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MINISTRY OF AGRICULTURE

SERVICE DELIVERY IMPLEMENTATION STRATEGY FOR SMALL SCALE IRRIGATION TECHNOLOGIES AND RELATED SERVICES

DEVELOPED BY

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ABBREVIATIONS

(A)TVET	Agricultural Technical and Vocational Education Training
AAMEI	Adama Agricultural Machinery and Engineering Industry
ACSI	Amhara Credit and Saving Institution
AGP	Agricultural Growth Program
AISE	Agricultural Input Supply Enterprise
AMRC	Agricultural Mechanization Research Centers
ATA	Ethiopian Agricultural Transformation Agency
CBE	Commercial Bank of Ethiopia
CRGE	Climate Resilient Green Economy
CSA	Central Statistical Agency
DBE	Development Bank of Ethiopia
DECSI	Dedebit Credit and Saving Institution
DPT	Department of Pump Technology
EBCR	Benefit Cost Ratio
EIAR	Ethiopian Institute of Agricultural Research
EIRR	Economic Internal Rate of Return
EDA	Enterprise Development Agencies
ERCA	Ethiopian Revenue and Customs Authority
ESA	Ethiopian Standards Agency
EDRI	Ethiopian development research institute
FCA	Federal Cooperative Agency
FDRE	Federal Democratic Republic of Ethiopia
GDP	Gross Domestic Product
GTP	Growth and Transformation Plan
IDE	International Development Enterprises
ISGWID	Integrated Shallow Ground Water Irrigation Development
MDG	Millennium Development Goals
MFI	Microfinance Institutions
MoF	Ministry of finance
MoI	Ministry of industry
MoA	Ministry of Agriculture
MoALR	Ministry of Agriculture
MoANR	Ministry of Agriculture and Natural Resources
MoFED	Ministry of Finance and Economic Development
MoI	Ministry of Industry
MoWIE	Ministry of Water Irrigation and Energy
MoWR	Ministry of Water Resources
NGO	Non-Governmental Organization
NPC	National planning commission
NPV	Net Present Value
O & M	Operation and Maintenance
OIDA	Oromiya Irrigation Development Agency
PASDEP	Plan for Accelerated and Sustained Development to End Poverty
PV	Photovoltaic

PTA	Pump Technician Association
PUA	Pump Users Association
RARI	Regional Agricultural Research Institutes
SITE	Small Scale Irrigation Technology expansion
SMIS	Small and Micro Irrigation Support
SNNPR	Southern Nations, Nationalities, and People's Region
SPT	Solar Pump Technology
SSI	Small Scale Irrigation
SSID	Small Scale Irrigation Directorate
SSA	Sub Saharan Africa
TAD	Transformational Agenda Deliverables
WUA	Water Users Association

EXECUTIVE SUMMARY

Development interventions that focus on rural households in Ethiopia could improve the livelihoods of about eighty-eight million people in the country. Irrigation development can optimize the economic, social and environmental interests concurrently. Empirical evidences suggest that small scale irrigation scheme could increase agricultural returns; employment and rise income of actors in the value chain.

Although the government has launched several policies, programs, projects and exerted huge efforts, the sector remained vulnerable due to several constraints including lack of ownership; lack of technical knowledge and skill; lack of finance; lack of operation and maintenance services; poor technologies; weak coordination and linkages among stakeholders. The representative assessment result suggested a specific strategy that can virtually respond to the institutional, supply and demand challenges of small-scale irrigation sector. The proposed strategy envisions to boost smallholder agricultural production and food security, create employment intros for the youth, women and farmers, and sustainable business while accounting for the social, economic, institutional and environmental sustainability.

This service delivery implementation strategy establishes decentralized special enterprises and develops them in providing effective services of all kinds in the sector including pump operation and maintenance services; supply of spare parts, fuel, pumps; trainings, other related technologies and services. The individual members of the enterprises are selected based on objective criteria-the practical skill, innate passion, dedication, social trust, education or trainings and familiarity with local socioeconomic context.

The recommended three business models (the entrepreneur model, enterprise model & integrated model) would be adapted flexibly depending on the existing technology, future demand and market viability of the local context. Moreover, the developed sample business plan presents the major activities to be done with their corresponding costs, benefits and financial feasibility analysis.

Accordingly in 2020 the strategy is assumed to establish more than 5 thousand service enterprises with an estimated initial investment of Bir 217 thousand per enterprise that can provide over 48 thousand operation and maintenance services for about 437 thousand motor pumps used to cultivate over one million hectares of land, employ over 2.5 million eligible youths, women and farmers, would generate profit of Birr 444 thousand in 2020 and Birr 715 thousand in 2025 per enterprise with a net present value of Birr 25.7. Generally, the strategy provides an integrated approach for small-scale irrigation technologies and related services to increase smallholder agricultural productivity and sustainable business within the sector.

Key Words: Service delivery implementation strategy, Small-scale irrigation technology, related services, Service enterprises, Ethiopia

1. INTRODUCTION

1.1 Rationale of the Strategy

The importance of small-scale irrigation in smallholder farming is proved to be significant and determine the extent of agricultural production and food security. Accounting its importance to the growth of agricultural sector and its contribution to aggregate output, the government of Ethiopia is committed to enhance agricultural production and employment through developing small-scale irrigation schemes. Since small holder agriculture accounts for over 90 percent of the total agricultural livelihoods in Ethiopia, such initiatives are expected to boost food production, consumption, employment and poverty reduction. The sector has received unique emphasis by the government, the community, development actors and donors. However, assessment reports indicated that there has been increased demand for the schemes by farmers, substantial inspirations and support activities given by the government, SSI programs, projects and other NGOs, but in a disorganized, uncoordinated and inconsistent manner. It requires a systematic approach to expand the technology across Ethiopia to exploit its advantages and untapped opportunities.

Both theoretical and empirical literature underlines the benefit of irrigation on agriculture and its livelihoods particularly under changing climate system. Irrigation has boosted agriculture and rural development in Africa (Babatunde, 2006; Steiner-Asiedu, et. al., 2012; Tekana and Oladele, 2011). Similarly, irrigation scheme could create wealth for millions and contributed much to non-farm rural development and national growth in Asia (Jin, et. al, 2012). The benefit-costs analysis associated with irrigation projects has been examined across the world and found positive significant net- benefit.

In Ethiopia, several studies (Anwar, 2014; Ayele, et. al., 2013; Hagos and Holden, 2003; Haile, 2008; Hanjra, et. al., 2009; Solomon and Ketema, 2015) on the small-scale irrigations show positive and significant effects on production, consumption, income as well as on food security. For example, Tizita (2017) studied the effect of Small-Scale Irrigation on Household Food Security in Bona-Zuria Woreda, Sidama Zone of Southern Ethiopia. The findings revealed that most of the irrigation users are found to be food secure. Furthermore, Ayele et, al. (2013) examined the impact of small-scale irrigation on household income and the likelihood of poverty in the Lake Tana basin of Ethiopia. By employing the logit model, they found that small scale-irrigation users' annual mean income increased by 27% compared to non-irrigators.

Specifically pump irrigation has increased in Ethiopia and improved production (Dessalegn and Merrey, 2015). Maximizing the advantages in small holder agriculture requires modernizing of the sector through developing irrigation schemes and strengthening its supply chain. The producers, consumers and distributors must be benefited from rise in production, investment and job creation. However, small scale irrigation value chain has been constrained by several factors (structural, supply, quality, service, linkage, legal, capacity). Among others, low farm production and high unemployment and poverty remained the key challenges. Although there is high and increasing demand for the scheme, poor supply of the technology and its related services has seriously constrained the expected benefits from the sector.

In addition, recently unemployment among youth and women become series challenge in Ethiopia. Fast population growth coupled with limited economic and livelihood options has resulted in significant increase in the rate and size of migration; rural-urban migration and mainly out-migration in the last few years. Yet ensuring productive employment opportunities both in rural and urban areas remained a double burden. Different strategies, programs and initiatives have been planned and implemented in agriculture.

Consequently, the government planned, as part of CRGE strategy (2011) and GTP-II (2015-2020), to support smallholders' farmers to increase crop production, ensure food security and reduce poverty through small-scale irrigation development while creating job opportunities for booming labor force and vulnerable groups. Small scale irrigation development is focused because smallholder agriculture supports over 90% of agricultural households; which has greater productive and absorptive capacity (NPC, 2016).

Irrigation development requires responsive body and effective supply chain that provide quality technologies, inputs and associated services. Farmers need improved service access. The public institutions are expected to facilitate activities in the entire chain; the private sectors. Individuals, enterprises and entrepreneurs or cooperatives as important players should be invited. In general, several stakeholders including suppliers, middle players and end users shall participate, contribute and benefit from the sector. For this to happen, strengthening and reforming the structure, creating linkages and coordination among state and non-state actors, through identifying the opportunities and challenges in the sector on sustainable basis. Strategic interventions are urgent to unveil the untapped opportunities in agriculture and establish sustainable business in the value chain.

MoA has initiated a project entitled: "*creating unemployed youth and women to become micro-entrepreneur in irrigation pumps and related technologies O & M and access services through training, licensing, registration and legalization"*. Findings from situation assessment in Amhara, Tigray, SNNP and Oromia regions revealed that the sector is constrained by several factors.
This implementation strategy is prepared based on findings of the assessment with ultimate goal of devising national mechanisms that to be implemented across Ethiopia in an organized and coordinated manner towards boosting production and employment creation.

1.2 Strategic Vision and Objectives

1.2.1 Strategic Vision

This strategy envisions *"excellence in service delivery for smallholder irrigation technology and related services to enhance sustainable agricultural production and food security and create sustainable business for increasing vulnerable labor within the sector across Ethiopia"*

1.2.2 Strategic Objectives

The strategy will have several direct and indirect purposes, amongst the major objectives are:

- *Provide accessible, affordable and sustainable services for the smallholder irrigators*
- *Increase agricultural production and productivity among smallholder irrigators*
- *Create employment opportunity and income for growing labor including women*
- *Increase income earnings of actors engaged in the value chain on sustainable basis*
- *Improve the welfare of consumers from increased food supply with reasonable price.*

2 STRATEGIC PRINCIPLES AND DIMENSIONS

2.1 Strategic Principles

The national strategy on the "*service delivery implementation strategy for small-scale irrigation technology and related services*" sees excellence in service delivery towards enhancing sustainable smallholder agricultural production and business enterprises under the guiding assumptions of inclusiveness, effectiveness, efficiency, fairness, integration, synergy and sustainability.

Inclusiveness: small scale irrigation technology scheme shall include all eligible vulnerable social groups such as unemployed youths, women, farmers and small investors that are engaged in SSI.

Effectiveness: the selection of service providers (individuals or joint enterprises) shall be based on experience of pump operation and maintenance followed by expected performance for this service.
Efficiency: all service providers, middle players and end users shall make business decisions that require minimum possible costs, wastage or lowest possible resource use.
Fairness: all possible costs incurred and benefits earned from services delivery in the sector shall be distributed fairly among actors by assuming the marginal cost-marginal benefits principle.
Integration: there shall be smooth linkage and communication among key stakeholders including suppliers, middle players and end users of the irrigation technology.
Synergy: upon application the strategy shall engage the public and private sectors, NGOs, and individuals such farmers, suppliers, enterprises, agents, experts, and authorities in key decisions.
Sustainability: the expansion of irrigation technology shall maintain sustainable use of water through augmenting environmental rehabilitation activities, tree plantation, and avoid unsafe waste disposal from pump operation to water bodies and the environment.

2.2 Strategic Dimensions

Sustainable irrigation technology expansion shall integrate four development dimensions namely the institutional, social, economic and environmental dimensions. The strategy shall promote institutional effectiveness, social fairness, economic feasibility and environmental sustainability.

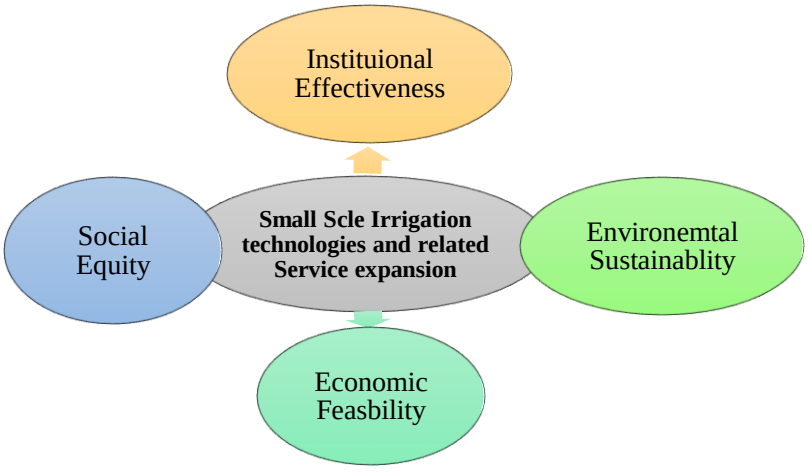

Figure 1: Strategic Dimensions

Institutional dimension of the technology expansion shall promote the institutional effectiveness: through ensuring the availability and enforcement of relevant irrigation pump technology

institutions such as structure, policies, proclamations, regulation and rules from federal level to lowest administrative levels.

Social dissension of the technology expansion shall maintain social equity in irrigation technology adoption and expansion in the value chain focusing on end users and affected demand side actors.

Economic dimension of the scheme expansion shall enhance economic feasibility, in irrigation technology growth in the value chain focusing on suppliers, service providers and affected actors.

Environmental dimension of the technology expansion shall maintain the resource and ecological sustainability. The wastage of water and waste discharge from operation and maintenance service centers and from agricultural fields shall be the lowest or zero, if possible.

2.3 Scope and Limitations

This country wide implementation strategy plan is prepared based on the field assessment results of existing operations and maintenances service delivery conditions of small irrigation pumps and related technologies. The field assessment task covered only four regional states; Amhara, Tigray, SNNPR, and Oromia with the assumption that these regions could represent the country.

After the field assessment issues that need outstanding attention have been emerged. Regarding the title of the document, the initial title of the proposal was "*A Strategy for Establishing Unemployed Youth and Women as Micro-Entrepreneurs for Service Delivery of Irrigation Pumps and Related Technologies*". However, it was found that service delivery of the sector was not and cannot be addressed by a single social group i.e. unemployed youth and women. On the contrary, extensive involvements of other groups such as farmers and their youngsters, local artisan, technicians etc. have been witnessed.

The same is true regarding the issue of "*related technologies*". Initially it was intended to assess the service delivery conditions of the irrigation pumps and technologies including manual (rope, treadle), electric, solar etc. pumps as well as hand dug drilling, renting of threshing, harvesting, plowing tractors etc. The pump irrigation sector was totally dominated by different models of fuel driven or motorized pumps. Rather within the assessed local communities, the service delivery sector was highly associated with technologies such as bajaj, motorcycles, fuel, generators, dynamo and so on. These cases dictate to reconsider the title and forced us to estimate the financial feasibility for motor pumps only. Despite these realities, due to strategic plan of the country that

expand these technologies for smallholder farmers, the implementation strategy has selected some related technologies and recommended as potential business areas.

2.4 Structure of the Strategy

This execution strategy comprises of three major parts; the first provides introduction, objectives principles and dimensions of the strategy; parts two presents the core strategic intervention and expected targets; and parts three includes proposed business models and sample businesses plan.

The first part describes the rationale for developing the implementation strategy, the background principles and existing situations in the value chain of the service sector. This section is the continuation of the field assessment report which contains extensive results of the existing service situations including SWOT analysis. Field assessment methodologies and findings were presented in the document entitled "*Assessment Report on Irrigation Pumps, Related Technologies and Service Delivery Situation in Ethiopia*" and advised to refer it whenever necessary.

Within section one, based on the findings and recommendations, the long and short-term strategic interventions, expected targets and implementation plans together with monitoring and evaluation mechanisms are discussed in detail.

Section two comprises three business models and sample business plans for enterprises to be established. The business models were developed focusing on improving service delivery to smallholder farmers, whereas the business plan was developed for an enterprise (individuals or groups) to be established formally and are expected to engage in the proposed service delivery activities.

2.5 Definitions of Important Terms

Different stakeholders may define the following terms in different way. In our particular case, the definitions are operationalized based on what to do, who to do, and how to do the proposed activities. The nature of the business, types of services, stakeholders (suppliers, service providers, meddle players) in the value chain. These definitions are used throughout the strategy document.

Strategy refers service delivery implementation strategy for smallholder irrigation technology and related services.

Smallholder or household irrigation: is irrigation agriculture undertaken in less than 5 ha of land area and benefited up to 10 households. Irrigation managed at household level through water lifting

and saving technologies. It can apply various energy sources to generate water such as motorized pumps for full and supplementary irrigation of seasonal and perennial food, industrial, energy and fodder crops.

Small scale irrigation technology: include various modern irrigation pumps and their spare parts.

Small irrigation water pumps**:** are any water pumps such fuel pumps, electric pumps, wind pumps, or solar pumps possessing 2 to 10 horse power; and used to abstract or deliver irrigation water from rivers, streams, rain or ground water to smallholder irrigation. This strategy focuses on fuel (diesel or gasoline/petrol) driven small irrigation pumps are called fuel pumps, motor pumps, or engine pumps.

Irrigation agriculture: refers to crop production that uses water through irrigation pumps and or animal production that uses water abstracted from different sources.

Operation and maintenance services**:** are activities and tasks performed, awareness, training and information shared to maintain proper utilization and healthy operation of small irrigation pumps.

Related technologies and services**:** are technologies and services that require; first, nearly similar technical knowledge, skills and facilities with that of small irrigation water pumps; second, that are directly or indirectly related to the sector; and finally, that are widely used by local community.

Service package**:** It consist various irrigation technologies and related services that can promote smallholder production and sustainable business for emerging irrigation enterprises. The package may include operation and maintenance service for pumps and related items, supply of spare parts, fuel and oil, trainings, pumps, water drillings, tractor, harvester, crusher and related services.

Service providers**:** may include individuals, enterprises, public and private organizations, and non-governmental organizations that are engaged in service delivery to actors in the value chain.

Suppliers: can be private enterprises, joint enterprises, government or NGOs that are engaged in manufacturing, import, wholesale, retail or distribution of irrigation pumps, related technologies, spare parts and services to end users. The special enterprises are vital suppliers in our case.

End users**:** are service recipients or irrigation scheme beneficiaries such as individual farmers, pump user associations, farmers associations, youth associations, women associations and small investors that are engaged in irrigation agriculture.

Middle players**:** may include individuals, private or organized enterprises, government or NGOs that bridge between suppliers and end users to enhance effective business transaction. They deal

with the organizational structure, staffing, facilitation, capacity building, financial, linkage, credit, legal service, coordination, information, evaluation and feedback system.

Enterprises: may refer to individual enterprises or joint enterprises to be established to engage in service businesses under SSIT and related services; shortly be called "SITE Enterprises". They are localized business centers that are mainly involved in providing SSIT packages.

3 IRRIGATION DEVELOPMENT IN ETHIOPIA

Irrigation in general and small-scale irrigation in particular is vital for agricultural development and poverty reduction (Awulachew, 2010; Cherre, 2006; Haile, 2008; Mpala, 2016). Both the traditional and modern irrigation has been implemented and contributing significantly in Ethiopia. Modern irrigation was started in 1950s in Ethiopia; but explicit policy, strategy and plan of the sector is well documented in recent years (Hanjra, et, al., 2009). Since agriculture is backbone of the economy, almost all regions were doing their best to develop the irrigation sector.

Since 1990s, the government has formulated different enabling policies, strategies and plans related to irrigation development. Among others, Water Resource Management Policy (1999), Water Sector Strategy (2001), Irrigation development strategy (MoWR, 1999; 2001); and GTP-I and GTP-II (Awulachew, 2010; MoFED, 2010; NPC, 2016) can be listed. The government was committed to improve the existing water and irrigation by enhancing water cantered development in the economic development planning (GWMATE, 2011). Specifically, GTP-I & GTP-II set broad-based accelerated and sustained economic growth through agriculture-based industrialization (MoFED, 2010).

3.1 Smallholder Irrigation

Irrigation schemes differ considerably in size and structure. In the Ethiopia, irrigation schemes are categorized in to three classes; small, medium and large scale. SSI schemes are those which have less than 200 ha. Medium scale schemes cover an area of 200-3000 ha while large scale irrigation schemes cover an area greater than 3000 ha). SSI schemes are the responsibility of the MoARD and regions, while medium and large scales are the responsibility of MoWR (MoWR, 2001).

SSI is also categorized as traditional and improved schemes. Some of the common SSI schemes are traditional schemes, modern diversion schemes, micro/medium dams, pumped schemes, micro-irrigation and shallow groundwater harvesting. Traditional schemes are often initiated, implemented and managed by the community, while modern schemes are typically initiated and

assisted by the government, NGOs and other donors (MoA-NRMD, 2011). Currently, the government aims to modernize and expand traditional irrigation schemes and encourage small scale irrigation (Dessalegn and Merrey, 2015).

Household irrigation is a transformative opportunity for smallholder farmers. In a traditionally rain-fed agricultural calendar, household irrigation opens cropping cycles during the dry season and enables farmers to grow high-value crops like vegetables. In many instances, irrigation can thus lift household income from US dollar 147 to 323 per hectare per year. With current irrigation practices covering below 2% of total land area, this income gain represents huge untapped potential for the country. It means household irrigation can enable more than 650,000 farmer households and almost 5 million Ethiopians to double their production and incomes, promoting food security, and catalysing growth in their communities. The national household irrigation strategy was created to realize this opportunity with overall vision of a vibrant and self-sustaining household irrigation sector. Increasing adoption and effectiveness of household irrigation technologies in order to; increase income for smallholder farmers, improve food security throughout the year and catalyse growth in farming communities (MoA and ATA, 2016).

According to ATA (2018) study report on Irrigation Technologies and Services Supply Chain, one million farming households will have access to shallow groundwater for irrigation that will be developed sustainably. Around 200,000 farmers (30% female) will have access to different irrigation technologies and services including energy efficient and water saving technologies for irrigation on 185,400 ha land.

3.2 Smallholder Pumps

The decision-making on “energy options for irrigation” lies at the heart of the water, energy and food nexus. This warrants a cross-sector examination of effective ways to deploy pumping technology for irrigation and maximize the benefits. When irrigation water withdrawing technologies are considered, lists of technologies could be narrowed into pressurized and gravity systems. Pumping water from either surface sources such as ponds, lakes, and canals, or from underground through open wells or deeper bore wells, is primary driver for irrigation. These pumps use various power sources, such as manual, fuel, electric, solar etc. and will be briefly discussed below in Ethiopian context.

3.2.1 Solar Pumps

Powering irrigation systems with solar energy is a reliable and environmentally sustainable option in a growing number of contexts (Abebe, 2016). Solar powered pumps exist in three main categories: concentrated solar, solar thermal and PV. Solar PV systems are more commonly available than concentrated solar and solar thermal pumps, which account for only a small share of the global solar-powered pump market. Complete PV systems are complex, consisting of a PV array, inverter, motor, pump and a water storage tank or a battery to store energy.

There is limited information about solar pumps in Ethiopia, but SSA accounts for only 9% of the world's PV systems, despite the fact that most countries receive, on average, between 4 and 6 kWh/m²/day of solar energy in most months of the year. This would allow a square meter of solar panel to generate 4 to 6 kW of electricity (Otoo et. al., 2018).

The major obstacles are information gap using the technology, farmers complained on the quality, lack of adequate foreign currency and shortage of finance the technology, inadequacy of reliable supply of spare parts and maintenance and insufficiency of periodical capacity building. Relatively high capital cost requires farmers to have access credit support, requirement of water storage for cloudy period; requirements of skilled technicians for repairs are among the bottleneck for adoption. Little is known regarding technical aspects of the technologies in the country; however, they are advocated for their environmentally friendliness (Otoo et, al. 2018).

According to (DACAAR, 2015), the costs for the solar pump with controller include a spare pump and all the components needed for the installation, from cables, controller and probes. The cost of systems varies widely because of the panel requirement for type of pump, quantity of water needed, depth of well, distance and or height to be pumped and placement of panels (fixed, movable through the seasons or with tracker). The expectation is that the bigger the turn-over (many systems placed near to each other) the lower the cost. Solar system technology and market is still in its infancy stage and therefore cost recovery by providers might be higher than in those areas that solar is better established.

Selection of providers should take into account a number of criteria that should be known. The provider should have local expertise, should have spares in stock, must have shop/workshop at least in the capital, give a guarantee on the components and installation, should have their own transport and technicians, should have been in the country at least for three years and can show some projects done, but especially rely on past experience.

Awareness creation for managers and training in all aspects for technical personnel would be beneficial for the dissemination of solar systems as per capita the systems can be cost effective especially when taking into account the O and M costs. Providers should train local personnel and the community.

Studies on suitability mapping of potential areas for solar pumps indicated that around 6 million ha of land is suitable for solar pump irrigation. Given the number of existing and potential motor pump users in Ethiopia, the scope for expanding the solar pump market for irrigation is significant. The government's strategy is to expand and introduce renewable energy sources such as solar pumps by replacing existing motor pumps, however; current usage of solar pumps in the country is very small and insignificant. It remains unclear as to what's hindering the diffusion of solar pumps in Ethiopia, given huge opportunities that the technology presents. As an off-grid technology with zero fuel costs and low maintenance requirement, solar pump technology seems particularly attractive for Ethiopia.

If the stated bottlenecks are addressed, the technology has the potential to be a business area along with service delivery of motorized pumps for the irrigation sector.

3.2.2 Manual Pumps

Pumps that are driven by human or animal powers to suck water (called suction pump) or lift (called lifting pump) from ground or surface sources to irrigate small farms not larger than 0.5 ha. The known technologies distributed across Ethiopia are pedal driven or treadle pump, hand pumps and, rope and washer pumps. Usually they are fabricated from locally available materials by small enterprises so are low cost. They are mostly applicable in a condition where the lift requirement is less than 7 meters (SMIS, 2016).

Rope pumps are ideal for traditional dug wells. As they can be produced domestically and low cost, they are more suitable for small scale irrigation and for household water supply systems. By using them, the quality of water and health condition of the bushers can be improved. These pumps usually yield from 5 to 70 liter per minute of water from a depth of 5 -40 meters when driven by a child or adult (SMIS, 206).

The treadle pump driven by pedal or foot when compared to the traditional rope and bucket system will increase irrigated surface areas and reduce irrigation labor time relative to the original irrigated surface area. This pump is widely distributed in the country and up to 0.4 ha vegetable can be

irrigated by this pump. It can transport water up to a distance of 50 meters across the ground or can push water to a height of 6 meters above the pump. Based on the operator capacity, treadle pump can produce up to 2 liters of water per second but in most cases continuous production of water is challenging (SMIS, 2016).

Due to the limited volumes of water harvested and stored compared with crop water requirements together with limitation of continuous production, using for irrigation purpose is challenging. Moreover, despite their simplicity and low cost for production, mostly users do not prefer them. Low quality manufacturing and high labor requirements for small plots or production hinder the expansion efforts so far made by regional and federal governments.

The technologies are highly suitable for supplying water for domestic use than agricultural purposes. In this perspective, these common features such as low-quality manufacturing, operational simplicity and low cost for production will make them the most attractive business areas and can be integrated with service delivery of the motor pump sector.

3.2.3 Electric Pumps

Electric driven pumps are often the least expensive and most efficient for pumping water in most countries. There are considerable modern irrigation farms using electric pumps to abstract water from ground or surface sources but it is not true for farmers on small, dispersed plots. Limited access to electricity is a key constraint to expanded irrigation: less than 20% of Ethiopian population is connected to the electricity grid due to poor grid coverage and dispersed nature of settlements in rural areas (Ooto et. al., 2018). On the other hand, there are indicators for the potential of electric motors. An area where electrical pumps are operating with considerable number is rural town of Eastern Harargie Zone. Around 3,465 electrical pumps are irrigating around 2,795 ha concentrating around small towns to produce high value crop especially chat.

Unless off grid power generation is implemented, adoption of these pumps for small farmers will not be realized in the near future. However, existing activity of the farmers in east Harargie zone has witnessed the potential of the technology as an alternative service delivery business area for motorized pumps.

3.2.4 Motor or Fuel Pumps

Small pumps driven by fossil fuel are categorized as motor pumps. Among modern pumps, centrifugal pumps are most widely used in irrigation. They are adapted to direct motor or engine

drives without the use of expensive gears. Centrifugal pumps are built on both horizontal and vertical shaft. Horizontal shaft centrifugal pumps have advantages of being efficient, simple in construction, relatively free of trouble, low cost, easy to install and high speeds (Abebe, 2016).

The use of fuel motor pumps is constrained by several factors, e.g., high initial cost, high operation and maintenance costs, shortages of fuel, lack of spare parts and also results in negative environmental impacts. Shortage or non-availability of local manufacturer exacerbated the challenges associated with these technologies.

Despite controversial number of motor pumps existing in the country, motor driven pumps have the lion share in Ethiopian irrigation sector. Although, the most recent field assessment reported existence of around 148 thousand pumps, some unpublished reports put the national figure up to 800 thousand and others reported in between. According to Ooto et al. (2018) around 1.4 million farmers are engaged in small scale irrigated agriculture, 210,000 to 400,000 of the farmers use motor pumps. According to ATA (2012), from 2004 to 2010, more than 482,000 pumps of different origin were imported. However, both reports did not specify the actual number of pumps operating in the irrigation sector.

In general, all the above facts witnessed the dominancy of motor pumps. On the other hand, the technologies demonstrated their potential to be selected as business candidates along with engine and motor pumps.

4 EXISTING PUMP SERVICE DELIVERY CONDITIONS

In order to use as inputs for strategic implementation and future development, constraints, opportunities and threats within the service delivery of small irrigation pumps are summarized with brief introduction about existing pump conditions in the country.

Opportunities are accumulated technical, material, social or financial resources, experiences or knowledge that can be used as an input for future development endeavor. Weaknesses are any drawback that can be and should be improved and integrated with the opportunities. On the other hand, threats are obstacles that have the potential risk to the intended development progresses unless properly managed from the beginning.

As explained earlier, the existing supply, demand and middle player performances in motorized pump value chain was assessed in selected four potential regions and comprehensive result was

presented in separate report. Here, only the major opportunities, challenges, potential threats of the sector and the corresponding recommendations were drawn.

4.1 Pump Population

Ten years ago (2009), the government distributed small water pumps in mass; for instance, 30,000 in Oromia; 10,000 in SNNPR; 20,916 in Amhara; and 10,000 in Tigray regional states. As indicated in table 1, the total number of registered motor pumps in four surveyed regions are about 156.6 thousand, out of which 11 percent was not functional. The growth rate of pump adaption per annum was attractive in all regions; the minimum, maximum and the mean growth rate was 12 percent (Tigray), 25 percent (Amhara) and 18 percent (national average) respectively.

Table 1: Pump Size and Growth by Region

Variable	Unit	Tigray	Oromia	Amhara	SNNPR	Total	National
Functional Pump	Number	26,000	66,173	44,205	14,585	150,963	421,707
Defected Pump	Number	2,879	2827	NA	2819	8,525	15,772
Total-Pump	Number	26,000	69,000	44,205	17,404	156,609	437,479
Defect Ratio	Percent	11	11	9	13	11	11
Annual Growth	Percent	12	18	25	15	-	18

Source: Survey data (April, 2019)

It is known that considerable number of pumps is existed in other regions especially in Somali. For instance, within the Shebelle, Afder, Liben and Dawa zones, around 9,777 and 8,253 small pumps were distributed by the government alone in 2010 and 2012 (ATA, 2017). Number of pumps is increasing in alarming rate with estimated regional annual mean growth rate of 18%, while the national growth is 10% (Table 1). In addition, it was assessed that the number of pumps actually operating within each region might be higher than the registered.

Based on these realities, generous estimate will project the existing number of small motorized pumps at national level to be a maximum of 200 thousand, from which, around 22 thousand (11%) are not functional. These figures are the benchmark of this implementation strategy.

4.2 The Opportunities

The identified opportunities in the sector may consist; increase demands and interest of farmers for small water pumps; availability of manpower especially youths to engage and willingness to be trained; and availability of local experiences in the sector. The opportunities may include; government commitments; sense of ownership; involvements of federal and regional agricultural offices; commencements of organizing unemployed youth and women; existences of experienced

development partners, initiative programs and projects, development goals, etc. towards building the sector. Moreover, the following are also potential of the sector; existences of TVET colleges and local manufacturers as well as credit, organizing and etc. institutions, their interests to support the sector are additional opportunities to transform the sector.

In general, the opportunities of the sector are increased demand for the scheme, untapped resources, existing local experience, commencements of organizing unemployed people; existences of development partners (e.g. gov't and NGO), and coherent development polices, strategies, goals, and plans.

4.3 The Challenges

Among others the identified challenges in the service delivery of small irrigation technologies specifically motorized pumps; lack of ownership to coordinate; unorganized and inconsistent capacity development activities of stakeholders; shortages of manpower across partners; knowledge and skill gaps; informality and uncertainty of the business; information gaps among involving partners; dominancy of sparsely populated, unstandardized and poor quality pumps and pump models; inconsistent and bureaucratic financial accesses; shortages of pump and spare part manufactures, water drilling machines and tractors altogether have constrained the scheme in the country.

Generally, the major challenges of the sector are lack of ownership; unstandardized pumps and spare parts; low knowledge and skill; poor operation and maintenance service; weak integration; lack of initial capital, informality of pump business, lack of improved seeds and chemicals, water drillers and tractors.

4.4 Potential Threats

Among the expected threats for future strategic improvement of the pump irrigation production as well as service delivery on O & M; fragmented and uncoordinated organizational set up and frequent restructuring; subsistence and low productivity of the production system; ground water depletion and poor water mismanagement; increased shortage of foreign currency, high import taxes and dominancy of illegal market are the major that should be mitigated beforehand.

To generalize the likely threats that may delay success of the scheme include inconsistent organizational set up and frequent restructuring of the sector; ground water depletion and water

mismanagement; untenable use of the existing water bodies such as lakes, rivers; illegal trade; lack of coordination and sense of ownership among stakeholders.

4.5 SWOT Analysis

The major identified strengths, weaknesses, opportunities and threats in the existing pump service delivery system of the country are selectively summarized and analyzed in the following table (Table 2). Based on the analysis, proper implementation strategies are forwarded in the coming sections of the document.

Table 2: SWOT Analysis on Pump Service Delivery

Factors	Strengths	Weaknesses	Opportunities	Threats
Supply	Distributing pumps by various stakeholders	Fragmented and unorganized distribution of pumps	Existences of importers and distributors and past experiences	Increased shortage of foreign currency and high import tax
	Assembling pumps locally	Non availability of spare parts	Existences of manufactures such as AAMEI	dominancy of illegal market and lack of integration
	Establishing quality control center	Limited distribution in quantity and poor in quality	Existences of standardized manual and quality control center	lack of integration
Demand	Buying and using of small pumps	existences of small pump number dominated with poor quality	The increasing interest and demand for the technology	subsistence nature of the sector, ground water depletion and poor irrigation water management
	Attempting to maintain their pumps	lack of knowledge skill in O & M on pumps	potential of the country (water and lands) for small irrigation pump	Shortage of fuel
O and M Services	Stimulating the importance of O & M	Few service providers	availability of local experiences and trained youths	Requirements of high investment cost and uncertainty of the business
	Developing standardized O & M manuals	Limited implementation	willingness of youths to engage in the sector	Requirements of individual's interest
	Provision of toolkits	Limited distribution in quality and quantity		Geographical distances of the farmer and service providers
	Engagement of private enterprises such as garage	High service charges	Availability within each rural town	Lack of trust and distance from the pump users
Capacity Building	existing technical and financial supports	limited training providing stakeholders	existence of experienced partners	Dependency on short lived projects

Factors	Strengths	Weaknesses	Opportunities	Threats
	Providing standardized training for organized youth, collage instructors, pump users, and office staff	Fragmented and unorganized capacity development	Existences of TVET throughout the country	Absence of equipped and connected local institution
	Developing standardized training materials	Shortage of skilled manpower	Existence of capacity developing services	
Supporting institutions	Assigning technical staff at Woreda level and attempts to organize youth	lack of ownership and weak integration	commitment of government	uncoordinated organizational set up and frequent restructuring
	Provision of credits, bailing out of the users, protecting and supporting of the farmers	Termination of revolving fund; bureaucratic access of credit services and lack of bail out	interests and involvements of credit and organizing institutions, development partners and so on	Existing set up and frequent restructuring of the sector

4.6 Strategic Recommendations

An innovative and strategic approach deemed necessary to transform the sector in Ethiopia. The country is very vast with unexploited potentials. Pump irrigation sector constitutes very diverse and numerous actors. On the contrary, institutional set up as well as technical, financial, material and managerial capacities of the stakeholders are at low level relative to the demands. Rather than piecemeal measures, focusing on selected strategic measures can have visible impacts within short period. The following major recommendations are some of the elements expected within the O & M service delivery of small pumps.

4.6.1 Sectoral Restructuring

Forming special responsible governmental body or Department of Pump Technology (DPT) under SSID, MoA and strengthening it with technical and legal support would be the first strategic action. This is expected to answer the question of ownership and provide special attention to the sector.

4.6.2 Capacity Building

Identifying, selecting and strengthening ATVET colleges and integrating them into the sector as continuous capacity building partner is very crucial for sustainable SSIT development. Both SSID

and ATVET colleges should be capacitated (financial, material and human) by integrated efforts of all development partners.

4.6.3 Supply Technologies

The service sector is constrained by many factors. Among them existence of small or limited number of pumps throughout the country is the major one. Increasing pump population through potential assessment will motivate the entire business sector and the agriculture at national level. The outputs of shallow ground water mapping project of ATA will help identification of potentials areas for pump irrigation. Questions regarding dominancy of illegal market and low-quality pumps, lack of standardization, high import tax, shortages of hard currency, availability of pumps and spare parts, distribution of items and proposed service can be dissolved by strengthening production capacity of local industries such as AAMEI.

Pumps to be distributed must have a guarantee from bulk providers at least for two or three years to support the users by availing spare parts and providing operation and maintenance services until local enterprises build their capacities. Such arrangements must be set up and organized by MoA in collaboration with regional offices.

4.6.4 Establish Special Enterprises

We need to establish special enterprises that can provide effective service for the entire value chain based and they are formed based on sufficient need assessment (discussed in detail below). The proposed business models should consider the number and spatial distribution of technologies, pumps; production potential of localities; availability of water, set up of service providers or enterprises; set up of pump users; types of required related technologies; suitable service delivery approach (either ‘door to door’ or ‘in-house’) and should be decided with caution. ‘One fit for all’ approach will not fit for the sector.

Creating localized small fuel stations at strategic location in areas where pump populations are concentrated will guarantee the supply and involvement of unemployed youth and women. The participation of women shall be realized through promoting and capacitating them in a way that they can deliver the intended service effectively in O & M, distribution of fuel, spare parts, marketing and other related services either jointly or individually.

4.6.5 Strengthen Coordination among Stakeholders

Coordination of stakeholders through information communication, building people and facilities, monitoring, evaluation, accountability and feedback system as vital success factors. It is advisable to establish special responsible body, say department of pump technology under MoA and SSID; select and equip special capacity building institutions (ATVET); establish/strengthen and develop pump enterprises, and small fuel stations in proper local areas; establish and enrich linkages of new enterprises with suppliers, financial institutions and market; improve credit access for smallholders that help them acquire the technologies and inputs, improve information system and integration through creating Pump Technology Association (PTA), Pump User Association (PUA), and WUA. The details of stakeholders and their roles are given in the subsequent sections.

5 STRATEGIC INTERVENTIONS

5.1 Conduct Need Assessment

Both the demand and supply side minimum requirements should be assessed by the department of pump technology at all levels. These may include the following elements.

Demand side survey: examines the readiness of responsible organization (human, financial, and technical) to coordinate the initiative on continuous basis, basic socioeconomic profile of the local community, agro-ecological zones, economic activity, the number (actual and potential) of pumps, models and operational performance, number of beneficiaries and willingness to pay for the technology adoption, financial capacity and its potential sources, the cultivated (actual and potential) land, availability and sustainability of water sources (underground, surface, rivers), performance of water user associations, and others relevant factors in each administrative level.

Supply side survey: assess the availability, access and adequacy of pumps, spare parts, models and their price, capacity of suppliers, their legal position and willingness to work with potential local enterprises and end users, modality of sale, delivery place and system and other relevant factors in the nearest possible market or town within a given administrative region.

Service provider survey: assess the existing individual technicians, enterprises, associations; potential youths, farmers, and women who are willing and able to engage in pump maintenance and related services in a given Woreda, zone or any other legal administrative jurisdiction.

5.2 Establishing Enterprises

Establishing service providing enterprises shall involve the following major activities including need assessment; selecting eligible candidates; capacity development; enterprise formation and legalization; certification; provision of startup capital; allocating work places; and creating supply and market linkages.

5.2.1 Select the Candidate

The potential individual members of the establishing enterprises (both male and female) shall be selected based on the following criteria; technical skill; willingness; education; trust; knowledge and membership in a given local administrative jurisdiction.

Technical skill: the operational skill acquired either through experiences or formal trainings shall take 50 percent of the total weight. Priority shall be given for practical skill, as the felt in problem of poor farmers is lack of accessible and affordable pump O&M service.

Willingness: the passion and dedication of individuals to engage in pump operation and maintenance shall account for 15 percent of the total weight.

Education: the minimum education level may be grade 10 and above. The specific fields required may include irrigation, mechanics or auto-mechanics, agricultural machinery, agricultural economics, natural resources, and related fields that can impart technical and theoretical skills in pump operation; which shall account for 10 percent. However, if the candidate has the required technical skill, the minimum education can be relaxed.

Knowledge: the eligible members shall acquire local knowledge such as culture, value, practice, norm and rules, etc.; this shall take 10 percent.

Membership**:** the individuals shall be a member of a given local administration such as Woreda, development corridors within Woreda or zone; which accounts 5 percent.

Trust: the candidates shall have social trustworthiness and acceptance by the respective local community; which accounts for 10 percent of the total weight allocated for candidate selection.

For those who qualify the minimum criteria during candidate selection if the male and female candidates have similar score, the female candidate would be selected as affirmative action.

5.2.2 Train the Candidate

Capacity building is the basic requirement; for previously trained or non-trained individuals.

Training: all eligible individuals (service providers) shall take a minimum of 45 days training that encompasses both technical skill and knowledge and shall receive competency certificate. This is precondition to be organized as private or group enterprises and will be used as a requirement for credit access. Short term trainings i.e. minimum of 10 days on basic and simple O and M services may be given for critical masses of pump users, farmers and be updated within three-year interval. All service delivery technicians should be trained for at least for 45 days up to 3 months on repairing of known pump models while a minimum of 6 months on packages of related technologies such as motor cycles, dynamo, bio gas, generator, submersible, solar and electric pumps, Bajaj, water supply lines and others. The training program should be continuous, practical, inclusive and progressive. In long-term plan, model ATVET will assume the entire responsibilities. The other disciplines proposed to work jointly as a business partner or stakeholder in the service sector should also be included in the training programs. Some of the trainings could be business management; accounting; customer handling; how to organize youth and women; and etc. The training types and level should be identified by experts.

Certification: any individual successfully participated on both practical and theoretical training programs should be awarded with certificate by the authorized institution particularly by training providing organization or institution. This certificate will acknowledge the awarded individual and will be used as a pre requisite to form an enterprise or to be a member of joint enterprise.

5.2.3 Legalize Enterprises

The establishment activity includes sub-activities such as determining forms/modes of enterprises, the number of members in an enterprise, the number of enterprises formed in a given administrative area and legalization of the enterprises.

Form of enterprises: the establishments can be formed as individual or group (youth, women, farmers) enterprises; can be new or existing ones such as youth irrigation agriculture associations.

Number of members: private enterprises are formally registered with one individual technician, whereas joint or group enterprises will contain five individuals based on the selection criteria defined in this strategy.

Number of Enterprises: Private enterprises can be established for a minimum of every 120 pump populations and group enterprises can be organized for a minimum of every 500 pump populations in a given administrative area. For example, in areas where 1000 pumps exist, two private enterprises and one group enterprises (together three enterprises) can be established. However, for beginning areas, a maximum of two enterprises can be established; one private enterprise (for surrounding town areas) and one group enterprises (remote rural areas).

Legalization**:** legal business permit or legal personality shall be given for selected enterprises by a relevant public authority; industry and enterprise development or other authorized public body.

5.3 Provide Startup Capital

The facilitation, provision, the amount of fund and terms shall be arranged for new enterprise. Department of pump technology together with SSID under the MoA facilitate all the processes.

Sources of Capital: the informed partner financial institution shall provide the initial investment capital for those enterprises which have legal personality and those could complete minimum requirements. Again, donors, NGOs and other partners can be a possible source as well.

Amount of loan: in principle, the amount of credit shall be determined based on business proposal submitted by enterprises. However, for beginner enterprises, the estimated minimum amount of loan is 216,615 thousand birr (in 2019 or 2011 E.C price) per enterprise (for the breakdown see Table 9). However, the current inflation rate shall be considered when estimating the loan amount overtime.

Term of loan**:** generally, the rate of interest, the repayment modality and period may be determined through negotiation between two parties (enterprises and credit provider institutions). However, the government shall keep the maximum rate of interest not exceeding the rate of current inflation by special negotiation. The repayment modality can be equal down installment starting from the payback period of the business or even earlier repayment is acceptable, if possible.

5.4 Allocate Work Place

The work place primarily land, workshop or shade shall be allocated only for legal enterprises by a relevant authority (e.g. urban or rural land departments).

Size of land: a minimum of 100 m^2 area of land shall be given in appropriate locations within a given administration area. Otherwise, prepared shades or houses can be given for work place.

Time of offer: the permitted land or share or house shall be given within a maximum of three months of the request date. This shall be treated carefully.

Use right: the given land, shade or house shall be used only for the intended service; cannot be sold, transferred or rented to any other person or body regardless of the purpose. But, after full repayment of the initial investment loan and business maturity, pump department in consultation with stakeholders may formally transfer the place for newly formed enterprises for similar activity.

5.5 Create Market Linkages

The supply and market linkage shall be created for legal enterprises through formal letter, communication and promotion activities. Enterprises that are ready to deliver the service shall be connected with their partner suppliers (pumps, spare parts, fuel, etc.) through formal letter. The letter may provide guarantee for the enterprises regarding their legality, customers, trade, finance, and other requirements. All transactions shall be written, signed, documented and shared for both parties and copied for the pump department, financial sources and any other relevant stakeholders. The enterprises shall be communicated to their key stakeholders (community and authorities) within a given administrative area through formal letter. The letter may provide guarantee for the enterprises regarding their legality, ability, accessibility, service packages and other relevant qualities. All transactions shall be written, signed, documented and shared for both parties and copied for the pump department, financial sources and any other relevant stakeholders.

5.6 Service /Business/ Packages

The enterprises are expected to engage on several businesses mainly services for small water pumps, related technologies and services.

Services for Engine Pumps

In this category, major services for which the enterprises to be established are listed including; engine pump operation and maintenance services, spare parts supply for pumps, pump rental services, fuel (both gasoline and diesel) and oil supply for pumps, hand pumps (rope and washer) repair and maintenance services, solar pumps distributions and so on.

5.6.1 Operation and Maintenance Services

This service is the first most important and compulsory service that every enterprise established under SSI technology value chain must deliver. The service primarily focuses on maintenance of motor pumps, and then may include maintenance of generator, Bajaj (three axle motor cycles), motorcycle and others which are mostly used by the local communities that can be maintained using already acquired skills and toolkits used to maintain pumps. Yet other maintenance services shall not be given at the expense of motor pumps.

The service price shall be charged shall be based on the level of defect, the place where the service is given (urban or rural; distance from town) and other relevant costs. Service-oriented negotiation shall determine the amount of fee. However, for beginners located in town areas, the average unit fee for maintenance of pump, generator, Bajaj and motorcycle can be 200, 185, 186, and 150 birr respectively.

5.6.2 Supply of Spare Parts

Supplying spare parts is the second most importance service to be given exclusively for pump users. Some of accessories may include carburetor, fasha, bella, water seal, casing, hose, candela, cylinder, gasket maker, ignition coil, starter, plaster, fuel filter, oil filter, air cleaner, glass paper and others. The supply linkage to be created with partner suppliers shall materialize the transaction. Spare part is complementary item for maintenance service and hence business viability; thus, attention shall be given to make it available besides the core service. Accessories or spare parts to be supplied must be compatible with the respective pump models, sizes, standards and prescriptions. This shall give guarantee for items distributed to end users.

Prices of spare parts shall be based on current purchase price, transportation and related transaction costs. However, as principle, the unit selling price shall not exceed 20% of the purchase price. This means up to 20% marginal charge is acceptable depending on the distance from the major market or town. Above all, business ethics and trust shall be the core values that ensure business sustainability.

5.6.3 Supply of Motor Fuel

Fuel supply can be treated as a special service compared to other basic services (supply of spare parts, pumps, maintenance) since it is fluid which requires different storage system and business

arrangement. The cost-benefit of this service may be slightly different and may require separate estimation.

Type of fuel can be gasoline/petrol, diesel, oil and other lubricants. Pumps that use diesel are more preferred. Price of fuel: the selling price of parts depends on the current purchase price, transportation and related transaction costs. However, as principle, the unit selling price shall not exceed 20% of the purchase price. However, note that this business may diminish and be changed as we implement the green targets and adapt improved pump technologies overtime.

5.6.4 Supply of Pumps

Initially the enterprise may provide information, guidance and facilitation service to end users. However, later on, up on business maturity, they may supply pumps based on actual performance. Adequate supply of these items and attractiveness of prices must discharge the illegal trade. Unless the formal market route could provide quality pumps with reasonable prices, controlling illegal trade would be impossible or difficult. Regarding pump models; all pumps shall meet the Ethiopian standardization developed by Ethiopian Standard Authority. Diesel pumps have been preferred compared to gasoline/petrol driven pumps. Yet, several options shall be made available for individual buyers based on their preferences.

Prices of pump depend on the current purchase price, transportation and related transaction costs. However, as principle, the unit selling price shall not exceed 20% of the purchase price.

Target customers: enterprises shall mainly distribute fuel to the targeted service recipients as defined in the strategy and for those who are currently under small scale irrigation agriculture.

5.6.5 Supply of Related Technologies

Primarily focuses of this service delivery implementation strategy is maintenances of engine and motor pumps. When similar technologies that can be maintained using already acquired skills and toolkits used to maintain motor pumps can be included as a service package. This fact was witnessed during the field assessments. For instance, local pump technicians of East Harargie were maintaining generators. Similar activities were observed in all assessed regions.

Manual, electrical and solar pumps are the first candidates in this respect. Manual pumps especially for domestic water supply are very common in local areas of the country. They are frequently damaged. In order to install and maintain rural water supply systems, youth are organized in Tigray region. Electric pumps of east Harargie are good example of technologies to be included in the

menu. When off grid system is established, electric pumps will be potential business area of the sector.

In Ethiopian context, fossil fuels are subsidized, centrally controlled and shortage is critical, prices are high, not renewable and not environmentally friendly while the smallholder irrigation sector is highly decentralized. Hence, solar pumps are potential business areas of the future.

Bajaj (3-wheel motors) and motor cycle also are very common in most of local communities where pump irrigation is practiced.

Maintaining and supplying of water delivery pipes and hoses; supplying of oils for pumps; maintaining horse carts; supplying and maintaining of geo-membrane are highly related service activities to be considered. Every locality has special technologies that can be integrated with service delivery of pumps.

The other potential related services related to small scale irrigation sector might include manual well drilling; rental services of multi crop thresher (teff, wheat, barely), corn sheller, tractors for plowing, harrowing, etc., transportation carts, and others.

Manual Tube Well Drilling; manual tube well drilling is a means for shallow groundwater development for multiple uses and can be considered as low-cost option (Weight, et, al., 2013). The drilling is a practical and affordable solution for wells less than 40 meters deep in alluvial soils (clay and sand) and soft weathered rocks. It can effectively provide water for drinking and irrigation to rural populations and is much cheaper than conventional machine drilling which is not affordable for the rural communities (ATA, 2018; IDEA, 2013). Manual well drilling is fast way of drilling small diameter borehole with labor and can be combined with a rope and washer pump or a suction-only treadle pump.

Although other equipment has higher success rates than the manual, they are either not available in the Ethiopian market or are not affordable. The total capital cost of the equipment is around 800 US dollar (around 20,000 birr) while that of mechanical drilling equipment is around 1555,000 US dollar (ATA, 2018). Average drilling speed manually is 1.5 meters per hour with a unit drilling cost of 9.5 US dollar per meter which may vary in different areas (from 33 up to 200 birr per meter). The equipment can be locally assembled and is light and portable. It requires middle skilled personnel comprising 4 to 6 people per well.

The technical and institution drawbacks for adopting the technology are; limited decentralized presence of private suppliers due high transport cost and less opportunity for economies of scale;

limited financial access and incentives for high quality local manufacturing, with lack of quality standards for raw materials; limited access to spare parts and fast moving items to users; limited to drill small diameters and technical requirement for earth retention and etc. Low demands for well drilling services due to limited awareness and promotion also discouraging startups and the equipment supply chain.

However, all the above challenges can be an opportunity if properly addressed for organized enterprises. Due to its technical simplicity, it can be maintained by local technicians and enterprises. The services can be complemented with pump installation. The target to address around 1 million households for shallow groundwater can be the potential market of manual well drilling and the activity can follow the available shallow ground water mapping by establishing proper regulation (ATA, 2018).

Recent efforts by different public institutions and development partners to capacitate and establish well drilling youth groups could be a spring board to implement on enterprises to be organized for service delivery of irrigation pumps.

Tractors; wide varieties of tractors are available, such as wheel tractor, walking tractors, and farm tractors. AAMEI is selling different types of agricultural implements with reasonable prices. Some are listed below as an example based on consultation meeting and other sources.

- 8 horse powers one-cylinder walking tractor with 30,168 birr. If all accessories are included such as trailer and thresher, the total cost will be about 82000 birr.
- 30 horse powers 2 cylinders tractor with all accessories will cost around 157,434 birr.
- 35 horse powers 3 cylinders tractor with all accessories is about 358,681 birr.
- Tube well drilling tools will cost a maximum of 70,000 birr.
- Thresher cost is 20-25 thousand birr.

It is possible to get these implements with loan if 30% payment is made. Moreover, the industry will provide services for all ploughing, harrowing, cultivating, seeding, pumping, threshing, trailing, loading, transportation etc. activities. On the other hand, with the current state of the industry, there is a possibility of arranging a more advantageous agreement.

All these listed technologies are good sources alternative incomes for technicians during the irrigation and off irrigation seasons.

While selecting technologies with the context of “related technologies”, it should not be carried out at the expenses of motor pumps. Mostly, trained youths even the organized ones have strong

tendencies to shift to more profitable, less time and skill consuming business sectors. Such tendencies create conflict of interests and significantly affecting the pump sector as observed in some Woreda. Because, the current pump service delivery condition is highly vulnerable and not that much profitable unless subsidized and supported.

Care must be taken especially at the beginning of the operation period. In the future when pump service delivery system become strong and independent business, other packages can be integrated selectively.

5.7 Stakeholders' Responsibility

Key stakeholders are the partners involved in small-scale irrigation scheme mainly on technical and supply related issues. How they contribute may determine the success of the sector at large.

These stakeholders include MoA (SSID, DPT), MoWIE, Enterprise and industrial development agency, MFI, Capacity building institutions (selected ATVET), MoI, Ethiopian Agricultural input enterprise (seed, fertilizer, chemicals), NGOs, MoF, NPC, EIAR and EDRI and relevant others. There shall be formal communication, integration and feedback system among them and other relevant players, towards building effective enterprise; sustainable production and business.

5.7.1 Ministry of Agriculture

Responsibility: several responsibilities like strategic or policy issues, initiation, coordination, facilitation, monitoring, communication and leading the overall development of SSI scheme in the country must be initiated and lead by SSID of MoA. The strategic issues include structures, quality standards, custom duties, fuel and foreign currency and others affecting national interest. It discharges its own activities and coordinates other stakeholders. To discharge these roles effectively, the Ministry may establish a special department that can accomplish this particular activity at all levels.

Department of Pump Technology (DPT): forming DPT would enhance ownership, responsibility accountability, and hence development of the sector. The department can be structured under small scale irrigation sub-sector or any other relevant sectors.

Staffing the department: the department should be equipped with appropriate staff and facility (office, networks, furniture, and workshop) at all levels. ***Units****:* within the department, planning and facility development unit, and operation and maintenance unit may be established.

Alternatively, the agricultural mechanization department can also take the technical aspects of pumps and other agricultural machineries needed for SSI sector.

Accountability: the department is accountable to respective agricultural offices, and the units shall report to the department at each hierarchy. ***Personnel:*** at least four personnel may be recruited or assigned at each hierarchy, namely, one coordinator (head), one planning expert, and two pump technicians.

Education requirement*:* considers the required minimum education level and specialization. The minimum education level for technical positions shall be diploma (10 + 3) and non-technical staff shall be first degree. But, at ministerial and regional experts had better hold second or first degrees with equivalent experience; while zonal and Woreda level experts can have first degree or diploma.

Field of study**:** the coordinator position invites professionals from irrigation, soil and water conservation, soil engineering and related fiends; planning experts can be from development economics, agricultural economics, resource economics and related fields; and the technician positions invite Auto-mechanical, Mechanical, or Agricultural engineering and other related fields. Adequate practical experience of pump maintenance will be mandatory for technical positions.

Selection criteria*:* those who meet the above minimum requirements shall be recruited based on the following criteria: experience (50%), education and field of study (40%) and work performance or willingness for new graduates (10%). The experience for technical and non-technical candidates shall be practical skill and work experience in that order. Finally, the department shall have full office facility such as furniture, office equipment and other facilities internet networks, electricity and water. Workshop facility shall be installed with machines, toolkits, equipment and other facilities that can be used for training and demonstration.

5.7.2 Manufacturing Industry

A special local manufacturing or assembling industry can also be identified, negotiated and signed as permanent partner to supply pumps at national level. The field survey indicated that the potential local assembling industry of pumps may be AAMEI. The capacity (financial and human), foreign currency and import tariff constraints shall be addressed through strategic intervention.

5.7.3 Importers and Suppliers

Similarity special major importer shall be identified, negotiated and signed as permanent partner to supply SSIT in Ethiopia. All required contracts and agreements shall be signed between Ministry

of Agriculture (MoA), SSID or DPT and major importers and suppliers. This would enable us controlling quality standards, price shocks, selling modality and post delivery system.
Largely, all required contracts and agreements shall be signed between MoA and major importers, suppliers or manufacturers or assembling industries.

5.7.4 Enterprise Development Agency

These agencies shall accomplish the enterprise (private and join) establishment process. It starts from registration to issuing legal personality. In some regions, the EDA is called “enterprise and industry development department”. First, EDA accepts eligible enterprises from client body (MoA), collects and approves documents (operational standards, competency certificate), issue legal personality, provide work place for newly established enterprises, support and monitor their performances. Facilitation should be played by MoA and its regional offices at each administrative level.
The established enterprises shall receive the indicated pool of incentives. However, EDA should monitor the enterprises not to change the business type for which legally registered; not transfer or change the work place or shade to any other body; to follow and obey the business regulations and rules.

5.7.5 Capacity Building Institutions

Sustainable capacity development is among the most vital elements in developing the scheme. Some selected agricultural colleges, research centers, or universities can be identified, equipped and assume complete resistibility of capacity building in each region and beyond.
Advantages: there are many advantages of creating special development centers: to standardize and improve the quality of the training and development, improve the service access to the local community, provide the service on sustainable basis, accommodate several trainees, learn and transfer new technologies, and others.
Model Colleges: specialized agricultural colleges may be better over other alternatives. These colleges shall be identified and fully equipped before providing the said development activities. It must be equipped with qualified human resource, materials and facilities such as buildings, laboratories, workshops, electricity, internet networks, water, road and other facilities. Relevant colleges may be selected at least at regional level that can regularly provide the service for existing

and emerging technicians, experts and model farmers. For instance, Wolayta Agricultural College can be the possible capacity building center for southern regional state.

5.7.6 Microfinance Institutions

Microfinance institutions would provide the investment money for enterprises in the form of loan. The provision involves submission of business plans, authorize competency certificate, prepare contact terms, rights and duties and sign contract and then print, bind, document and share between the MoI and MoA or respective regional DPT and key stakeholders. Other financial institutions such as credit associations, banks can also support the scheme with finance. The donations and other aids can also provide initial investment capital and expansion of the business.

5.7.7 Policy and Legal Support

The strategic interventions shall address control standards, import tariff for the technology (pump, spare parts); fuel supply for irrigation purpose; foreign currency for technology importers; financial support such as special credit scheme and donations, and other relevant aspects. All issues shall be facilitated by the responsible federal body i.e. MoA.

Pump quality and standards: the qualities pump technology shall be controlled and standardized, both for imported and locally manufactured. Recently, to answer this question there is an attempt to set standards and erecting of quality control facilities. Pump standards of the country and pump quality controlling equipment can be used as platform for the monitoring mechanism. Similar facilities should be established in areas where pumps and spare parts are manufactured, assembled and imported. The facilities shall be equipped and managed by qualified staff. The standardization and controlling system should be implemented in coordination with stakeholders such as custom offices, industry ministers, and regional states and should be supervised and monitored by MoA. On top of that controlling procedures should be standardized throughout the country.

Import tariff: import tariff should be provided for pump technology. The existing market tariff rate shall be reduced for these special technologies so as to boost the technology expansion. Actual rate may be set in consultation with customs authority. This year, the government has decided to remove tariff on agricultural technologies; so, we may follow its implementation.

Fuel Supply: Special fuel supply system shall be billed for motor-irrigation pumps. When fuel is imported quota shall be given for small-scale irrigation pumps. Lack of fuel shall not constrain agricultural production, harvest and related businesses.

Foreign Currency: Adequate foreign currency shall be allocated and provided for signed partner importers when the technology is demanded. The currency shall be used only for importing pumps, related technologies and spare parts.

Financial Support: Special credit system shall be arranged for pump technology for service providers, facilitators, and end users. Donor sponsored financial support shall be searched for the sector. It may be used for technical and capacity building initiatives. The government may also provide the revolving fund in the form of loan for emerging enterprises to be repaid back within the due date signed on the contact.

6 EXPECTED TARGETS AND IMPLEMENTATION PLANS

6.1 Expected Targets

Implementation of the strategic activities should have final achievable results that can be measured at a given time within the implementation period. The expected results will guide to select proper intervention areas where major stakeholders should focus because they are measurable and key performance indicators of every activities. The background data and major assumptions being used for the estimation of the expected targets are:

- Although not finalized, recent information collected by MOA indicated that the area irrigated by small scale irrigation throughout the country is around one million hectares.
- The number of motor pumps currently operating in the country is around 200 thousand.
- From collected data which is annexed (Annex B), in Eastern Harargie zone the average area irrigated by a single pump is 1.5 ha (varies from 0.25 ha up to 9.9 ha) while in Amhara region the average area is 4.2 ha. Average of the two is 2.8 ha. Therefore, it is reasonable to assume the national average to be around 2.4 ha.
- The implementation strategy targeted by 2020 around 237.5 thousand pumps will be distributed for the farmers throughout the country. The existing pump population is quite small compared to the potentials (suitable land, surface and ground water, experiences of

the farmers etc.) of the regions. In regions where water and farm land is available as well as pump irrigation is widely practiced, for instance Oromia, Amhara, Somali, SNNP etc., it is possible to distribute roughly around 40 and 50 thousand pumps in the year 2020. Previous experiences and demands of farmers strongly support this assumption.

- The total area to be irrigated by small pumps will be around one million hectares while the total irrigated land by small scale scheme will be two million hectares (Table 3).
- A single private enterprise may be established in areas where at least 120 pumps exist while one group enterprise may be established where a minimum of 500 pumps existed.
- Actually, additional background data and assumptions are already explained throughout the document so can be referred.

Regional distributions of the targets should consider potential of each Kebele or Woreda for the development of small motor pump irrigated agriculture based on important information such as hydrological, agricultural, socio economic, institutional, climate, and so on. In other word, it requires developing of national suitability map for small holder irrigation. In this regard, shallow ground water mapping currently prepared by ATA will help a lot.

Since the targets are fixed based on the information extracted from financial feasibility of small motor pumps, the selected indicators are totally related with service delivery of the sector. With the same reasons, incorporating of "related technologies" should be decided based on further need assessments at Kebele or Woreda levels in consultation with the community.

Table 3: Expected Targets and Implementation Plan **(**2020-2025)

S. N.	Activities/Targets	Units	2020	2021	2022	2023	2024	2025
1	**Productions**							
	By SSI	Ha	2,071,500	2,278,650	2,506,515	2,757,167	3,032,883	3,336,171
	By Pump	Ha	1,035,750	1,139,325	1,253,258	1,378,583	1,516,442	1,668,086
	Pumps	No	437,479	481,227	529,350	582,285	640,513	704,564
	Spare Parts	Birr	758,952	834,847	918,332	1,010,165	1,111,182	1,222,300
	Fuel Supply	Liters	51,787,500	56,966,250	62,662,875	68,929,163	75,822,079	83,404,287
	Beneficiary HH	No	2,500,000	2,750,000	3,025,000	3,327,500	3,660,250	4,026,275
2	**Operation & Maintenances**							
	Private Enterprises	No	8,020	8,822	9,705	10,675	11,743	12,917
	Youth Enterprises	No	40,102	44,112	48,524	53,376	58,714	64,585
	Total	No	48,123	52,935	58,228	64,051	70,456	77,502
3	**Enterprise Establishment**							

S. N.	Activities/Targets	Units	2020	2021	2022	2023	2024	2025
	Private Enterprises	No	4,207	4,627	5,090	5,599	6,159	6,775
	Youth Enterprises	No	841	925	1,018	1,120	1,232	1,355
	Total	No	5,048	5,553	6,108	6,719	7,391	8,130
4	**Labor Employment**							
	Private Enterprises	No	8,413	9,254	10,180	11,198	12,318	13,549
	Youth Enterprises	No	4,207	4,627	5,090	5,599	6,159	6,775
	Wage Labor	No	12,620	13,882	15,270	16,797	18,476	20,324
	Family Labor	No	2,500,000	2,750,000	3,025,000	3,327,500	3,660,250	4,026,275
	Total	No	2,512,620	2,763,882	3,040,270	3,344,297	3,678,726	4,046,599
5	**Capacity Development**							
	Departmentalization	%	20	40	60	75	90	100
	Select ATVET Colleges	No	9	18	27	36	45	54
	Build SSITE Workshops	No	18	36	54	72	90	108
	Build SSITE Database	No	18	36	54	72	90	108
6	**TRAININGS**							
	Technical Staff (Office)	No	1,010	1,111	1,222	1,344	1,478	1,626
	Technicians	No	8,413	9,254	10,180	11,198	12,318	13,549
	Enterprises	No	4,207	4,627	5,090	5,599	6,159	6,775
	Model Farmers	No	125,000	137,500	151,250	166,375	183,013	201,314
	Total	No	138,629	152,492	167,741	184,515	202,967	223,264
7	**Training Expenses**							
	Technical Staff (Office)	Birr	25,239,173	27,763,090	30,539,399	33,593,339	36,952,673	40,647,941
	Technicians	Birr	210,326,442	231,359,087	254,494,995	279,944,495	307,938,944	338,732,839
	Enterprises	Birr	105,163,221	115,679,543	127,247,498	139,972,247	153,969,472	169,366,419
	Model Farmers	Birr	1,562,500,000	1,718,750,000	1,890,625,000	2,079,687,500	2,287,656,250	2,516,421,875
	Total	Birr	1,903,228,837	2,093,551,720	2,302,906,892	2,533,197,581	2,786,517,340	3,065,169,074
8	**M & E System**							
	Support Coverage	%	100	90	80	70	60	50

All the expected targets listed in the above table are calculated based on the total area that could be cultivated by small scale irrigation schemes and the expected share of pump irrigation which are designated as SSI and Small Pump, respectively in the table, hence, are quite critical front drivers for the accomplishment other targets.

Distribution of pumps should be substantiated by quality control measures as indicated in the document so quality testing facilities as well as standardizing should be implemented while distributed either imported or locally produced pumps and spare parts starting from the beginning of the strategy period.

The expected fuel supply target is estimated based on the number of pumps, running hours and consumption. It could be distributed through establishing fuel stations where pump population is critically high because fuel shortage of the critical threat of the sector.

Regarding the proportion of private and youth enterprises either on establishing them or delivering services, the targets are just indicators. The natures or types of the enterprises to be established are location specific. Similarly, expected numbers of service delivery are also dependent on the enterprises type as well as the conditions of the pump operations.

The training supports are expected be given in three major categories; (1) technical training for technical staff or experts, technicians and farmer; (2) business training (deal with business management for the enterprises; demand-supply analysis, marketing, financial and social aspects), and (3) awareness training actors such as farmers, community representative, officials, development partners. All would enhance the execution and sustainability of the irrigation sector as well as the business.

6.2 Implementation Plans

The strategic implementation or intervention plan comprises the core activities that should be focused in the proposed strategy period. Broadly speaking, department formulation and capacitating, capacity development such as improving the existing and adding new TVET colleges; establishing workshops, strengthening the linkages with stakeholders, supplying credit access, monitoring and evaluation, information and data-based management as well as integration among stakeholders are vital to realize the strategic targets.

In order to expand and transform the service delivery of the sector throughout the country as well as to achieve the intended targets, several strategic interventions have already been recommended. Much of the recommended interventions are focusing on strengthening of institutions and their coordination. However, due to the natures of the interventions, institutional capabilities and other similar factors, all cannot be materialized in parallel or at the same time.

The key strategic interventions are broadly grouped either in “short term” or “long terms” to simplify orders of their implementation. The first three years (2020-2022) may be considered as “short terms” and the next three years (2023-2025) would be treated as “long term” implementation periods.

Implementation period meant to indicate a given intervention is to be implemented at least to be started at national level within that time period. Few interventions might require the accomplishment or the beginning of other interventions while most of them might be accomplished in parallel. There might also be continuation or overlaps among each other within or across the short- and long-term periods so that should be treated accordingly. Thus, the selected interventions are listed in these categories as follows.

6.2.1 Short-term Interventions

Out of the six years allotted, the first three years (2020-2022) are considered as 'short term' and highly prioritized interventions that should be implemented in parallel with existing effort are listed in this category. Most of these interventions can be started within the existing framework of the federal and regional offices as well as service delivery systems while widening the implementation capacities and interventions simultaneously.

- Forming special department under SSID of MoA and strengthening the capacity up to Woreda and Kebele levels with extension system.
- Distribute large quantity of standardized and quality pumps with spare parts.
- Creating awareness and strong relationships with regional partners such as job creation, youth organizing, credit services providing and etc.
- Revising the responsibilities and relationships among stakeholders involved in the sector
- Selecting and capacitating TVET colleges and engaging in training provision programs with the other partners.
- Standardizing of selection and organizing criteria for service providers, training and quality testing manuals, regulations, etc. across the country
- Identifying site specific potential technologies and services related to small irrigation pumps
- Organizing youth and women to establish private and joint enterprises in mass
- Starting standardized and continuous trainings for farmers, technicians and experts in model Woreda
- Arranging the reinstallation of revolving funds
- Communicating capable and interested private companies and importing quality model pumps and spare parts

- Start to implement quality testing of imported and locally manufactured pumps and spare parts
- Identifying potential irrigable areas for small pumps with the help of shallow ground water map and field assessments
- Selecting potential areas and establishing model fuel stations.
- Implementing M and E in selected model Woreda of regions.

6.2.2 Long-term Interventions

In the last three years (2023-2025) of the strategy period, it is believed that most of the interventions previously started in the short-term period will begin to mature and transform the sector as well as the implementation of the next intervention. More importantly, it should be expected that most of the short-term interventions might extend up to the end of the strategy period. Generally, during this period the following activities are identified as vital factors for implementation:

- Distributing locally manufactured standardized pumps and spare parts
- Implementing pump standardizing and testing services across the country
- Launching country wide trainings by TVET colleges for farmers, service providers, stakeholders and experts
- Launching pump and related technologies evaluation and improvement program
- Establishing fuel stations in pertinent areas throughout the country
- Establishing site workshops across the country
- Establishing spare parts retail shops at Woreda level
- Strengthening the M and E program and implementing at national level.
- Establishing chain of service structure from site up to National level

7 INTERVENTIONS AND ENVIRONMENTAL SUSTAINABILITY

Different technologies involve different costs and benefits. Some pump technologies incur higher costs and spillover effects compared to others. For instance, fuel pumps incur high running costs and pollute the environment. Emergence of improved models often motivates an adoption of succeeding technologies. The potential benefits expected from SPT suggested adoption of the technology. Its benefits include the use of renewable energy, low environment pollution, low cost

of production, and sustainability. Solar pumps can provide reliable, cost effective and environmentally sustainable energy for decentralized irrigation services in a growing number of settings. When deployed, the benefits include improved livelihoods (increased productivity and incomes, and food security), increased social welfare (poverty alleviation, emissions reduction) and reduced spending on fossil fuel subsidies and centralized infrastructure. In an effort to contribute to a number of SDGs, these solutions are becoming increasingly widespread, as demonstrated by the initiatives of a growing number of governments, development agencies, and the private sector.

However, when adoption of such system is planned, it should be executed with possible care. At least a three-year guarantee on the system components would need to be demanded while the panels have longer year guarantee for the well-known manufactured panels. Provider of solar systems without having recommended spares and maintenance services should not be selected for the provision of solar systems. The sector is future targets and untapped opportunities of the country so popularizing activities such as demonstration and awareness creation coupled with technical capacity building and researches should be started soon.

Though expanding irrigated land might reduce greenhouse gas emissions, increasing the number of fossil fuel driven pumps will have reversing effects. In such cases, solar pumps will have exponential advantages. Hence whenever possible it is advisable to popularize such technologies in the near future.

Unless the subsistence nature of smallholder pump irrigation and its low productivity are improved, service delivery of pumps will not have any opportunity for progressive transformation as well as sustainability. The sector is constrained by non-availability of agricultural inputs such as fertilizer, seed, and chemicals so on which in turn increase cost of production. Absence of reliable markets is also critical challenges for the entire sector.

The other sustainability issue is related with agronomic practices and irrigation water management. Pumps are running using fossil fuel which is highly costly. In order to benefit from the irrigation activity, the amount of water and the time of irrigation for each crop should be managed properly. Planting date and pattern, rate of application of fertilizer or seed should be practiced scientifically. Hence interventions to improve such activities are expected for sustaining the service sector.

Mismanagement of irrigation water will have additional impact on the environment; ground water depletion and salinity are the two major threats of the irrigation sector. Farmers in Harargie are

forced to dig deeper and deeper every year due to raping recession of groundwater. Unless mitigated beforehand, they will have negative impact on the environment as well as for the sector. Therefore, enforce proper water management and groundwater use policies. Defining water use rights and promoting of water saving technologies are necessary.

The pump service delivery sector is the untapped potential of the irrigation sector where women can highly participate. Without the participation of women, the success of the sector is under question because it is strongly attached with household production system. They can participate in every activity listed in this implementation strategy. If they are supported by the capacity development programs, their contribution will play important role in the achievement of the strategy.

8 MONITORING AND EVALUATION

The ultimate goal of this implantation strategy is to provide sustainable operation and maintenances services for pump users. The successes of the strategy will depend on the extents and depths of future monitoring and evaluation activities. Regular and objective oriented M & E programs on the progresses of the interventions are very important.

The implementation should be monitored with periodic intervals based on capacity of the supervisors and it should be evaluated at the mid and end of the strategy periods against the intended targets by Ministry of Agriculture. The achievements or the outcomes should be measured using the selected indicators. The indicators selected to measure these outcomes include; total number of pumps distributed for users and their quality; distribution share of locally assembled pumps; total number of trainings provided; total number of farmers trained; total number of established service providers; technical and financial performances of service providers. The indicators will be refined whenever necessary.

The performance report of enterprises such as its core activities, successes, challenges, threats and remedial options to be taken shall be presented to pertinent stakeholders at each of administrative hierarchies: federal, regional, zonal and Woreda levels. Besides others, extensive discussions on external factors and practical remedies would be suggested for shared actions.

The DPT and SSID sector shall take continuous support, monitoring and evolution of enterprise performances. M & E is aimed to take early corrective measures to sustain the scheme and the business.

At least two meetings per year may be made at national level by the coordination of federal SSID and DPT in collaboration with other key stakeholders. At regional levels, at least one meeting per quarter may be held by the coordination of regional SSI unit and DPT in collaboration with other key stakeholders. Every two months or six meeting per year may be set by the coordination of zonal SSI units and DPT in collaboration with other stakeholders. At Woreda level, at least one meeting per month may be held by the coordination of Woreda SSI unit and DPT in collaboration with other partners or stakeholders.

Table 4: Expected Results, Indicators and Measurements for Monitoring the strategy

Expected results	Indicators	Measurements	Data sources
Quality pump distributed	Pumps distributed	% of total plan	Regional offices
	Standardized pumps distributed	% quality test increased	Regional offices
	Spare parts availability	% increased	Farmers
	Share of locally produced pumps and spare parts	% increased	Regional offices
	Cost of pumps and spare parts	% reduced	Distributors/farmers
Increased O & M service providers	Established service providers (with regional distributions)	% increased	Woreda/zonal offices
	Service providers established near pump users	% increased	Woreda/Kebele offices
	Performances of service providers	% increased	Woreda/Kebele offices
	Nonfunctional pumps	% reduced	Woreda/zonal/regional offices
	Self-maintained pumps	% increased	Kebele/farmers
	Pump maintenance costs	% reduced	Farmers
Improved training supports	Trainings provided	% of total plan	Woreda/zonal/regional offices
	Pump users trained	% of total trained	Woreda/zonal/regional offices
	Engagement of TVET	% increased	Woreda/zonal/regional offices
	Stakeholders involved	% increased	Woreda/zonal/regional offices
Increased financial support	Enterprises support	% increased	Woreda/zonal/regional offices
	Finance provided for service enterprises	% increased	Woreda/zonal/regional offices
	Support providers engagement	% increased	Woreda/zonal/regional offices
	Users' satisfactions	% increased	Farmers

Since M & E programs are intended to evaluate and support performances of implementation activities on different predefined intervals at each administrative level, the expected targets to be measured should be set accordingly. For instance, if the total number of pumps expected to be in the hands of users in the year 2020 is 437 thousand (currently 200 thousand pumps existed) at national level, and if monitoring program is fixed every six months, the expected increment within the first six month will be 50% while for the second six months it will be 33.3% (100 thousand pumps per six months should be distributed and the percent should be calculated relative to existing pump number). All units of measurements should be set with the same logic at all levels.

9 BUSINESS MODELS

Three business models are proposed based on the on nature of service providers. These are the individual (entrepreneur) model, the joint (enterprise) model, and the integrated (mixed) model. The first two models assume regular service; the third model serves on demand basis in areas where pump enterprises were not effective or were not established at all. The details follow below.

9.1 The Entrepreneur Model

The entrepreneur business model uses individual technicians as key service providers. The model initiates innate talents, practical skills and dedication in pump maintenance service. These individual entrepreneurs become formally established as individual enterprises.

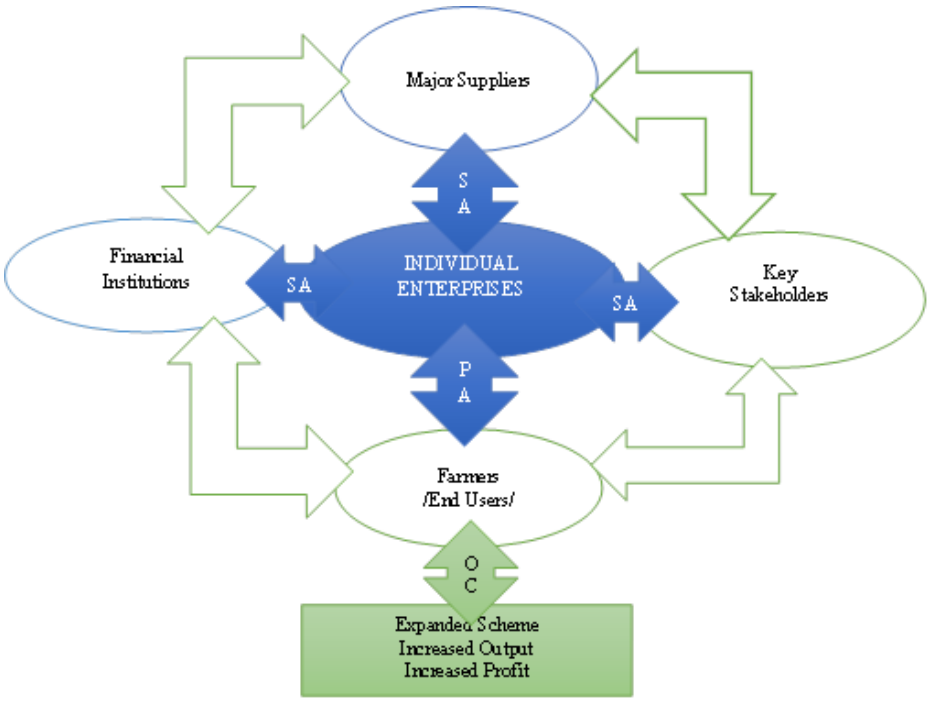

Figure 2: Value Chain for Entrepreneur Model

Where, PA = primary activities, SA = secondary activities, OC = outcome (Consultants, 2019)

The approach reduces the channels between the service providers and service recipients.

Values of the model include *efficiency, productivity, service-orientation, quality, timeliness, and sustainability* of service delivery.

Assumptions: three assumptions are outlined. First, the effectiveness of service business mainly depends on the practical skill of actors. Second, the entrepreneur's passion enhances the sustainability of the service. Third, lowest conflict of interest within an entrepreneur exceedingly reduces business risk.

Porter and Millers' value chain model identifies both primary and secondary activities. Primary activities consist inbound logistics, operations, outbound logistics, sales and marketing, and maintenance services. The applied experience of the entrepreneur could significantly contribute to the successful accomplishment of these primary tasks.

The supports are those activities that enhance the actual delivery of the intended service. These include access to items (supply), finance, capacity development, enterprise formation, work place, linkage, and information communication. These entities are expected to provide an uninterrupted service to the entrepreneur. The term "secondary activity" never undermine role of tasks but it infers that they are indirect services to users.

The major suppliers include manufacturers and major importers; the financial institutions contain microfinance, credit associations and banks that provide loan for the entrepreneur; the key stakeholders include capacity building colleges, MoA, Enterprise and industry development agency, and development partners such as NGOs. The special technology supply, credit facility, capacity development and coordination among players are expected to continue so as to improve the service, increase productivity, boost business viability. The established partnerships with the entrepreneur shall persist. The initiative provides special supply and credit with faire interest and payment period. In general, we recommend that initially priority shall be given to experienced individuals or groups in pump maintenance service.

9.2 The Enterprise Model

The enterprise business model considers group of organized people as service providers. The selected individuals are established as joint enterprises so as to provide service under pump technology sector.

The associations can be youth, farmer and women enterprises. It organizes five members per enterprise; to decentralize service delivery down to the local area, to expand the technology, to boost production and create job for vulnerable people at each administrative level. The values stated under entrepreneur model may work for this form with some limitation regarding efficiency, productivity and sustainability of the service business.

The assumptions of the model include the following. First, it can create more job opportunity for booming labor force; second, improve access to service for local farmers; thirdly, it may provide more service in a given period; finally, it may provide learning and experience sharing.

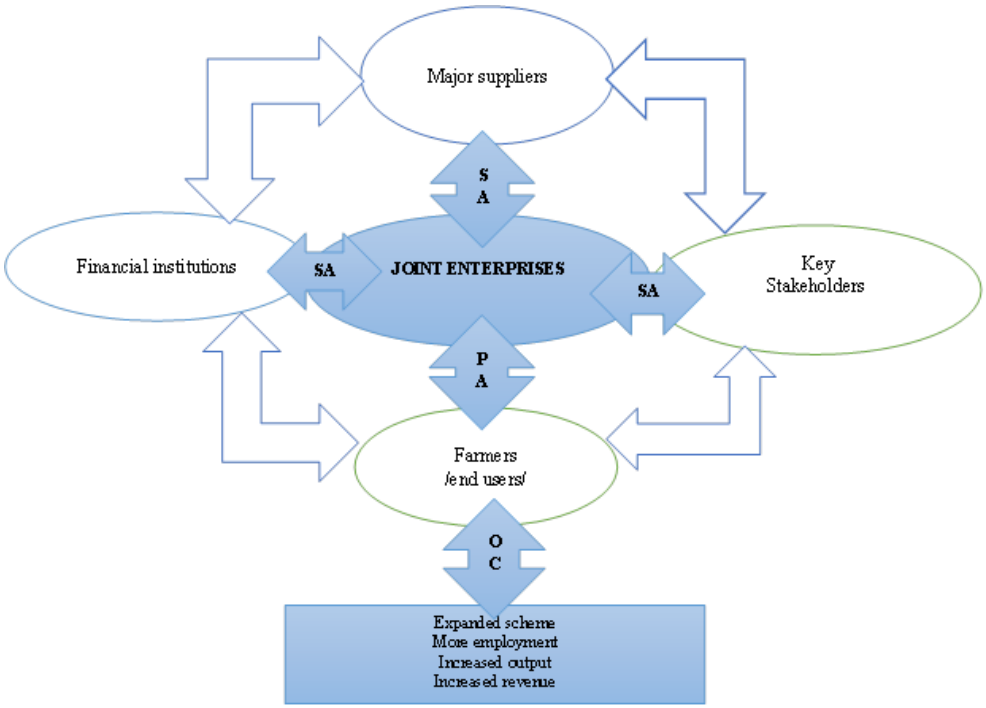

Figure 3: Value Chain for Enterprise Model

Where, PA = primary activities, SA = secondary activities, OC = outcome (Consultants, 2019)

The established cooperation with the enterprises shall persist; in terms of special supply, credit scheme, capacity development and market network. However, the establishments are expected to repay the loan and its interest within the payback period. Given such incentives, both the economic and business viability is likely to rise, while boosting labor employment in various localities and across the country.

9.3 The Integrated Model

The integrated business model is a mixed business approach that comprises both individual enterprises, joint enterprises and the government as service providers depending on the distribution of pump and nature of pump business.

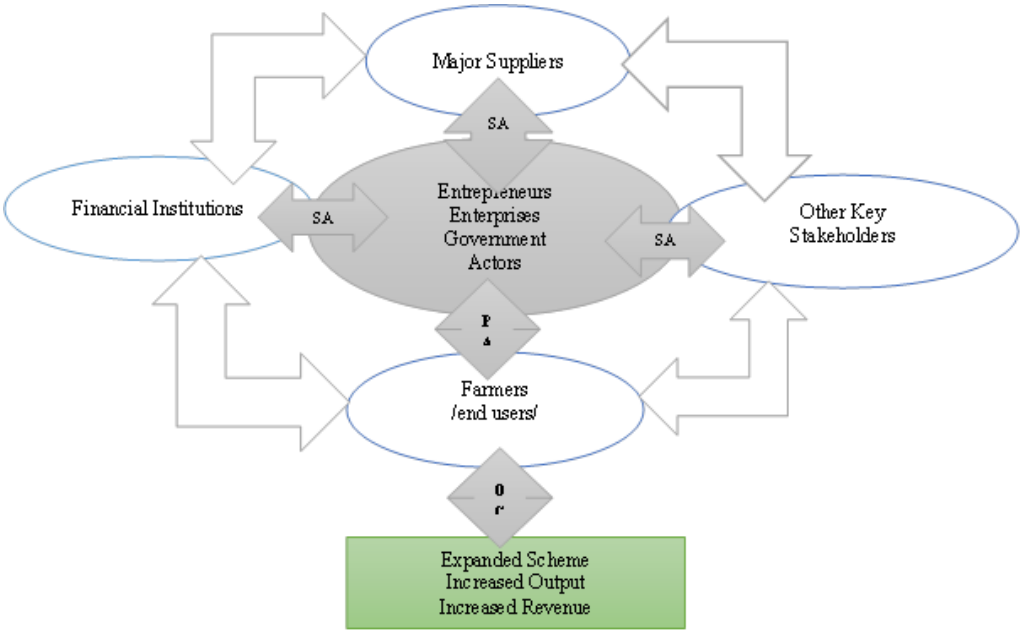

Figure 4: Value Chain for an Integrated Model

Where, PA= primary activities, SA=secondary activities, OC= outcome (Consultants, 2019)

For instance, in areas where relatively large number of pumps present, joint enterprises would be better; where small number (up to 120) of pumps, the private actors; and in areas where few (less than 81) pump exist, the government itself may take the responsibility i.e. business as usual (BAU). This mixed model may provide better access to service for growers experiencing different realities through shared efforts of the indicated three actors. Although the current critical question of pump users was lack of maintenance service and spare parts, special credit facility shall be arranged for smallholder farmers for at least pump acquisition. Realization of this requires a strong integration and coordination among stakeholders and lasting support from development actors and the state; these efforts together may enhance the technology advancement and its resulting multiple gains to actors and Ethiopia as well.

Furthermore, all three the models can comprise basic enterprises and auxiliary enterprises.

Basic enterprises include both individual and group enterprises engaged in the operation and maintenance service of irrigation pump and delivery of its spare parts to end users. Auxiliary enterprises consist both individual and group enterprises engaged in the delivery of fuel, oil and lubricants used for motor pump to end users. The classification is based on the type of pump technology. For example, basic enterprises provide pump operation and its spare parts; and auxiliary enterprises trade with fuel and lubricants used for pumps.

10 SAMPLE BUSINESS PLAN

The sample plan shows business plan per enterprises. Pump enterprises can be basic or auxiliary enterprises based on the type of services they deliver. Since, the basic enterprises provide basic services (O & M) both individual and joint enterprises also assume similar cost-benefit items and the unit values. The startup capital and the business plan per basic enterprise is set based on some assumptions.

10.1 Activities and Associated Costs

The major business activities to be commenced by the basic enterprises are operation and maintenance services and supply of spare parts; and that of auxiliary enterprises supposed to engage in the supply of fuel and lubricants to pump users and related customers.

Both enterprises forms assume almost similar startup capital, but different operating costs depending on the type of services delivered. However, this sample business plan focuses on basic enterprises. The cost estimates are given as follows.

10.1.1 Startup Capital

Initial capital includes initial investment and pre-operating costs. Considering special assumptions given below, the startup capital per basic enterprises is estimated as 216, 615 birrs; out of which the initial capital acquisition accounts 121,485 birr and the balance 95,130 birr goes to pre-operating costs (Annex D). The joint enterprises are expected to obtain the startup capital from browning or credit. Although special credit scheme is expected as affirmative action, to be more confident in finding this basic fund, 15% interest to be repaid on equal amortization starting from or before the payback period.

Assumptions: the following assumptions are considered while estimating the startup capital for newly established pump enterprises.

i. Startup capital include operating cost incurred in the first month of business implementation.
ii. Startup capital will be financed through special credit scheme
iii. Land will be given freely by the local government
iv. The enterprises exercise only use right of the land allocated
v. The allocated land or other work place shall be used only for pump business

vi. Major decisions related to the given land and legal personality issues shall be consulted and authorized by a relevant agency.

10.1.2 The Initial Investment

The initial investment refers to the money required for initial capital acquisition. The total initial capital required to start individual pump enterprise is estimated to be 121,485 birr and the detail items are shown in Table 5. In the list, land has no price since it is expected to be given for free as special incentive to motivate pump business. However, this doesn't mean that the value of land is zero; thus, its forgone value shall be estimate as opportunity cost. Since the resource is likely diverted from its next best economic activity, at least its scarcity value might be accounted.

Table 5: Initial investment per Enterprise in Birr

S.N.	Item	Unit	Amount	Unit Cost	Total Cost
1	Training	Days	50	550	27500
3	Land	M^2	100	-	-
5	House Construction	Number	1	24000	24,000
4	Toolkit	Set	1	16500	16,500
5	Compressor	Number	1	16000	16,000
6	Table	Number	2	500	1,000
7	Chair	Number	6	200	1,200
8	Shelf	Number	1	3500	3,500
9	Motorcycle	Number	1	26000	26,000
10	Miscellaneous	Bulk	1	5785	5785
	Total				**121,485**

Hence, economic analysis shall account for such forgone values as opportunity costs or as an indicator of scarcity of the resources.

10.1.3 Pre-operating Costs

In our particular case, pre-operating costs comprises costs required for maintenance and related services, and purchase of spare parts (complement) during the first month of the business launch.

This operational definition is given because the new pump enterprise owners lack money and required to finance them from credit sources as part of startup capital.

Maintenance cost: since maintenance service is the most important service required by under users, it is included as core business package. Thus, major maintenance service and its related cost items and unit values are identified, calculated and presented in Table 6. After completing formal establishment process, an enterprise is expected to borrow from already agreed financial institutions. Accordingly, the total variable cost of maintenance service per enterprises for the first month is birr 25,134. Note that the cost items included and their unit cost may not be conclusive and may be revised.

Table 6: Variable Costs of Maintenance Service (in Birr)

S.N.	Cost Item	Unit	Amount	Unit Cost	Total Cost
1	Maintenance Services				
1.1	Pump Maintenance	Number	78	80	6,240
1.2	Generator Maintenance	Number	78	75	5,850
1.3	Bajaj Maintenance	Number	78	75	5,850
1.4	Motorcycle Maintenance	Number	78	70	5,460
1.5	Total Maintenance Service cost		312		*23,400*
2	Related Service Costs				
2.1	Electricity	Watt	500	2	1,000
2.2	Water	Liter	520	0.2	104
2.3	Oil	Liter	5	126	630
2.6	Total Related Service Costs				*1,734*
3	***Total Variable Cost (TVC)***				***25,134***

Purchase of Spare parts: since supply of spare parts to end users is the second most important service, pump enterprises shall trade this complementary item besides maintenance service. Consequently, the list of common spare parts, their unit price (2019) and total outlay is given in Table 7. The total expenditure on spare parts for the first month of the start of the business is estimated at birr 63,246.

Table 7: Purchase of Pump Spare Parts (in Birr)

S.N.	Item	Unit	Amount	Unit Price	Total Price
1	Carburetor	Number	26	300	7,800
2	Vella	Number	13	306	3,978
3	Water Seal	Number	6	240	1,440
4	“Fasha”	Number	5	336	1,680
5	Casing	Number	4	830	3,320
6	“Hose”	Number	9	200	1,800
7	Candela	Number	40	48	1,920
8	Cylinder	Number	6	1440	8,640
9	Gasket Maker	Number	50	90	4,500
10	Ignite Coil	Number	4	420	1,680
11	Starter	Number	9	250	2,250
12	Plaster	Number	40	22	880
13	Air Cleaner	Number	6	600	3,600
14	Glass Paper	Meter	2	144	288
15	Oil	Liter	80	120	9,600
16	Gasoline/petrol	Liter	250	21	5,250
17	Nafta	Liter	220	21	4620
	Total	-	-	-	***63,246***

Similar to the maintenance costs, recall that the accessary items included may not be exhaustive and their unit prices change over time; up to date revision may be important.

Fixed costs: monthly overhead cost incurred by the enterprise is also estimated. Since fixed costs are assumed even when the basic pump services are not delivered and is presented in Table 8.

Table 8: Fixed cost Per Enterprise (in Birr)

S.N.	Item	Unit	Outlay
1	Fixed Costs		
1.1	Salary	Birr	3000
1.2	Administration	Birr	2550
1.3	Transaction	Birr	1200
1.4.	***Total Fixed Costs (TFC)***	Birr	***6,750***

Finally, the startup capital will be the sum of the initial investment and pre-operating costs. The pre-operating costs further includes the maintenances cost (TVC), spare parts acquisition, and overhead costs (TFC). The sum of these cost estimates together will give us the startup capital required per individual pump enterprise establishment. Table 9 summarizes the total cost estimates per enterprise including initial capital investment.

Table 9: Startup Capital Per Enterprise

S. N.	Item	Unit	Outlay
1	Initial Investment	-	
1.1	Capital Acquisition	Birr	121,485
2	Pre-Operating costs	-	
2.1	Total fixed cost (TFC)	Birr	6,750
2.2	Total variables cost (TVC)	Birr	25,134
2.3	Spare Part Acquisition	Birr	63,246
2.4	Total Pre-Operating Costs	Birr	95,130
3	***Startup Capital (SC)***	*Birr*	***216,615***

From the above data, unit cost of maintenance service is calculated for further analysis. The unit cost of maintenance is the ratio of total variable cost of maintenance service to the number of maintenance services given. Employing data from tables, the number of maintenance services (NMS) delivered per month is 312 and the total variable cost (TVC) is birr 25,134. Then, the variable cost per maintenance service is calculated as:

$$\text{VC} = \frac{\text{Total Maintenance service cost (TVC)}}{\text{Number of Maintenance services delivered (NMS)}} = \frac{25{,}134}{312} = 80.56 \text{ birr}$$

Therefore, the enterprises will incur cost of 80.56 birr per unit of maintenance service given. To be profitable the unit price shall be charged above the calculated variable cost.

10.2 Services Delivered and Revenue Earnings

The basic enterprises are supposed to provide O & M and spare parts to end users. Therefore, the potential revenue earned from operation and maintenance service, and revenue from sale of spare parts is estimated and presented. Accordingly, estimated monthly earning from maintenance service will be 56,238 birr per basic enterprise (Table 10).

Table 10: Revenue from Maintenance Service (monthly earnings in Birr)

NO.	Service Type	Unit	Amount	Unit Price	Revenue
1	**Maintenance Services**				
1.1	Pump Maintenance	Number	78	200	15,600
1.2	Generator Maintenance	Number	78	185	14,430
1.3	Bajaj Maintenance	Number	78	186	14,508
1.4	Motorcycle Maintenance	Number	78	150	11,700
1.5	**Total**	Number	**312**		**56,238**

In this case, if we assume that one technician can handle three maintenance service per day, works 26 days per month, about 78 services would be given per month per person and further if four enterprise members (out of five members) participate in the service delivery, we will have 312 maintenance services per month per joint enterprise. The remaining person may act as facilitator. The revenue from spare part sale is also calculated and presented for the same basic enterprise. In this case, the selling price charges 20% markup on the top of the purchase price. Business ethics and social responsibility are key to enhance customer loyalty, market share and sustainability.

Table 11: Revenue from Spare Parts Sale (monthly estimate in Birr)

S.N.	Item	Unit	Amount	Unit Price	Revenue
1	Carburetor	Number	26	360	9,360
2	Vella	Number	13	367.2	4,774
3	Water Seal	Number	6	288	1,728
4	“Fasha”	Number	5	403.2	2,016

S.N.	Item	Unit	Amount	Unit Price	Revenue
5	Casing	Number	4	996	3,984
6	Hose	Number	9	240	2,160
7	Candela	Number	40	57.6	2,304
8	Cylinder	Number	6	1728	10,368
9	Gasket Maker	Number	50	108	5,400
10	Ignite Coil	Number	4	504	2,016
11	Starter	Number	9	300	2,700
12	Plaster	Number	40	26.4	1,056
13	Air Cleaner	Number	6	720	4,320
14	Glass Paper	Meter	2	172.8	346
15	Oil	Liter	80	144	11,520
16	Gasoline/petrol	Liter	250	25.2	6,300
17	Nafta	Liter	220	25.2	5,544
	Total	-	-	-	75,895

Then, the revenue collected from sale of spare parts per month is estimated at birr 75,895 (Table 11). The aggregate revenue from basic services will be the sum of revenue from maintenance service and sale of spare parts. That is 56,238 plus 75,895 equals 132,130 birr. If the pre-operating cost is deduced from gross revenue (132,130 minus 95,130) around birr 37,000 will be the gross net revenue per month per enterprise. However, since the marginal analysis provides defendable information, the following estimations lead to return from the business analysis.

10.3 Business Performance

Marginal analysis yields better estimator for future business decisions. Various parameters such as unit costs, revenue, profit and breakeven point is commenced. These estimations required over ten step processes starting from variable cost to per capita revenue and profit.

Variable Cost: first we calculate the variable cost of basic services using formula:

$$\mathrm{VC} = \frac{\text{Total service cost (TVC)}}{\text{Number of services delivered (NSD)}} = \frac{25{,}134}{312} = 80.56 \text{ birr}$$

Unit Revenue: second**,** revenue per maintenance service (R) can be estimated. The unit revenue per maintenance services is the ratio of total fee from maintenance service to the number of maintenance services given. Mathematically, we can express this as:

$$\mathrm{R} = \frac{\text{Total fee from maintenance service cost (TFM)}}{\text{Number of maintenance services given (NMS)}} = \frac{\text{Birr } 56{,}238}{312} = \text{Birr } 180.25$$

Breakeven Service: third, breakeven services level will be assessed. Breakeven maintenance service (BEMS) is the ratio of total fixed cost to (unit maintenance service fee minus unit maintenance service cost). Mathematically, the BEMS can be given by the formula:

$$BEMS = \frac{\text{Total Fixed Cost (TFC)}}{\text{Unit services fee (P)} - \text{unit service cost(VC)}} = \frac{6{,}750}{(180.25 - 80.56)} = \frac{\text{Birr } 6{,}750}{\text{Birr } 99.69} = 67.71 =$$
$$= 68 \text{ Maintenance services}$$

Where, total fixed cost data is adapted from Table 8 or 9; the unit service cost and unit service fee from the first and second steps just immediately above the current estimation process.

The breakeven level service indicates that at 68 maintenance services total revenue equals total cost. In other words, at this level of services (68), one joint enterprise can cover total maintenance cost and fixed cost; i.e. TVC and TFC. Shortly when 68 services are given per month, there will zero profit (neither profit, nor loss). This implies to earn positive profit; the enterprise shall provide service more than the breakeven point. The unit service price is also important for next analysis.

Unit price: fourthly, the unit price of service will be estimated using the following formula:

Unit price (P) = Unit maintenance fee-unit service cost = 180.25 - 80.56 = 99.69 birr.

Optimum service: fifth step determines the number of maintenance services that lead to economic profit. Taking the difference between the total number of maintenance services (TNMS) and breakeven service amount. Therefore, number of maintenance service leading to economic profit = Service level lying above the breakeven Point = 312 - 68 = 244 Services. This means that starting from the 69th service to 244th service; the enterprise is expected to earn positive economic profit.

Revenue from Maintenance (RM): Sixth step calculates revenue per month using this arithmetic: Monthly revenue from maintenance services = P*Q = 180.25*244 = 43,981 birr. Furthermore, if the entire service plan is considered, total revenue per month will be 56,238 birrs.

Revenue from Spare parts (RS): the 7th step calculates monthly revenue from sale of spare parts. Revenue from spare parts per month = Total expenditure on spare parts minus total sales of spare parts. Therefore, RS per month = 75,895.2 - 63,246 = 12,649.2 birr.

Total Revenue (TR): the eighth step determines the combined monthly revenue per enterprise. The total monthly revenue from maintenance and related services is the sum of revenue earned from maintenance services and revenue earned from sale of spare parts. Total revenue per month = 56,238 + 12,649.2 = 68,887.2 birr is the monthly service delivery earning.

Per capita Revenue (PCR): nightly the monthly per capita revenue of enterprise members is estimated. This can be determined by taking the ratio of total monthly revenue of the enterprise to the number of members in the enterprise.

$$\text{PCR} = \frac{\text{Total Revenue per month (TRM)}}{\text{Number of Members included in the enterprise (NMS)}} = \frac{68{,}887.2}{5} = 13{,}777.44 \text{ birr}$$

Therefore, each member of joint enterprises is expected to earn 13,777 birr per month. This indicates that the business is attractive. If the assumed business form is individual enterprise, about birr 69 thousand will be generated as monthly revenue. From the same data, if similar service delivery, cost and sales is assumed; the annual revenue per enterprise and annual revenue per members would be birr 826,646.4 and birr 165,329.3 respectively.

Total profit (TP): tenthly, the total profit per enterprise and profit per person shall be estimated. Accordingly, the monthly profit of the enterprise is computed by taking the difference between total revenue and total cost. That is TP = TR - TC = Birr 68,887.2 - Birr 31,884 = Birr 37,003.20. This is the arithmetic net-revenue enjoyed by the enterprise.

Percapita Profit (PCP): finally, estimates the profit per enterprise members, which often yields better business edge than the gross profit. The value is determined by taking the ratio of total profit (TP) of the enterprise by the number of members (NM) in the same enterprise. Therefore, PCP = TP/NM = 37,003.2/5 birr = 7,400.64 birr per month. Furthermore, financial analysis provides improved business feasibility and hence estimated analyzed in the subsequent section.

10.4 Financial Analysis

The financial and economic analysis shows the monetary and economic viability of the business over the project period. The underlying assumptions focus on depreciation, growth rate of the business or the project, the discount rate, the opportunity cost for economic analysis and also the income statement, financial rate of return and cash flow by setting the underlying assumptions.

10.4.1 Assumptions

The major assumptions of the financial analysis are the following. The hypothesis is based on data from national planning commission (NPC, 2016), and our current survey assessment result. The financial analysis focused on actual monetary outlay of the proposed business. Thus, project period is six years, the annual deprecation rate is 10 percent, the growth rate of the business is 10 percent per year (the survey result shows 14 percent growth), the annual interest rate at 18%. Further, these new enterprises may be exempted from profit tax for the project life time. Similarly, the growth rate of the business is roughly equal to the recent growth rate (i.e. 10 percent) of annual GDP.

10.4.2 Profitability

The business will make a profit throughout its operational life time. (2020-2025). Annual net profit before tax increases from Birr 444,038 birr in the first year (2020) to Birr 715,128 at the last year of the operation (2025). Furthermore, the net profit as percent of service revenue 53%, which is high figure. Net profit to total initial investment (ROI) is also very attractive. For details see the attachments in the annex.

10.4.3 Financial Rate of Return

Internal Rate of Return (IRR): is an indicator of the efficiency of an investment. A project said to be good investment, if IRR is greater than rate of return that could be earned by alternate investment or bank interest. So, the IRR of the business is calculated at 16.27% which is greater than the market interest rate (15%) indicating the feasibility of the business.

Net Present Value (**NPV):** refers the total present (discounted) value for series of cash flows. NPV aggregates cash flows that occur during different periods of time during the life of a project in to a common measuring unit i.e. present value. Accordingly, our proposed pump business will generate a positive net present value throughout its life time specially; the projected net present value is 25,678 birr per enterprise. Details can be seen from tables in the Annex D.

11 REFERENCES

Abebe Kibatu (2016). *Pumps for Drip Irrigation System Module-B.* Small Scale & Micro Irrigation Support (SMIS) Project. Bahir Dar, Ethiopia

ATA (2018). *Irrigation Technologies and Services Supply Chain (ITSSC) Study Report*. Addis Abeba, Ethiopia.

Anwar Alamin (2014). *Impact of Small-Scale Irrigation on Household Welfare; the case of Laelay Dayu Irrigation Scheme, Alamata District, Tigray*. A Thesis Submitted in Partial Fulfilment of the Requirements for Master of Science in Economics Specialization: Development Policy Analysis, Mekele University.

Awulachew S. B. (2010). *Irrigation Potential in Ethiopia: Constraints and Opportunities for Enhancing the System*. International Water Management Institute.

Ayele, G. K., Nicholson, C. F., Collick, A. S., Tilahun, S. A. and Steenhuis, T. S (2013). *Impact of small-scale irrigation schemes on household income and the likelihood of poverty in the Lake Tana basin of Ethiopia*. In: Wolde Mekuria (2013). Rainwater management for resilient livelihoods in Ethiopia: Proceedings of the Nile Basin Development Challenge science meeting, Addis Ababa, 9–10 July 2013.NBDC Technical Report 5. Nairobi, Kenya: International Livestock Research Institute.

Babatunde, O. (2006). *Differential Poverty Reduction Impact of Small-Scale Irrigation Development between its Beneficiaries and Non-Beneficiaries in Nigeria,* University of Sussex, UK.

Carter, Richard, Desta Horecha, Etsegenet Berhe, Eyob Belete, Eyob Defere, Yetnayet Negussie, Belete Muluneh and Kerstin Danert. (2006). *Drilling for Water in Ethiopia: A Country Case Study by the Cost-Effective Boreholes Flagship of the Rural Water Supply Network.* WSP/RWSN, Federal Democratic Republic of Ethiopia.

Cherre S. (2006). *Irrigation Policies Strategies and Institutional Support Conditions in Ethiopia*: Proceeding of a MoARD/MoWR/USAID/IWMI Symposium and Exhibition. Addis Ababa, Ethiopia 7-9 March, 2006.

DACAAR (2015). Best practices on Solar Water Pumping System. DACAAR Secretariat Copenhagen, Denmark

Dessalegn, M. and Merrey, D. J. (2015). *Motor pump revolution in Ethiopia: Promises at a Crossroads*. Water Alternatives 8(2): 237-257. www.water-alternatives.org

Fitsum Hagos and Stein Holden (2003). *Rural Household Poverty Dynamics in Northern Ethiopia 1997-2000*. Analysis of Determinants of Poverty. AaS, Norway.

GW-MATE (2011). *Ethiopia: Strategic Framework for Managed Groundwater Development*. GW-MATE (Groundwater Management Advisory Team) in Cooperation with Ethiopian Ministry of Water Resources, MetaMeta, Acacia Water and Nuffic.

Haile, T. (2008). *Impact of Irrigation Development on Poverty Reduction in Northern Ethiopia*. National University of Ireland, Cork.

Hanjra, M., Ferede, T., and Gemechu, D. (2009). *Pathways to Breaking the Poverty Trap in Ethiopia: Investments in Agricultural Water, Education, and Markets*. Agricultural Water Management 96(11):1596-1604.

IDEA (2013). *Assess the potential for low cost manual drilling in North/East Tigray, Ethiopia*. International Development & Environmental Assistance-IDEA

IWMI (2005). *Experiencing and Opportunities for Promoting Small Scale/Micro Irrigation and Rain Water Harvesting for Food Security in Ethiopia*. International Water Management Institute (IWMI). Addis Ababa, Ethiopia.

Jin, S., Yu W., Jansen, H. G. P. Muraoka, R. (2012). *The impact of Irrigation on Agricultural Productivity: Evidence from India*. Selected Poster prepared for presentation at the International Association of Agricultural Economists (IAAE) Triennial Conference, Foz do Iguaçu, Brazil, 18-24 August, 2012.

MoA and ATA (2016). *Realizing the Potential of Household Irrigation in Ethiopia; Vision, Systemic Challenges, and Prioritized Interventions.* Working Strategy Document. Addis Ababa, Ethiopia.

MoA, MoWIE and ATA (2016). *National Smallholder Irrigation and Drainage Strategy*. Addis Ababa, Ethiopia.

MoA-NRMD (2011). *Small-Scale Irrigation Situation Analysis and Capacity Needs Assessment.* A Tripartite Cooperation between Germany, Israel and Ethiopia. Addis Ababa, Ethiopia.

MoFED (2010). *Growth and Transformation Plan 2010/11-2014/15*. Volume I: Main Text. Ministry of Finance and Economic Development, November 2010, Addis Ababa.

MoWR (1999). *Ethiopian Water Resources Management Policy*. Ministry of Water Resources, Addis Ababa, Ethiopia.

MoWR (2001). *Ethiopian Water Sector Strategy*. Ministry of Water Resources, Addis Ababa, Ethiopia.

Mpala C. (2016). *The Socio-Economic Impact of Smallholder Communal Irrigation Projects: A Case Study of Tshongokwe Smallholder Irrigation Scheme in Lupane District in*

Matabeleland North Province, Zimbabwe. International Journal of Social Science and Economic Research, 01, (07).

Nahusenay, Teamer Gebrehiwot, Kassa Amare Mesfin and Jan Nyssen. (2015). *Small-scale Irrigation: The Driver for Promoting Agricultural Production and Food Security (The Case of Tigray Regional State, Northern Ethiopia).* Irrigat Drainage Sys Eng 2015, 4:2.

NPC (2016). *Growth and Transformation Plan II (GTP II) (2015/16-2019/20)*. Volume I: Main Text. National Planning Commission-NPC. Addis Ababa, Ethiopia.

Otoo, M., Lefore, N., Schmitter, P., Barron, J., Gebregziabher, G. (2018). *Business model scenarios and suitability: smallholder solar pump-based irrigation in Ethiopia*. Agricultural Water Management–Making a Business Case for Smallholders. Colombo, Sri Lanka: International Water Management Institute (IWMI). 67p. (IWMI Research Report 172). doi: 10.5337/2018.207.

SMIS (2016). *Manual Irrigation Pumps Module VII (B)*. Small Scale & Micro Irrigation Support Project. Addis Abeba.

Solomon, S. and Ketema, M. (2015). *The impact of irrigation technologies on rural households' poverty status: The case of Fogera District, North-western Ethiopia*. Agris On-line Papers in Economics and Informatics, 7(1), 59– 67.

Steiner-Asiedu, M., Abu, B. A. Z., Setorglo, J., Asiedu, D. K., & Anderson, A. K. (2012). *The impact of irrigation on the nutritional status of children in the Sissala West District of Ghana.* Current Research Journal of Social Sciences, 4(2), 86–92.

Tekana, S. S., and O. I. Oladele. (2011). *Impact analysis of Taung Irrigation Scheme on Household Welfare among farmers in North-west Province, South Africa*. 36(1), 69–77.

Tizita Damtew (2017). *The Effect of Small-Scale Irrigation on Household Food Security in Bona-Zuria Woreda. Sidama Zone, Southern Ethiopia*. Thesis Submitted to School of Environment, Gender and Development Studies Hawassa University, College of Agriculture.

Unpublished report (2017). *Solar pumps for irrigation in Ethiopia- Barriers to diffusion and suitable business models*. Final Draft.

Weight E., Yoder R. and Keller, A. (2012). *Manual Well Drilling Investment Opportunity in Ethiopia.* March 2012.

Weight, E.; Yoder, R.; Keller, A. (2013). *Manual well drilling investment opportunity in Ethiopia*. Colombo, Sri Lanka: International Water Management Institute (IWMI) Working Paper 155, 25p. doi: 10.5337/2013.210.

12 ANNEXES

Annex A. Surveyed Areas

Table A-1: Summary of Survey Areas

	Tigray	Oromia	Amhara	SNNPR
ZONES	Central Tigray	Estarn Hararge	South Gondar	Gurage
	Eastern Tigray	Eastern Shoa	Central Gondar	Silte
	Sothern Tigray	Arsi	West Gojam	Gamo
WOREDA	Adwa	Haromaya	Dera	Meskan
	Kiltawelalo	Adami Tulu Jido Kombolcha	Fogera	Siliti
	Offla	Tiyo	Misrak Dembia	Merab Abaya
	-	-	Jabi Tenan	-
KEBELE	Gendebta	Finkile	Shina	Bati Lejamo
	Woreta Aulala	Negalign	Beboksa	Kuno 01
	Kessela	Ilika Challamo	Arbayitu Ensisa	Yayke
	Adishmbekit	-	-	Kolla Mulato

Annex B. Surveyed Regional Motor Pump Population

Table B-1: Inventor of small pumps in East Harargie zone of Oromia in 2010 EC

Districts	Pump type	Quantity	Capacity (inch)	Fuel used	Irrigate (ha)	No. Household	Source of water	Status		
								Functional	Non functional	New 2009
Babile	Boshan	29	2"	Diesel	581	19	G/Water	19		
	Boshan	42	4"	"	247	42		22		
	Eagle	271	3"	Petrol	402	1086		204		
	Honda	298	3"	"	335	1117		193		87
	Total	**640**			**1565**	**2264**		**438**	**0**	**87**
Gursum	Boshan	40	4"	Diesel	116	445	Pond & G/Water	20		
	Eagle	1137	3"	Petrol	1496	2546		1112		
	Honda	403	3"	"	464	650	"	376		4
	Total	**1580**			**2076**	**3641**		**1508**	**0**	**4**
Chinaksan	Boshan	15	2"	Diesel	63	90	River	7		
	Boshan	15	3"	"	44	90	Spring	3		
	Eagle	111	3"	Petrol	280	633	""	96	50	
	Honda	55	3"	"	134	310		41		
	Total	**196**			**521**	**1123**		**147**	**50**	**0**
Kombolcha	Boshan	7	2"	Diesel	2.6	11	Spring	7		
	Boshan	15	3"	"	4.25	17	Spring H/Dg	14		
	Eagle	4393	3"	Petrol	1106.25	4428	"	4311		
	Honda	4383	3"	"	1103	4434	"	4312		
	Dynamo	560	1"	Eletri	140	560		560	600	122
	Total	**9358**	**0**	**0**	**2356.1**	**9450**	**0**	**9204**	**600**	**122**
Jarso	Boshan	25	2"	Diesel	32	68	Spring	25		
	Boshan	25	3"		38	69		20		
	Eagle	1835	3"	Petrol	2350	5044	"	1805	350	
	Honda	790	3"	"	985	2102	"	750		
	Total	**2675**	**0**	**0**	**3405**	**7283**	**0**	**2600**	**350**	**0**
Fadis	Boshan	7	2"	Diesel	20	20	River & G/W	-	7	
	Boshan	7	3"	"	45	26	"	4	3	
	Eagle	269	3"	Petrol	619	702	"	269		

Districts	Pump type	Quantity	Capacity (inch)	Fuel used	Irrigate (ha)	No. Household	Source of water	Status		
								Functional	Non functional	New 2009
	Honda	270	3"	"	645	727	"	308	52	
	Total	**553**	**0**	**0**	**1329**	**1475**	**0**	**581**	**62**	**0**
Haramaya	Boshan	90	3"	Diesel	12.8	90	Pond & G/Water	-		
	Boshan	7	4"	"	67	193	"	7		
	Roben	240	3"	Petrol	168	363		110		
	Eagle	9347	3"	Petrol	6063	15163	"	7896		
	Honda	6852	3"	"	4337	10849	"	5681	2030	1133
	Dynamo	2305	1"	Eletri	2655	2905		2055		
	Total	**18841**	**0**	**0**	**13302.8**	**29563**	**0**	**15749**	**2030**	**1133**
Qarsa	Boshan	96	2"	Diesel	132	322	River & G/W	62		
	Boshan	111	3"	"	155	337		72		
	Boshan	2	4"	"	22	54		-		
	Eagle	563	3"	Petrol	1400	3481		481		
	Basso Marcus	553								
	Honda	600	3"	Petrol	2093	5105	"	527		
	Robin	87	3"	"	13	32		66		450
	Total	**2012**	**0**	**0**	**3815**	**9331**	**0**	**1208**	**0**	**450**
Meta	Boshan	27	2"	Diesel	159	449	Spring & river	27		
	Boshan	42	3"	"	627	1770	"	42		
	Eagle	143	3"	Petrol	915	2591	"	93		
	Honda	95	3"	"	724	2045	"	64	60	8
	Total	**307**	**0**	**0**	**2425**	**6855**	**0**	**226**	**60**	**8**
G/gutu	Boshan	22	2"	Diesel	60	92	Pond & G/Water	15		
	Boshan	22	3"	"	86	131		16		
	Boshan	14	4"	"	96	147		12		
	Eagle	372	3"	Petrol	1684	2590		323	200	19
	Honda	40	3"	"	27	42		5		
	Total	470	0	0	1953	3002	0	371	200	19
Dadar	Boshan	40	4"	Diesel	40	380	Spring G/w	37		
	Eagle	241	3"	Petrol	1564	3082	"	227		
	Honda	67	3"	"	850	1500	"	100		
	Honda-Kosh	30	3"	"	"	255	450	30	80	
	Total	378	0	0	2454	5217	450	394	80	0
M/Balloo	Boshan	21	2"	Diesel	21	53	Spring & Rev	21		
	Boshan	30	3"	"	33.25	128	"	20		
	Eagle	47	3"	Petrol	12.25	153	"	30		
	Honda	80	3"	"	50	285	"	70		
	Roben	22	3"	"	5	33	"	12	100	22
	Total	200	0	0	121.5	652	0	153	100	22
K/challe	Boshan	20	4"	Diesel	80	320	Pond & River	20		
	Eagle	194	3"	Petrol	468	1879	"	114		
	Honda	66	3"	"	360	1440	"	53	38	39
	Total	280	0	0	908	3639	0	187	38	39
Gurawa	Boshan	60	4"	Diesel	1080	3240	Spring River	24		
	Eagle	54	3"	Petrol	380	956	"	25		
	Honda	273	3"	"	2376	7128	"	262	93	120
	Total	387	0	0	3836	11324	0	311	93	120
Gol/odaa	Boshan	8	2"	Diesel	56	168	River. G/w	3		
	Boshan	7	3"	"	70	240		4		
	Boshan	20	4"	"	300	675		12		
	Eagle	136	3"	Petrol	611	1306	"	82		
	Honda	27	3"	"	200	435	"	15		
	Robin	20	3"	"	104	342	"	13		
	Casion	5	3"	"	25	50		3		
	Lifan	1	3"	"	4	10		1	80	
	Total	224	0	0	1370	3226	0	133	80	0
Badano	Boshan	25	2	Diesel	175	319	Spring	12		
	Boshan	25	3	"	305	946	River	11		
	Eagle	40	3	Petrol	102	287	"	103		
	Honda	54	3	"	570	1540	"	110		

Districts	Pump type	Quantity	Capacity (inch)	Fuel used	Irrigate (ha)	No. Household	Source of water	Status		
								Functional	Non functional	New 2009
	Robin	6	4"	"	120	324		-		
	Honda-kosh	2	3"	"	45	121		2		
	Tiger	8	3"	"	45	119		8	65	8
	Total	160	11	0	1362	3656	0	246	65	8
Mayu	Boshan	7	2"	Diesel	140	184	River	-		
	Boshan	7	3"	"	196	258	"	-		
	Eagle	17	3"	Petrol	434	578		12		
	Honda	15	3"	"	211	287	"	19	10	5
	Total	46	0	0	981	1307	0	31	10	5
Qumbii	Boshan	2	2"	Diesel	3	6	River	1		
	Boshan	3	3"	"	3	6	"	1		
	Eagle	36	3"	Petrol	125	507	"	25		
	Honda	9	3"	"	4.5	9	"	5		
	Robin	2	3"	"	2	4		2	10	
	Total	52	0	0	137.5	532	0	34	10	0
	Total Fuel Pump	**38,359**			**43,918**	**103,540**		**33,521**	**3,828**	**2,017**
	Total Electrical pump	**3,465**			**2,795**	**3,465**		**3,465**	-	-
Go/Muxii	**G/Total**	**41,824**	-	-	**46,713**	**107,005**	-	**36,986**	**3,828**	**2,017**
Total Pump Providing services							35,341			
Total Pump difficult to get spare parts for maintenance							3,980	0.11		

Table B-2: Inventor of small motor pumps in Arsi zone of Oromia Region

No	District	Pump numbers	Area irrigated, ha	Beneficiary household	Scheme Status	
					Functional	Non-Functional
1	Amigna	38	629.00	732	25	13
2	Aseko	41	182.50	294	33	8
3	Bele	13	55.00	172	10	3
4	Chole	21	141.00	103	16	5
5	D/Tijo	54	224.00	150	35	6
6	Doddota	71	206.50	379	67	4
7	Dekisi	12	18.00	35	7	1
8	Gololcha	145	843.00	1,686	118	12
9	Guna	5	23.00	59	3	2
10	H/Wabe	31	82.00	104	25	6
11	Hetosa	13	19.50	33	9	4
12	Jeju	238	357.00	651	209	29
13	L/bilbilo	49	73.50	164	42	7
14	L/Hetosa	39	76.00	186	31	8
15	Merti	81	124.00	368	75	6
16	Munessa	43	65.75	156	36	7
17	Robe	79	128.00	257	68	11
18	Seru	68	159.00	184	54	14
19	shirka	166	322.00	641	151	15
20	Sire	39	74.50	282	35	4
21	Sude	24	60.00	240	19	5
22	Tena	71	144.00	206	60	11
23	Tiyo	35	72.80	210	34	1
24	Z/Dugda	624	1,872.00	3781	603	21
	Grand Total	**2,000**	**5,952.05**	**11,073**	**1765**	**203**

Table B-3: Inventor of small pumps in SNNPR in 2011 EC (regional agricultural bureau)

No	Zone/special Woreda	Functional	Nonfunctional	Repaired
1	የም ልዩ ወረዳ	28	12	0
2	ጋሞጎፋ	**1876**	**140**	**0**
3	ባስኬቶ ልዩ ወረዳ	6	8	0
4	ወላይታ	**1757**	**226**	**100**
5	ጉራጌ	**2977**	**625**	**315**
6	ሀዲያ	424	166	18
7	ሲዳማ	**1136**	**44**	**10**
8	ጌዴኦ	57	1	0
9	ከፋ	143	30	0
10	ከምባታ ጠንባሮ	606	149	0
11	ቤንች ማጂ	348	50	0
12	ደ/አሞ	128	191	0
13	ደውሮ	169	106	0
14	ሀላባ	105	28	0
15	ሸካ	47	5	0
16	ኮንታ	11	4	0
17	ስልጤ	**3710**	**310**	**59**
18	ሰገን /አ/ህዝ	807	201	0
19	ሀዋሳ/ከ/ አስተዳደር	250	21	0
	ድምር	**14585**	**2317**	**502**

Table B-4: Inventory of small pumps in Amhara Region in 2011 EC (regional agricultural bureau)

ሞተር ፓምፕ ወደ ስራ ማስገባት	የሞተር ፓምፕ የ2011 እቅድ ብዛት	በነባር ብዛት	በአዲስ ብዛት	የሞተር ፓምፕ ጥገና	በሞተር በ 2011 የሚያለማ	በነባር የለማ መሬት	በአዲስ የሚለማ መሬት	ተጠቃሚ አርሶ አደር	በነባር	በአዲስ
የ 2011 እቅድ	ቁጥር	ቁጥር	ቁጥር	ቁጥር	ሄክታር	ሄክታር	ሄክታር	ቁጥር	ቁጥር	ቁጥር
	44,205.00	**35,119.00**	**9,086.00**	**3,081.00**	**184,330.00**	**147,986.00**	**36,344.00**	**455,271.00**	**427,489.00**	**27,782.00**
ምዕራብ ጎጃም	8,382.00	6,822.00	1,560.00	540.00	33,367.00	27,127.00	6,240.00	61,316.00	59,106.00	2,210.00
ምስራቅ ጎጃም	4,901.00	**3,781.00**	1,120.00	300.00	21,448.00	16,968.00	4,480.00	46,838.00	43,219.00	3,619.00
አዊ	3,048.00	1,948.00	1,100.00	210.00	7,546.00	3,146.00	4,400.00	4,607.00	4,432.00	175.00
ምዕራብ ጎንደር	1,050.00	250.00	800.00	120.00	3,200.00	-	3,200.00	-		
ማዕከላዊ ጎንደር	550.00	250.00	300.00	60.00	32,097.00	30,897.00	1,200.00	110,776.00	101,601.00	9,175.00
ሰሜን ጎንደር	5,045.00	4,195.00	850.00	350.00	4,357.00	957.00	3,400.00	5,170.00		5,170.00
ደቡብ ጎንደር	7,946.00	7,046.00	900.00	600.00	44,804.00	41,204.00	3,600.00	125,718.00	121,732.00	3,986.00
ሰሜን ወሎ	1,533.00	1,013.00	520.00	110.00	5,130.00	3,050.00	2,080.00	14,448.00	12,879.00	1,569.00
ደቡብ ወሎ	3,867.00	3,437.00	430.00	280.00	11,367.00	9,647.00	1,720.00	51,181.00	50,922.00	259.00
ሰሜን ሸዋ	3,694.00	3,184.00	510.00	260.00	8,717.00	6,677.00	2,040.00	20,738.00	20,280.00	458.00
አሮሚያ	2,143.00	1,783.00	360.00	140.00	7,068.00	5,628.00	1,440.00	8,981.00	8,113.00	868.00
ዋግሽምራ	746.00	406.00	340.00	63.00	2,078.00	718.00	1,360.00	3,117.00	2,946.00	171.00
ባህር ዳር ከተማ	943.00	733.00	210.00	30.00	2,119.00	1,279.00	840.00	1,388.00	1,266.00	122.00
ጎንደር ከተማ	273.00	217.00	56.00	4.00	774.00	550.00	224.00	863.00	863.00	-
ደሴ ከተማ	84.00	54.00	30.00	14.00	258.00	138.00	120.00	130.00	130.00	-
2ኛ ሩብ	20,490.00	18,209.00	2,281.00	1,081.00	96,287.00	86,527.00	9,760.00	285,195.00	256,493.00	16,702.00
3ኛ ሩብ	23,715.00	16,910.00	6,805.00	2,000.00	88,043.00	61,459.00	26,584.00	170,076.00	170,996.00	11,080.00

Table B-5: Inventory of small pumps in Tigray Region in 2011 EC (regional agricultural bureau)

	በ 2010 ዓም የተሰራጨ		የውሀ መሳቢያ ሞተር ብዛት		
ወረዳ	ዕቅድ	ክንውን	የሚሰራ	የማይሰራ	በ 2010 የተጠገነ
ጣ/አበርገለ	35	43	113	49	14
ቆ/ተምቤን	85	22	597	30	45
ወ/ለኺ	70	23	611	54	54
ታ/ማጨው	90	73	611	54	64
ላ/ማጨው	55	56	854	18	0
መ/ለኺ	75	54	536	0	0

	በ 2010 ዓም የተሰራጨ		የውሀ መሳቢያ ሞተር ብዛት		
ወረዳ	**ዕቅድ**	**ክንውን**	**የሚሰራ**	**የማይሰራ**	**በ 2010 የተጠገነ**
ና/ዓዲ'ት	30	8	300	137	131
ኣሕፈሮም	90	45	842	121	131
ዓድዋ	90	66	754	25	25
ማዕከላዊ	**620**	**390**	**5218**	**488**	**464**
ኣ/ዕምብላ	105	35	576	153	53
ፀለምቲ	70	11	373	137	137
ታ/ቆራሮ	65	42	136	55	0
ላ/ኣድያቦ	50	22	316	70	26
መ/ዛና	75	33	511	76	72
ታ/ኣድያቦ	60	51	916	53	36
ሰ/ምዕራብ	425	194	2828	544	324
ወልቃይት	120	113	1265	106	44
ፀገዴ	80	74	1559	34	4
ቃ/ሑመራ	300	130	1670	106	25
ምዕራብ	**500**	**317**	**4494**	**246**	**73**
ኣ/ወምበርታ	100	70	518	100	79
ክ/ኣውላዕሎ	225	178	2295	100	405
ሳ/ፃ/እምባ	100	67	1636	260	243
ሓውዜን	125	69	1825	109	114
ጉ/መኸዳ	50	27	330	175	51
ጋ/ኣፈሹም	50	39	548		57
ኢሮብ	50	0			
ምስራቅ	**700**	**450**	**7152**	**744**	**949**
ራ/ኣላማጣ	30	59	92	49	0
ኣፍላ	65	43	229	40	0
እ/መኾኒ	20	25	83	34	14
እ/ኣላጀ	40	11	332	13	8
ራ/ዓዘቦ	20	13	71	1	1
ደቡብ	**175**	**151**	**807**	**137**	**23**
ደ/ተምቤን	100	58	559	125	45
እንደርታ	100	133	1030	400	105
ሕ/ዋጅራት	70	71	604	115	0
ሳ/ሳምረ	90	70	945	80	55
ደ/ምስራቅ	**360**	**332**	**3138**	**720**	**205**
መቀሌ	20	5			
ክልል	**2,800**	**1,839**	**3,637**	**2,879**	**2,038**

Annex C. Stakeholders' Involvement in Regional Pump Distribution

Table C-1: Pump supply processes and stakeholders involved in the regions (source ATA…)

Components	Amhara	Oromia	Tigray	SNNP
Demand Assessment	RBoANR: Extension DAs and irrigation experts collect the data on the ground	RBoANR: Extension DAs collect the data on the ground OIDA: Plans to have its own irrigation DAs	RBoARD: DAs collect the data on the ground	RBoANR: Extension DAs collect the data on the ground
Procurement	RBoANR: Conducts national competitive bidding	OIDA: Uses revolving fund to procure pumps through national competitive bidding	RBoWR- Revolving Fund Office: Uses revolving fund to procure pumps through international competitive bidding	RBoANR: Conducts national competitive bidding

Components	Amhara	Oromia	Tigray	SNNP
Distribution	Ambasel: Imports and distributes the pumps through its retail offices across the region	WBoANR: Collect pumps from private suppliers to distribute to farmers in the Woreda	RBoWR-Revolving Fund Office: Distributes the pumps to farmers via its offices in the Woreda	WBoANR: Collect pumps from private suppliers such as Wondo to distribute to farmers in the Woreda
Access to finance	ACSI: Provides loans for pumps purchase to farmers coming both in group and individual modality at 13-18% interest with 2-5 year repayment period	METEC: Provides pumps to farmers with 30% upfront payment with remaining paid in 2 years without additional interest	RBoWR- Revolving Fund Office: 25% upfront and 75% in 2 years with 10% profit margin Dedebit: Provides loans of up to 60,000 Birr at 9% interest to be repaid in 2-3 years	Omo: Provides loans for pumps purchase to farmers coming in group modality at 15% interest with 1 year repayment period

Annex D. Financial analysis

Table D-1: Investment, Cost and Revenue per Enterprise in Birr

S.N.	Description	Project Years					
		2020	2021	2022	2023	2024	2025
1	Startup Capital	216,615	238,277	262,104	288,315	317,146	348,861
2	Initial Investment	121,485	133,634	146,997	161,697	177,866	195,653
3	Pre-Operating Costs	95,130	104,643	115,107	126,618	139,280	153,208
4	Fixed Cost	81,000	89,100	98,010	107,811	118,592	130,451
5	Service Cost	301,608	331,769	364,946	401,440	441,584	485,742
6	Total Cost	382,608	420,869	462,956	509,251	560,176	616,194
7	Gross Revenue	826,646	909,311	1,000,242	1,100,266	1,210,293	1,331,322
8	**Gross Profit**	**444,038**	**488,442**	**537,286**	**591,015**	**650,117**	**715,129**

Table D-2: Projected Income Statement in Birr

S.N.	Description	Project Years					
		2020	2021	2022	2023	2024	2025
1	Service Revenue						
	Gross Revenue	*826,646*	*909,311*	*1,000,242*	*1,100,266*	*1,210,293*	1,331,322
2	Operating Cost						
	Fixed cost	81,000	89,100	98,010	107,811	118,592	130,451
	Variable Cost	301,608	331,769	364,946	401,440	441,584	485,742
	Total Operation Cost	*382,608*	*420,869*	*462,956*	*509,251*	*560,176*	616,194
3	NPBTID	444,038.40	488,442.24	537,286.46	591,015.11	650,116.62	715,128
	Interest payment	38,991	42,890	47,179	51,897	57,086	62,795
4	NPBTD	405,048	445,552	490,108	539,118	593,030	652,333
	Depreciation	12,149	13,363	14,700	16,170	17,787	19,565
5	*NPBT*	*392,899*	*432,189*	*475,408*	*522,949*	*575,244*	*632,768*
6	*Net Profit*	*392,899.20*	*432,188.98*	*475,408.04*	*522,948.71*	*575,243.74*	632768.114

Table D-3: Cash Flow Statement in Birr

SN	Description	Project Years						
		Year 0	2020	2021	2022	2023	2024	2025
1	Cash Inflows							
	Loan	216,615	-	-	-	-	-	
	Net Profit		392,899	432,189	475,408	522,949	575,244	632,768
	Total Cash Inflows	*216,615*	392,899	432,189	475,408	522,949	575,244	632,768
2	Cash Outflows							
	Initial Investment	121,485	-	-	-	-	-	
	Pre-operating cost	95,130	-	-	-	-	-	
	Depreciation	-	12,149	13,363	14,700	16,170	17,787	19,565
	Interest payment	-	38,991	42,890	47,179	51,897	57,086	62,795

SN	Description	Project Years						
		Year 0	2020	2021	2022	2023	2024	2025
	Total Cash Outflows	*216,615*	*51,139*	*56,253*	*61,878*	*68,066*	*74,873*	*82,360*
3	Net Cash Flow	-216,615	341,760	375,936	413,530	454,882	500,371	550,408

Table D-4: Projected Financial Rate of Return in Birr

SN	Description	Project Years						
		Year 0	2020	2021	2022	2023	2024	2025
1	Cash Inflows	1	1.1	0.826446281	0.751314801	0.683013455	0.620921323	0.5644739
	Service Revenue	-	826,646	909,311	1,000,242	1,100,266	1,210,293	1,331,322
	Total Cash Inflows	-	826,646	909,311	1,000,242	1,100,266	1,210,293	1,331,322
2	Cash Outflows							
	Initial Investment	121,485	-	-	-	-	-	
	Pre-operating cost	95,130	-	-	-	-	-	
	Operating Cost	-	382,608	420,869	462,956	509,251	560,176	616,194
	Total Cash Outflows	*216,615.00*	382,608	420,869	462,956	509,251	560,176	616,194
3	Net Benefit	-216,615	444,038.00	488,442.20	537,286.32	591,014.75	650,116.63	715,128.29
	FIRR Before Tax	19.25%						
	FNPV@18%	12,525.78						
	FBCR	2.6						

Source: Consultants (August, 2019)