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The Role of Participatory Watershed Management Practice to Ensure Food Security: Case Study in Chenetaly Watershed, Guagusa Shikudad Woreda

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Abstract: Degradation of natural resources coupled with high rate of population growth and food insecurity are major development problems. The rapid global population growth and increasing impacts of climate change have resulted water and food shortage. Successful management of healthy landscapes helps to protect the balance between the carrying capacity, water utilization and quality, soil health and biodiversity and improve food security. The objective of this study was to investigate the contribution of SLMP initiated watershed management practices for food security in Chenetaly Watershed. The study has focused on the assessment of outcomes of WM intervention in terms of food production (availability) and access to food indicators household levels. The general objective of this study was to analyze participatory watershed management practice and its role on food security among the rural community in Chenetaly Watershed, which is located in Guagusa Shikudad Woreda, Amhara National Regional State he results showed that Chenetaly watershed was severely degraded due to inappropriate cultivation, over grazing, gully formation and deforestation factors before the introduction of watershed management practices. Due to the presence of high watershed degradation, the agricultural productivity of this area was very low and about 60% of the sample households did not able to cover their annual food demand from their own production. To overcome this problem, watershed management program was introduced in Chenetaly Watershed and many physical and biological conservation measures were implemented to reduce soil erosion, rehabilitate gully formation and decrease loss of soil fertility. The results of this study confirmed that the introduction of watershed management has brought some important changes in local ecosystem. Some of the major ecological changes include decrease in soil erosion, increase soil fertility and agricultural productivity, increase forest cover and firewood availability; increase the availability of grass and other livestock fodder. The food security outcomes of watershed management intervention achieved through improved crop and livestock's productivities diversify sources of incomes, increases availability of food and increase food access. It is concluded that watershed management can play significant role to improve ecology and food security condition of the local people. The result of this study indicated that effective watershed management intervention has been undertaken in Chenetaly Watershed such best practices should extend to neighboring watersheds.

Keywords: Watershed Degradation, Watershed Management, Food Security

1. Introduction

1.1. Background the Study

Degradation of natural resources coupled with high rate of population growth and food insecurity are major development problems [5]. Due to the increasing pressure from anthropogenic activities the terrestrial and aquatic ecosystems and their interrelation are largely disrupted. As the result, the benefit we get from the ecosystem has reduced, this calls for a shift in the management of ecosystems and the use of water for food security [33]. Watershed management considers the sustainable management of natural resources in a comprehensive way and makes the link between natural resources management, agricultural production and livelihoods in and around protected areas [16].

Watershed management reduces rural poverty and building resilience in the watershed communities by the transformation of their economies, crop intensification and diversification with high-value crops that allowed households to achieve production of basic staples and surplus production for consumption and income generation [28]. Watershed management improved food security and reduce poverty by increase production through access to improved seed and inputs, enable all farmers and encourage the consumption of foods, particularly those available locally, that contribute to diversified and balanced diets [13].

Watershed management enhanced the productivity of crops and to some extent mitigated the adverse impact of drought thereby provided better food security to families and increase the availability of food grains and vegetables [6]. Land degradation is the most chronic problem in Ethiopia. Soil erosion and denudation of vegetation covers are tending to enlarge in the area of degraded watersheds. Due to this, watershed management was introduced and widely practiced with an objective of sustainable management of natural resources to improve food security across the country [1]. Today there is a massive movement in watershed management in almost all regions of the country and has evolved as comprehensive development concept for sustainable and efficient utilization of natural resources for the benefit of the local community with special attention to the rural poor [15].

1.2. Statement of the Problem

Ethiopia is one of the rich countries in sub-Sahara Africa (SSA) in terms of natural resources. Natural resources are the foundation for agricultural development and meeting the food security and basic needs of the rural population. However, the country is affected by multiple environmental and socioeconomic problems that include land degradation, recurrent droughts, flood hazards, rapid population growth, extreme poverty, poor natural resources management and traditional farming methods that make the agricultural sector stagnant [28]. Watershed degradation in Ethiopia is one of the main constraints for agricultural productivity, resulting from the interaction of natural and anthropogenic factors [10].

Ethiopia has been engaged extensively in natural resources management by considering watersheds with collaboration communities and NGOs. According to [FAO] in 2000 long-term national program called Sustainable Land Management Program (SLMP) was launched. The objective of SLMP was to provide assistance for smallholder farmers to adopt sustainable land management practices on a wider scale that can ultimately result in reversing land degradation in agricultural landscapes, increase agricultural productivity, income growth and protect ecosystem integrity and functions. SLMP is taking more systematic implementation approach by targeting small watersheds. Important feature of SLMP is the explicit and clear focus on enhancing farmers' income and food security [13].

Agriculture growth is accepted as guarantee against food insecurity in the country. Food security strategy also places focusing on the three aspects, increasing agricultural production (food availability), and increasing food entitlement and strengthen the capacity to managing risks [17]. In 2001 Sustainable Land Management Project (SLMP) has been implementing watershed management practices in Chenetaly Watershed. Different types of conservation measures including biological and physical SWC measures have been implemented for the last years [20]. However, the effect of this watershed management practices on natural resources and food security yet not investigated by scientific study. Therefore, the objective of this study was to investigate the contribution of SLMP initiated watershed management practices for food security in Chenetaly Watershed. The study has focused on the assessment of outcomes of WM intervention in terms of food production (availability) and access to food indicators household levels.

1.3. Objective of the Study

The general objective of this study was to analyze participatory watershed management practice and its role on food security among the rural community in Chenetaly watershed, which is located in Guagusa Shikudad Woreda, Amhara National Regional State.

The specific objectives of the study were to:

i) Assess farmers' perception on watershed degradation and management works in the study.
ii) Investigate the roles of watershed management to ensure food security (food availability and food access) in study area.

2. Review of Related Literatures

In recent decades, in many parts of the world, watershed degradation has emerged as serious problem causing natural resources degradation and acting as a determinant for the efforts of achieving food security and led to negative environmental and socio-economic impacts [30]' Watershed degradation affects functionality of watersheds which provide essential goods and services to local communities and national economies [21]. The declining of per capita land and fresh water availability coupled with soil erosion and land degradation is posing serious threat to environmental, food, social and economic security [21, 32]. Resource degradation threatens food production, water availability and rural livelihoods in many developing countries. It denies farmers to access basic livelihood assets and attain food self-sufficiency [23].

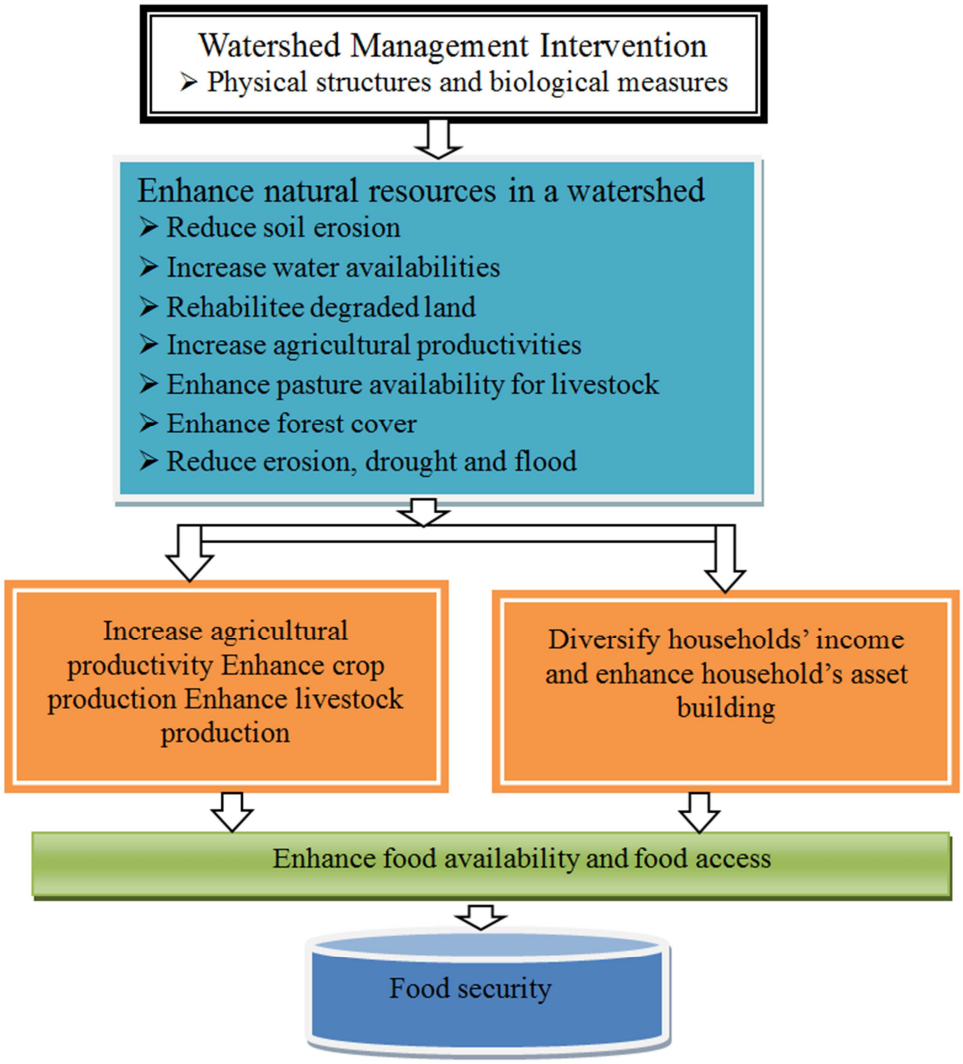
In developing countries human needs for watershed resources are increasing from time to time, on the reverse the existing watershed resources goes down and unable to meet the demands of urban and as well as rural communities. Due to this fact, watershed management has been considered as one of the strategies to create healthy environment, improve livelihood and ensure food security [26]. Watershed management is an integrated use of land, vegetation and water in a geographically discrete drainage area for the benefit of its residents, with the objective of protecting or conserving the hydrologic services that watershed provides and reducing or

avoiding negative downstream or groundwater impacts [9].

In recent decades the protection and management of watersheds has emerged as both a local and national policy initiative throughout the developing world [8]. Watershed management program also significantly improved the socio-economic status of the watershed community. It has increased income and reduced poverty of the people in the watershed and it also generated good employment opportunities [6].

2.1. Watershed Degradation and the Prevalence of Food Insecurity

Degradation of watersheds in recent decades has brought the long-term reduction of the quantity and quality of land and water resources. Changes in watersheds have resulted from a range of natural and anthropogenic factors [31]. Land degradation is highly linked with food security and environmental balance. Food security and quality of environment and hence human well beings are threatened by the increasing rate of land degradation [35]. According to [Ephrem] increase food production is critical for achieving food security for the growing population. However, land degradation and decline of productivity of soils due to interrelated interwoven factors poses serious threat to agricultural production in many areas and land productivity being a key determinant of food security. The figure below shows that the conceptual linkages between food shortage (food insecurity) and land degradation [12].



Source: [9]

Figure 1. *Conceptual frame work of the study.*

2.2. The Role of Watershed Management to Ensure Food Security

Watershed management program addresses environmental and ecological problems like deforestation, over-utilization of water and most importantly it seeks to convert unsustainable agriculture to sustainable agriculture besides tackling unemployment faced by the farmers as well as landless people [29]. Sustainable land management programs have the potential to provide global environmental benefits through

their contribution to combating land degradation and to arresting and reversing decline in biodiversity deliver social and economic benefits through productivity gains and food security [19].

Food security as a state where all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. The four pillars of food security are availability, access, utilization and stability [14]. Food security is dependent upon agricultural system which is resilient from land degradation. Food security includes at the minimum, the ready availability of nutritionally, adequate and safe goods and assured abilities to acquire socially acceptable way [22].

2.3. Conceptual Framework of the Study

The prevalence of watershed degradation has created many environmental and socio-economic problems across the world. Soil erosion, loss of soil fertility, water shortage and forest reductions are typical environmental problems resulted from watershed degradation. Watershed management intervention is best instrument to reduce soil erosion, increase water availability and rehabilitate degraded lands. Sustainable land that well managed increase domestic agricultural production and diversify sources of income that play great role to enhance food security through increasing food availabilities and access.

3. Materials and Methods

3.1. Description of the Study Area

Latitudinal location of Chenetaly Watershed is located between 10°44'0"N to 10°48'0" N and 37°0'30" E to 37°3'30"E in Gusha Shinkurita Kebele, Guagusa Shikudad Woreda, Awi Administration Zone of Amhara National Regional State. It is one of the 54 watersheds found in Guagusa Shikudad Woreda. The watershed surrounded by Gibgedel and Samuel Kebeles in the north, Gusha Kebele in the west, Gusha Kebele in the south and Samuel Kebele in the east. The total land area of the watershed is estimated 483.6 hectares.

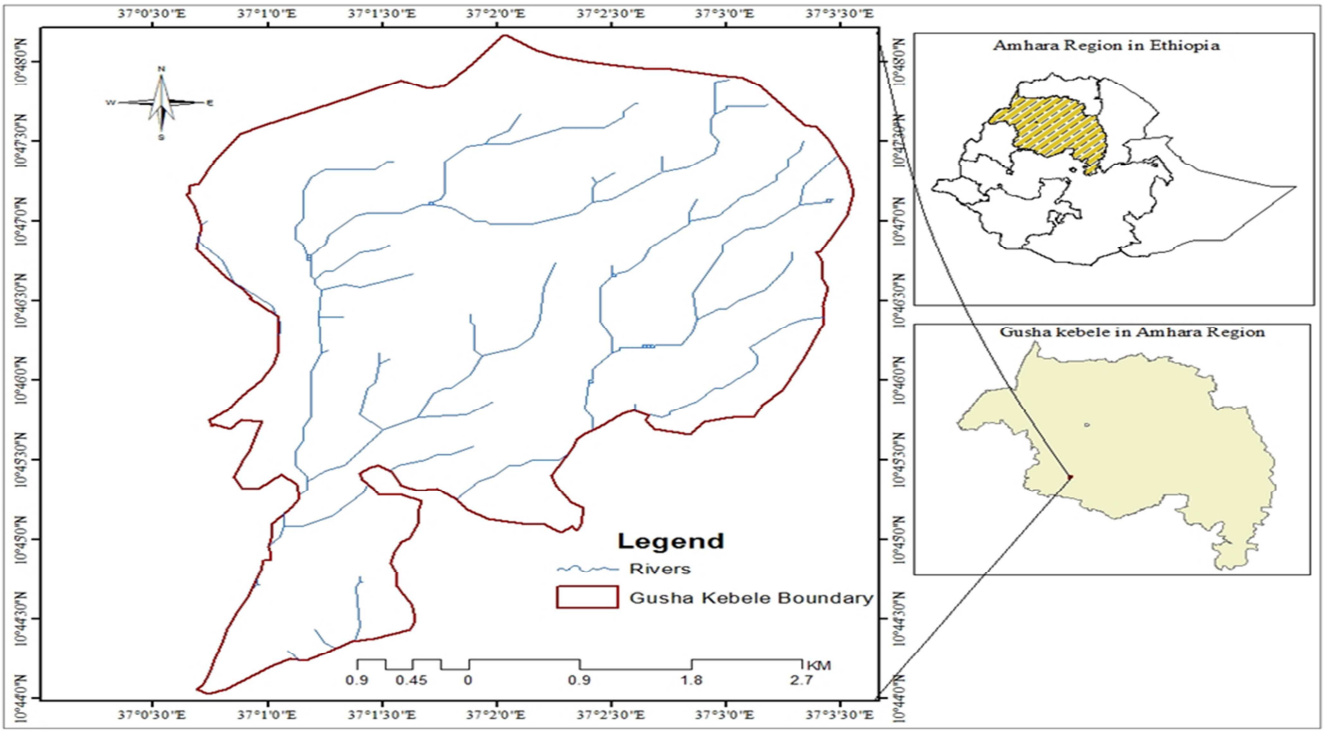


Figure 2. *Map of study area.*

3.2. Research Design

In this study mixed research design (both qualitative and quantitative) method was used. Cross-sectional survey method was employed to collect data from household on the role of watershed management intervention to improve food security household survey. The qualitative methods that include focus group discussion, observations and key informants' interview were used for the purpose of compensation and data triangulation.

3.3. Data Sources and Types

Both primary and secondary data sources were used for this study. Primary data sources were household heads, 'kebele' and 'woreda' natural resource experts through household survey, key informant interview and focus group discussions. On the other hand, secondary data sources for this study were books, internet, research papers, journals and reports on the role of watershed management ensure food security.

3.4. Sample Size and Sampling Technique

Sampling technique was used to select the representatives from total population. In Guagusa Shikudad Woreda the implementation of watershed management activities was practiced in four different watersheds. Chicketie, Wagishitie, Washintie and Chenetaly are the four watersheds that found in this woreda and experienced SLMP. Among these watersheds Chenetaly Watershed was selected purposively from four watersheds for this study purposes due to the fact that Chenetaly Watershed has experienced effective watershed management practices compared to the other watersheds. The total population of watershed is 1140 from those 210 are households living in Chenetaly Watershed from these 84 household heads select through simple random techniques to administer questionnaires. Sample size was determined using the following method as used in [7]:

$$\text{No} = z^2pq \rightarrow n = \frac{no}{1+\frac{no-1}{N}} = \frac{1.96^2 \times 0.1+0.6}{0.05^2}$$

$$\text{No} = \frac{0.345744}{0.0025} = 138.2976$$

$$n = \frac{138.2976}{1+\frac{138.2976-1}{210}} = \frac{138.2976}{1.6537961} = 83.624 = 84$$

Where; no is the desired sample size when the population is greater than 10000, n is number of sample size when population is less than 1 0000, Z is 95% confidence limit i.e. 1.96, p is 0.1 (proportion of the population to be included in the sample i.e. 10%) q is 1 -0.1 i.e. (0.9), N is total number of population that is 210 and d is margin of error or degree of accuracy desired (0.05). Thus, the sample size to this study was 84 households.

3.5. Methods of Data Collection

Multiple data collection methods were used in this study. These include household survey through questionnaire, focus group discussion, and key informant interview and field observation.

3.6. Methods of Data Analysis

Both qualitative and quantitative techniques were used to analyze the data. Descriptive statistics such as mean, percentages and frequency were employed to analyze quantitative data collected through questionnaire and the data was summarized by using table and chart. This study also applied comparative analysis to evaluate the contribution of watershed management on food security and ecological conditions of the study watershed in the last decade before watershed management intervention and after watershed management intervention. Statistical tests and measures of variation such as t test were used to analyze quantitative data. SPSS software was used to analysis quantitative data. Data obtained from FGDs and key informants' interviews were analyzed descriptively. Qualitative data were used validate findings of quantitative data.

4. Results and Discussions

4.1. Farmers' Perception on Watershed Degradation

Understanding farmers' perception on watershed degradation is a vital step to take appropriate planning and management intervention measures at a given area [17]. According to [Dessalew], it is necessary to understand the attitudes of local people on resources degradation in order to design a useful plan of action for environmental protection. This is because, farmers' decision to conserve natural resources are determined by their knowledge on problems. In this study, sample household [11].

Household heads were asked to indicate the existence and extent of resources degradation in the watershed before intervention of watershed management practice. Accordingly, all respondents (100%) indicated that there was severe natural resources degradation in Chenetaly Watershed before the introduction of watershed management activity.

About 78.6% and 21.4% of the respondents rated the prevalence of soil erosion before the introduction of watershed management as very high and high, respectively (Table 1). Due to this, the fertility of soil at Chenetaly Watershed has declined as confirmed by 98.8% of the respondents. About 79.8% of respondents have confirmed that there was very high gully formation before the introduction of watershed management practice. As indicated in Table 1, about 48.8% and 45.2% of the respondents rated the prevalence of animal fooder shortage as very high and high before the introduction of watershed management intervention, respectively. The productivity of land was also declined at a very high rate as confirmed by 85.7% of the respondents. About 81.1% of the household heads confirmed the presence of very high flood hazards in Chenetaly Watershed. Furthermore, 76.2% of the respondents reported the presence of very high-water shortage in the study area before the introduction of watershed management intervention. The destruction of biodiversity in the watershed was also very high as confirmed by 72.4% of the respondents.

According to information obtained from FGDs and key informant interviews, Chenetaly Watershed has experienced very high level of soil erosion and gully formation. They also indicated that due to shortages of land and poor agricultural productivity on the existing farmlands, most households were forced to use hillsides or steep slope areas for farming purpose. According to [18], gully formation and expansion is one of the major problems in degraded watersheds that reduce the cultivable area and grazing lands. On the other hand, gullies facilitate surface runoff from upstream degraded landscapes and carrying large amount of sediment and posing problem of siltation in downstream dams, rivers and cultivated or grazing lands.

Table 1. *Respondents 'perception on watershed degradation before the introduction of watershed management at Chenetaly Watershed*

Indicators of watershed degradation	Response (%)				
	1	2	3	4	5
Soil erosion	78.6	21.4	-	-	-
Loss of soil fertility	78.6	20.2	1.2	-	-
Gully formation	79.8	19	1.2	-	-
Shortage of grazing land	48.8	45.2	4.8	-	-
Deforestation	76.2	20.2	1.2	-	2.4
Reduce land productivity	85.7	11.9	2.4	-	-
Flood hazard	81.1	16.5	1.2	1.2	-
Water shortage	76.2	21.4	2.4	-	-
Loss of biodiversity	72.4	22.6	4.8	-	-

Key: 1= very high 2=high 3= low 4=very low 5= not a problem
Source: Own survey

Source: Guagusa Shikudad Woreda Agricultural Office

Figure 3. *Gullies formed in Chenetaly Watershed due to soil erosion before the intervention of watershed management that taken in 1999 E.C.*

4.2. Farmers' Participation in Watershed Management Activities

Farmers' local knowledge and active participation are relevant in the field of watershed management intervention at a given area [35]. This study attempted to see the participation of sample respondents in watershed management activities and their perception on benefits of watershed management activities. All respondents have responded that watershed management is the best solution to conserve natural resources in the Chenetaly Watershed. The result indicated that all the sample households were participated in the watershed management activities (Table 2). Participants in the FGDs and key informant interviews also confirmed that all households in the watershed were participated in the management activities. The household participated from problem identification, planning, management and monitoring activities. Participants have indicated that, inhabitants in the watershed were actively engaged in management activities as they aware of watershed management intervention. They mentioned that "we actively engaged in watershed management activities, since it helps to enhance our living condition by rehabilitating the degraded lands and increasing agricultural productivity". The result of this study was consistent with [3] who argued that farmers' decision to conserve natural resources determined by their knowledge of the problem and the perceived benefits of conservation.

Table 2. *Households' participation and perception on watershed management activities.*

Questions	Response					
	Frequency			Percent		
	Yes	No	Total	Yes	No	Total
Did you or any member of your family participate in watershed management activities?	84	0	84	100	0	100
Do you think that watershed management intervention can be a solution for resource degradation in the watershed?	84	0	84	100	0	100

Source: Own survey

This study has also identified different biological and physical conservation measures implemented in Chenetaly Watershed. Some of them were soil bunds, tree planting, terraces, area closure and stone bund. As confirmed by data from household survey, almost all household heads were participated in area closure and terracing works (Table 3). On the other hand, 57.5%, 56% and 4.8% of the respondents confirmed as they were participated in tree planting, soil bund and stone bund

constructions, respectively. According to information obtained from FGDs and key informant interview farmers in the study area were participated in the implementation of different physical and biological measures such as soil bund, stone bund, trench, and terrace, closure of grazing land, crop rotation, mulching, contour plough and agro forestry.

a) b)

Source: field photo,

Figure 4. *a) Agro forestry and b) Farm lands plough with crop residues.*

Source: Google earth satellite image

Figure 5. *Satellite map of treated gully and farmland in Chenetaly Watershed.*

Table 3. *Types of watershed management measures implemented in Chenetaly watershed.*

Types of Conservation measures implemented in the watershed	Response	
	Frequency	Percent
Area closure	82	97.5
Traccing	84	100.0
Planting trees	48	57.5
Soil bund	47	56.0
Stone bund	4	4.8

Source: Own survey

a) b)

Source: Field photo

Figure 6. *Gully treatment activities in Chenetaly Watershed.*

4.3. The Contribution of Watershed Management Intervention for Crop Production and Its Implication for Food Security

In addition to conserve natural resources, the objective of watershed management intervention is to enhance the productivity of farmlands and increase the food security condition in one area [30]. The introduction of watershed management program in the study area has bought significant positive impacts on crop productivity (Table 4.). The survey result has shown that crop production was much higher after the introduction of watershed management program and crop production per hectare has increased. According to the survey result the productivity of teff per hectare has increased from 7.72 to 16.12 quintals, wheat has increased from 14.92 to 28.92 quintals, and barley has increased from 12.52 to 23.56 quintals. Similarly, the productivity of maize per hectare has increased from 13 to 26.52 quintals, while pea and bean have increased from 8 and 9.76 quintals to 16.04 and 19.04 quintals, respectively. The average per hectare production of onion and potato also increased from 6.4 and 27.24 to 13.6 and 62.6 quintals per hectare, respectively.

The change in crop productivity likely has significant impacts on households' income and food security conditions. As indicated by participants in the FGDs and key informants' interview, the enhanced crop productivity in the study area attributed to reduced soil erosion, enhanced soil fertility, increased surface and groundwater availability, improved crop management practices like integrated nutrient and water management, integrated pest management and improved crop varieties. For example, the low level of fertilizer application (only by 20.2% of sample farmers) before watershed management intervention has increased into higher level (90.5%) after the introduction of watershed management intervention (Table 5). In addition to promotion and awareness creation, farmers were encouraged to prepare and apply organic fertilizers (compost and crop residues).

a) b)

Source: GSWARDO

Figure 7. *a-improved a) teff and b) wheat varieties on farmers' plots.*

Table 4. *Improvement on agricultural productivity per crop type.*

Before watershed management intervention (2000)		**After watershed management intervention (2009)**	
Crop types	**Average production in quintal per hectare**	**Crop types**	**Average production in quintal per hectare**
Tdff	7.72	Tdff	16.12
Wheat	14.92	Wheat	28.92
Barley	12.52	Barley	23.56
Pea	8.00	Pea	16.04
Bean	9.76	Bean	19.04
Potato	27.24	Potato	62.60
Maize	13.00	Maize	26.52
Onion	6.40	Onion	13.60

Table 5. *Farmers' response on the applications of agricultural fertilizers.*

Did you used fertilizer to increase crop production?	**Farmer response (%)**	
	Before watershed management intervention	**After watershed management intervention**
Yes	20.2	90.5
No	79.8	9.5

4.4. The Role of Watershed Management Intervention on Livestock Production and the Implications for Food Security

Livestock rearing is an integral part of farming system and it is particularly important for rural population to generate income and food. Thus, variation in livestock ownership is often used as an indicator of food security status. In the study area farmers owned different types of livestock that include: cattle, cheep, donkey, horse and chicken. For this study purpose, households' livestock ownership was measured by the average amount of Tropical Livestock Unit (TLU). The total ownership of

livestock is measured by Tropical Livestock Units that allows all different animal types to be aggregated to one single number [34)]. Thus, TLU were calculated using the following weighted index factors: Cattle= 0.7, Horses= 0.5, Donkey=0.5, Sheep= 0.1 and Chickens= 0.01.

Table 6 presents the type and size of households' livestock ownership in Chenetaly Watershed. Based on the survey result size of livestock has increased after the intervention of watershed management. Thus, the average number of cow increased from 133 to 231, the average number of oxen increased from 181 to 251, the average number of sheep increased from 165 to 300, the average number of donkey increased from 29 to 50, the average number of horse increased from 17 to 38 and average number of chicken increased from 74 to 102. The average numbers of livestock's before and after watershed management intervention was 265.14 and 423.82, respectively. Thus, average numbers of livestock per household before and after watershed management are 3 and 5, respectively.

As indicated by farmers before intervention of watershed management there is shortage of animal fodder availability due to high level of gullies and soil erosion. But after intervention of watershed management productivity of livestock increased due to enhanced pasture growth, water availability and supply of additional livestock fodder from crops residues. The result of this study is consistent with [Arya] who reported that watershed management intervention has increased the number of livestock as it can have improved the biomass of grazing lands, the availability of fodder and drinking water [4].

Sources: field photo

Figure 8. *The contribution of watershed management on fodder availability in Chenetaly Watershed.*

Table 6. *Distribution of the livestock population among sample households.*

Livestock species	Before watershed management			After watershed management		
	No. of livestock	TLU conversion factor	Total TLU	No. of livestock	TLU conversion factor	Total TLU
Cow	133	0.7	93.1	231	0.7	161.7
Oxen	181	0.7	126.7	251	0.7	175.7
Sheep	165	0.1	16.5	300	0.1	30
Donkey	29	0.5	14.5	50	0.5	25
Horses	17	0.8	13.6	38	0.8	30.4
Chicken	74	0.01	0.74	102	0.01	1.02
total	-	-	265.14	-	-	423.82

In addition to improve the productivity of the livestock sector, improvement in vegetation cover helped farmers to practice bee keeping activity as confirmed by some respondents (22.6%) (Table 7).

Table 7. *The effect of watershed management practices on beekeeping activity.*

Did you have participate in beekeeping?	Response (%)	
	Before watershed management intervention	After watershed management intervention
Yes	1.2	22.6
no	98.8	77.4

4.5. Benefits of Watershed Management Intervention on Farmers' Annual Income Sources

Farmers' response on the contributions of watershed management intervention on crop farming and their annual income is presented in Table 8. This study found that after the introduction of watershed management program, farmers started to diversify their income, particularly from crop production sector. Previously farmers in the watershed have produced limited type of crop varieties, (wheat, barley, teff, maize, potato, bean and pea) and most of farmers depend on food crop production and animal rearing. However, following watershed management intervention, about 29.7% of the respondents have started to cultivate some commercial crops like vegetables and fruits in addition to previously produced crop varieties and animal rearing. After watershed management intervention beekeeping was also a new income sector that becomes an additional source of income for 22.6% of the sample households. It was also confirmed by key informants and focus group discussants that the rehabilitation of degraded lands and water development activities in their area due to watershed management intervention allow them to diversify their crop production and start beekeeping activity. It was also reported that by other study [18] that watershed management practices can create many opportunities for farmers that ranges from resources ownership to income diversification. These help households to obtain more income from farm that plays important role in building resilience and increase food security. All these contribute to increase food quality, smoothing consumption and reducing the

vulnerability of households to seasonal food insecurity.

Table 8. *Incom sources of respondents before and after watershed management intervention.*

Sources of income	Response (%)	
	Before watershed management intervention	After watershed management intervention
Crop production only	24	2.4
Crop and animal production	90.5	45.2
Crop, animal, vegetation and fruit production	6	29.8
Crop, animal production and beekeeping	1.2	22.6

Source: own survey

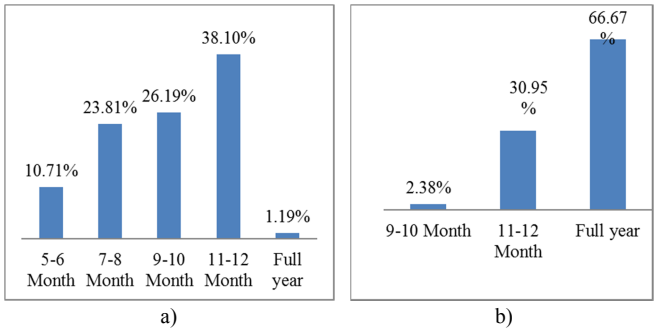
4.6. Contribution of Watershed Management Intervention on Food Security

Watershed management intervention enable better use and management of natural resources and efficient use of natural resources and positively impacted agricultural productivity and food security in the study area. Watershed management intervention largely builds resilience on food security by enhancing agricultural production and income diversification. According [Gebregziabher], watershed management has contributed to reduce food insecurity through concerted efforts of water harvesting and improved agricultural productivity. This study attempted to assess the contribution of watershed management on some components or indicators of food security (food availability and food access) [14].

4.7. Contribution of Watershed Management Intervention on Food Availability

Increasing the availability of food through domestic production is among one pillar of food security strategy adopted by Ethiopian government, as domestic production is the main source of food entitlement for most Ethiopian farming community in terms of direct consumption of food [17]. The finding of this study therefore has indicated the presence of some improvement in food availability due to the introduction of watershed management program in the study area. The majority of households (60%) were able to cover their food demand from their own production for less than 10 months, before the introduction of watershed management practice in the watershed. Of these 10.7%, 23.8% and 26.2% of the respondents were able to cover their households' food demand from their own production for 5-6 months, 7-8 months and 9-10 months, respectively, and only 38.1% the sample households were able to cover their food demand for 11-12 months (figure 9). However, an important improvement has been observed after the introduction of watershed management program as the availability of food from their production has increased.

As shown in Figure 9, about 66.67% of the households were able to cover their annual food demand from their own production. Other 30.95% of respondents cover their food demand from 11-12 months from their own production. While other, 2.38% of the respondents was able to covers 9-10 months from their own production. Evidence from FGDs and key informants interview assured that the availability of food crops has been increased due to improvement on their crop production from their own farmland. Similarly, the sample mean test result has shown the presence of statistically significance ($p<0.05$ level) variation in food availability before and after the watershed management intervention in the study area, and the availability of food was relatively higher after watershed management practices. Improvement in food availability due to watershed management intervention was also reported by previous studies [25, 32].



Source: Own survey

Figure 9. *Farmers' response on the availability of food crops a) before and b) after watershed management intervention.*

Table 9. *Paired mean test result of food availability.*

Item	Paired differences		t	df.	Sig. (2 tailed))
	Mean	Std. Deviation			
Food availability before and after watershed management intervention	-1.690	0.918	-16.877	83	0.000

Source: Own survey

4.8. Frequency of Food Consumption Per Day Before and After Watershed Management Intervention

The number of meals per day and the composition of each meal vary between rural households due to differences in food availability, access to consumption resources, the season and amount of agricultural production [25]. Table 10 shows the average frequency of meals of households' in the study area. Accordingly, about 66.7% of the respondents indicated that

members of their households had meals only two times per day before the introduction of watershed management intervention and only 33.3% of the respondents had meals three times per day. However, after the introduction of watershed management intervention about 47.6% of the households had meals three times per a day and 50% had four times per day. But still there were about 2.4% of households that unable to feed three times per a day. The statistical test has also confirmed the presence of statistically significant ($P<0.05$ level) difference in the daily food consumption pattern before and after watershed management intervention. The consumption patterns of households were higher after watershed management intervention than before.

Table 10. *Farmers perception of frequency of meal per day before and after watershed management intervention.*

frequency of meal per day	Response (%)	
	Before watershed management intervention	After watershed management intervention
Two times per day	66.7	2.4
Three times per day	33.3	47.6
Four times per day	0.0	50.0

Source: Own survey

Table 11. *Paired mean tese result for the frequency of meal per day before and after watershed management intervention.*

Item	Paired differences		t	df.	Sig. (2 tailed))
	Mean	Std. Deviation			
Number of meal time per day before and after watershed management intervention	-1.151	0.510	-20.338	83	0.000

Source: Own survey

4.9. The Contribution of Watershed Management Intervention on Food Access

Access to food is related to entitlement to resource and ability of households or individuals to transform resources into food through production or purchase or through gift [2]. Accordingly, access to resources such as land, labor, loan and oxen determine households' access to food. The ability to control these resources and their products also influence one's access to food [27]. Households were asked to indicate the status of their food access before and after watershed management intervention. Based on the survey results, only 3.6% and 9.5% of sample household heads were strongly agree and agree as they had sufficient access to food before the introduction of watershed management intervention, respectively. The other 79.8% of the respondents indicated as they did not have sufficient food access. However, the implementation of watershed management intervention has increased food access for about 70.2% of the respondents. Other 22.6% of households also agree that their food access have improved due to the introduction of watershed management program in the study area.

Table 12. *Respondents' perception on the effect of watershed management intervention on access to food.*

Before watershed management intervention		After watershed management intervention	
Level of agreement	Response (%)	Level of agreement	Response (%)
Strongly agreement	3.6	Strongly agreement	70.2
Agree	9.5	Agree	22.6
Neutral	7.1	Neutral	3.6
Disagree	41.7	Disagree	3.6
Strongly disagree	38.1	Strongly disagree	0.0

Source: Own survey

5. Conclusion and Recommendations

5.1. Conclusions

Chenetaly Watershed which is located in Guagusa Shikudad Woreda is one of the watersheds where effective watershed management activities have implemented during the last nine years through Sustainable Land Management Project. Thus, the objective of this study was to assess the contribution of this watershed management program for food security.

Chenetaly Watershed was highly degraded before the introduction of this watershed management program. Some of the major indicators of resource degradation in this watershed were soil erosion, loss of soil fertility and reduced agricultural productivity, gully formation, deforestation, declined groundwater table and surface water resources, shortage of fodder for livestock, flood hazards and loss of biodiversity due to poor management of land, poor agricultural productivity and farming of steep slope areas. To reduce and/ or mitigate the observed watershed problems many physical and biological soil and water conservation measures such as soil bund, trench, terrace, afforestation, area closure (protection and management), water management, spring development and grazing land management were implemented in the watershed during the

last nine years by the community in collaborate with Sustainable Land Management Project.

The finding of this study indicated that the introduction of watershed management has brought some important changes in local ecosystem. Some of the major ecological changes include decrease in soil erosion, increase soil fertility and agricultural productivity, increase forest cover and firewood availability, increase the availability of grass and other livestock fodder and improve local climate condition. The food security outcomes of watershed management intervention achieved through improved crop and livestock's productivities diversify sources of incomes, increase availability of food and increase food access. All these have improved households' food security in the study area.

5.2. Recommendations

Based on the findings of this study, the following recommendations were drawn for better success of the watershed management intervention and its contribution for food security.

The current watershed management practices focus on short term benefits like increase agricultural productiveness through rehabilitate degraded land, awareness creation should be made for farmers to plant permanent fruits and vegetable trees that have long term benefits.

The study found that there is poor linkage between concerned government institutions at woreda level. The concerned body should be strengthening the linkage between institutions to perform sector-based activities effectively in the watershed.

Based on result of this study effective watershed management intervention has been undertaken in Chenetaly Watershed such best practices should extend to neighboring watersheds.

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