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REGULAR ARTICLE

THE EFFECT OF WATER HYACINTH ON SMALLHOLDER RICE FARMER'S LIVELIHOOD: THE CASE OF LAKE TANA BASIN, ETHIOPIA

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ABSTRACT

Background: Invasive aquatic weeds like water hyacinth are of a great concern in Ethiopia, posing particular problems on aquatic biodiversity and fisheries in major water bodies and agricultural land in the surrounding water bodies. The study was aimed to analysis of the effect of water hyacinth on the livelihood of smallholder rice farmers around the Lake Tana, Ethiopia.
Methodology: Two districts and four Kebeles adjacent to Lake Tana and well known in rice production were purposively selected for the study. Individual interviews and key informants' checklists were used as data collection methods to achieve the desired objectives.
Results: The result showed that 48% of the rice cultivated land was infested by water hyacinth and 32.08% of rice farm area was not harvested totally due to Water hyacinth infestation in the study year. It showed a statistical significance mean difference on yield of rice between affected and non-affected plots, it could reduce by 1944 kg/ha. Moreover, households perceived that water hyacinth makes land preparation and crop production difficult, dehydrates farmland, reduces fish production, and contaminates water, destruction of animal feeds, causes disease on humans and animals. Smallholder rice-producing sampled households perceived that the rice production has been decreasing due to the spread of water hyacinth. Farmers by themselves implemented different adaptation strategies to resist the water hyacinth problem. The major adaptation strategies implemented by smallholder farmers are participating in water hyacinth removing campaigns or weeding, constructing a fence around their farm to defend the coming water hyacinth weed before invading their rice farms, and switching off from farm activity to other income-earning activities. The study results revealed that 73% and 91.5% of the sampled households received rice production extension services and information regarding water hyacinth, respectively.
Recommendation: To solve the problems of water hyacinth effects participatory approach to control water hyacinth, support farmers to produce crop in off season using irrigation, promote agricultural technologies and assist them to search other income earning activities.

Keywords: water hyacinth, rice, livelihood effect.
JEL Codes: Q15

INTRODUCTION

Invasive aquatic weeds are a growing threat worldwide, causing losses in biodiversity, changes in ecosystems, and impacts on economic enterprises such as fisheries, agriculture, forestry, power production, and international trade. Because of a wide range of adaptation to varying amounts of water, aquatic weeds are reaching alarming proportions in many parts of the world, especially in tropical water bodies where they have led to serious ecological and economic losses **(Xub, 2012)**. Water hyacinth is considered as one of the 10 top world's worst weeds invading lakes, ponds, canals, and rivers **(Ethiopian Biodiversity Institute, 2019; Wise *et al.*, 2007)**.
Due to its extremely fast growth, the weed has become the major floating water weed of tropical and subtropical regions. Africa has particularly been affected by the introduction and spread of water hyacinth, facilitated in part due to a lack of naturally occurring enemies. According to **(Mujingni, 2012)**, water hyacinth infestation in eastern, southern, and central Africa, was first recorded in Zimbabwe in 1937, Mozambique in 1946, and in Ethiopia in 1956.
Invasive aquatic weeds are of great concern in Ethiopia, posing particular problems on aquatic biodiversity and fisheries in major water bodies and agricultural land in the surrounding water bodies **(Firehun *et al.*, 2014)**. Since its introduction the infestation of water hyacinth appears in rivers like Baro, Gillo, and Akobo Rivers and lakes like Tana, Ellen Koka **(Rezene 2005; D Tewabe 2015; Ebro *et al.* 2017)**. The emergence of water hyacinth in Lake Tana has been reported and recognized as an ecologically dangerous and worst invasive weed in September 2011 **(Anteneh, 2015; Tewabe, 2015)**. In the year 2015, 18 *Kebeles* in the 5 districts bordering Lake Tana were infested by water hyacinth **(Anteneh 2015)**. According to Tana Lake and Aquatics resources Conservation and Development Agency, the water hyacinth infestation has been expanded to 7 districts and 28 *kebeles* in the Tana basin in 2020.

Even though efforts to remove water hyacinth in Lake Tana have been made by a number of institutions including government offices, universities, research centers, and local communities **(Anteneh, 2015; Anteneh *et al.*, 2014)**, the spread of the weed and its impact on the ecosystems in and around the lake are yet uncontrollable.
Most earlier studies have been emphasized the expansion of the weed, distribution, management option for water hyacinth, and perceptions on socioeconomic effects of water hyacinth in the Lake Tana basin**. (Damtie *et al.*, 2021; Yigrem, Mengist & Moges, 2019; Tewabe *et al.*, 2017; Getnet *et al.*, 2020; Minychel *et al.*, 2020).**
However, no prior research in the study area specifically addresses the impact of water hyacinth invasion on smallholder rice farming. Using a range of factors, this study aimed at analyzing the effects of water hyacinth on the livelihoods of smallholder rice-producing farmers in the Tana basin. This study could add to the body of literature by analyzing the effect of water hyacinth on rice producer farmers and providing greater insights to the responsible bodies so they can focus on water hyacinth mitigation and control strategies. Therefore, this study assesses the effects of water hyacinth invasion on smallholder rice farmers' livelihoods and rice farm households' perceptions regarding water hyacinth in Lake Tana basin, Ethiopia.

RESEARCH METHODOLOGY

Area description

Lake Tana is located in the highlands of northwestern Ethiopia. The Lake Tana Biosphere Reserve is located in the Amhara National Regional State; it is one of Africa's most unique wetland ecosystems and the source of 50% of the freshwater of the country. The average altitude of Lake Tana is approximately 1800m, and the area of the basin (including water surface area) is 15,096 km^2. The Lake has a surface area of 3111 km^2 and 284 km^3 volume. Gilgel Abay, Ribb, Gumera, and Megech are the most important rivers feeding into Lake Tana and contribute over 90% of the total water inflow **(Chuangye Song, Lisanework Nigatu, Yibrah Beneye, Abdurezak Abdulahi, Lin Zhang, 2018)**. The only out-flowing river is the Abay (Blue Nile) and it covers 20% of the surface area of the Lake Tana sub-basin.
The study was conducted in the Eastern part of Lake Tana in which rice crop is produced and invaded by Water hyacinth. The study was conducted in *Fogera* and *Libokemkem* districts which are two of the ten Woredas bordering Lake Tana and found in South Gondar Administrative Zone. Fogera district has 33 kebles, two of its kebles (Nabega and Wagetera) bordered by Lake Tana in the west and heavily affected by water hyacinth, The district has area coverage of 1,111.43 km^2 whereas *Libokemkem* district comprises of 34 *kebeles*. Out of these *kebeles*, four of them namely Tezamba, Kab, Agid & Kirgna are bordered by Lake Tana. The district has an area of 1,560 km^2.

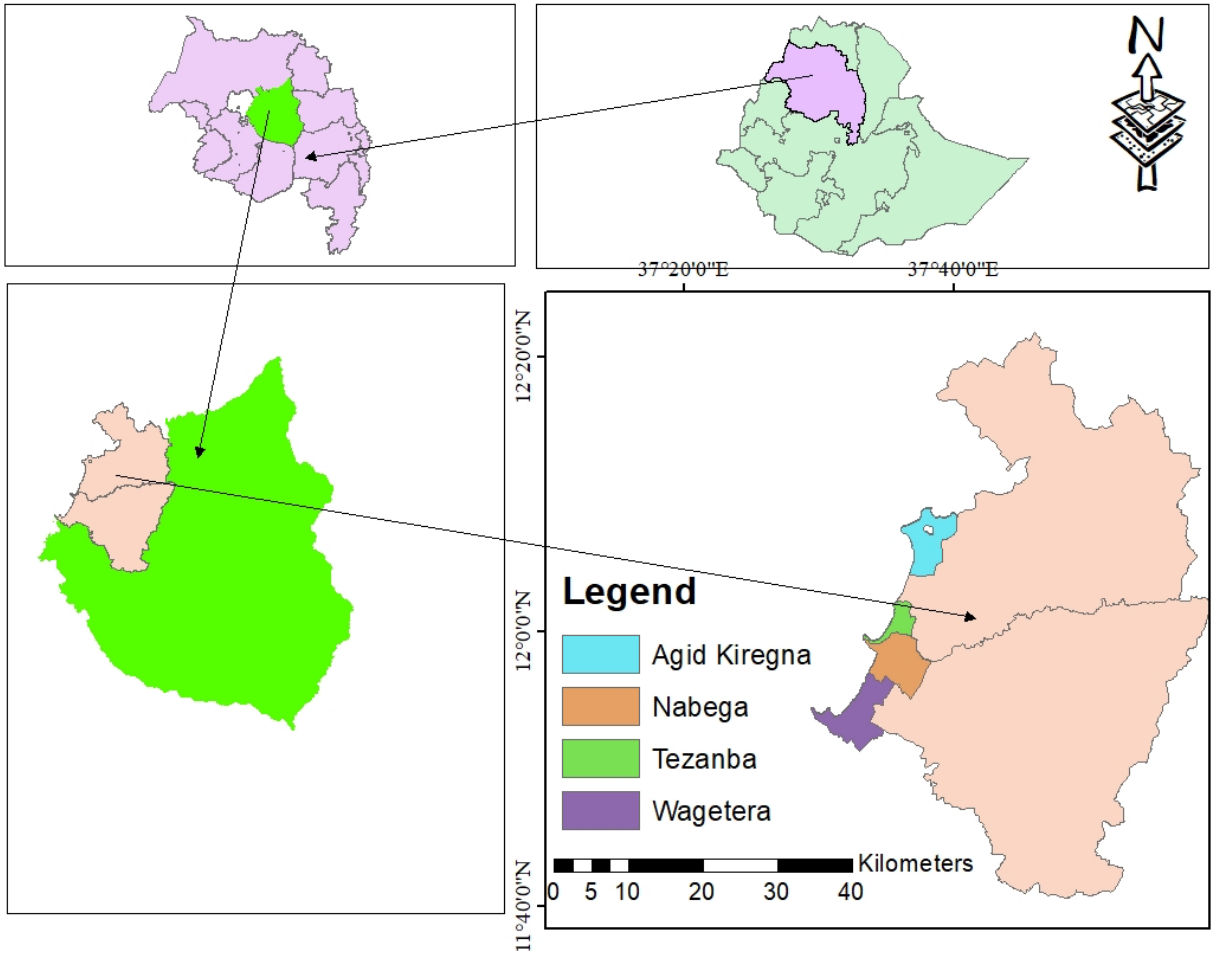

Figure 1 Map of the study areas
Source: Manipulated from Ethiopian map

Data and Survey design

The study was used primary and secondary data sources. Household and plot-level data were collected using structured questionnaires from randomly selected rice producing farm households in the study area. A community survey was also conducted to collect data through focus group discussion with community leaders, key informants with experts at district and Region level and direct observation. Through these methods, mainly qualitative data, focusing on the current status of water hyacinth infestation and its possible impact on rice production, controlling mechanisms done by different stalk holders was collected.

Additionally, data were also collected from secondary sources including journals, reports, conference proceedings, internet sources, and unpublished sources.

Based on the expansion magnitude of water hyacinth, the study uses purposive sampling techniques to select districts, accordingly, *Fogera* and *Libokemkem* districts were selected. First, numbers of rice producer *kebeles* that are affected by water hyacinth in each district were identified and then 2 *kebeles* in each district were selected purposively. A total of 189 households were selected randomly. The sampling distribution across each *kebele* is shown in Table 1 below.

Table 1 Sample distributions

District	*Kebele*	Sample size
Fogera	*Wagetera*	47
	Nabega	48
Libokemkem	*Aged- Keregna*	59
	Tezaamba	35
Total		189

Source: Own computation, 2019

Methods of Data Analysis

The study was used descriptive statistics and inferential statistics to analyze quantitative data. Descriptive statistics such as mean, frequency, percentage, t-test, and standard deviation were used to assess water hyacinth effect difference on crop yields. It is also used to explain the different socio-economic characteristics of the sampled households about their rice production status. On the other hand, some of the responses from the respondents were quoted directly in the analyses of qualitative data.

RESULTS AND DISCUSSION

Household Characteristics and Socioeconomic Factors

The average **age of household head was about 44 years (range 20 to 80 years). The average family size was 5.6 persons per household, with a minimum of 2 and a maximum of 12 members. A total of 54 % of the family members were of working age (15-64 years). In terms of farming experience, farmers had a mean of 23.78 years (Table 2). Regarding rice farming experience, the average was 14 years, and the younger respondent had one year and the older had 40 years of rice cultivation experience.**

The survey result depicted that males accounted for 92% of sample household heads, while females accounted for 8%. Nearly half of the household heads in the study area couldn't read or write (Table 2).

Table 2 Characteristics of the Household

Variable	Mean	Std. Dev.	Min	Max
Age of household head (years)	44.01	13.88	20	80
family size	5.61	2.02	2	12
Farming experience	23.78	13.74	3	61
Rice farming experience	14.30	6.73	1	40
Since when water hyacinth appeared on farm(years)	3.68	1.57	1	8
Own land holding size (ha)	0.89	0.55	0	4
Rented in land (ha)	0.05	0.13	0	0.5
Shared in land (ha)	0.13	0.24	0	1.75
Off/non-farm income (Ethiopian Birr/ETB)	3942.91	11649.93	0	126000
Farm income (ETB)	23668.31	20578.83	0	139350
Total Income (ETB)	27611.22	23953.20	0	147350
Land infested by WH (ha)	0.38	0.30	0	2
Nearest distance to lake Tana (kms)	2.73	2.47	0	12
Nearest distance to cooperatives (kms)	3.31	2.97	0	18
Nearest distance to extension office (kms)	3.05	2.47	0	12

Nearest distance to all weather roads(kms)	11.30	6.79	0	21
Proportion of family member between age 15 & 16 years	0.54			
Independency ratio	0.46			
Sex of the household head (male)	0.92			
Proportion of illiterate household head	0.51			
Proportion of literate household head	0.49			

Note: Average exchange rate in 2019: 1 USD=29.2123 ETB.
Source: Survey result, 2019

Access to roads that are reliably passable year-round is critical for many rural development processes, including access to inputs, markets, education, and campaigning services. Preferably, such roads should be paved to ensure all-season access for heavy vehicles. As observed in Table 3, in the study area households are far away from all-weather roads. This indicates road infrastructure is not accessible; this might prevent the easy control and monitoring of water hyacinth in the study areas. The average distance of farmers residence far from Lake Tana is 2.73 kms. The average own landholding size is estimated at 0.89 ha. In addition to this, farmers were used shared in, and rented in land for crops production, which is common in the study area. More than 45% of the land was devoted to an irrigation production system, mainly used lake Tana water source.

Major crops Produced

In the study area rice is one of the major crops produced; households on average allocated 0.876 ha of the land to rice crop, and were producing 2678 kg (Table 3). Rice contributed 55% of the area cultivated and 80% of production from all crops grown in the study area (Table 3). Teff is the second important crop, often produced through irrigation that it takes average land coverage of 0.46 ha per household. Finger millet, Maize, Grass pea, Chickpea, lintel, vegetables, and other crops were produced in the study areas to a limited extent. In the marshy lands near the lake coast **(Getnet *et al.*, 2020)** noted the dominance of rice, vetch, and chickpea farming.

Table 3 Major crops in the study area

Crops	Number of growers	Average area planted (ha)	Average production (kg)	Crop share	
				Area harvested (%)	Production (%)
Rice	189	0.88	2678	55.45	80.10
Teff	145	0.46	486	24.43	11.14
Grass pea	58	0.33	301	7.21	2.77
Chickpea	50	0.38	246	6.44	1.95
Maize	32	0.27	383	2.76	1.94
Finger millet	11	0.33	323	1.33	0.56
Lentil	10	0.19	188	0.73	0.30
Onion	2	0.09	150	0.07	0.05
Other crops(oat, garlic, etc	20	0.22	380	1.58	1.20

Source; survey result 2019

Rice is produced in the rainy season (*meher* season), generally planted in June and harvested in December while pulses (Grass pea, Chickpea, Lentil) are produced in residual moisture whereas teff, maize, and vegetables are produced using irrigation in the dry season.

Livestock resources

Cattle, sheep, donkey, goat, poultry, beehives are the common livestock types that the household is rearing in the study area. As it is observed in Table 4, out of the total interviewed households, 91.01% of them had owned at least an ox. To assess the livestock holding of each household, the tropical livestock unit (TLU) per household was calculated and an average livestock holding of sample households was 3.98 in TLU.

Table 4 Livestock ownership Status

Livestock Type	% of households owned	Mean	Min	Max
Oxen	91.01	1.70	0	4
Bulls	17.99	1.32	0	3
local cows	69.31	1.49	0	4

crossbreed cows	5.291	1.20	1	2
Heifers	46.03	1.32	0	3
Calves	52.91	1.29	1	3
Goats	2.65	2.40	0	4
Sheep	46.56	3.16	0	15
Poultry (chicken)	61.38	4.39	0	18
Donkey	51.32	1.16	0	2
Horse	0.529	2	2	2
Mule	1.587	1	1	1
Beehives	0.529	15	15	15

Source: Survey result, 2019`

Source of Income

Table 5, presents the amount of income earned from different sources by households in the study area. Households were engaged in different income-earning activities. The main income earnings are the income from crops, livestock, and non/off-farm activities. The main source of livelihoods income was from the sale of rice crops (41.31%), followed by livestock and livestock products selling (31.76%). This indicated that rice has been an important livelihood source of farmers even though it is affected by Water hyacinth.

The average total income of farmers in 2019 was ETB 27, 611.22 per year and the annual average off/non-farm income was ETB 3942 per household the maximum reached up to 126,000 ETB per year (Table 3). Close to 39% of the respondents took part in off/non-farm activities to supplement income from on-farm activities and it contributes 12.31% of the total household income. The main source of non/off-farm income activities was from petty trading. As connected with farmers living around lake Tana, a considerable proportion of farmers earned income from fishing activity (26.3%). This study is supported by the results in Malaysia rice producer district; non-farm activities contributed 12.47% the total respondent income whereas rice contributed 73.85% of their average income **(Ibrahim *et al.*, 2013).**

Table 5 Income from different sources

Income source	Share (%)
Sell from rice crop	41.31
Sell of livestock and its' products	31.76
Sell from other crops	14.56
Non/off farm income	12.36
Total income	100

Source; Survey result, 2019

The effect of Water hyacinth invasiveness

The average households' cultivated land infested by water hyacinth was 0.38 ha. The devastated season is usually from August to October, when the water hyacinth is pushed by a wave and rests in the rice fields. Just as rice is grown in the *meher* season, the worst damage has occurred on rice crop. In the study area, 48% of the rice cultivated land was infested by water hyacinth. The extent of invasiveness becomes worsening, 32.08% of rice farm area which was planted was not harvested totally due to Water hyacinth infestation (Table 6). During floods and waves, a mat of water hyacinth completely covers the rice field, made rice production difficult **(Dereje Tewabe *et al.*, 2017)**.

Table 6 Extent of Water hyacinth invasiveness on rice farms (%)

Water hyacinth invasiveness	Area of planted farm	Area of Harvested farm	Area of unharvested farm
Infested rice farm	48.50%	39.73%	32.074%
Non infested rice farm	51.50%	60.27%	2.97%
Total	100%	100%	17.09%

Source; Survey result, 2019

Water hyacinth has been imposed great effect on rice production than other crops. As observed in Table 7, the average productivity of farms which infested by water hyacinth was 2122 kg/ha while the average yield goes up to 4066 kg/ha in non-infested farms. Water hyacinth brought a significant difference in rice yield at a 1% level of significance. The result indicates that water hyacinth reduces rice production by two-fold. Though there were no statistically significant differences in other crops, water hyacinth reduces the yield of other crops too. Previous research in the same

study area found that rice farmers whose rice fields were damaged by the weed's dense mats did not grow chickpea, grass pea, or vegetable crops of land due to the difficulty of clearing the mats from rice fields, with a loss value of up to USD 21,333 in chickpea and grass pea production **(Getnet *et al.*, 2020)**.

Table 7 Mean yield (kg/ha) comparison water hyacinth infested and non-infested farms

Crops	Yield in infested farm		Yield in non- infested farm		Combined		T Value
	Mean	SD	Mean	SD	Mean	SD	
Rice	2122	2308	4066	2320	3222	2506	-9.73***
Teff	1096	1011	1320	1055	1235	1042	-1.61
F.Millet	660	631	660	631	1634	1991	-1.23
Maize	2471	2772	1379	1944	1942	2433	1.30
Grass pea	860	582	1041	862	1014	825	-0.64
Lentil	3973	5258	1104	1093	1965	2977	1.49
Check pea	527	422	802	775	752	729	-1.13
	2600	2143	2177	2455	2292	2331	0.37

Source; survey result, 2019

According to data from regional office expert, rice production in 4 districts (Dera, Fogera, Lebkombek & Denbiya districts) has been affected by water hyacinth. In the study ditricts (Fogera and Libokekem) the affected farmland estimated that 1774 ha of the land in the year 2019. As seen in the Table 7 above Water hyacinth could reduce rice productivity by 1944 kg/ha. This has led to the loss of rice production in these districts by 3,448,655 kg and the value 38,073,162.24 birr per year by taking the nominal market price of rice (1774 ha*1944 kg/ha*11.04 ETB/kg), and if it continues in the present trends cause damage to previously untouched areas could totally distract rice production in this districts surrounding lake Tana.

Rice production trend over five years

The trend of rice production has been decreasing over the last five years. Farmers also perceived the reduction of rice crop production, out of the interviewed households 83.07% of the households confirmed the rice production reduction. There might be contributing factors for the production decrease; limited use of fertilizers, poor agronomic management, unable to afford improved rice seeds, flooding of rivers like *Rib* & *Gumara* put sedimentation on land and other factors. But no one can take a more share beyond water hyacinth. Because production showed decreasing trend since 2015, where water hyacinth was started to invade the farm lands in most of the study areas.

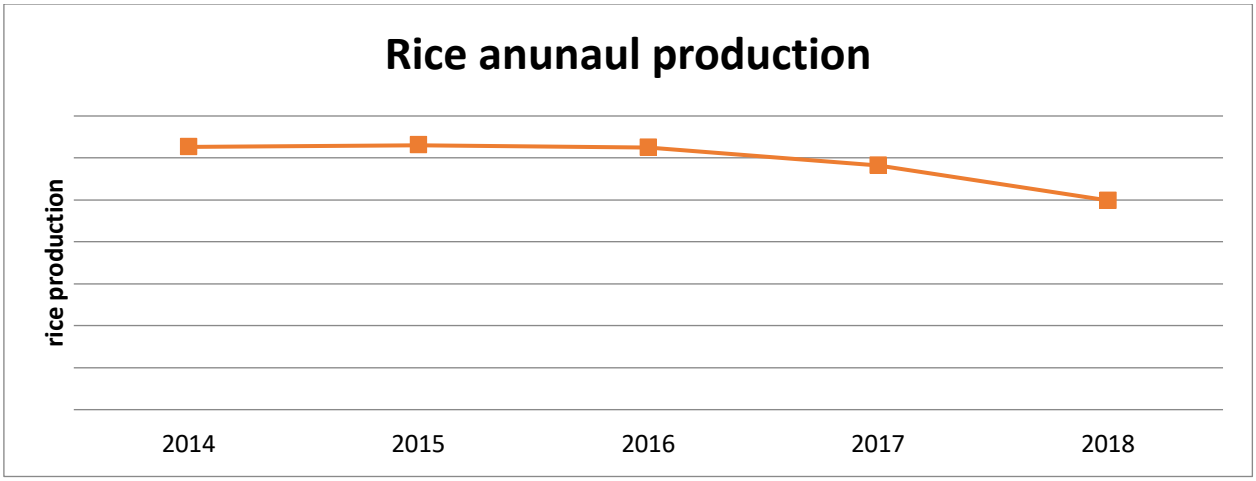

Figure 2 Trends of Rice production over the last five years
Source; survey result 2019

According to data from farmers, rice production has been declining over the past 4 years from 2015, primarily due to the water hyacinth. Although the weed is mainly grown in the rainy season, it also indirectly causes moderate damage to crops that were produced in the dry season through irrigation. Farmers replied that various diseases and insects were observed on the farm fields of teff, maize, and other crops, which are irrigated in dry season, resulting in a reduction in the quality and quantity of produce. Interviewed farmers added that in addition to crop production reduction, there are other side effects, such as when animals use it for food, it also affects the quality of cow milk, it is a waste of grazing

land, and it creates a favorable environment for various insects that harm human beings. It also demands a great deal of energy and time of labor and it causes skin itching for humans during removal of water hyacinth. Various studies have shown that it has positive effects mainly used for animal feeds, soil conservation & fertility, fuel production, **used as a raw material to make items that include baskets, cupboards, tablemates, seats, handbags, earnings, bangles, necklaces, trays, chairs and coffins** and other uses **(Osoro, 2014; Balasubramanian *et al.*, 2013; Agengo, 2013),** but farmers were not utilizing it in usable form in the study area. Even though different researches showed that water hyacinth has a positive contribution, the comminute in the study area almost nothing reported that water hyacinth is important for animal feed, soil fertility, and as a raw material to produce finished goods. However, according to a key informant interview with an expert from the Lake Tana and Aquatics Resources Conservation and Development Agency, water hyacinth has many positive effects in addition to its negative ones.

"Before 2019, the top priority was to eradicate the water hyacinth outbreak on Lake Tana," the expert said. To eradicate the weed, it will take longer periods. The Agency are collaborating with relevant governmental and non-governmental organizations on a pilot project to control and manage the water hyacinth by using it as a raw material to create finished goods for human use. Among those who have success with this, for instance, is an international NGO, NABU project. According to his observations from prior studies, water hyacinth is utilized to produce biofuel, soil fertilizer, charcoal, handicrafts, biogas, and ethanol, as well as animal feed.

There is good beginning charcoal production from water hyacinth in Lake Tana, which are run by international NGOs. The Agency intends to scale up the effective methods and include more products made from water hyacinth. Knowing that water hyacinth is a natural resource that can be utilized for a variety of purposes to create the aforementioned finished goods could be taken as an opportunity.*"*

Furthermore, previous studies show that paper hand sheets are made from a blend of water hyacinth pulp and bamboo pulp **(Goswami & Saikia, 1994)**. **Tham (2012)** evaluated water hyacinth was used as animal feed has potential as feed for livestock due to high crude protein content and high dry matter, which may be improved by the addition of molasses or rice bran.

Households Perceptions and the effect of water hyacinth

In the study area water hyacinth affected the farmers around Lake Tana in many ways. As observed in Table 8, sample households perceived that water hyacinth makes land preparation and crop production difficult, dehydrates farmland, reduces fish production and contaminates water, destruction of animal feeds, cause disease on humans and animals.

Table 8 The effect of water hyacinth

Effects	Freq.	Percent
Makes land preparation and crop production difficult	172	91.01
Dehydrates farm land	125	66.14
Makes fishing difficult	123	65.08
Contaminates water	107	56.61
Others(Cuase disease on humans and cattle)	12	6.35

Source; Survey result, 2019

Since 2014, fishing in the study area becomes tiring due to the expansion of this invasive weed **(Asmare, 2017).** According to this source water hyacinth impose a negative impact on fishing activity in Lake Tana, it affected catch rates, increasing fishing costs and blocked many fishing grounds.

Water hyacinth negatively affected fish catch rates, reduce crop production where water hyacinth mate covering fields during wave time, collected water hyacinth (heap) makes the farm land fragile, also affects diversity, distribution and abundance of life in aquatic environments **(Dereje Tewabe *et al.*, 2017, Damtie, Mengistu & Meshesha, 2021)**. It also created a favorable breeding environment for mosquitoes, adversely affects aesthetic and recreational value, Excessive water loss from the river has been regarded as a threat to food security especially in the face of climate change of the river to the communities along Shagashe River in Zimbabwe **(Chapungu, OC & B, 2018).** Due to this weed**, s**mallholder farming along River Tano and Tano Lagoon in Ghana perceived that in the future their living conditions will be worse off if it continues to remain at a level **(Honlah *et al.*, 2019).**

Of the total farmers interviewed, 84.13% of them think that the government/other organizations are recognizing the problem and working against the problem. The government is also providing various supports, including training on how to control the weed, on adaptation strategies and removing water hyacinth using improved technologies, financial support and supplying of oil and soap. A majority of farmers aware that water hyacinth removal using machines practiced in other parts of the area in which water hyacinth invading the lake should also be done alongside with manual control of the weed to improve the prevention work.

Table 9 Farmer's participation and access to information

Particulars	Freq.	Percent
Adapting a strategy to resist the water hyacinth problem	175	92.59
Participation in campaign of removing water hyacinth	169	89.42
Information access regarding water hyacinth	173	91.53

Source: Survey result, 2019

As observed in Table 9, 92.59% of the households used adaptation strategy to resist the water hyacinth problem by themselves. Mostly they participate in removing water hyacinth in campaign or individually by weeding, collect and burn. Few farmers locally constructed fence around their farm to defend the coming water hyacinth before invading their rice farms. Others switch-off from farm to other income earning activities (off/non-farm type). Most of the farmers in the study areas were participated in Watter hyacinth removal campaign. It is coordinated by governmental office experts at *kebele*, *woreda*, *zone* and Region level. Communities contribute as labor to remove water hyacinth.

From the interviewed households 89% of the farmers were willing to participate in removing water hyacinth in community water hyacinth removal campaign. In the campaign different stalk holders were participated like farmers, DA, environmental experts from *woreda*, *Zone* and Regional level. Farmers contribute their labor and time to remove water hyacinth, DAs' and experts at different level create awareness to mass campaign to remove water hyacinth, government organizations supply materials like oil, soap to those participants. The campaign mostly done in months of November to December. The water hyacinth removal activity has been continuing and done by hiring daily labourer till month of May.

Farmers replied that different problems were happened during removing water hyacinth. Some of the difficulties encountered during WH removal were: Bitten by different types of insects (*Alekit*, snake, etc.), cause human skin sick, difficult for movement on water body, weeding is time and energy consuming, and bad smell, cause human disease

The survey result revealed that 91.5% households had access to information regarding water hyacinth in different sources like from Extension workers (43.39%), own experience, fellow framers, mass media and training/workshops.

Trainings about water hyacinth were given to the communities in different times. It was organized by government. The environmental conservation office at different levels; regional, zonal and woreda level was mainly responsible to provide formal training on water hyacinth. There are responsible persons at each level who are experts with environmental in addition to training; they are following up the removal of water hyacinth. The training topics was focused on removing water hyacinth and its' effect on farming and human health.

CONCLUSION AND RECOMMENDATION

Most the population in the study area was found in productive age category, between 15 to 64 years. Half of the household heads were able to read and write. Rice cultivation has been started log years ago. Farmers are very close to the lake and far away from the year-round road, it makes it extremely difficult for the institutions/ individuals/communities to enter the area and avoid water hyacinth.

Since rice is their main crop, more land has been allocated to this crop, and in addition, they can supplement their livelihoods by producing other crops and raising livestock. If the water hyacinth effect continues, they may turn their faces toward rice. Farmers could get difficulty in sustain their life unless donations would be given. Even though tef, lentil, rice and chick pea were the crops produced for market in the study areas, the livelihood of the community decreasing from time to time. As compared with other source of income, farmers still get more income from sell of rice. It is important to work against the water hyacinth effect since it is imposing higher damage. If the proper management strategies are not designed to reduce/eradicate the effect of water hyacinth that could be obtained from rice would lead to risk because it affects not only rice crops but other crops, grazing lands, fishing, and livestock.

Water hyacinth affected the farmers around Lake Tana in many ways, affected negatively crop, fish and livestock production, and contaminates the lake water that could be used for drinking and irrigation and cause animal and human diseases. One third of the planted rice farm was not harvested totally due to Water hyacinth infestation. This led to loss of more than 38 million ETB per year. On the other hand, different findings indicated that it has benefits like the use as animal feed, producing of fertilizer and other finished goods.

Based on the study results, we recommend the following:

The farming communities along *Fogera* and *Libokemkem* districts largely depends on lake Tana water body to access the sources of their livelihood, their quest to sustain themselves economically should be easily made possible through interactive participatory management approach involving the farmers, district authorities, newly established Agency named Lake Tana and Aquatics resources Conservation and Development Agency, local community leaders and rural development agencies to ensure the control of the water hyacinth. Smallholder farmers should be made to participate in joint analysis of the problems created by water hyacinth invasion and the possible solutions, with concerned bodies. This will lead to action plans and the strengthening of existing local institutions whose mandate it is to address the water hyacinth invasion problem.

Water hyacinth significantly reduces income obtained from rice crop mostly and other crops which are produced in irrigation system even though its effect is relatively lower. There needs supporting of farmers whose livelihood affected by water hyacinth in many ways, we suggest the government/ NGOs and individuals to support directly and strength the

irrigation development in the study area alongside with this promote of agricultural technologies (crops and livestocks technologies) to these areas. Further to this, creating enabling environment to switch the livelihoods of farmers to other income earning activities that could sustain their life. In addition to weed removal, local residents in the surrounding should be made aware of the possibility of using the weed as a raw material to produce various goods, more research on the use of water hyacinth for social benefits is also essential.

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