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Determinant Variables for Women's Participation in Soil and Water Conservation Practices in North Western Ethiopia: The Case of Shebel Berenta District (Woreda), East Gojjam Zone, Amhara National Regional State

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ABSTRACT: Soil erosion occurs throughout the world and is a very serious problem especially in dry land areas of Ethiopia. Rural inhabitants try to develop some erosion control measures to reduce the negative impacts; however, the role of the women is not known and deserves to be studied to understand how land degradation processes are mitigated. Hence, the main goal of this study is to identify the determinant variables of women's participation in soil and water conservation (SWC) practices in Shebel Berenta Woreda of Amhara Region in Ethiopia as a study case. Mixed-research method with sequential explanatory research design was employed through survey questionnaire, interview, key informant interview, focus group discussion, and field observation as data collection methods since 2019. Descriptive statistics and a binary logistic regression model were used to analyze the collected quantitative data. The result showed a significant number of respondents (86.4%) frequently participate in SWC, while 14.6% do not. Among those participated in SWC, 55.6%, 18.85 %, and 42.8% were highly involved in terracing, vegetation cover, and compost preparation as a part of SWC practices, respectively. In addition, 50.4% has participated in decision making about SWC, while 49.6% had not any involvement. The binary logistic regression model analysis shows widowed women (adjusted odds ratio [AOR] = 0.23, 95% confidence interval [CI] = 0.001, 0.814, $P = .038$); are able to read and write (AOR = 0.164, 95% CI = 0.027, 0.995, $P = .049$); have secondary education and higher levels (AOR = 0.139, 95% CI = 0.022, 0.874, $P = .035$). Similarly, those who do not have farm land (AOR = 0.263, 95% CI = 0.072, 0.964, $P = .044$); their lands do not show soil erosion (AOR = .043, 95% CI = 0.006, 0.296, $P = .001$); have not discussions about SWC (AOR = 0.142, 95% CI = 0.021, 0.952, $P = .044$); not receiving any advice to apply them (AOR = 0.145, 95% CI = 0.030, 0.694, $P = .016$) were variables that determine women's participation in SWC. Therefore, the local government should work on awareness transference, providing new technologies, and building complete infrastructures to achieve better results of SWC.

KEYWORDS: Soil, soil erosion, water conservation, practices, gender, participation

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Introduction

Soil erosion occurs throughout the world; it is a common serious problem in dry land areas.[1] Soil erosion disturbs agricultural, environmental, and ecological functions performed by the soil and results in the depletion of soil fertility, decreased moisture storage capacity, and consequently in decreased crop productivity.[2] In addition, it also increases environmental pollution through the transport of chemicals and higher amounts of nutrients, increasing the sediment load in streams and rivers, and disturbing the aquatic life. In the long term, soil erosion affects socio-economic conditions of the society by causing floods, silting up water reservoirs, and disruption of communication systems.[3,4] Since soil and water conservation (SWC) measures were introduced within Africa in the early 1970s to improve land management practices, the main activities of reforestation and SWC practices initiated in drought-prone areas of a country especially in Sub-Saharan Africa.[5]

However, land or soil is the main resource base for many people in Sub-Saharan Africa. It is expected that soils of these territories will experience increasing pressure as a natural resource to provide for the needs of its people and due to an estimated population growth from the current 900 million to 1.4 billion in 2030.[6] With an estimated 65% of arable lands, 30% of grazing land and 20% of forests already degraded in Africa.[7] Despite of this, cereal production has increased marginally over the past 2 decades, more than 70% of this growth is due to area expansion rather than yield increases.[8,9]

In many parts of Sub-Saharan Africa, women are part of the primary labor force heading approximately a third of rural households, while contributing as much as 70% of household food production. On the other hand, men are decisions maker concerning fieldwork activities, while women are decisions maker concerning household and childcare; however, women assist in a range of fieldwork activities through yield increasing agricultural technologies such as SWC are often labor intensive. The additional labor requirement is sometimes met by involving women's labor in farm activities which result in some share in decision making that serves as an "invisible hand" to influence conservation decisions.[3,10]

Notably, soil erosion is the most dangerous ecological process observed in Ethiopia, degrading the precious soil resources which are the basis of agricultural production and food for the country people.[11] Soil erosion is caused by the interacting effects of factors such as biophysical and socio-economic

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aspects, and occurs mainly during the rainy season in the form of water erosion.[10,11] Rills, gullies, and brown rivers full of sediments show a lot of soil being carried away and lost for agricultural production. However, it occurs on grassland as gullies and in forests if they are not properly managed.[12]

As many parts of Ethiopian highlands, farmers have a pool of indigenous knowledge with which they use and manage their land resources.[5] The problem of soil erosion is more threatening in Amhara region; approximately 90% of its population lives in the highlands which constitutes 66% of its total land area, and of this land, 90% is regularly cultivated, exposing to soil erosion.[13] Areas severely worn away are found in Waghimra and North Wollo followed by North and South Gonder, South Wollo, East Gojjam and northern part of North Shewa zones.[14]

To overcome the problems of land degradation and soil erosion, SWC and management is vital. Thus, sustainable management of natural resources, particularly soil and water is of utmost importance to agriculture in Ethiopia. Since the inception of agriculture several millennia ago, little has been done by peasants and societies to conserve natural resources as land was abundant. The highlands were deforested for agriculture, especially in the past century when the population started to grow exponentially. But, conservation measures on agricultural land were applied in very few instances only and were introduced on a broader scale by the government and foreign programs in the aftermath of the great famine of 1972 to 1973, which was drought-induced, but caused by a lack of political response.[10,15] Traditionally, women have been responsible for subsistence and survival for water, food, fuel, fodder, and habitat though rarely credited for nurturing life support systems. In addition, environmental destruction worsens women's problems in ways that are very different from those of men. Women have always been the major conservers of biodiversity; even today, they perform duties such as seed selection, multiplication, and conservation. The on-farm conservation traditions of rural and tribal women with reference to agro-biodiversity are well known.[3]

Many studies on women and environment have shown women playing key roles in natural resource management through environment rehabilitation and conservation and in addressing some key environmental problems. Women through their roles as farmers and as collectors of water and firewood have a close connection with their local environment and often suffer directly from environmental problems.[16]

Women's involvement with natural resource production and management is not confined to agriculture; gender roles typically tie poor rural women far more than men to direct and regularly use, and dependence on natural resources, particularly common lands, forests, and water.[16,17] Cognizance with the problems of soil erosion and land degradation in the region especially in Shebel Berenta district, there is a need to have a broader perspective both on how the problem is occurring and a set of possible solutions to be considered. Farmers are more concerned about short-run benefits than long-run advantages of the soil, which aggravate the soil erosion in the study area.[18]

Therefore, this study would contribute in terms of issues, areas, and target groups. In a sense that this study used women as a target group which is not given attention previously, both low and highlands areas were covered, as well as the issues of SWC and its determinants were investigated. Thus, this study has tried to identify the variables that determine women's participation in SWC by implementing mixed-research method and conducted assessment on different literatures associated with the issues and study area to achieve this goal.

Methods and Materials

Description of the study site *(area)*

Shebel Berenta *Woreda* (District) is located in East Gojjam Zone, situated in the north central highlands of Ethiopia in the Amhara National Regional State. It extends from 10° 15′ N to 10° 30′ N latitude and from 38° 15′ E to 38° 27′ longitude as CSA, 2007 cited in Tenalem.[19] It is found 293 km north east from Addis Ababa, the capital city of Ethiopia. Shebel Berenta *Woreda* is bordered on the South-West by Dejjen *Woreda*; on the North-West by Enemay *Woreda*; on the north by Enarj Enawga *Woreda*, and on the South and South East by Abay River Gorge, which separates it from Oromia region. The major town of Shebel Berenta *Woreda* is Yedwuha.[20]

Shebel Berenta *Woreda* covers a total land area of 89,714 ha. Topographically, 8% of the *Woreda* is mountainous, 44% plain, and 48% is valley. Its altitude ranges from 1800 to 2150 m a.s.l. It has 2 agro-ecological zones with (28%) *Woyina-Dega* and (72%) *Kolla*. The largest part of the *Woreda* is situated in the lowlands (*Kolla)* along the Abay river gorge and is extremely depleted, deforested, and eroded.[19] Regarding the ecological features, 31%, 13%, 5%, and 4% are covered by crops, natural and human made forests, grazing lands, and residential areas, respectively. Gorges, steep slopes, and other areas that are not favorable for agriculture cover the remaining 47%. With regard to the soil type, 29% of the soil is black, 30% brown, 11% red, and 30% "gracha" following the local soil classifications, attending the organic carbon content, soil texture, and parent materials.[21]

The rainfall is highly seasonal; vivid evidence indicates that almost 90% of the total annual rainfall in the *Woreda* occurs during summer only. The average annual rainfall ranges from 4000 to 1000 mm.[22] In a common year, the study area experiences one short spring and a long summer rainy season. The long summer season starts from the middle of June and extends up to the end of September. On the other hand, the short spring rain occurs between March and May. But, during drought years, the area experiences only one short summer rainy season, which extends from the middle of June to the beginning of September.[21]

In addition, water pollution is more severe in the Abay Bishalo livelihood zone as the majority of households use rivers and springs sharing with their livestock. Especially during summer, springs and rivers are mixed with flood

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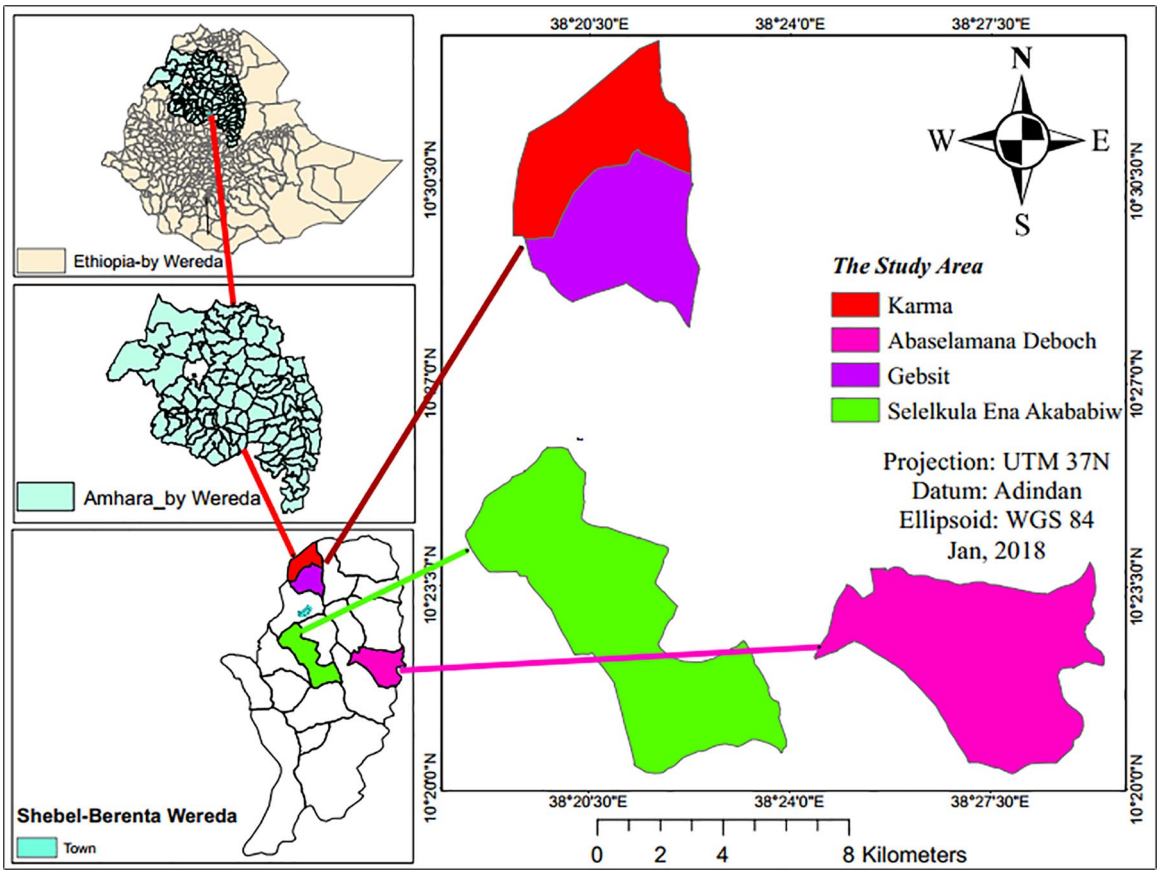


Figure 1. Location map of the study area (Shebel Berenta *District* and Selected *Kebeles*).

water, which is beyond the control of individual households. In the South *Woyina-Dega* Teff livelihoood zone, traditional hand dig wells face the same conditions even if these water sources are not usually devoted to drinking purpose even during dry seasons. So, water for home consumption may come from anywhere either of the sources installed by government or any development agents, but for how long such deliveries continue in the future.[19]

Despite, the rainfall is sufficient for good agriculture in the midland livelihood zone as opposed to that occur in the lowland or Abay Bishalo zone, where rainfall is highly erratic and unreliable even during summer season. Drought and seasonality that usually brought about hazards to the livelihood and water resources are stronger in the lowland than in otherwise. Thus, it has been realized that water unavailability and inaccessibility is a clear features in Abay Bishalo zone of the study area.[19,22] With regard to temperature, the same thing is happening to rainfall conditions where the lowland is hotter and warmer when compared to the midland agro-ecologies that enjoy mild or moderate temperature. The warmest and coldest months of the year are in May and January having the maximum and minimum temperature records of 29.8°C and 9.4°C, respectively. Thus, there is a variation in rainfall and temperature that greatly influences people's way of life and their economy including water availability to households.[19,21]

Demographics and socio-economic characteristics of the study area

Shebel Berenta *Woreda* has 26 Kebeles, of which 2 are urban and 24 rural *Kebeles* (Small administration unit) (Figure 1). The estimated total population of Shebel Berenta *Woreda* is 129,156: 61,640 males and 67,516 females. The total population, 11,271 (4955 Male; 44 %) and (6316 females; 56%) are urban dwellers and the remaining 117,885 (56,685 males; 48%) and (61,200 female; 52%) residing in the rural areas of the *Woreda*. The 32,589 rural households counted in this *Woreda*, consists of 22,839; 70% male-headed, and 9750; 30% female-headed households.[23] Agriculture is the mainstay of the district livelihood activities for rural residents characterized by subsistence crop production, mainly dependent on rainfall, which is erratic in nature; the dominantly traditional farming system results in low-crop yields.[19]

In addition, the improper land usage, mainly plowing of marginal areas (steep slopes and grasslands) and poor land treatment (poor SWC practices) aggravate the intensity of drought in Shebel Berenta *Woreda*. The chemical and physical properties of the soils of the cultivated and grazing lands, which covered up to 66% of the area, were found to be severely degraded. Hence, the degraded land retains little soil moisture leading to declining farm productivity and thus increasing risk of crop failure. These problems are likely to be even more serious in the future as long as measures are not being taken toward environmental

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rehabilitation.[21] Even if the *Woreda* has long boundary line with Abay river, economic gains from the river is limited to some households in the low-land livelihood zone as its deeper valley inhibit the irrigation agriculture. Thus, the only means of sustenance and source of income in the study area is farming, includes crop production and livestock herding. One or two crop domination is the main features of the local agriculture, which is another source of vulnerability to the poor households.[19]

In the study site, drought has an immediate and severe impact on aggregate agricultural production or socio-economic activities mainly on crop production and environment. These conditions lead to stagnation of economic growth, food insecurity, famine, resettlement and migration, or forcing the population to live with worsening situation.[21] To cope with the impacts of drought, farmers opted to lower food consumption, sale of livestock, and reduced socialization.[19,21] The available study by Rämi[20] also indicated that in 2002, it was judged to be one of the 4 chronically food-insecure *Woredas*' in this part of the Amhara region, due to much of their farmland being extremely depleted, deforested, and eroded. All physical and economic evidences shows that the study area is facing a complex set of problems ranging from rapid population growth and environmental degradation to drought, crop yield reduction, poverty, and food shortage.[18,21] Despite of this, the productive safety net program is still provided as preventive social protection. The governmental response strategies also included relief aid and resettlement, food-for-work programs, introducing drought resistant crops, soil conservation schemes, and on-farm water harvesting.[18,19,21]

Research method and design

The objective of this research demands both quantitative and qualitative data, and taking into account this rationale, the study has applied a mixed-research method. Principally, women have diverse experiences and practices in SWC, so their participation in SWC is determined by different demographic and socio-economic factors. Thus, the factors that determined their participation were assessed by the quantitative research method. Therefore, to examine these issues, mixed-research method was relevant to produce both statistical results and verbal results and to minimize some of the limitations of using single method. Moreover, the philosophy of pragmatism (ie, what works is what should be considered to be important to answer research questions) might be conducted concurrently (conducting both parts at roughly the same time) or sequentially (conducting one part first and the other second) to address a research questions.[24,25] Cognizance of this essence, sequential explanatory research design was employed for the purpose of addressing the research question.

Sampling techniques and sampling procedures. The rationale for the choice of Shebel Berenta *Woreda* is based on 2018 *Woreda* communication affairs reports stated the woreda has severe problems of low productivity of agriculture, food insecurity, and the continuous existence of drought due to severe soil erosion; it also needs an insight about sustainable SWC management. Thus, provide a clue about SWC is the best alternative to recover from the vulnerability and risks. Principally, based on the observations and experiences in the study area, there is a deep-rooted problem of ignoring women's SWC work decisions so there is a need to investigate the problems of women for further interventions. Here, women from both male- and female-headed household were used as the primary unit of analysis. The list of male-headed and female-headed households were obtained from each *Kebele* (small administration unit).

Multistage sampling is one of the sampling techniques choosing a sample from the random sampling schemes in multiple stages.[26] Hence, this research was employed multistage sampling technique to select sample women. In the first stage, stratified random sampling was employed to select rural Kebeles because the rural *Kebeles* of the study area are already categorized into 2 agro-ecological zones of *Woyina Dega* and *Kolla.* From these strata, 4 sample Kebeles (*Selelkula* and *Gebsit)* from *Woyina Dega*, while (*Karma* and *Abaselma ena Deboch*) Kebeles from *Kolla* were selected randomly of the total 26 rural *Kebeles* by taking agro-ecology into account. In the second stage, stratified random sampling technique was employed to select male- and female-headed households from each *Kebele*, considering there was a woman in the male-headed household. Proportional stratified random sampling was employed in accordance with the size of the *Kebele*. Each *Kebele*'s list of male- and female-headed households was used as the sample frame. Finally, systematic random sampling technique was applied to select sample women from each *Kebele* based on the lists obtained from the respective *Kebele*'s administration office.

Sample size and sample size determination. There are a number of strategies in determining a sample size including using a census for small populations, imitating a sample size of similar studies, using published tables, and using formulas to calculate a sample size. Among such strategies, the researcher used formula based on the real context of this study. In applying a formula, certain factors have to be considered to determine the appropriate sample size such as the level of precision, level of confidence or risk, and degree of variability in the attributes being measured in addition to the purpose of the study and population size.[27] Using formulas to calculate a sample size can provide a useful guide to determining the sample size of proportions.[28] As quoted by Amugune[28] and Singh and Masuku,[29] Cochran (1963) suggested the most commonly used formula for a questionnaire survey study, sample size determination when the population is large and the needed representative sample is to analyze proportion. Equation (1) can be applied as follows

$$n_0 = \frac{z^2 pq}{e^2}$$

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Table 1. The summary of sampled women by *Kebeles*.

SAMPLE *KEBELES*	STRATUM	NUMBER OF HOUSEHOLDS IN EACH *KEBELE*			NUMBER OF SAMPLE WOMEN TAKEN FROM EACH *KEBELE*		
		MALE HEADED	FEMALE HEADED	TOTAL	MALE-HEADED	FEMALE-HEADED	TOTAL
Selelkula ena Akababiw	Woyina-Dega	1396	736	2132	66	34	100
Gebsit	Woyina-Dega	846	523	1369	40	24	64
Karma	Kolla	508	217	725	24	10	34
Abbaslma ena Deboch	Kolla	975	480	1455	46	23	69
Total		3725	1956	5681	176	91	267

Source: Field survey, 2019.

where n_0 is the required numbers of sample, z is the value of the desired confidence level or confidence interval (95% = 1.96), e is the desired level of margin error or precision, p is estimated variability or proportion of an attribute in the population (50% = 0.5), and q is $1 - p$

Accordingly, it was decided to use 95% confidence level ($z = 1.96$), the maximum variability among the population (50%), and ±6% margin of error/precision to achieve the expected criteria.

Then, the results showed that $n_0 = ((1.96)^2 0.5(1–0.5))/(0.06)^2 = (3.8416 \times 0.5 \times 0.5) / 0.0036 = 266.77 \approx 267$ Therefore, the required sample size of this study was 267 women (in this study, 17 women did not respond their questionnaire so it was not used for further analysis). But, the question is how can these individuals be selected? Although with this method, each *Kebele* was fairly represented, proportional allocation of the sample have been made based on the size. This sample size was allotted to 4 *Kebeles* using proportionate stratified sampling formula. Through this equation, each *Kebele* was fairly represented as follows:

1. Sample size of Selelkula ena Akababiw = 2132 × 267/5681 = 100 women.
2. Sample size of Gebsit = 1369 × 267/5681 = 64 women.
3. Sample size of Karma = 725 × 267/5681 = 34 women.
4. Sample size of Aba Selma ena Deboch = 1455 × 267/5681 = 69 women.

As already mentioned, among the target population of 5681(women in male-headed and female-headed families), the researcher took 267 respondents as calculated based on the above formula. Finally, the required sample households were selected via systematic random sampling within each Kebele, based on the lists every ith element (ie, every 21st), until the required sample size was reached after the first respondents were selected randomly (see Table 1, in detail).

Qualitative research used for identifying and selecting individuals or groups of individuals that is knowledgeable/experienced with a phenomenon.[30] So, in this study, the participants for qualitative information were selected using purposive sampling for participants in interview and focus group discussion who had experiences in SWC and who work regularly throughout the year. The participants in FGDs were selected purposively in each *Kebele* in such a way because the researcher intended to hold one group discussion on each of *Kebele*. Accordingly, 7 key informants and 28 focus group discussants with 4 groups having 8 members and 6 members in 2 groups were taken to get required results. The selected key informant interviewees were individuals who have knowledge on the issues and specific expertise about the needed information. Hence, the informant interviewees were from agriculture and rural development officials, women and children affairs officials, and local administration officials from each selected *Kebeles* of Shebel Berenta *Woreda*.

Data sources and data collection instruments. This study used primary and secondary sources to obtain the necessary information. Hence, primary sources include survey respondents, key informants, and FGD participants. Secondary sources such as articles and annual reports that relate to the research problem or are in direct relation to this study were included. In line with this Kothari[31] indicates that using secondary data collecting and analyzing by someone else or written sources enables interpretation and recording of primary data. Questionnaire, interviews, key informant interviews, field observation, and FGD were the data collection instruments used to gather the primary data.

Data analysis techniques. In this study, both quantitative and qualitative data analysis techniques were employed. Accordingly, descriptive and inferential statistics were used to analyze the quantitative data. As Yong[32] noted, descriptive statistics used as a tool in any research that describes a setting or events in numerical terms for the sake of quantifying data to organize, summarize, or easily understand the information. Hence, for quantitative method, upon completion of the data collection, the data were coded, edited, and entered into the SPSS (Statistical Package for Social Science, version 20, IBM, USA), and

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then the data were analyzed through descriptive and inferential statistics. The analysis for the data gathered to the demographic and socio-economic characteristics were through descriptive statistics such as frequency and percentage distribution. Whereas, binary logistic regression model was used to examine the factors that determine the participation of women in SWC. It is a powerful statistical tool allowing us to determine the effect of independent variables on the dependent variable while holding any number of other independent variables constant. In relation to this, binary logistic regression is a form of regression used when the dependent variable is dichotomous or dummy and the independents are of any type.[33] Binary logistic regression is also planned for discrete dependent variable systems and to a number of independent variables.[34] It is called binary logistic regression model when the dependent variable is articulated in 2 categories and several categories of applying the explanatory variables.[35] Thus, the logistic regression model that was employed in this study is a binary logistic regression model, where the dependent variable is *Y* and independent one is *X*. To elucidate the model, the following logistic distribution function was employed[36-38]

$$Pi = \in\left(Y = \frac{1}{Xi}\right) = \frac{1}{1 + e^{-(\beta 1 + \beta 2 Xi)}} \tag{2}$$

In the logistic distribution equation, *Pi* is the independent variables, *X*i is the data, *i* is the possibility of a preference by an individual (option of having 1 and 0 values). When $\beta 1 + \beta 2Xi$ in equation (2) is replaced by *Zi*, equation (3) is obtained

$$Pi = \frac{1}{1 + e^{-Zi}} \tag{3}$$

Zi is between $-\infty$ and $+\infty$, and *Pi* is between 1 and 0. When *Pi* shows the possibility of participation in SWC, the possibility of this event's nonparticipant in SWC is $1 - Pi$.[39] Then, the probability of nonparticipant can be explained as in equation (4) as follows

$$1 - Pi = \frac{1}{1 + e^{Zi}}$$

Equation (4) is obtained by dividing the participant by nonparticipants (simply odds ratio)

$$\frac{Pi}{1 - Pi} = \frac{1 + e^{Zi}}{1 + e^{-Zi}} = e^{Zi} \tag{4}$$

where e^{Zi} is the irrational number *e*, raised to the power of *Zi*

When the natural logarithm of both sides of the equation is written, equation (5) is obtained

$$Li = \ln\left(\frac{Pi}{1 - Pi}\right) = Zi = \beta 1 + \beta 2 Xi \tag{5}$$

Thus, nonlinear logistic regression model is liberalized based on both its parameters and variables. "*L*" is called "logit" and models such as this called "logit models."[38] When there are more than one independent variables with one dependent variable, (*X*1, *X*2,. . ., *XK*), binary logistic regression model apply. In these situations, equation (2) is used for proper transformations

$$Pi = \in (Y = \frac{1}{Xi} = \frac{1}{1 + e^{-(\beta 1 + \beta 2 X1 + \beta 3 X2 + \ldots + \beta kXk)}} \tag{6}$$

Also, odds and odds ratio are significant terms in logit model. Odds ratio is defined as the ratio of the number of events that occurred to number of events that did not occur (Morgan and Teachman, 1988 cited in Menard).[40] "Odds ratio" on the other hand, is the ratio of 2 odds, in other words, the ratio of likelihood to another. In equation (4), 2 probabilities, participant, and nonparticipant probability of an event are proportioned, and this is the odds of proportion. It is important to understand that, possibility, odds, and logit concepts are 3 different ways of explaining the same thing.[40]

Z_i is a function of N-explanatory variables and expressed as

$$Zi = \beta 1 + \beta 2 X2i + \cdots + \beta \mathrm{n} X \mathrm{n} i \tag{7}$$

$\beta 1$ is the intercept and $\beta 2 \ldots \beta n$ are parameters.

The contingency coefficients are computed as:

$$CC = \sqrt{\frac{X^2}{N + X^2}} \tag{8}$$

where CC is the coefficient of contingency, χ^2 is the chi-square random variable, and N is the total sample size.

The values of the contingency coefficient implied that there was no multicollinearity problem among the explanatory dummy variables, that is, the decision rule value is less than 0.75. However, all the hypothesized explanatory variables were tested for the existence of multicollinearity problem before running the logistic regression model. The measure was done using contingency coefficients for testing association among dummy variables. Hence, CC is a chi-square-based measure of association. For that reason, chi-square test was used to examine the association of the categorical variables such as demographic factors, socio-economic factors, and institutional factors with the dependent variable. On the other hand, summarizing what was heard in the discussions words, phrases, or patterns were the major tasks accomplished in the qualitative data analysis. Hence, the information that collected through interviews, key informant's interviews, focus group discussions and field observations in relation to women's participation in SWC was analyzed textually to complement the statistical results from the structured questionnaire.

The model goodness-of-fit in the study

To know the model goodness of fit (GOF), it is imparative to examine the adequacy of the model before the estimated

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function becomes a permanent part of the decision-making apparatus.[41] Once a model has been developed, it is necessary how effective the model is in describing or denoting that the predictor variables select has a combined effect on the outcome variable. This is referred to as GOF. In this study, omnibus test was used to compute the fitness of predictor variables to outcome variable. The omnibus test of model coefficient had chi-square value of 117.401 with 13 degree of freedom and a highly significant at $P < .05$, that is, .000, denoting that the predictor variables selected had a combined effect on predicting the participation of women in SWC. The predictive efficiency of the model displayed that from all women included in the model, 93% respondents were correctly predicted. The sensitivity (correctly predicted participated women) and specificity (correctly predicted women not participated) were found to be 97% and 66%, respectively. Therefore, the model is effective in describing the outcome variable. The model summary demonstrated that (Pseudo $R^2 = 0.675$), which means that the outcome variable explained by 67% via independent variables. Hosmer and Lemeshow test was also employed to evaluate the adequacy of logistic regression model because this test is an approach used to evaluate model fitness or to compute a GOF statistics. The Hosmer and Lemeshow GOF had a chi-square value of 3.499 on 8 degree of freedom, and significant at $P > .05$, that is, .835, vindicated that logistic regression model has GOF.

These are formal tests of the null hypothesis that the fitted model is correct, and their output is a *p*-value; again a number between 0 and 1 with higher values indicating a better fit. In this case, however, a *p*-value below some specified alpha level (say, 0.05), indicates the model is not acceptable as Paul[42] indicated. If the Hosmer and Lemeshow GOF test statistic is 0.05 or less, we reject the null hypothesis since there is no difference between the observed and predicted values of the dependent; if it is greater as we want, we fail to reject the null hypothesis, there is no difference, implying that the model estimates fit the data at an acceptable level. It divides subjects into deciles based on predicted probabilities, and then computes a chi-square from observed and expected frequencies.[42,43]

Issues of reliability and validity, and ethical considerations

The researcher has conducted a pretest to assure the reliability of the study among 20 respondents before the execution of the actual study. This helps to avoid ambiguity of questions and to know the level of understanding among respondents. In addition, Chron-bach alpha was employed because it measures the internal consistency of the instrument or to test the reliability of the study. Therefore, the reliability of test statistics to women's participation on SWC indicates that the questions were reliable at Chron-bach alpha value of 0.816. For a solution to assuring the validity of the study, the researcher employed multiple sources of information, established a chain of evidences and had key informants' review reports, and submitted a copy of the questionnaires to the advisors to examine the items and content validity.

Experts also added some constructive ideas to improve the structured questionnaires and discussion guides, and avoid unnecessary content. Thus, some useless, repeated or redundant, and ambiguous items were omitted according to standards in terms of adequacy, structuring, and sequence of ideas. This study employed triangulation via data sources, a sound description to convey the findings and to complement statistical results with the qualitative part of the study. Generally, questions in the instruments were developed based on review of literature. The results of this study were interpreted in relation to the review of literatures for analytical generalization (Figure 2).

Regarding ethical concerns, the researcher has taken permission letters from the University of Gondar and administrator of the District. Negotiations were made with the participants and respondents for their permission to conduct discussions and fill questionnaires ethically. Hence, the ethical clearance was attached with cover page of the questionnaires to make clear about the purpose of the study and the data were handled confidentially. All participants were informed about their identity would remain anonymous in the study document. The researcher also paraphrased all literatures consulted in this study and acknowledged them properly.

Results and Discussions

Demographic and socio-economic characteristics of respondents in the study area

Regarding the age of respondents, the minimum age is 21 and maximum of 59 where the average age is 36. This implies a concentration of adults in the labor force. The data also show an average family size of 5 with a mean of 2 female and 3 male children (Table 2).

Marital status and status of household heads of the respondents in the study area. The marital status of women appears to motivate their participation in soil conservation activities. The survey results shows, majority of respondents (83%) were married women, while 2% were widows. The rest 4% and 11% of the respondents were single and divorced women respectively (Table 3). From this result, it can be concluded that majority of the respondents were married. The data from informant interview's affirmed that unmarried, divorced, and widowed women easily participate in SWC activities even though with no male counterpart and they have a heavier load. In the case of household head, majority of the respondents (64 %) were concentrated in male-headed households, while 36% were female-headed households (Table 3). The qualitative data also verified that majority of the respondents were male-headed rural households due to their marital status and decision-making power of male other than female counterpart.

Educational background of the respondents in the study area. From the results shown in Figure 3, majority of the respondents (52%)

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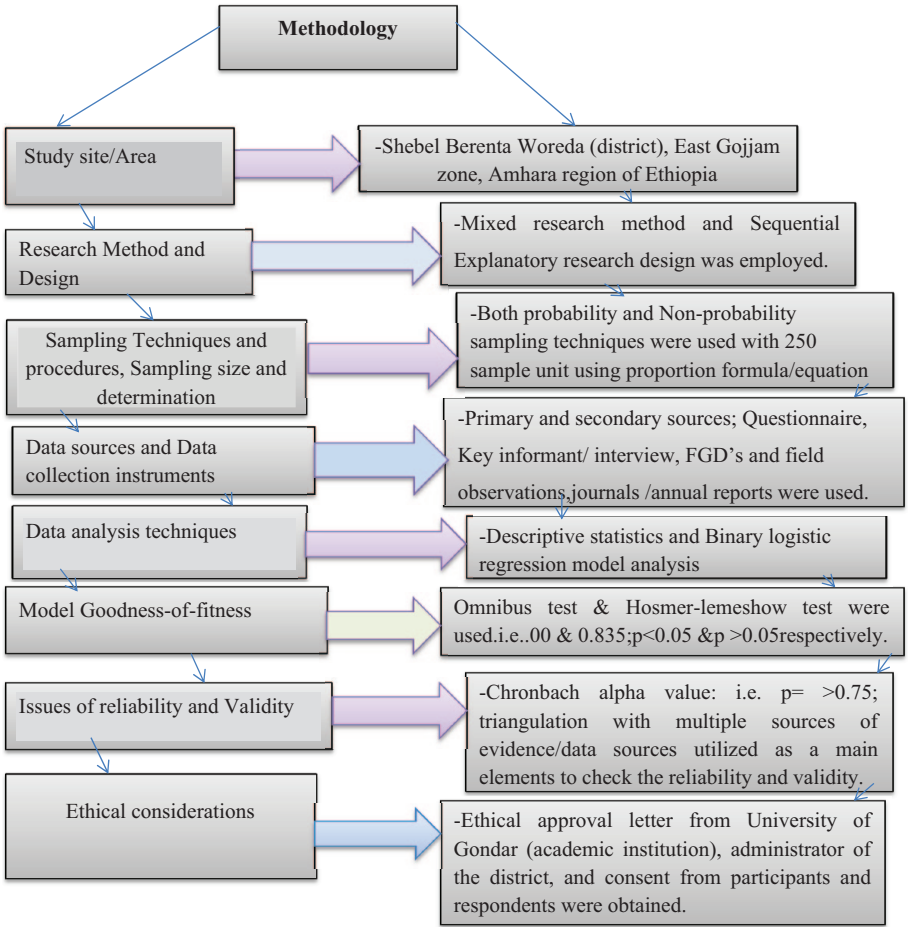


Figure 2. Summary of the methodology.
Source: Modified from Eyayu.[44]

Table 2. Age, number of male and female children, and family size of respondents in the study area (N=250).

	AGE OF THE RESPONDENTS	NUMBER OF MALE CHILDREN	NUMBER OF FEMALE CHILDREN	TOTAL FAMILY SIZE
Mean	36.1680	2.2000	2.5000	4.7040
Std. error of mean	0.63987	0.05525	0.07198	0.10013
Median	35.0000	2.0000	2.0000	5.0000
Mode	27.00	2.00	2.00	3.00
Std. Deviation	10.11717	.87353	1.13806	1.58316
Variance	102.357	.763	1.295	2.506
Range	38.00	6.00	5.00	9.00
Minimum	21.00	.00	.00	1.00
Maximum	59.00	6.00	5.00	10.00
Sum	9042.00	550.00	625.00	1176.00

Source: Obtained from survey data, 2019.

were illiterate, 7% could read and write, 31% had a primary education (1-8), and 10% had secondary education and above. Majority of the respondents were illiterate and faced difficulties to participate in soil conservation and land management tasks due to lack of awareness on how to conserve it. On the other hand, women with a primary and secondary education were involved in soil conservation tasks such as terracing, watershed protection, and preparing the traditional composition of wastes.

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Table 3. Respondents response to their marital status and household heads (N = 250).

VARIABLES	OPTIONS	FREQUENCY	PERCENT (%)
Marital status	Single	11	4.4
	Married	206	82.4
	Divorced	28	11.2
	Widowed	5	2.0
Status of household head	Male-headed	161	64.4
	Female-headed	89	35.6

Source: Obtained from survey data, 2019.

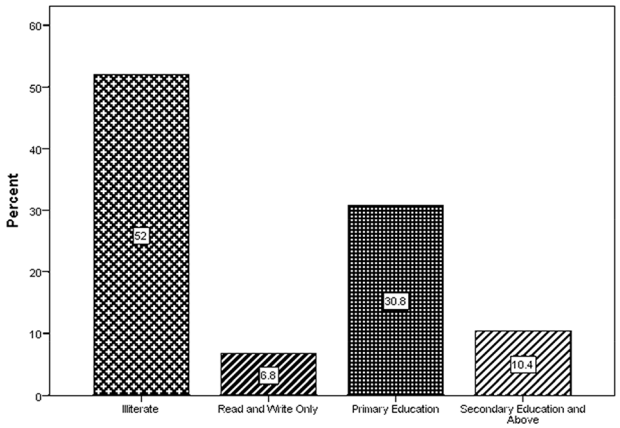


Figure 3. Respondents' response to their educational status in the study area (N = 250).
Source: Obtained from survey data, 2019.

This implies that illiteracy-constrained women to being involved in SWC activities, while literacy has helped to increase engagement in SWC to improve soil fertility and land management. To identify the association between educational level and women's participation in SWC, chi-square test was employed. The results showed a statistically significant association was observed between the educational level of women and their participation in SWC practices (= 67.312, *df* = 3, *P* = .000, *P* < .05). Consistently, the findings by Aryal and Zoebisch[45] show that educated women are more aware of land degradation and measures of conservation activities.

Access of land and its productivity in the study area. As it can be inferred from Table 4, 76% of the respondents had their own land for crop production to feed their families, while 24% did not. This majority could conserve their soil from erosion and floods and manage their land from desertification so as to improve soil fertility and agricultural productivity. The data also show 39% of respondents said their crop production was sufficient to support and feeding their family, while 61% did not have. About 1%, 12%, and 57% of the respondents have large family size, low soil fertility, and inadequate plot of land, respectively. The chi-square test result shows a statistically significant association among ownership of farming land, having sufficient production and women's participation in SWC (= 57.988, *df* = 1, *P* = .000, *P* < .05; = 15.661, *df* = 1, *P* = .000, *P* < .05), respectively. However, the results obtained by Bekele and Drake[10] show the current land tenure system is found to have little or no prohibitive effect on the conservation investment decision of farmers. As poor farmers generally possess less land, they are more often engaged in non/off-farm activities. This can decrease their interest to invest on SWC.[5,46]

Decision-making processes for participation of respondents in SWC. With relates to the decision-making process for the participation of women in SWC, half of the respondents (50%) were participated in SWC decisions, while 50% have no involvement.

The result also revealed, 98% of respondents said they believe that women play a key role to SWC, while 2% respondents have no assumption about their roles in SWC. Among those who had participated in SWC, 56%, 19%, and 43% were highly involved in terracing, vegetation cover, and compost/animal dung preparation as a part of SWC activities, respectively (Table 5). From the result, it can be seen that women from both female-headed and male-headed households play an immense role to SWC especially in terracing and animal dung preparation.

The chi-square value also showed, there is a significant association between participation in decision-making process and their participation in SWC with the value of (= 173.570, *df* = 1, *P* = .000, *P* < .05). In agreement with this result, an investigations elaborated by Yazdanbakhsh et al[4] and Ali and Kedru[47] demonstrated that indigenous soil conservation technologies such as contour plowing, manuring, crop rotation and residue, cut-off drains, and ditches are considered as an effective methods of conservation measures. Other authors also affirmed that hills, together with side terracing and check dams, were among the most frequently used physical structures for SWC.[5]

The findings of Mitiku et al[48] also considered terraces, soil (earth), and combined stone/earth bunds, and compost/manure application are among the types of SWC activities those implement in Ethiopia. On the other hand, the study elaborated by Mary et al,[49] the complexity of business and family arrangements on many farms, particularly farms where women play

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Table 4. Respondents' response to ownership of land and its productivity (N = 250).

VARIABLES	OPTIONS	FREQUENCY	PERCENTAGE (%)
Do you have your own farming land?	Yes	191	76.4
	No	59	23.6
Do you think your production is enough to support your family?	Yes	97	38.8
	No	153	61.2
[Reasons for not to have sufficient production] Large family size[a]	Yes	3	1.2
	No	150	60
Lower soil fertility[a]	Yes	18	11.5
	No	135	49.7
Inadequate sized plot of land[a]	Yes	142	56.8
	No	11	4.4

Source: Obtained from Survey data, 2019.
[a]Multiple responses were recorded.

Table 5. Respondents' response to decision-making roles and participation in SWC (N = 250).

VARIABLES	OPTIONS	FREQUENCY	PERCENTAGE (%)
Have you ever participated in decision making to soil and water conservation at household level or at public level?	Yes	126	50.4
	No	124	49.6
Do you think women play any role in land management and soil conservation activities?	Yes	246	98.4
	No	4	1.6
Terracing[a]	Yes	139	55.6
	No	109	43.6
Vegetation cover[a]	Yes	47	18.8
	No	201	80.4
Compost/animal dung preparation[a]	Yes	107	42.8
	No	141	56.4

Source: Obtained from survey data, 2019.
[a]Multiple responses were recorded.

significant roles, means that models which gather data on a single operator may not adequately capture the dynamics of conservation-related decisions. But comparatively, women try to apply in the most of cases of the best practices to conserve biodiversity and play a vital role in land conservation.[3]

The time frame/hours spent in SWC practices in the study area. As shown in Figure 4, majority of the respondents (72%) has spent from 3 to 4 h of their time in SWC, while 3% of the respondents spent only 2 up to 3 h per day. The study also found 13% and 12% of the respondents spent from 1 to 2 h and >4 h per day, respectively. This implies that majority of women have a double burden.

The chi-square result showed, a statistically significant association between the time frame and participation in SWC (=173.570, df=3, P=.000, P<.05). Consistently to this

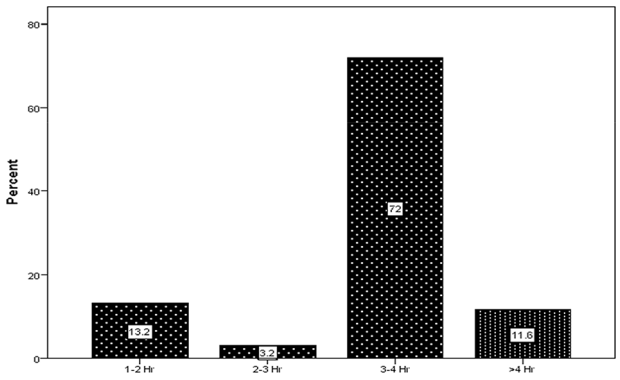


Figure 4. Respondents response to the hour spent in SWC practices in the study area (N = 250).
Source: Obtained from survey data, 2019.
SWC, soil and water conservation.

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Table 6. Respondents response to the existence of soil erosion, advice, and discussions to SWC in the study area (N = 250).

VARIABLES	OPTIONS	FREQUENCY	PERCENTAGE (%)
Is there a soil erosion or degradation in your locality?	Yes	243	97.2
	No	7	2.8
Do you perceive the problem of soil erosion on your farming land?	Yes	238	95.2
	No	12	4.8
Do you get an advice regarding soil and water conservation practices from extension agents or other concerned bodies?	Yes	177	70.8
	No	73	29.2
From whom did you hear about the impact of soil erosion?	Development Agents	48	19.2
	Agricultural Experts	177	70.8
	Other Farmers	24	9.4
	NGO'S	1	0.6
Have you ever discussed on soil and water conservation in women's local groups or associations like *Ekub, Iddir, Yelimat-Budn* etc?	Yes	156	62.4
	No	94	37.6

Source: Obtained from survey data, 2019.

finding, determined the time a woman spends on gathering fuel, fodder, and water as well as attending to household work, agricultural work, and animal care reduces her competence.[3] However Bekele and Drake[10] indicate the effect of women's participation in fieldwork activities of a farm is positively correlated. In contrast, women's involvement with natural resource management is not confined to agriculture; gender roles typically tie poor rural women far more than men to direct and regular use their time spent on natural resources.[17]

The existence of soil erosion and discussion of respondents about SWC in the study area. As Table 6 demonstrates, 97% of the respondents responded that the problem of soil erosion exists in their locality, while 3% did not exist. 95% of the respondents stipulate the problem of soil erosion has occurred in their own land, while 5% said it had not occurred. It is also demonstrated that 71% of the respondents obtained advice, while 29% did not obtain advice about SWC practices. About 19%, 71%, 9%, and 1% of the respondents obtained information, particularly about the impact of soil erosion from development agents, agricultural experts, farmers, and nongovernmental organizations (NGOs), respectively.

In addition, 62% of the respondents discussed about SWC in local institutions, while 38% were not involved in those discussions (Table 6). From this result, it can be concluded that the problem of soil erosion is severe both in locality (local residence) and their farming land. Similarly, eventhough the advice and information obtained from different concerned bodies; farmers themselves and NGOs have not shared their information about SWC.

The chi-square result shows a statistically significant association between perceiving the problem of soil erosion in their land and their participation in SWC ($=13.568$, $df=1$, $P=.000$, $P<.05$). Similarly, there is an association between getting an advice about SWC from stakeholders, being involved in discussions within local institutions and women's participation in SWC ($=50.802$, $df=1$, $P=.000$, $P<.05$; $=55.737$, $df=1$, $P=.000$, $P<.05$), respectively. These findings confirmed with the study of Birhanu and Meseret[50] who show the factors influence continued use of physical soil conservation measures were the perception of soil erosion problem. Soita[16] shows that rural women rely heavily on natural resources for the survival of their families; the deterioration of natural resource base is threatening rural livelihoods.

An interest, assumption, and participation of respondents in SWC in the study area. Regarding an assumption of controlling the problem of soil erosion, 99% of the respondents said the problem is controllable, while few of respondents (1%) said not controllable. Having this assumption, 97% of the respondents have an interest to control soil erosion via SWC, while 3% do not. Therefore, majority of the respondents (86%) has participated in SWC, while 14% have no involvement (Table 7). From this empirical evidence, we know that a significant number of women have participated in SWC through ambitious assumption/thinking, and an interest to reduce the problem of soil erosion for environmental sustainability.

Similarly, the chi-square test shows an association between an interest to control soil erosion via SWC and women's participation in SWC ($=50.767$, $df=1$, $P=.000$, $P<.05$). The

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Table 7. Respondent's response to their interest and assumption, and participation in SWC practices in the study area (N = 250).

VARIABLES	OPTIONS	FREQUENCY	PERCENTAGE (%)
Do you think that soil erosion can be controlled?	Yes	249	99.4
	No	1	0.6
Do you have an interest to control soil erosion via SWC practices?	Yes	242	96.8
	No	8	3.2
Do you frequently participate in soil and water conservation activities?	Yes	215	86
	No	35	14

Source: Obtained from Survey data, 2019.

study of Ali and Kedru[47] confirmed that due to the lack of vision and interest, poverty, awareness, and carelessness, the majority of farmers have not practiced conservation methods. The findings by Birhanu and Meseret[50] shows the major factors influencing continued use of physical soil conservation measures was the slope of the plot and the perception of soil erosion problem and profitability. A study of Bekele and Drake[10] also shows approximately 64% of the households that did not adopt conservation measures are those households where women are not involved in fieldwork activities, while 67% of the households where women are involved in field work activities. Generally, the results confirms, there is an invisible hand of women influencing conservation technology adoption by farmers in the male-dominated farming community; further studies are required to understand the specific mechanisms that influences and strengthen women's role in SWC efforts.

Determinants of women's participation in SWC: logistic regression model analysis

The binary logistic regression model was employed to establish the relationship between dependent (participation of women in SWC) and independent variables (demographic and socio-economic factors) affecting women's participation in SWC in the study area.

For that reason, 9 explanatory variables were selected to explain the dependent variable. However, 7 independent variables (widowed marital status category, read and write only, secondary education and above educational level, access of own farming land, existence of soil erosion in their land, discussion about SWC practices, and obtaining advice from concerned bodies about SWC) were determinant factors influences the dependent variable.

Accordingly, the logit model analysis indicates that is being other variable remain constant, there is less probability of widow's participation in SWC activities when compared with those who are unmarried. As the binary logistic regression result shows, the probability of participation of widowed women in SWC decreased by the odds ratio of 0.023 than unmarried women since the result has statistically significant relation at $P < .05$ in all cases. Hence, widowed women had a negative relationship to SWC participation decisions. The result implies the marital status of women has a statistically significant relationship to probability of participation in SWC. Nevertheless, previous studies focus on the aggregate household probability of participation in SWC rather than women's participation; overlooked each marital status in SWC. Comparatively, a study of Zitta et al[51] showed women have participated actively in environmental protection to ensure sustainable use of environmental resources. But, their findings did not identify which marital status is more or less likely to participate in SWC in comparative ways.

The binary logistic regression model result also demonstrates that women with an educational level of read and write only, and secondary education and above when compared with illiterate, their participation in SWC decreased by the odds ratio of 0.164 and 0.139, respectively. The result was statistically significant at $P < .05$, with alpha value of .049 and .035. This means that, women have formal education are more likely participate than those who do not have formal education. Hence, women with an educational level of read and write, and secondary education or above have a significant positive relationship to participate in SWC.

This result is confirmed with the findings by Aryal and Zoebisch,[45] which show women without formal education usually have excellent practical knowledge and experiences in all aspects of land management. Here, women without school education use to obtain their local knowledge principally from older women and by practical experiences. The result is inconsistent with the findings of Soita,[16] who shows that the population pressure and lack of awareness makes rural women tend to exploit land, water, and forest resources without considering the needs of future generations. However, the result of Dilebo,[52] confirmed that, education level of houdsehold heads and training participation were found significantly affecting adoption decision of farmers to SWC practices.

The logistic regression model result reveals, when other variables remain constant, women without their own farming land when compared with those having their own farming land, the probability of participation into SWC decreased by the odds ratio of 0.263. The result was statistically significant at $P < .05$; .044 in all cases. Meaning that women with their

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Table 8. Determinant variables of women's participation in SWC in the study area.

VARIABLES	CATEGORIES	ß	S.E	WALD	SIG	ODDS RATIO
Marital status	Unmarried **(RC)**					
	Married	–3.204	1.737	3.402	.065^{ns}	.041
	Divorced	–1.689	1.443	1.371	.242^{ns}	.185
	Widowed	–3.773	1.820	4.299	.038*	.023
Educational level	Illiterate **(RC)**					
	Can read and write	–1.806	.919	3.864	.049*	.164
	Primary education	–1.039	1.028	1.021	.312 ^{ns}	.354
	Secondary and above	–1.972	.937	4.426	.035*	.139
Status of head of household	Male headed **(RC)** Female headed	.674	.669	1.015	.314^{ns}	1.962
Access of own farming land	Yes **(RC)** No	–1.337	.663	4.060	.044*	.263
Sufficient production	Yes **(RC)** No	–.861	.825	1.090	.296^{ns}	.423
Soil Erosion in locality	Yes **(RC)** No	18.940	12,885.731	.000	.999 ^{ns}	168,162,270.373
Soil Erosion in their land	Yes **(RC)** No	–3.157	.990	10.164	.001*	.043
Discussion on SWC	Yes (RC) No	–1.949	.970	4.041	.044*	.142
Advice from Agricultural Agents/others	Yes (RC) No	–1.931	.799	5.847	.016*	.145
Constant		–12.353	12,885.731	.000	.999	.000

Source: Survey data, 2018.
^{ns}not significant; RC, Reference Category; SWC, soil and water conservation.
*Significant at .05.

own farming land are more likely to participate in SWC than who do not have farming land by 4.4%. In correspondence with this result, the finding of Ofgeha[53] indicates the important factors affecting communities' acceptance, and adoption of SWC includes the small size of agricultural land and farming production, lack of financial and material disappointments with local leaders. Confirmingly Ofgeha[53] pointed out that land ownership certificate significantly determines the decisions of farmers for SWC activities. In contrast, in Western Uganda, farmers adopted the use of structural SWC measures only after land registration program, while in Kenya (Kisii, Vihiga, and larger part of central Kenya highlands), land tenure problems are more common in continuously fragmented lands, resulting in low adoption of soil conservation techniques.[46,54]

The analysis also shows that when other variables remain constant, women with no soil erosion on their land are less probable to practice SWC as compared to the existence of soil erosion event in their land. As binary logistic regression model result revealed, the probability of participation of women with no soil erosion to SWC decreased by the odds ratio of 0.043 than women vulnerable to soil erosion because the result has a statistically significant relationship with the value of 0.001; has significant at $P < .05$ in all cases. Therefore, the existence of soil erosion is statistically significant to the participation of women in SWC work decisions.

The result is in agreement with Bekele and Drake,[10] findings, which indicates that due to their role in households such as childcare, cooking food, woods for fuel and fetching water, women feels more responsible for the availability of food for families. Hence, the exposure of women to the problem of soil erosion may improve the perception of the whole household to the problem and thereby influence the decision-making process. This result is also consistent with the works of Ali and Kedru,[47] which shows people in the uplands are not vulnerable to soil erosion, they do not actively participate in SWC, especially females and poor farmers (Table 8).

Concerning the discussion among women on the issues of soil erosion, women with no involvement in discussions about SWC issues in local institutions show less probability of participation in SWC than those women involved in discussions. As binary logistic regression model analysis shows, women with no involvement in the issues of SWC have a value of

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(ß = −1.949; P = .044; odds ratio = .142) have a statistically significant relationship to participate in SWC. This implies that women who actively involved in discussions, meetings, and different community dialogues are more likely to participate in SWC by 14.2% than those not involved in discussions at all. Consistent with this study finding, Ali and Kedru[47] show traditional administration and discussions in social institutions plays essential role in maintaining strong social linkage and cooperative labor environment in SWC practices. It is also confirmed by Bekele and Drake.[10]

Finally, concerned with access of advice and information about SWC practices, women who have no access to advice and information had less probability of participation in SWC than women with access. As logistic regression model analysis revealed, the odds ratio of women with no access to advice decreased their probability of participation by 0.145 than women with access. Meaning that, the absence of advice and training constrained their involvement in SWC. The result has a statistically significant association at $P < .05$, with a value of .16. Hence, access to advice from concerned bodies has a statistically significant relationship to the participation in SWC in the study area. Consistent with this finding, the study of Dilebo,[52] affirmed that extension contact significantly affects the decisions for SWC practices. A study from Southern Italy also noted that the adoption of soil conservation practices is promoted by increasing engagement between researchers and stakeholders or concerned bodies.[55-57] Women with better access to extension have a better understanding of modern technologies to SWC practices.[45]

This result is inconsistent with the findings by Ali and Kedru,[47] who show a significant number of farmers did not perceive and were not aware of the effectiveness of indigenous SWC measures and the practices of mulching, mixing, and strip-cropping. Most of the farmers benefit and practices the structures of soil (stone) bunds, and some artificial water ways very well in their farming and grazing plots as effective and efficient ways for recovering soil fertility, increasing productivity, and to decrease the magnitude of soil erosion. However, consistent with this result, the findings of Ahmed[58] show that practicing these structures has many advantages to proper structural conservation actions and an ability of increasing the farmers' level of awareness on the importance of conservation structures through agricultural extension and training services is a prerequisite to SWC practices.

Conclusion

The intersectionality of gender and environment is still lacking an attention in developing countries, especially in Sub-Saharan Africa to achieve both gender equality and environmental sustainability of SDG-II. Therefore, even though women play the lion's share roles in environmental management, the determinant factors for the participation of women's in SWC activities in Ethiopia is still overlooked. Having this rationale this study magnifies the determinant variables of participation in SWC in north-west parts of rural Ethiopia. Regarding the participation of women in SWC, majority of the respondents (86%) had participated in SWC practices, while 14% of them had no any involvement in SWC practices in the study area. It can be concluded that a significant number of women participated in SWC through ambitious assumption/thinking and interest to reduce the problem of soil erosion and land degradation for environmental sustainability.

In addition, half of respondents (50 %) had participated in decision-making processes in SWC activities, while 50% had no involvement. The survey result also reveals 98% of the respondents disclosed, they believe women play a paramount role in SWC, while 2% of the respondents have no assumed roles in SWC. Among those who participated in SWC, 56%, 19%, and 43% were highly involved in terracing, vegetation cover, and compost/animal dung preparation as a part of SWC activities respectively. From the result, it can be deduced that women from both female- and male-headed households play an immense role in SWC for sustainable environment through conservation of soils and water resources. The binary logistic regression model analysis shows, the marital status of women, their educational level, access to their own farming land, existence of soil erosion on their land, involvement in discussions about SWC, and obtaining advice from concerned bodies about SWC were the determinant factors influencing the participation of women in SWC practices in Shebel Berenta *Woreda.* The unique finding of this study is that both women from male- and female-headed households were considered as a unit of analysis; their marital status and access to and ownership of farming land are the major significant variables that determine their participation in SWC practices. Further studies should be conducted on women's challenges and its copying strategies, and opportunities in SWC practices. It should be also undertaken on each marital status of women and their participation in SWC since all women have no similar socio-economic characteristics for sustaining environment in the study area.

Recommendations

The findings of this study show participation of women in SWC activities was high even though different factors influences their participation for proper land management activities. Hence, based on the findings, the following points are forwarded assuming they can be important inputs for government and NGOs:

- The government and institutions should provide appropriate support for women in SWC; there is no required institutional or governmental support to help SWC practices with technology and working materials.
- The administrative officials and experts should provide awareness transference and adequate education for women concerning environmental conservation, soil fertility, and

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land management activities; not only for women, but also to all rural dweller's about SWC activities in the study area.

➢ Agricultural experts and other concerned bodies should provide enough technology for SWC practices to raise the use of technology and increase the available fertile land.

➢ The government should fix the time spent in SWC and should strengthen the dialogues and discussions covering the issues of SWC to reduce the problems of cultural influences, socio-economic factors, and infrastructural problems.

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Author Contributions

EKB is the only contributor to the proposal development and analysis of the article. EK facilitated the data collection processes of the manuscript in the study area and conducted the analysis and interpretation of the manuscript. The author also conducted the selection of available studies for systematic review, drafted the first structure of the study, read and wrote based on the guidelines and the standards of the journals. Finally, all procedures and tasks throughout the development of the manuscript have been carried out by the author solely.

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