International Journal of Industrial and Manufacturing Systems Engineering
2025, Vol. 10, No. 4, pp. 82–90
https://doi.org/10.11648/j.ijimse.20251004.12

Research Article

Assessment and Technical Constraint Identification of Existing Water Lifting Pump in Eastern Hararghe Zone of Oromia

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Abstract

The survey was conducted with the objective of assessing and identifying the major problem and constraint on water lifting pump for irrigation purpose. The assessment result identifies technical pump problem facing the farmer on the field. From the result, eagle and koshin type pump were easily and frequently damaged after purchased. Cylinder gasket and pump impeller damage were the two main problem of those pump. Those eagle and koshin pump were mix the fuel and oil which was cause of pump stop and lead to pump damage. Spark ignition plug was the other pump problem from the survey result. Due to this spark ignition problem the pump was not running smoothly and with optimum noise which leads to decrease and damage engine efficiency and performance. The survey results also indicate that, getting of best pump with long life-span was the main pump problem facing the farmers. The result shown that, Honda pump was very preferred by farmers because of its not easily damage and its long durability. The result shown that 96.3% of total sample response as there was no organization support on access, maintenance and filling technical gap of using water pump. From the result the farmer needs organization support on getting best pump, information, capacity building and filling technical gap on using of pump. The result indicates that, the farmers facing economic crise from expensive to very expensive cost of pump maintenance. All stakeholder and government should facilitate and monitor on access and maintenance of small holder water pump. The farmers should follow the recommended guidance on using of water pump especially on operation and oil change time. The farmers should get information from field of specialization and expert when purchasing the pump. The government should solve maintenance problem of pump by facilitating and employing technician at agricultural office.

Keywords

Water Pump, Pump Type, Pump Problem, Irrigation

1. Introduction

The advancement of irrigation technologies can boost extremely low levels of production and productivity by creating alternative sources of water for agricultural production [8]. This is expected to improve the income of small-scale farm HH. Recently, the Ethiopian government has started paying attention to the expansion of irrigation projects to increase production and productivity. Specifically, it planned to increase the area of land covered by irrigation from 2.34 million

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Received: 21 August 2025; **Accepted:** 30 October 2025; **Published:** 31 December 2025

hectares in 2014/2015 to 4.14 million hectares by the end of 2019/2020 and provide access to at least one alternative water point for 1.74 million ha of additional irrigated land [6]. Irrigation has contributed much to poverty alleviation, food security, and improving the quality of life for populations [15]. Studies in sub-Saharan Africa (SSA) and other developing countries show a positive impact of irrigation in agricultural productivity and poverty reduction [13]. However, most smallholder farmers in sub-Sharan African countries lack access to irrigation technologies [14].

Investment in irrigation, particularly in small-scale irrigation development, has been identified as one of the core strategies to delink agricultural performance from rainfall and then to ensure sustainable growth and development [9]. In line with this, expansion of small, medium and large-scale irrigation in Ethiopia has been emphasized in the five-year plan of (GTP-1) [5]. Although scheme level irrigation expansion is still important, it is capital intensive to address all smallholders and limited in land coverage, implying that it cannot fully exploit available opportunities that can be adopted and used at household level, while smallholder irrigation is seen as cost effective compared to scheme level irrigation projects, because they are managed by farmers themselves. Given the surface and ground water potential of the country, promoting adoption of household level irrigation technologies is vital for improved production and food security at household level [3, 2].

The development of irrigation in Ethiopia is currently at only about 15% of its potential, of which the largest proportion is from small-scale irrigation schemes [10]. Small-scale irrigation in the Ethiopian context is a scheme with an irrigated area of less than 200 ha, typically managed by individual farmers or small communities [4]. According to data from the World Bank show that Ethiopian farmers have the lowest farm income [12]. Countries with little capital to invest in large-scale irrigation projects can introduce household-level small-scale irrigation motor pumps to improve farmers' incomes [11]. However, smallholder pumped irrigation systems is faced by many challenges such as lack of appropriate skills during irrigation system selection, design and operation as a result of inadequate technical assistance. Other challenges include lack of appropriate irrigation system components matching farmer's needs, high operation costs and low water use efficiency. Even, Selecting the correct pump for an irrigation system will not only result in better crop production, but save money on running costs over its life but, Water use efficiency for small holder irrigated pumped irrigation system is still remains low.

The report of [7] state that pump efficiency depended greatly on geography, total head, rotational speed and flow rate rather than Manufacturer's specifications and manufacturer's specifications do not include the effects of site-specific factors such as well characteristics or suction and discharge pipe sizes not determine to the current pump capacity.

The growing demand for manual and motorized pumps has greatly expanded the numbers of different types, sizes and origins of imported and locally manufactured motorized and manual pumps without consideration of quality and performance. The excessive failure rate both due to poor quality and lack of spare parts and service facilities has been a major cause of frustration among farmers using irrigation [1].

Objectives

The activity was done with the objectives of assessing problem of water pump and identification of technical constraint on water pump.

2. Materials and Methods

2.1. Description of Study Area

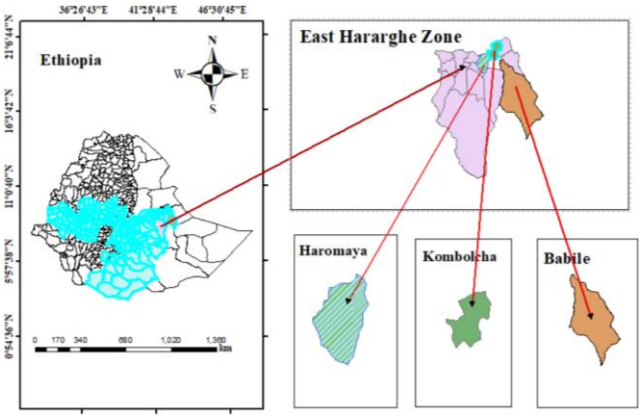

Figure 1. *Map layout of study area.*

2.2. Sample Selection Procedure and Questioners Design

Quantitative sample survey with Structured questionnaire containing questions on house hold demographic characteristics, Water source, irrigation practice, Problem facing the water pump during operation, Durability problem of water pump, Depth of water source and water pump problem, Pump problem during priming, Pump problem during water sucking and delivery system and Maintenance problem of water pump were used to undertake the activity. Qualitative Assessments which including interviews and discussions with key stakeholders for the success of this survey was undertaken.

The survey was conducted on a sample of 160 households using purposive sampling technique. Three districts; Haromaya, kombolcha and babile were selected purposively to conduct the assessment on the pump problem. Three kebele from Haromaya; Tuji gabisa, Ifa Oromia and ammuma were selected purposively. Three kebele from Kombolcha district; bilisuma, Qerransa and sibilu. Two kebele from babile; Erer

Ibada and Ifadin were selected purposively. The questionnaire was designed to assess the problem and technical constraint on water lifting pump. Structured questionnaires with individual house hold and another stakeholder was used.

2.3. Sample size Selection Techniques

To determine the required sample size of small holder pumped irrigation purposive sampling techniques were applied for sample selection and the number of required samples of each small holder pumped irrigation was given by;

$$n = \frac{N}{1 + N(e^2)}$$

Where: n = the number of required samples of each small holder pumped irrigation (sample size); N = total households of use pump irrigation (population size); e = confidence level (0.05 or 95%) level of precision.

2.4. Statistical Data Analysis

The data obtain from the questionnaire were analyzed statistically using the statistical package SPSS. Descriptive types of statistics such as percentage and frequencies were used to summarize and categorize the data.

3. Result and Discussion

Table 1. *Characteristics of the survey households.*

Characteristics of the survey households		Frequency	Percent
Sex of respondent	Male	160	100
	Female	0	0
Marital status	Married	152	95.0
	Single	8	5.0
Educational status	Non literate	62	38.8
	Basic literate	10	6.25
	Grade 1-4	30	18.8
	Grade 5-8	49	30.6
	Grade 9-10	6	3.8
	Degree	3	1.9

The above table shown that, 100% of respondent was male due to the pump operator were totally male. The table shown that 95% of respondent was married and 5% was single from the total respondent. Most of respondent were non literate which cover 38.8% of the total sample.

3.1. Source of Irrigation

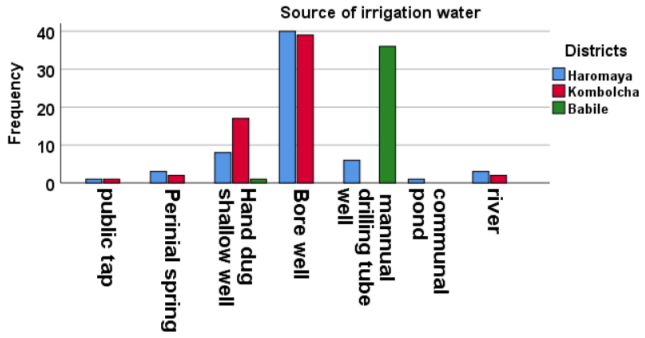

Figure 2. *Different source of irrigation water.*

The survey result shown that, bore well ground water was the dominant irrigation water source in kombolcha and haromaya district. The dominant irrigation water source in babile district was manual drilling tube well. Hand dug shallow well was the third irrigation water source in study area. River and perineal spring were the used as water source in very small amount in study area.

3.1.1. Depth of Well in Study Area

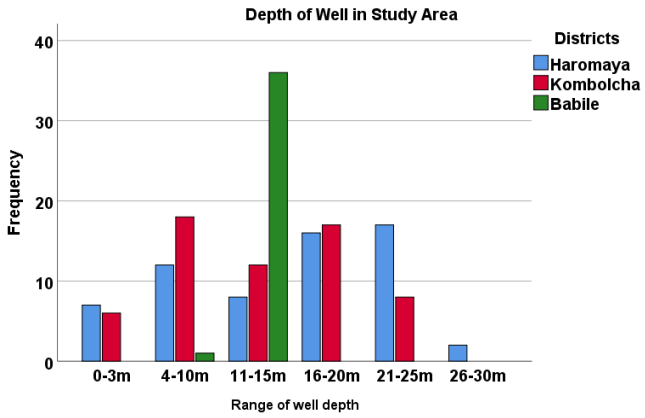

Figure 3. *Depth of wells.*

From the result, the depth of well used as irrigation water was obtained between 3m-30m in study area. The study shown that, haromaya and kombolcha district operate maximum well depth which was 21m-30m depth. In babile district the dominant well depth was 11-15m.

3.1.2. Irrigation Method of Study Area

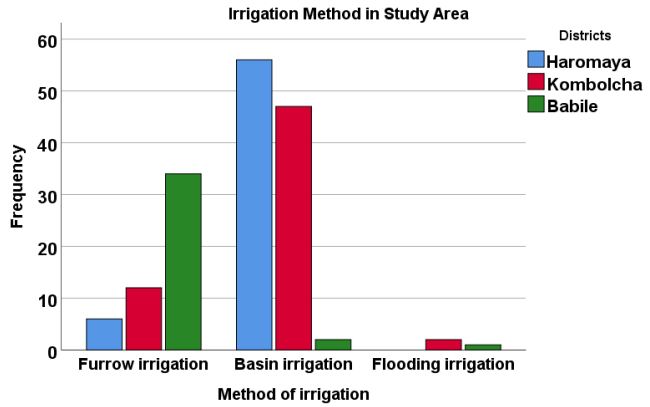

Figure 4. Irrigation method practiced in the study area.

The result indicates that, basin irrigation method was the dominant irrigation method in kombolcha and haromaya district. The furrow irrigation method was widely practicing in babile district. There was a formation of flooding irrigation method in haromaya and kombolcha district. The result indicates that, majority of the respondent states that there was water loss during irrigation in study area.

3.2. Reason for Water Loss

The reason for irrigation water loss in study area was mainly due to over watering. Since the dominant irrigation method that farmers are using was basin irrigation method, there were high amount of irrigation water losses. The survey results also shown that, there was water loss due to pipe damage and delivery pipe miss fit. The pump installation problem was also cause for irrigation water loss in study area.

3.3. Type of Pump Dominantly Obtained in Study Area

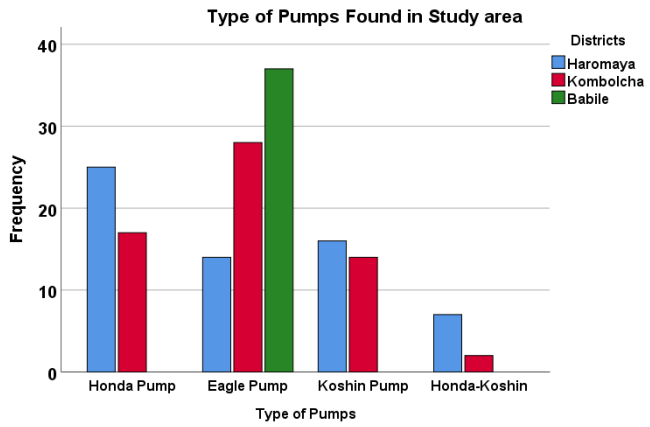

Figure 5. Different type of pumps in the study area.

The survey result shown that, the dominant type of water pump obtained in the study area was eagle pump which cover 49.4% of the total pump sample. The result indicates that, the farmers prefer eagle model pump because of its access, sufficient spar part and its good discharge. The second pump dominantly using in the area was Honda water pump which cover 26.3% of the total sample. Koshin water pump model was putted on the third in terms of dominantly distributed in the area and it cover 18.8% of total sample. The result from responders shown that, honda type water pump was not obtained in Babile district. The distribution of Honda type water pump was more obtained in Haramaya and Kombolcha district.

3.3.1. Source of Pump

Table 2. Source of pump.

Source of pump	Frequency	Percent
Government gift	2	1.3
Purchased	158	98.8
Total	60	100

The result show that, all most all of the pump obtained in the surveyed area were purchased which cover 98.8% of the total sample. Only 1.3% of pump was given to the farmers as government support. The survey result show that, since there was limitation from government support to distribute water pump, the farmers of the study area purchase the pump by their own cost.

3.3.2. Consulting Field of Specialist and Source of Information When Purchasing the Water Pump

Table 3. Source of information when purchasing the pump.

source of information		Frequency	Percent
Consulting specialist	Consulting	26	16.3
	Not consulting	134	83.8
Source of information	Personal preference	7	4.4
	Local dealer	22	13.8
	Other farmers	131	89.9

As shown in the above table, 83.8% of respondent not consulting expert and field of specialist while purchasing the water pump. The main source of information when purchas-

ing the water pump was from each other or another farmer which cover 89.9% of total sample. They also get information of pump from local dealer or sellers as shown in the above table and cover 13.8% of sample. This survey result indicates that, there was a gap in getting required information on water pump from field of specialization and government concerned body.

3.3.3. Average Working Time of Pump

Table 4. Average working time of pump in the area.

Average working time of pump	Frequency	Percent
2-3 hours	9	5.6
3-5 hours	10	6.3
5-6 hours	35	21.9
6-7 hours	27	16.9
7-8 hours	29	18.1
Greater than eight hours	50	31.3
Total	160	100

The maximum working or operating time of surveyed pump was greater than eight hours which cover 31.3% of total. The result show that the farmers of study area operate their pump for long time without stopping or rest. The minimum working time of the surveyed pump were 2-3 hours which cover 5.6% of the total.

3.3.4. Average Suction Head of Pump

Table 5. Suction head of pump.

Suction head of pump	Frequency	Percent
Operated at 3 m suction head	7	4.37
Operated at 4 m suction head	7	4.37
Operated at 6 m suction head	100	62.5
Operated at 9 m suction head	45	28.1
Operated at 15 m suction head	1	0.625
Total	160	100.0

The survey result indicates that more of the farmers are operating the pump at 6 m suction head which cover 62.5% of total sample. The others farmers were operating their pump at 9 m suction head which cover 28.1% of total. The result also indicates that there was a farmer who are operating their pump at 15 m suction head about 0.625 which was above recommended. Operating the pump above the recommended standard was lead to pump damage and fuel consumption.

3.3.5. Average Pump Delivery Capacity

Table 6. Pump delivery capacity.

Pump delivery capacity	Frequency	Percent
50-75m	1	.6
75-100m	19	11.9
100-150m	58	36.3
150-200m	82	51.2
Total	160	100.0

The above table shown that, the maximum delivery capacity of the surveyed pump was from 150 m-200 m which cover 51.2% of total sample surveyed. The minimum delivery capacity of the pump was 50-75 m which was 6% of total sample.

3.3.6. Priming Time

Table 7. Priming time of pump.

Pump problem at time of priming		Frequency	Percent
Priming time	5 minutes	88	55.0
	10 minutes	65	40.6
	15 minutes	4	2.5
	Greater than 15 minutes	6	3.75
Pump problem at time of priming	Engine part temperature increase	111	69.4
	Fuel consumption	35	21.9
	Pump part temperature increase	11	6.9

The survey result from the above table shown that, 55% of the pump takes 5 minutes to priming. The second priming time was 10 minutes which cover 40.6% of total sample. About 3.75% of pump sample takes greater than 15 minutes. The survey results shown that, there was different pump problem as it takes long time for priming. From the result temperature increase of engine pump part was the main pump problem related with priming time which cover 69.4% of total sample. The second pump problem related with priming time was fuel consumption and pump part temperature increase

which cover 21.9% and 6.9% of total sample.

3.3.7. Age of Pump

Table 8. Ages of pumps.

Age of pump	Frequency	Percent
One year	16	10.0
Two years	12	7.5
Three years	33	20.6
Four years	14	8.8
Five years	33	20.6
Greater than five years	52	32.5
Total	160	100.0

The above table show that, the dominant age of surveyed pump was greater than five years, which cover 32.53% of total pump sample. The result indicates that, the respondent uses their pump through continuous maintaining as in the below table.

3.4. Pump Maintenance

Table 9. Maintenance of pump.

Do you maintain your pump?	Frequency	Percent
Maintain the pump	143	89.4
Not maintain the pump	17	10.6
Total	160	100.0

From the result 89.4% of respondent maintain their pump throughout its life span. The rest 10.6% of respondent not maintain their pump. This survey result indicates that, the pump was damaged by different reason and maintain when damaged throughout its life span.

3.4.1. Average Working Time after Maintenance

Table 10. Working time after maintenance.

Average working time after maintenance	Frequency	Percent
3 months	13	8.1
4-7 months	20	12.5
8-months	19	11.9
8-11 months	10	6.3
One year	68	42.5
Greater than one year	30	18.8
Total	160	100.0

The other important issue was average working time of pump after maintenance undertaken. The survey result shown that, 42.5% of total sample was only serve for one year after first maintenance. Greater than one year was only 18.8% of total sample. About 8.1% of sampled pump was serve only for 3 months. Which is a very short service duration after first maintenance.

3.4.2. Pump Durability / Long Life Span, Frequent of Damage

Table 11. Life span of pump.

Pump durability		Frequency	Percent
Pump durability	Honda pump	151	94.37
	Eagle pump	8	5
	Cushin pump	1	0.625
Model of pump worn frequently	Eagle pump	62	38.8
	Cushin pump	98	61.3
	Honda Pump	0	0

From the result, Honda water pump has long durability or long-life span which cover 94.37% of total sample. The result from respondent shown us Honda model water pump has good durability than all other pump. Its durability was indicated in terms of not easily damage and worn frequently. But this pump is not easily available in the market and its spare part is not easily obtained. The Eagle type pump was putted next to Honda pump with 5% of total sample. Koshin pump was least durability and it easily damaged. The other important issue from the survey was identifying the pump which have short life span or easily damaged. From the result 61.3% of respondent result show koshin pump was worn frequently and very short life span. Eagle pump cover 38.8% in term of frequently damaged next to koshin pump.

3.4.3. Pump Part Worn and Damage Frequently

Table 12. Damage on pump.

Pump part frequently damaged	Frequency	Percent
Cylinder block	3	1.9
Cylinder gasket	43	26.9
Spark ignition plug	33	20.6
Pump impeller damage	24	15.0
Cylinder gasket and pump impeller damage	53	33.1
Not problem of worn	4	2.5
Total	160	100.0

The survey result indicates that, the pump part worn and damage frequently was cylinder gasket and pump impeller damage which cover 33.1% of total sample. The result shown that cylinder gasket and pump impeller damage was mainly observed on eagle and koshin pump type. The next pump part damaged frequently was cylinder gasket with 26.9% of total sample. Spark ignition plug cover 20.6% of total sample. Pump impeller damage cover 15% of total sample.

3.4.4. Problem of Suction Depth on Pump

Table 13. Problem of suction depth.

	Frequency	Percent
Reduce time of oil change	14	8.8
Reduce oil level suddenly	25	15.6
Increase engine temperature	121	75.6
Total	160	100.0

The main negative effect of increasing suction depth on pump was increasing of engine temperature. The survey result show that, 75.6% of total sample state that there was increasing of engine temperature when suction depth increased beyond the normal depth. Many the farmers increase the suction depth when the water in well is depleted. The other problem related to suction depth increase was, reducing of oil level suddenly which cover 15.6% of total sample. Reducing time of oil change was also another related pump problem when suction depth is increased.

3.4.5. Following Recommended Guidance on Using of Pump and Oil Change

Table 14. Following pump guidance.

		Frequency	Percent
Following guidance	Yes	25	15.6
	No	135	84.375
Time of oil change	After 5 working days	24	15.0
	After 10 working days	50	31.3
	After 15 working days	46	28.7
	After 20 working days	14	8.8
	>20 working days	1	0.625
	By checking oil viscosity and color	25	15.6

The result indicates that, 84.375% of respondent were not following recommended guidance on using of pump and oil change. Only 15.6% of respondent follow recommended guidance on using and pump oil change. This result indicate that the main cause of frequent pump damage was due to using the water pump without recommended standard according to pump type. The other important thing related to pump problem was oil changing time which is the main reason for pump to be damaged. The survey result shown that, only 15.6% of total respondent change the oil by checking the oil viscosity and color according to guidance. Many of the respondent change the pump oil whether below or above the recommended guide for oil change. Changing oil above or below recommended time bring pump damage or economic effect.

3.4.6. Sufficient Spar Part

Table 15. Pump spar part.

Pump spar part status	Frequency	Percent
Honda pump	3	1.9
Eagle pump	129	80.6
Cushin pump	28	17.5
Total	160	100.0

From the above table, the result shown that, eagle pump had sufficient spare part when compared to another pump. The required spar parts of this pump were widely available on

market. The next pump type with sufficient spar part was koshin pump. The spar part of Honda type pump was not easily available on local market and its spar part was not sufficient.

3.4.7. Organization Support

Table 16. Organization support.

Organization support	Frequency	Percent
Yes	6	3.75
No	154	96.3
Total	160	100.0

The result show that, the support of any organization was very low in study area. From the above table 96.3% of total respondent show that there was no organization support. In the study area, farmers buy the pump and get information of pump by their own budget and motivation. The result from the respondent shown that, the farmers need government and other organization support on getting best pump, getting technical training on pump operation and maintenance.

3.4.8. Place of Pump Maintenance

Table 17. Pump maintenance place.

Maintenance place and level of cost		Frequency	Percent
Place of maintenance	Private garage	61	38.1
	Traditional/local pump maintainer	99	61.9
Level of cost	Normal	13	8.1
	Medium	13	8.1
	Expensive	58	36.3
	Very expensive	76	47.5

From the above table, the result show that, the dominant maintenance place of pump was traditional or local pump maintainer. The level of maintenance cost from the above table shows the farmers paying very expensive pump maintenance cost which cover 47.5% of total sample. This because of no formal or government maintenance place was available for farmers. The survey result indicates that, the farmers highly need the government interference on pump maintenance.

4. Conclusion

The survey was conducted with the objective of assessing and identifying the major problem and constraint on water lifting pump for irrigation purpose. The survey result indicates that, there were different problem facing farmers on using of water pump for small scale irrigation. Starting from a very initial stage for purchasing water pump, the farmer did not get information about the pump from concerned body and field of specialist. The survey results also indicate that, getting of best pump with long life-span was the main pump problem facing the farmers. The result shown that, Honda pump was very preferred by farmers because of its not easily damage and its long durability. But the access, availability and spar part of this pump not easily obtained for farmers.

The assessment result identifies technical pump problem facing the farmer on the field. From the result, eagle and koshin type pump were easily and frequently damaged after purchased. Cylinder gasket and pump impeller damage were the two main problem of those pump. Those eagle and koshin pump were mix the fuel and oil which was cause of pump stop and lead to pump damage. Spark ignition plug was the other pump problem from the survey result. Due to this spark ignition problem the pump was not running smoothly and with optimum noise which leads to decrease and damage engine efficiency and performance.

The survey result identifies and indicate the pump problem related with following the recommended guidance for specific pump. The result shown that, all most all of the farmers were not following recommended guidance on using of pump. The survey result shown that, only 15.6% of total respondent change the oil by checking the oil viscosity and color according to guidance. Many of the respondent change the pump oil whether below or above the recommended guide for oil change. Changing oil above or below recommended time bring pump damage or economic effect. The other problem facing the pump was using the suction hose above the recommended depth. The farmers are elongating the suction hose depth because of water depleted in the well. From the result using of suction depth above the recommended bring increase temperature of engine part which lead to pump damage up to burn.

The other very important issue related with pump problem identified from survey result was support from government and other stake holder on accessing and maintenance of water pump. The result shown that 96.3% of total sample response as there was no organization support on access, maintenance and filling technical gap of using water pump. From the result the farmer needs organization support on getting best pump, information, capacity building and filling technical gap on using of pump. The result indicates that, the farmers facing economic crise from expensive to very expensive cost of pump maintenance.

5. Recommendation

1) The farmer should use Honda pump type because of its long-life span and not easily damage.
2) The way the farmer get more durable pump like Honda should be facilitated by government.
3) All stakeholder and government should facilitate and monitor on access and maintenance of small holder water pump.
4) The farmers should follow the recommended guidance on using of water pump especially on operation and oil change time.
5) The farmers should get information from field of specialization and expert when purchasing the pump.
6) The government should solve maintenance problem of pump by facilitating and employing technician at agricultural office.
7) East haraghe agricultural office and same office should use this survey result to improve water pump use for small holder farmer.

Abbreviations

No	Number
N	Population Size
e^2	Confidence Level

Conflicts of Interest

The authors declare no conflict of interest.

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