Dimensions of Food Insecurity and Adoption of Soil Conservation Technology in Rural Areas of Gursum District, Eastern Ethiopia

Abebaw Shimeles[1,2]*, Penporn Janekarnkij[2] and Vute Wangwacharakul[2]

ABSTRACT

Defining food security in terms of availability and access to sufficient food to meet dietary needs for a productive and healthy life, this paper assessed the dimensions of food insecurity and its association with the adoption of soil conservation technologies in the Gursum district of Eastern Ethiopia. Stratified random sampling was employed to select 280 rural households, from which primary data were acquired by means of structured questionnaires.

This study applied the Foster, Greer and Thorbecke (FGT) model, which was originally developed for poverty analysis, to examine the incidence of food insecurity, and the food insecurity gap and severity of food insecurity. Sixty seven percent of the total sampled households adopted structural soil conservation measures. Of those who were adopters, 43 percent and 57 percent undertook traditional and introduced soil conservation measures, respectively. The results indicated that almost 66 percent of the sampled households were food insecure during the survey period, with the food insecurity gap and severity of food insecurity being 27 and 14 percent, respectively. Moreover, food insecurity was also found to be significantly higher in households that were non-adopters of soil conservation measures.

Keywords: food insecurity, soil conservation, technology adoption, Gursum district, Ethiopia

บทคัดย่อ

จากนิยามของความมั่นคงด้านอาหาร ในมิติของการมีอาหารและการเข้าถึงอาหารเพื่อการบริโภคในระดับที่เพียงพอต่อความต้องการด้านโภชนาการเพื่อชีวิตและสุขภาพที่ดี บทความนี้ประเมินความไม่มั่นคงด้านอาหารซึ่งมีความเชื่อมโยงกับกิจกรรมการอนุรักษ์ดินของครัวเรือนชนบท ในตำบลเจอร์ซัม ซึ่งอยู่ทางตะวันออกของประเทศเอธิโอเปีย ใช้วิธีการสุ่มตัวอย่างแบบจัดชั้นจำนวน 280 ครัวเรือน

การศึกษาครั้งนี้ใช้แบบจำลอง Foster, Greer and Thorbecke (FGT) ซึ่งเดิมพัฒนาเพื่อการวิเคราะห์ความยากจน มาประยุกต์เพื่อวิเคราะห์ความไม่มั่นคงด้านอาหาร ช่องว่างของความไม่มั่นคงด้านอาหาร และความรุนแรงของความไม่มั่นคงด้านอาหาร พบว่าร้อยละ 67 ของครัวเรือนตัวอย่างมีการใช้เทคนิคการอนุรักษ์ดิน จากครัวเรือนดังกล่าว ร้อยละ 43 ใช้เทคนิคการอนุรักษ์ดินแบบดั้งเดิม และร้อยละ 57 ใช้เทคนิคการอนุรักษ์ดินที่ได้รับการส่งเสริม จากจำนวนครัวเรือนทั้งหมดพบว่ามีความไม่มั่นคงด้าน

[1] Somali Region Pastoral and Agro-pastoral Research Institute, Somali Region, P.O. Box 398, Jijiga, Ethiopia.

[2] Department of Agricultural and Resource Economics, Faculty of Economics, Kasetsart University, Bangkok 10900, Thailand.

* Corresponding author, e-mail: shabebaw@yahoo.com, shabebaw@gmail.com

อาหารร้อยละ 66 โดยมีช่องว่างความไม่มั่นคงด้านอาหารร้อยละ 27 และมีร้อยละ 14 ที่มีความไม่มั่นคงด้านอาหารในระดับรุนแรง นอกจากนี้พบว่าความไม่มั่นคงด้านอาหารพบในครัวเรือนที่ไม่ทำกิจกรรมการอนุรักษ์ดินเป็นสัดส่วนสูงอย่างมีนัยสำคัญ

คำสำคัญ: ความมั่นคงด้านอาหาร การอนุรักษ์ดิน การยอมรับเทคโนโลยี ตำบลเจอร์ซัม ประเทศเอธิโอเปีย

INTRODUCTION

Land degradation is defined as a long-term decline in ecosystem function and productivity. It is one of the fundamental problems confronting sub-Saharan Africa in its efforts to increase agricultural production, reduce poverty and alleviate food insecurity (Bogale, 2002). It has been referred to as a "quiet crisis and a creeping catastrophe", because it is not generally apparent to the farmers and policy makers, until much of the damage has occurred (Bogale, 2002). By the time the symptoms are visible, it is often too late to tackle the underlying causes.

In today's world, the degradation of land has become an alarming global environmental problem threatening sustainable development and food security in most developing countries. Unfortunately, many conservation programs designed to redress this problem in the traditional agricultural sector have fallen far short of expectations. Findings (for example Lapar and Pandey, 1999; Bekele and Drake, 2003; Anley *et al.*, 2007; Batiwaritu and Mvena, 2009) have shown that despite the availability of a number of potential soil and water management technologies, adoption by farmers was still very low. This has been due to complex socio-economic and demographic factors that have affected the choice of land and water technology investments to improve food security.

Soil erosion coupled with growing populations, falling per capita food production, worsening poverty, and loss of productive land due to land degradation undermines rural livelihoods and national food security (Shiferaw and Holden, 1999). Hence, strategies to cope with and redress land degradation may be adopted at various levels. These include strategies undertaken at the level of individual land users, communities, and governments. Moreover, collective strategies integrate efforts of these different levels by creating institutions to link livelihood strategies at the household level, and to enhance or maintain soil productivity and food security (Bogale, 2002).

Even today, Ethiopia's food self-sufficiency ratio, as measured by the extent of food demand met from domestic production, remains below one. The World Bank, the Food and Agriculture Organization of the United Nations, and the US Agency for International Development define *food security* as *access* by all people at all times to sufficient food to meet dietary needs for a productive and healthy life (USAID, 1992). However, the country cannot provide this right to all of its citizens yet.

According to Devereux (2000), current conventional wisdom on food insecurity in Ethiopia asserts that the problem can be conceptualized simply. To begin with, landholdings are too small to allow most farming households to achieve food production self-sufficiency. Population increase reduces landholdings further and places intolerable stress on an already fragile, natural resource base (Devereux, 2000; Bogale, 2002). Soil fertility, already very low, is declining due to intensive cultivation and limited application of yield-enhancing inputs (Devereux, 2000; Enquobahrie, 2004). Recurrent droughts add food production shocks to abnormally low yields. Further, limited off-farm employment opportunities restrict diversification and migration options, leaving people trapped in increasingly unviable agriculture (Devereux, 2000; Enquobahrie, 2004).

In Ethiopia, an exact estimation of the national incidence of food insecurity is very difficult because food production and population statistics in Ethiopia are notoriously unreliable; all estimates of national food availability and consumption requirements are 'guesstimates' at best (Devereux, 2000). During the late 1980s, 52 percent of Ethiopia's

population consumed less than the recommended daily allowance of 2,100 kcal, but in the record harvest year of 1995/96 this proportion fell only to 43 percent (Clay *et al.*, 1999). This figure approximates the 40 percent of rural households who farm less than 0.5 ha, which is inadequate to meet subsistence food needs, even in good rainfall years.

The study was carried out in the rural areas of Gursum district, Eastern Ethiopia, which is situated in the north eastern part of the East Harerge zone of Oromia regional state and covers an estimated area of 88,900 ha under various land uses. According to the report from the District Disaster Prevention and Preparedness Office (DPPO) in 2007, 25.7 percent (22,847 ha) of this area was under cultivation and a further 17 percent (15,113 ha) was grazing land. Forest, bushes, and shrubs account for 21 percent (18,669 ha) and the remaining was classified as settlement area. However, according to the same source, 48 percent of the total land area is degraded. Application of manure, fertilizers, crop rotation and short fallowing methods are not exercised extensively in the district. To counteract the effect of soil degradation, farmers use structural Soil Censervation (SC) measures, yet, the annual agricultural production is not sufficient to cover the annual food needs of the district. For example in 2007, the agricultural production was about 18,829 tonne which fell short of the 49,117.6 tonne needed in that year to meet demand. The district is one of the food deficit districts of the region. In about 6-9 months of any given year, households depend on food handouts. Furthermore, the situation in Ethiopia is not an exception.

Under such a situation, an understanding of the dimensions of food insecurity and its association with SC can provide pertinent information to enable successful food security programs. This knowledge can also inform development practitioners and policy makers to better target interventions that mitigate the severity of the problem in the rural area at large. This study was undertaken with the specific objectives of estimating the food insecurity gap and its severity, and examined its association with SC among rural households in Gursum district. It is hypothesized that those who adopt SC are in a better position with regard to food consumption than non-adopters.

RESEARCH METHODS

Data collection

An in-depth household survey was undertaken to collect data on the dimensions of food security and SC activities. The study adapted purposive and stratified random sampling procedures with the rural households as the ultimate sampling unit for acquiring primary data. Sample units were defined by stratifying Gursum district into three fairly homogenous agro-ecologies (highland, midland, and lowland). The Peasant Associations (PAs) found in the highland and midland agro-ecologies became potential candidates from which to draw the sample units. Then, four PAs were selected from the two agro-ecologies, two from each, purposefully based on the level of land degradation, SC activities, and accessibility to the PAs. The households were drawn randomly from the four selected PAs in numbers proportional to the population size of the PAs. In total, 280 households were selected and interviewed. The household surveys were carried out between December 2009 and March 2010.

In the process of data collection, key informant interviews and focus group discussions were conducted first, followed by the household surveys. The discussions were undertaken using a checklist, mainly to identify SC technologies found in the study area. A structured survey questionnaire for the household survey was prepared and pre-tested. The primary data collected included demographic characteristics, crop and livestock production, farming systems, productive resources, access to rural financial services, and land use and management, as well as livelihood strategies employed by the sampled household.

Measuring food security

The major food types used in the study district are cereals, pulses and oil seeds. Animal products, fruits and vegetables are rarely consumed by farming households in this area. The common ways of acquiring food in this district are own-farm production and purchase from markets. Other ways of acquiring food include gifts, food loans and food aid from the United Nations World Food Program (WFP). As already indicated in the previous section, the district has a food deficit and storing food for carry over to the following year is a rare phenomenon.

In line with the definition of food security given in the previous section, in this study, *food security* was defined as *access* by all people at all times to sufficient food to meet dietary needs for a productive and healthy life.

Food security in this study was measured in three steps. Firstly, the food supply at the household level was determined by compiling a Food Balance Sheet for each sampled household. The variables entered the Balance Sheet as additions to or subtractions from the production of grain at the household level, with additions being grain purchases (+), grain received as gifts (+), grain borrowed (+), and grain received from hiring out of labor (+), while subtractions were post harvest grain losses (-), cereals used for seed (-), cereals given out for hiring in labor (-), repayment of crop borrowings (-), and grain marketed (-). Then, the available grain was converted to total calories available to each household using the food consumption table for Ethiopia (EHNRI, 1997).

Secondly, the food supply at the household level calculated in step one was used to calculate the calories available per kilogram per adult equivalent (AE) per day for each household. Units of measurement were standardized and conversion factors were used to compute AE. The calculation of AE for food consumption takes into account the age and sex of the household members, as described by Gassmann and Behrendt (2006). Accordingly, adult males aged 19-59 were given a weighting of 1.0 and women of the same age were weighted by 0.88. Weightings for children varied according to age, from 0.4 to 0.80 for boys and 0.4 to 0.88 for girls. The weights assigned to male youths aged 13-18 varied from 1.0 to 1.2, while females of the same age were assigned a weight of 1.0. Older persons were weighted as 0.80 for men and 0.72 for women. The government of Ethiopia has set the minimum acceptable weighted average food requirement per AE per day at 2,100 kcal (Kifle and Yosef, 1999; FDRE, 2001; MoFED 2002). Therefore, in this study 2,100 kcal per AE per day was employed as a cut-off value between food-secure and food-insecure households. Thus, households whose per AE household food energy was below the minimum subsistence requirement of 2,100 kcal, were deemed to be food insecure, and those households who managed to attain at least 2,100 kcal per AE per day were considered to be food-secure households.

Household factors, such as number of people, age of the household head, dependency ratio, and land to labor ratio were considered as determining factors of the dimensions of food insecurity. The dependency ratio of a household was calculated as the ratio of the number of individuals aged less than 15 years plus those greater than 65 years to productive individuals aged between 15 and 65 years within the household. Calculation of person-day equivalents for agricultural labor contribution took into account the sex and age of the household members and conversion factors were used, as described by Johnson (1982), Ruthenberg (1983), Nair (1985) and cited in Bogale (2002). Accordingly, males aged 17-50 were given a weight of 1.0 and women of the same age were weighted by 0.80. Weightings for children varied according to age, from 0.20-0.50 for boys and 0.20-0.40 for girls. Younger children below the age of 10 were weighted as 0.0, whereas older persons greater than the age of 50 where weighted as 0.70 for men and 0.50 for women. The land to labor ratio for the household was calculated as a ratio of cultivated land size to person-day equivalents of the household.

Analytical tool

Among the various measures of poverty that have been developed, the Foster-Greer-Thorbecke (FGT) class of poverty index is the most commonly applied (Bogale, 2002). This index was suggested initially by Foster *et al.* (1984) and has several desirable properties that have been enhanced in recent years for the purpose of food-insecurity analysis (Hoddinott, 2001; Shimelis and Bogale, 2007). The FGT index was used in the present study to estimate the food-insecurity gap and its severity among rural households classified as SC technology adopters and non-adopters.

The FGT index can be expressed as Equation 1:

$$F(\alpha) = \frac{1}{n}\sum_{i=1}^{q}\left[\frac{(m-y_i)}{m}\right]^{\alpha} \quad (1)$$

$$= \frac{1}{n}\left[\frac{(m-y_1)^{\alpha}}{m}+\frac{(m-y_2)^{\alpha}}{m}+\ldots+\frac{(m-y_n)^{\alpha}}{m}\right]$$

where: n is the number of sampled households;

q is the number of food-insecure households;

m is the cut-off between food security and food insecurity (expressed here in terms of calorie requirement);

y_i is the food calorie intake per AE of the i^{th} household; and

α is the weight attached to the severity of food insecurity.

Thus, if $m < y_i$, the household is food secure, and if $m > y_i$, the household is food insecure, and if $\alpha=0$ then $F(\alpha)=q/n$. In the equation, $(m-y_i) = 0$ if $y_i > m$. That means, we consider $(m-y_i) = 0$ when the household has enough food energy and it is food secure.

Hoddinott (2001) and Shimelis and Bogale (2007) explained that giving no weight to the severity of food insecurity is equivalent to assuming that $\alpha = 0$. The formula then collapses to $F(\alpha = 0) = q/n$, which is called the 'head count ratio'. This ratio measures the incidence of food insecurity and shows the proportion of households below the defined subsistence level (2,100 kcal). It does not indicate the depth of food insecurity, nor does it indicate whether the food insecure households are only slightly below the subsistence requirement level or whether their consumption falls substantially short of this.

Giving equal weight to the severity of food insecurity among the food-insecure households is equivalent to assuming that $\alpha = 1$. So, to measure the food insecurity gap, summing the numerator, $\sum_{i=1}^{q}(m-y_i)$, gives the food insecurity gap: dividing this by *m* expresses the figure as a ratio. This index, $F(\alpha = 1)$, allows estimation of the resource required to eliminate food insecurity through proper targeting. That is, the product $(n \times m \times F_i)$ gives the total calorie commitment needed to bring the food-insecure households to the minimum daily level.

The weight attached to the severity of food insecurity can be greater than one. The most common approach in poverty and food insecurity literature is to set $\alpha = 2$ (Hoddinott, 2001). This index of severity, $F(\alpha = 2)$, gives greater attention to the most food-insecure households by weighting them according to the square of their shortfall below the subsistence level. After measuring the extent of food insecurity, it can be verified whether there is a statistical difference between adopters and non-adopters of SC measures.

Adoption of SC measures and household factors were expected to determine the dimensions of food insecurity in the study area. Adopters in this study were defined as households that had established soil bund conservation structures, namely a level bund, in at least one parcel of their farm. Further, households with the adoption of traditional and introduced soil bunds were treated separately to determine the dimension of food insecurity.

RESULTS AND DISCUSSION

Demographic characteristics

Food security concerns in rural households depend to a large extent on the size and age structure of the household. The number of household members capable of contributing to food production or who

can be employed in non-farm income earning activities determined the household's own production and its capacity to acquire food.

Summary statistics of basic demographic characteristics of sample households presented in Table 1 reveal that the overall mean household size was 6.26 members, composed of 2.35 children up to 14 years old, 3.81 adults between 15 and 64 years old, and 0.09 elders more than 64 years old. The household size of food-insecure households sampled was on average 6.73 persons, whereas in the food-secure households, it was 5.33 persons per household. A t-test confirmed that there was a statistically significant difference in the means between the two groups ($p < .01$).

Incidence of food insecurity

The association between household factors and food insecurity was examined by comparing the incidence of food insecurity among household groups with different characteristics (Table 2). The prevalence of food insecurity among households with nine or more members was more than 6.5 times that of households with less than three members. The incidence of food insecurity was found to be positively related with the age of the household head: the incidence was 1.9 times higher in households with a household head aged 60 or more than in households with a household head younger than 30. The incidence of food insecurity also increased as the proportion of children and elders increased in the household. Almost all households with a dependency ratio greater than three were found to be food insecure, with an incidence of 1.6 times more than that of households with a dependency ratio less than one.

Table 1 Demographic characteristic of sampled households

(n=280)

Household demographic characteristics		Food security status		
		Food secure	Food insecure	
Total number of sampled households		94	186	
a. Household size (person)	Mean	5.33	6.73	6.26
	SD	1.96	1.69	1.89
t-value of mean difference			-6.102***	
b. Age of household head (years)	Mean	37.94	42.27	40.82
	SD	9	10	9.84
t-value of mean difference			-3.556***	
c. Dependency ratio	Mean	1.1	1.35	1.26
	SD	0.78	0.93	0.89
t-value of mean difference			-2.262**	
d. Household composition-person per age group		% total	% total	Ratio
			.....mean members.....	
< 7		0.96	1.13	1.08
7-14		1.73	2.27	1.27
15-25		1.11	1.35	2.09
26-45		1.33	1.41	1.38
46-64		0.18	0.41	0.34
> 64		0.03	0.11	0.09

*** = $p < .01$; ** = $p < .05$. SD = standard deviation.

Source: Household survey results, 2009.

The findings of this study (Table 2) related to household factors (household size, age of household head, and dependency ratio) were consistent and in agreement with the findings of Shimelis and Bogale (2007) and Hailu and Regassa (2007). In line with these studies, the positive relationship of age of household and risk of food insecurity reflects the situation in rural Ethiopia. In Ethiopia, households with a household head in the lower age brackets were relatively better off. Moreover, the results of the study, regarding the direct relationship between the dependency ratio and the incidence of food insecurity was in full conformity with the finding of Shimelis and Bogale (2007). Both findings confirmed that carrying more dependent members in a household makes the household prevalent to food insecurity.

In addition, an inverse relationship was found between the incidence of food insecurity and the land-to-labor ratio. Food insecurity was 100 percent in households with a land-to-labor ratio less than 0.09. This strongly supports the findings of Birihanu (2003) and Shimelis and Bogale (2007).

Succinctly, the incidence of food insecurity was found to be 66 percent, meaning that only 34 percent of the sampled households met the energy requirement recommended for subsistence. The incidence of food insecurity is easy to calculate and interpret. It is a good indicator of food insecurity. However, it does not take into account the depth or severity of food insecurity. Moreover, the head count index does not reveal whether all the food-insecure households are equally food insecure or not.

Table 2 Dimensions of food insecurity in the households surveyed in Gursum district grouped by four household factors

Household factor	Grouping criteria	No. of sampled households in Grouping (n)	No. of food insecure households(q)	Incidence of food insecurity (%), (α=0)
	Total	280	186	66
Household size (person)	< 3	15	2	13
	3-5	84	50	60
	6-8	148	106	73
	≥ 9	33	28	85
Age of household head (years)	< 30	40	20	50
	30-39	82	53	65
	40-49	103	68	66
	50-59	41	32	78
	≥ 60	14	13	93
Dependency ratio	< 1	99	61	62
	1-2	145	99	68
	2.01-3	30	20	67
	> 3	6	6	100
Land to labor ratio	< 0.09	23	23	100
	0.09-0.20	128	95	74
	0.21-0.32	67	38	57
	0.33-0.44	39	19	49
	0.45-0.56	19	9	47
	> 56	4	2	50

Source: Household survey results, 2009.

Therefore, it needs to be complimented with a measure of the depth and severity of food insecurity.

Food insecurity gap and severity of food insecurity

The food insecurity gap index or the depth of food insecurity is a measure that takes into account how far food-insecure households, on average, are below the recommended subsistence energy requirement level. For the present study, it was calculated to be 0.27 (Table 3). So, if the government could mobilize resources to meet 27 percent of the daily calorific requirement and distribute these resources, it would bring each food-insecure household up to the daily calorific requirement level. Then, at least in theory, food insecurity would be eliminated. More specifically, assuming that the sample households were representative of the rural population in Gursum district, then, according to the DPPO, in Gursum district, the number of households in the rural Gursum district is 46,950 , which is equivalent to 237,098 in AE (AE is a standardized unit of measurement for different age and sex of a household member, Table 4). The total resource required to bring all households to the recommended daily subsistence level would amount to 134,434,283 Kcal per day. Assuming that cereals can produce about 3,700 Kcal per kg, this is equivalent to 363 quintals of cereals per day (a quintal is a unit of weight equal to 100 kg). That would mean an estimated 13,249.5 tonne of cereals per year would be required.

Table 3 Dimensions of food insecurity in the households surveyed in Gursum district according to SC adoption

SC technology	Grouping criteria	Number of households in grouping	Number of food insecure households	Incidence of food insecurity (%), α=0	Food insecurity gap (%), α=1	Severity of food insecurity (%), α=2
	Adopter	188	121	64[1]	23	11
Total	Non-Adopter	92	65	71	35[a]	19[a]
Traditional soil bund	Adopter	107	70	67	23[b]	11[b]
Introduced soil bund	Adopter	81	51	63	23[b]	11[b]
	Overall	280	186	66	27	14

N.B: Within column percentages followed by different letters are significantly different ($p < .01$).
Source: Household survey results, 2009.

[1] Note: Method used to calculate the percentage in groups. For example, using the first raw data of Table 3.

1. Within the group of adopters (n=188), there were 121 food insecure households (q=121). So, $F(\alpha=0)=q/n$, i.e., percentage of food insecure households in the group = 0.6436, which can be rounded to 64 percent.
2. The food insecurity gap, $F(\alpha = 1) = (1/188)\sum_{i=1}^{121}[(2100-y_i)/2100]^1 = 0.2331$. It is customary in the poverty and food security literature to report as a decimal fraction or in percentage terms. To convert to a percentage, by multiplying the result by 100, gives 23.31 percent which in rounded terms is 23 percent. The latter method (percentages) was applied in this study.
   Thus, adopter sample households consumed on average 23 percent less than the recommended subsistence level.
3. The severity of food insecurity, $F(\alpha = 2) = (1/188)\sum_{i=1}^{121}[(2100-y_i)/2100]^2 = 0.1123$. Based on the above information and method, the severity of food insecurity among the adopters was 11 percent.
   Methods of computation and interpretation of the results are consistent with the literature.

The survey result also revealed that the severity of food insecurity in the study area was 0.14 (Table 3). This indicates that not only the incidence and food insecurity gap were relatively high in the study area, but also the inequality among the food insecure households was intense.

Food insecurity and adoption of SC measures

In the study area, the features of household food insecurity among the sampled households were also examined with respect to adoption of SC technologies. Farmers in the study area used both traditional and introduced SC measures. Though it was claimed that introduced and traditional SC measures existed in the study area, in reality, it was very difficult to distinguish which measures were traditional and which were not. According to the information from the DPPO, Agriculture and Rural Development Office (ARDO), key informant interviews, and the researcher's direct observations of the structures, there was no marked difference between these technologies. The only differences mentioned were the approaches in constructing the structures and whether they were constructed based on technical advice or not. Otherwise they appeared to be exactly the same. However, in this study, they were treated as separate technologies (traditional soil bund and introduced soil bund) and as both of them are level bunds, they were treated as a level bund as well.

Accordingly, the study found that 38 percent of sampled households used traditional soil bunds and 29 percent used introduced bunds, whereas, 67 percent of the sampled households were found to be users of level bunds (Table 3).

The incidence of food insecurity among the adopter households was found to be less, being 7 percent higher in the level bunds for non-adopter compared with adopter households (Table 3). This suggests there is a noticeable relationship between the prevalence of food insecurity and the adoption of SC. Moreover, the food insecurity gap was calculated between adopter and non-adopter households sampled, which indicated that food insecurity was significantly higher in non-adopter households (Table 3). A comparison across the three SC adoption groups (non-adopter, adopters of traditional SC measures, and adopters of introduced SC measures), using analysis of variance (ANOVA) confirmed that the differences among the groups were statistically highly significant ($p < .0009$).

Furthermore, the extent of food insecurity, as measured by the index of severity, was significantly higher in non-adopter households (Table 3). Analysis of variance statistics showed that the difference in the index of severity of food insecurity across the three groups of sampled households was statistically highly significant ($p < .0009$). However, there was

Table 4 Adult equivalent scale

Age group	Male	Female
0-2	0.40	0.40
3-4	0.40	0.48
5-6	0.56	0.56
7-8	0.64	0.64
9-10	0.76	0.76
11-12	0.80	0.88
13-14	1.00	1.00
15-18	1.20	1.00
19-59	1.00	0.88
≥ 60	0.80	0.72

Source: Gassmann and Behrendt (2006).

no difference between the traditional and introduced SC adopters for both the food insecurity gap and severity index.

The results indicated that not only the incidence of food insecurity and the food insecurity gap were higher in the non-adopter households sampled, but also that the inequality among the food insecure households was very severe. These results support the results of Shimelis and Bogale (2007). In their study, they also found that the food insecurity gap and severity of food insecurity were higher and more severe in land degraded areas of rural Dire Dawa, Ethiopia.

CONCLUSION AND RECOMMENDATION

The study results indicated clearly that households with a large family size were more prevalent to food insecurity than smaller households, indicating that there was a direct relationship between household size and food insecurity in the study area. Therefore, to mitigate the incidence of food insecurity, the regional and local governments and non-governmental organizations (NGOs) operating in the study area need to help households to limit their size. Practical steps could include awareness creation and the incorporation of family planning lessons in adult education programs.

According to the study results, the inverse relationship of the land-to-labor ratio, with the dimensions of food insecurity, implied that cultivated land size is an important variable in mitigating the risk of food insecurity. However, increasing the land size available to households under the existing population pressure may be very difficult. Therefore, both government and NGOs should consider the creation of alternative livelihood activities as an important alternative.

The study revealed that the extent of food insecurity was higher among non-adopter households, suggesting that to mitigate the risk of food insecurity and enhance the food security of households in the study area, the operating organizations (ARDO, DPPO and NGOs) should work more on SC activities to improve SC adoption in the study area. This could be done by creating more awareness about the importance of level bund SC technologies to lessen the extent of food insecurity in the study area. Moreover, introducing other related SC technologies that have been proven to be the best in other areas of the country having the same agro-ecological and socioeconomic setting as Gursum district, could help to reduce the risk of food insecurity in the study area.

ACKNOWLEDGEMENT

The authors thank the Rural Capacity Building Project (RCBP), under the Ethiopian Ministry of Agriculture and Rural Development, for funding this study.

LITERATURE CITED

Anley, Y., A. Bogale, and A. Haile-Gabriel. 2007. "Adoption Decision and Use Intensity of Soil and Water Conservation Measures by Smallholder Subsistence Farmers in Dedo District, Western Ethiopia." *Land Degradation and Development*, 18: 289–302.

Batiwaritu, G. and Z. S. K. Mvena. 2009. "Determinants of the Adoption of Physical Soil Bund Conservation Structures in Adama District, Oromia Region, Ethiopia." *East Africa Journal of Sciences*, 3(2): 142–152.

Bekele, W. and L. Drake. 2003. "Soil and Water Conservation Decision Behavior of Subsistence Farmers in the Eastern Highlands of Ethiopia: A Case Study of the Hunde-Lafto Area." *Ecological Economics*, 46: 437–451

Birihanu, T. 2003. *Influence of Farm Size on Household Food Security: The Case of Deder District of Oromia Region.* Alemaya University, Ethiopia.

Bogale, A. 2002. *Land Degradation, Impoverishment and Livelihood Strategies of Rural Households*

in Ethiopia: Farmers' Perceptions and Policy Implications. Aachen; Shaker Verlag.

Clay, D., D. Molla, and D. Habtewold. 1999. "Food Aid Targeting in Ethiopia: A Study of Who Needs It and Who Gets It." *Food Policy*, 24(4): 391–409.

Devereux, S. 2000. *Food Insecurity in Ethiopia.* A Discussion Paper for DFID. IDS Sussex.

Enquobahrie, A. 2004. *Understanding Poverty: The Ethiopian Context.* A Paper Presented at The Gambia AAPAM Roundtable Conference, Banjul, Gambia. (19–23 April, 2004).

EHNRI (Ethiopian Health and Nutrition Research Institute). 1997. *Food Composition Tables for Use in Ethiopia.* Addis Ababa: EHNRI.

FDRE. (Federal Democratic Republic of Ethiopia). 2001. *Food Security Strategy*. Updated Version. Addis Ababa.

Foster, T., J. Greer, and E. Thorbeke 1984. "A Class of Decomposable Poverty Measures." *Econometrica*, 52: 761–766.

Gassmann, F. and C. Behrendt. 2006. *Cash Benefit in Low Income Countries: Simulating the Effects on Poverity Reduction for Senegal and Tanzania.* Discussion Paper No. 15, Issues in Social Protection. Gebeva, Swizerland: International Labour Office.

Hailu, A. and N. Regassa. 2007. "Correlates of Household Food Security in Densely Populated Areas of Southern Ethiopia: Does the Household Structure Matter?" *Studies on Home and Community Science*, 1(2): 85–91.

Hoddinott, J. 2001. "Method for Rural Development Projects." *Food Security in Practice*, Volume 1, IFPRI, Washington. DC.

Johnson, C. 1982. *MITI and the Japanese Miracle: The Rise of Industrial Policy*. Berkeley: University of California Press.

Kifle, L. and G. Yosef. 1999. *The Food Security Situation in Ethiopia. Concept, Status and Trends.* Addis Ababa.

Lapar, M. L. A. and S. Pandey. 1999. "Adoption of Soil Conservation: The Case of Philippine Uplands." *Agricultural Economics*, 21: 241–256

MoFED. (Ministry of Finance and Economic Development). 2002. *Ethiopia: Sustainable Development and Poverty Reduction Program.* Addis Ababa.

Nair, P. K. R. 1985. *Agroforestry in the Context of Land Clearing and Development in the Tropics.* Working Paper No. 33. International Council for Research in Agroforestry (ICRAF), Nairobi, Kenya.

Ruthenberg, H. 1983. *Farming Systems in the Tropics.* 3rd ed. Oxford: Oxford University Press.

Shiferaw, B. and S. Holden. 1999. "Soil Erosion and Smallholders' Conservation Decisions in the Highlands of Ethiopia." *World Development*, 27: 739–752.

Shimelis, A. and A. Bogale. 2007. "Dimensions of Food-insecurity and Livelihood Strategies among Rural Households in Dire Dawa, Eastern Ethiopia." *Tropical Science*, 47(2): 73–80.

USAID. 1992. *Definition of Food Security*. Washington, D.C.: USAID.