the main problems.	the price is too small and not enough for the authority. We are willing to pay for the improved one.		atoKalidAbdela Owner 0911984019
27	Tendaho sugar farm	L	Afar	gov't	dam	11300	sugarcane	furrow	measurement is taken at the intake of the dam.	stored water is released from the dam based on the demand requested.			high loss of water due to the operators' low skill and awareness.	the payment is fair	pricing should be based on study. The canal should be frequently maintained.	AtoBelachew Team leader mob. 0910277936
28	Shewarobit Prison farm	M	Amhara	gov't	robi river	130		furrow								



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29	gewanewereda		Afar		river	3812	cotton, maize, tomato, onion	furrow	no.	diversion, pump			fluctuation of flow (flooding, and scarcity) is the main problem.	no way till now but willing to pay if main canal and other infrastructures are built by the authority.	flood protection structures should be built.	moyalekedirweredacomitee mob. 091108107282
30	kaluwereda	M	Amhara		river	7236.5	chat, coffee, apple	furrow, flooding	no.	diversion, pump		water quality is good.	scarcity, adaptability of crop, and market	no.	canal should be constructed,	AtoAmedkebede farm expert mob.0913837058
31	kewetwereda	m	Amhara		river	6347	20% tobacco, tomato, cabbage	floodind, furrow	no.	diversion, pump		peridical (tera)	salinity is the major problem.	no. but willing to pay if there is fulfillment of infrastructures.		Atokitawhaile farm expert mob. 09130281524
32	dubtiwereda	L	Afar	Asso	Awash river, dam	3467	Onion, Tomato, Maize, Pepper		Yes, at the intake				flooding, quality of water(disease), salinity(plenty of land).	no. but willing to pay if there is fulfillment of infrastructures.	Cnalefficiency should be increased	AtoAlli milleweredaadmi.

### Annex 3: Maps of routes for data collection and Pictures

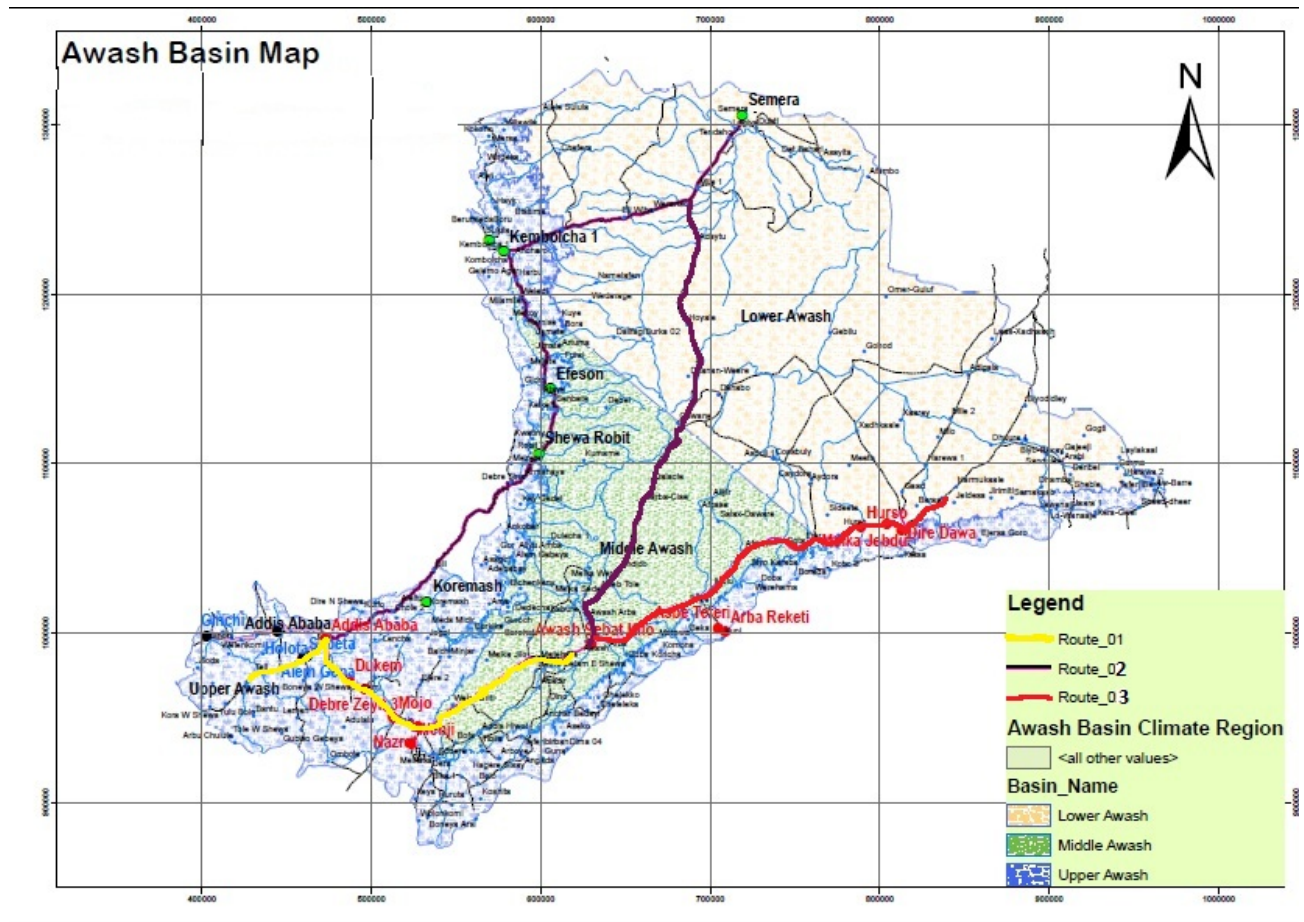


Figure showing the routes for the three team (Route 1 -3) during data collection

**Annex 4:** List of Institution consulted by WP-2 team during the first field visit:

No	Name of Institution	Person/s Interviewed	Position	email
1	Awash Basin Authority(ABA)	Getachew,	Director of ABA	
2	Tendaho Sugar Factory and Tendaho Dam and Irrigation Project	Abdulshekur Muhgir Seid Ahmed	Engineer Engineer	<a href="mailto:aymenabdu2007@gmail.com">aymenabdu2007@gmail.com</a> <a href="mailto:seid8642@gmail.com">seid8642@gmail.com</a>
3	Afar Regional Water Bureau	Abdule Muhammed Abdulaziz	Planning and program head water resource management head	
4	Amibara Middle Awash Irrigation Development Company	Elias Sahlemariam Sileshi Assefa	General Manager Engineering Department Head	<a href="mailto:eliassahlemariam@gmail.com">eliassahlemariam@gmail.com</a> <a href="mailto:seleshea@yahoo.com">seleshea@yahoo.com</a>
5	Demlew Gebeyehu	Private Farmer at Werer	Farm Manager	
6	Werer Agricultural Research Center	Desta Gebre	Director of the Center	<a href="mailto:destabanje89@gmail.com">destabanje89@gmail.com</a>
7	Wonji Sugar Factory	Ato Shushay W/Selassie	Civil, irrigation, infrastructure construction and maintenance Division head	<a href="mailto:legeseshushay@gmail.com">legeseshushay@gmail.com</a>
8	Wonji Area Sugar cane grower Farmers Association Union	Ato Teshome Abera	Union's D/Manger	
9	Cattle Fattening Enterprise	w/o Kebere Mulat, Seyum Balcha	President of Livestock fattening and exporting association member of the association	

<b>10</b>	Ministry of Water, Irrigation and Electricity	Abiti Getaneh  Asmamaw Kumessa	Director, Research and Development Directorate Transboundary River Basin Management	
<b>11</b>	Oromia Water, Mineral and Energy Bureau (OWMEB)	Gezahegn Lemecha	Water Supply Process owner	
<b>12</b>	Ministry of Agriculture (MoA)	Elias Awol	Small Scale Irrigation Development Directorate Director	
<b>13</b>	South Wollo Zone Water, Irrigation and Energy Bureau	Umer Aragaw  Tefera Melaku	Expert  Fruits and vegetables expert	
<b>14</b>	Kalu Woreda	Jemal Mohammed Sadik Mohammed	Fruits and Vegetable, Irrigation Water Use Process Owner	
<b>15</b>	South Shoa Zone Water Resources Administration Process Irrigation Infrastructure Construction Process	Mulatu Fikre,  Tigist Molla Abebe Eshete	Process Head  socio-economist watershed management expert	