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**Original article**

# RURAL LIVELIHOOD VULNERABILITIES, COPING STRATEGIES AND OUTCOMES: A CASE STUDY IN CENTRAL RIFT VALLEY OF ETHIOPIA

**Sime G[1&2*] and JB Aune[2]**

**Getachew Sime**

*Corresponding author email: abigiag@yahoo.com

[1]Department of Biology, College of Natural Sciences, Hawassa University, PO Box 05, Hawassa, Ethiopia

[2]Department of International Environment and Development Studies (Noragric), Norwegian University of Life Sciences (NMBU), 1432 Ås, Norway

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**ABSTRACT**

Extensively vulnerable mixed rain-fed farming system is the underlying mainstay of livelihoods of farmers in the central Rift Valley of Ethiopia. This study aimed to assess determinants of farmers' livelihood vulnerabilities to shocks, their coping strategies and outcomes. Cross-sectional data were collected from farmers, agricultural experts, and other development workers through formal and informal focus group discussions, key informant interviews and complemented by field observations. Results showed that natural, institutional, and physical factors are the overriding determinants triggering rural livelihood vulnerabilities to frequent food shocks. Particularly, unpredictable rainfall timing and severity, and ineffective early warning system had practically escalated livelihood vulnerabilities to food shocks. Farmers varied in their assets and socioeconomic capabilities, including wealth status, livestock and poultry holding size, farm size and its soil fertility status, participation in local social networks, and financial capital and access to credit facilities. Farmers also varied in their vulnerability to encountering food shocks and capability to coping. Strategies practiced by households to increase livelihood resilience to rainfall variability include selection of appropriate crop variety, selection of appropriate calendar for planting, intercropping, crop rotation and indigenous *in situ* rainwater harvesting. Sharing grains among households themselves, selling small ruminants, engaging in off-farm activities and migration were key ameliorative strategies to handle small-scale and temporary food shocks. While, institutional interventions with Food Aid and Safety Net programs were commonly used as the underlying coping strategies for severe and large-scale food shocks. The livelihood outcomes were characterized by continued endeavors to avert the inappropriate land management system, to adapt to the recurrent drought and dry spells, and to improve the inadequate early warnings condition for seasonal agro-meteorology. Therefore, authors suggest concerted efforts of stakeholder institutions and local communities to improve the livelihood outcomes that should enhance household capabilities, activities, assets and accesses; reduce vulnerabilities to shocks; and ensure sustainable agricultural production system in central Rift Valley of Ethiopia.

**Key words:** sustainable livelihood approach, asset, rainfall variability, food shock, outcome, semi-arid Ethiopia

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## INTRODUCTION

There is a strong and complex relationship between the governance of natural resources and the pursuits of rural communities in low-income countries who depend on the availability of and access to natural resources for supporting their livelihoods [1]. The livelihood framework recognizes five main asset categories (human, social, physical, financial and natural) and the activities and the access to these are mediated by institutions and social relationships – that together determine the living gained by the individual or household [1, 2]. This study hypothesized that these livelihood assets, activities and accesses are the underlying determinants of the livelihood of rural farming and its vulnerabilities to various shocks, coping strategies and outcomes in the semi-arid central Rift Valley (CRV) of Ethiopia.

Ethiopia depends heavily on agriculture, which remains the most volatile sector due to its heavy reliance on rain-fed systems and high vulnerability to frequent seasonal rainfall shocks [3-6]. While agriculture is characterized by low external input, widespread land degradation further impairs the practice [4, 5]. Soil fertility depletion is one of the main biophysical causes of declining per capita food production, particularly in the semi-arid mixed farming systems of Ethiopia [7]. According to the Environmental Protection Authority (EPA) of Ethiopia, arid, semi-arid and dry sub-humid lands occupy approximately 65 % of the total land mass of the country, 46 % of the total arable land and represent the crop production zone, which suffers from serious moisture stress [8].

In Ethiopia, the major determinants constraining farmers' livelihood and increasing vulnerabilities to shocks are climate variability [9], increasingly severe land degradation [3, 10, 11] and poor rural socioeconomic conditions [12]. However, in-depth studies engaging all stakeholders in a platform is lacking in the study sites in particular and in the CRV in general. The Sustainable Livelihood Approach (SLA) was used as the analytical framework. The application of the livelihoods approach is flexible and adaptable to specific local settings. Specifically, livelihood assets, vulnerability to shocks, coping strategies, and outcomes were evaluated based on the viewpoints of the stakeholders, collected through discussions, interviews and complemented by field observations.

## MATERIALS AND METHODS

### Analytical framework

The SLA (Fig. 1) is a broad and multidisciplinary approach that aims to promote a better understanding of and response to the multiple dimensions of livelihood. It combines ongoing development trends with concepts derived mainly from the fields of political economy and political ecology. These included *Amartya Sen*'s capitals and capability framework and concepts from the New Institutional Economics with regard to the importance of institutions in economic growth and development [2]. The SLA vulnerability context relates to these concepts, and sensitivity and resilience are thus incorporated as factors related to livelihood [2]. The SLA is concerned with the differential capability of rural families to cope with shocks such as drought, floods or

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plant and animal pests and diseases [13]. The SLA brings together assets and activities, and illustrates the interactions between them [2].

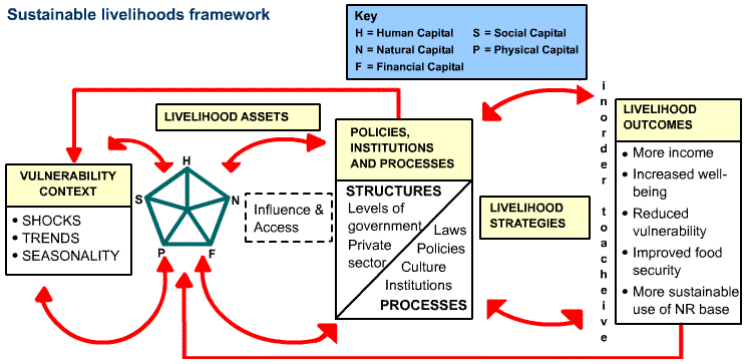


**Figure 1**: **Adapted from UK Department for International Development Sustainable Livelihoods Framework [2]**

The capital assets owned, controlled, claimed, or by some other means accessed, by the household are grouped into five categories. These are physical capital (at household level, such as house or bicycle, but also at community or citizen level, access to infrastructure such as harbors, road networks, clinics, schools); financial capital (savings, credit, insurance); natural capital (livestock owned, land owned, crops cultivated); human capital (people's capabilities in terms of their health, labour, education, knowledge, and skills); and social capital (the kinship networks, associations, membership organizations and peer-group networks that people can use in difficulties or turn to in order to gain advantage). Access to both assets and activities is enabled or hindered by policies, institutions and processes, including social relations, markets and organizations [1, 2]. Livelihood sustainability is also affected by external factors – referred to as the vulnerability context – comprising cycles, trends and shocks that are beyond the household's control. Trends might include decreasing agricultural productivity, increasing prices for inputs, and factors unrelated to agriculture that nevertheless affect households, such as rising costs of food staples or medicines. Shocks include rainfall damage to crop production and livestock keeping. Understanding how people succeed or fail in sustaining their livelihoods in the face of shocks, trends and seasonality can help in the design of policies and interventions to assist people's existing coping and adaptive strategies [2].

Mobility and migration are important components of many rural livelihood strategies (both men in the tillage, weeding, harvesting, and women in the post-harvest sector). Strategies can also relate to people's consumption choices. Short-and long-term measures to ensure survival are often distinguished as 'coping' and 'adapting', respectively. Finally, this framework points to outcomes. A livelihood is sustainable if people are able to maintain or improve their standard of living related to wellbeing and income or other human development goals, reduce their vulnerability to external shocks and trends, and ensure their activities are compatible with maintaining the natural resource base – which, in this case, is crop production [2, 14]. In a similar order, this study assessed the rural

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livelihood assets and the vulnerabilities to shocks, the coping strategies and the outcomes in the CRV of Ethiopia.

**Description of the study site**

The study site, Adami Tullu Jido Kombolcha district, is located in the East Shoa Zone of Oromia Regional State, in the CRV of Ethiopia at $7^0$ 10' north, $38^0$ 45' east, at an altitude of 1,645 meters above sea level between 166 and 178 kilometres south of Addis Ababa (Fig. 2). Three villages in the district were targeted as a case study site. The CRV lies in the semi-arid areas in Ethiopia where farmers mainly lead vulnerable livelihoods, which depend heavily on rain-fed cereal-based mixed agriculture [8, 12]. The three rural communities were chosen for the study as representative of a larger farming system in the CRV because of their strategic location in the CRV, the agro-ecological setting, socioeconomic setting and farming system they practice. Therefore, the findings obtained from this study might be useful for other areas with similar settings.

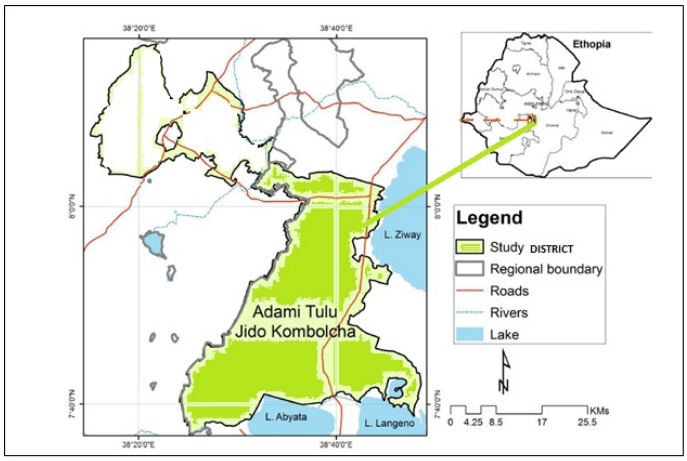


**Figure 2**: **Map of the study area**

**PROCEDURES FOR INFORMATION GATHERING**

Following the SLA, this study was based on key informant interviews, focus group discussions, informal discussions and series of field observations. Primary data were collected from farmers, development agents and agricultural experts and were assessed in order to evaluate the available livelihood capitals or assets; and farmers' capabilities, policies, institutions; vulnerability to shocks; coping strategies; and outcomes.

One focus group discussion engaging nine farmers was held in each village, making the total number of discussant farmers engaged 27. The discussant farmers had comprehensive information about the farming systems and livelihoods in the villages. They had better community acceptances and roles in agricultural activities, and belonged to different wealth, age and sex categories. Predetermined semi-structured questions were developed and asked. The questions were arranged from broad to specific categories, and the participants' anonymity was maintained. A comfortable environment was created to enable the farmers to reflect freely on issues raised. Discussants were allowed to respond to questions and comments raised by other members of the

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discussion. They were also allowed to interact with each other. This was used as a cross-checking method to increase the validity and reliability issues raised during discussions in each village. Repeated discussions and interactions with various stakeholders enabled getting comprehensive knowledge of a problem under investigation [15]. For further cross-checking of the information collected from discussant farmers, three other similar discussions were held separately with three extension workers at each village. There were three extension workers at each village. This makes the total number of extension workers involved in the study nine.

In each village, informal discussions were held with 12 randomly selected farmers representing different wealth categories (local wealth differentiation system depends mainly on livestock holding size, farm size, and annual income, among others) and both sexes. These farmers were different from the ones interviewed in focus group discussions. This brings the total number of informant discussants to 36, of whom nine were females. In addition to discussing issues raised in the focus group discussions and key informant interviews, the informal discussions were focused on exploring coping strategies (of farmers and institutions) to various shocks and stresses determining farmers' livelihoods. A series of field observations were also carried out during planting, weeding and harvesting to examine the distribution of household resources on operationalizing agricultural activities. During the field observations, timeliness of supply of external inputs, planting, weeding, harvesting, and marketing procedures were explored. For the key informant interviews, three experts with expertise in different areas, namely crop, livestock and environmental management, were selected and interviewed with in-depth probing. For the purpose of cross-checking the information already collected, most of the issues assessed in focus group discussions and field observations were raised in this interview. While conducting the discussions, interviews, and field observations, comprehensive notes were taken by the researcher and an assistant.

For data analysis, a comparison analysis was used to assess common themes and subthemes in reaching data saturation. Finally, every theme and subtheme were described using a narrative analysis or approach.

## RESULTS AND DISCUSSION

Tables 1, 2 and 3 below summarize livelihood assets and their characteristics, institutions, polices and process, and characteristics, livelihood vulnerabilities, coping strategies and outcomes, and their characteristics, respectively. The Tables present the summary of responses to the questions originally raised during focus group discussions, key informant interviews, and field observations:

### Livelihood assets and socioeconomic capabilities

#### *Human capital*

Following the local wealth differentiation system, there are three groups of households: small, medium and large (Table 1). This wealth differentiation is based on the average ownership of resource such as the type of housing, number of livestock (cattle, small ruminants and equines), farm size, grain yield per hectare, type of crop grown, the use of

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chemical fertilizers and improved crop varieties, farm income, food security, off-farm income, and number of children going to school. Besides, livestock holding size, landholding size, grain yield per season per household, number of food-secure months in a year, and annual income generated from livestock and grain sale, are among the overriding criteria for the differentiation of wealth in the villages.

Ownership associated with labour size, land size, and number of oxen (Table 1) determines the management of timely planting (within the short window periods) and weed control. Large variations in crop yields occurred because of differences in agronomic management activities. Such agronomic management activities include quality of seedbed preparation, time of planting, method of seed sowing, fertilizer rate, method and time of thinning, time and number of weeding operations, and time of harvesting. Apart from these factors, medium and large households cultivate diverse crop species such as haricot bean, wheat, *teff*, pepper, and sorghum, whereas small households only have a few crop varieties. Diversification of crop production systems helps to diversify nutrition and income as well as being used as a coping mechanism to deal with crop failure from climatic shocks.

**Natural capital**

***Livestock and poultry***

As in other parts of the CRV [12, 16], livestock husbandry is found to be an integral component of the mixed-farming systems in the study areas. Farmers keep varying number of livestock and poultry depending mainly on their status of wealth and size of landholding (Table 1). The farmers in central rift valley of Ethiopia, like farmers elsewhere in sub-Saharan Africa [17, 18], consider cattle to be the most important indicator of status in terms of wealth. This is a result of the multiple functions that cattle provide in the economy of smallholder farms [19]. Livestock is important for the livelihoods of farmers as sources of food, income and traction power. Cattle (oxen and cow), goat and sheep, poultry (chicken) and equines (donkeys) are the most important livestock kept in the study areas. Livestock and poultry also provide manure, hence are source of organic fertilizers and domestic fuels. Cattle and poultry, therefore take a major capital investment with strong integration to crop production and contribution to food security and income generation.

Farmers indicated that marginal and natural pastures are used as the major source of livestock fodder. However, because of the expansion of crop production to marginal and pasturelands and the breakdown of the traditional fallow system, there is an increasing pressure on the availability and quality of natural pasture for livestock feeding. Farm fields are mostly left unplowed during off-seasons for livestock to feed on the stubble. In addition, there is low productivity of grazing lands, lack of improved fodder crops and inadequate livestock water supplies, which critically challenge the livestock sector.

***Traction power and tillage***

Oxen as a major source of traction power reduces the labour demand for agronomic activities. However, shortage of sufficient traction power is a critical challenge mostly for small farmers, increasing the risk of their inability to produce sufficient food for the household. Farmers use tillage for multiple purposes, including seedbed preparation,

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weed control, thinning, facilitating water infiltration and improving yields. The frequency of tillage operations varies depending on the type of crop to be cultivated, soil type and soil stiffness, weed density and weed types (annual or perennial, grass or broad-leafed, and time of the tillage operation (whether early or late in the season). Farm fields with compacted soils (with textural class of either well-drained loam or well-drained clay loam), high weed density and perennial weeds need intensive tillage for seedbed preparation, weed control and improving yield. Crops that need intensive tillage (three to five strips) include maize (*Zea mays* L.), wheat (*Triticum aestivum* L.), barley (*Hordeum vulgare* L.), and *teff* (*Eragrostis tef* (Zucc.) Trotter). Sorghum *(Sorghum bicolor* (L.) Moench) and haricot bean (*Phaseolus vulgaris* L.) require less tillage (a maximum of two strips) according to farmers and extension workers. This agrees, for the most part, with earlier studies that farmers plow their land from two to six times per planting depending on the crop that is to be planted [20]. Many farmers mentioned seedbed preparation, weed control and soil warming as reasons for repeated tillage [21]. Apart from that, tillage frequency varies with the education level and experience of farmers, farmers' level of understanding of the purpose of tillage, and availability of resources such as size of landholding and labour, and number of oxen [21]. Farmers stressed that intensive tillage saves the labour demand for manual seedbed preparation, hoeing and uprooting weeds because it loosens the soil.

Nevertheless, such tillage practice forms plow pans, locally called *Xarfa* that impedes infiltration. Because of repeated tillage at shallow depths, commonly between 13 and 16 centimeters, plow pans form below the plow layer [21, 22]. Formation of plow pan is common in the sandy loam soils in the rift valley that needs continuous manipulation. *Xarfa* is often removed three to four weeks following sowing, using a tillage practice locally called *Shilshalo* in maize. Second weeding in maize usually follows *Shilshalo* that gives multiple benefits including thinning, rainwater harvesting and infiltration.

***Soil fertility***

Stakeholders stressed that there is a strong integration between keeping livestock, soil fertility management and crop production as necessary to pursue a sustainable livelihood. Livestock manure is used as sources of organic fertilizers, and domestic fuels. Compost – which is usually made from different materials including livestock byproducts (dung and urine) – is also used as an organic soil fertility amendment. However, the coverage of organic fertilizers is still low. This supports the finding of a previous study that there is ample opportunity to use animal manure for soil fertility improvements in the CRV [22]. In addition to the application of manure and compost, crop residues and household wastes are discharged into farms around the homestead.

Previously, traditional fallow was used as an effective way of improving soil fertility. However, owing to population pressure and increased demand for land for crop production (Table 1), in recent times there is a complete breakdown of the fallow system and increased cultivation of marginal lands, pasture lands and forested lands. Previous studies indicated that the CRV has witnessed a general decline in the use of fallows and fallow periods as a means of replenishing soil fertility, together with an increase in the use of marginal land and consequent land degradation [23, 24]. Lack of access to alternative sources of income for livelihood further intensifies deforestation and land

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degradation, and therefore increases the problems of soil erosion and nutrient depletion in the rift valley of Ethiopia [25].

**Social capital**

Some examples of traditional social networks (Table 1) and relationships in the community through which the farmers pursue their livelihood are oxen rental arrangements, sharecropping and contracting out land under shortage of traction power, reciprocal arrangements between the youth during labour peaks at weeding and harvesting, and sharing grain among households under food shocks. Farmers also use social networks for sharing information on new technologies and markets.

However, inadequate awareness of the importance of saving and careful timing of marketing of agricultural products is one of the challenges that aggravated the food shortage in many households for most of the year. Such shortages of food often lead to migration of the young and active members of households and dropping out of school. Starvation and malnutrition are common shocks in a considerable number of households. Poor health conditions, resulting from inadequate diets and health services and contaminated water, are also common challenges to farmers' livelihoods.

**Physical capital**

The villages are located approximately 36 to 48 kilometers away to the closest marketplaces, particularly for the livestock. Farmers take most of their agricultural output to the marketplaces with the help of donkeys. Agricultural inputs are difficult to access. Although the network connection is inadequate, a significant number of farmers use mobile phones for accessing information regarding input and output market prices. Young farmers also use media, mostly radios, for similar purposes. Farm tools such as the *Maresha,* and its accessories are not easily available at local markets. Physical capital (Table 1) is therefore one of the underlying challenges hampering the pursuits of sustainable livelihoods.

**Financial capital**

Most farmers do not benefit from price peaks because of highly volatile market prices for agricultural outputs (Table 1). They usually sell their grains immediately following the harvest season to satisfy their cash needs, pay back creditors or buy livestock. The market price for outputs is highly volatile between harvests and planting. The market price at harvest is usually the lowest for grain and livestock, because of market saturation. Such an uneconomical marketing practice exposes farmers to early exhaustion of food grains, increasing their vulnerability to transitory food insecurity and chronic food shock. Therefore, at planting, a considerable number of farmers lack sufficient finance or stored grain. This problem caused persisting constraints for buying chemical fertilizers and improved seeds, as these are expensive for most farmers. Credits or subsidies for purchasing external inputs are lacking. Farmers purchase external inputs from farmers' cooperative, unions or government institutions (Table 1). Previous studies indicated financial capital to be among the principal factors determining the use agricultural technologies in Ethiopia [12]. Further, high cost of inputs and insufficient credit services are among the most critical constraints for farmers using the available seed–fertilizer technology packages in Ethiopia [26].

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**Institutions, policies and processes**

Institutions are ineffective in practicing formulated policies and ensuring continuity of policies to the sustainability of farmers' livelihoods (Table 2). Stakeholders in general, and farmers in particular, conversed that inadequate information about input and output market and agro-meteorology, high cost of inputs, inadequate commitment in arranging credit facilities or subsidies for inputs and inadequate extension services are among the major factors which increase uncertainties of farmers livelihoods in the study sites. Furthermore, the market price of outputs was usually unknown at the time of planting – when decisions need to be made for application of fertilizers, as well as the use of improved seeds and technologies. Farmers also complained about the quality of institutionally provided improved maize seeds, witnessing that these seeds contain a considerable number of broken and inviable seeds, and weed seeds (Table 2).

The land tenure policy in relation to land use management for better ecosystem governance and service has many limitations. Natural vegetation and natural pasture are communal resources. Owing to the communal ownership of the natural resources, most of the natural vegetation cover is subjected to devastation by free riders for farmlands as well as charcoal and firewood making (Tables 1-3). Due to a decrease in the landholding size, there is an increase in the conversion of marginal and natural pasture into permanent farmlands. Furthermore, fallowing gradually diminishes and poses a negative impact on the ecosystem balance. Previous studies also reported that population growth raised the demand for cropland and for biomass, which led to deforestation in the CRV [11, 27]. The existing land tenure system, environmental management practices and population policies appeared to cause an ineffective governance of the natural resources and local ecosystems. The farmers perceived that the currently increasing variability in rainfall, low crop productivity and high food insecurity are largely resulting from the wide-scale loss of land cover or vegetation (Tables 2 and 3). Socioeconomic and institutional factors such as population pressure and land tenure arrangements were the main contributors to land degradation and food insecurity in the CRV of Ethiopia [11, 12, 27].

**Vulnerabilities to food shocks and coping strategies**

Farmers perceived an increase in inter- and intra-seasonal rainfall variability (Table 1). They witnessed a frequent but unpredictable drought. Discussants and interviewees further witnessed the high likelihood of drought to occur every year or two years. Therefore, prolonged dry spells or droughts are the underlying factors affecting the heavily rain-fed agricultural system. Growing season rainfall variability is the main cause of crop yield variability and production uncertainty in the CRV [3]. Furthermore, about 99 % of farmers perceived an increase in temperature and 94 % perceived a decrease in rainfall over the last 20 to 30 years in the CRV. The observed climate data (1977 to 2009) also showed an increasing trend in temperature and inter-annual and intra-seasonal rainfall variability [12].

Therefore, the underlying factors intensifying livelihood vulnerabilities to shocks are the unpredictability of rainfall and the lack of dependable seasonal agro-meteorological information, the low input and output agriculture with high volatility of market prices, the high price of the inadequately accessible inputs, and the poor infrastructure. Low

access and high prices of agricultural inputs such as fertilizers, improved seeds, technologies and inadequate infrastructure were among the most important constraints causing transitory food insecurity and poverty in the CRV [12]. The seasonal rainfall was highly unpredictable and resulting in crop failure and low productivity [10], which escalated farmers' risk-averse behavior, discouraging them from investing in fertilizers and improved seeds [28]. Farmers identified drought in general as the most catastrophic natural factor causing chronic food shocks to humans and livestock. In particular, prolonged drought sometimes causes migration of active members of households, diseases and chronic malnutrition. As in many places in Ethiopia [4, 5, 29], rainfall variability and associated droughts were major causes of food insecurity and famine. Previous studies also indicated that farmers in semi-arid East Africa prioritize drought as their major productivity-reducing factor [30]. Wet years also present a risk of flooding (Tables 1 and 2), that frequently occurs with high intensity over the short-term, usually in the middle of the wettest months, July and August. Such situations also hamper the performances of standing crops despite causing considerable soil erosion.

In addition to the considerable roles which institutions play, most of the livelihood vulnerabilities and the shocks are traditionally managed primarily by farmers' capabilities (Table 3). Such management practice varies with households, depending on wealth category, educational level and experience. When there is a large-scale food shock, for instance, because of prolonged dry spells or droughts, households themselves, institutions or both manage it. When such a shock is a small-scale, it is primarily managed by the traditional method of collecting grain from relatives living in other areas or members in the same village with sufficient food, traditionally called *Hirpa* (Tables 1-3). Food-secure households, whereas use stored grains from the previous season. *Hirpa* is a reciprocal arrangement. Therefore, depending on the degree of kinship between the supporter and recipient, the grains received would be reciprocated, either in kind with grains normally at harvest, or by executing different kinds of livelihood pursuits (Tables 1 and 3). This sometimes form a vicious cycle for the poorest farmers. Yet, when the shock is large-scale and affects all households and villages, large households sell small ruminants. When the traditional method is insufficient, institutions intervene via various strategies such as Food-For-Work through the Safety Net Program and food aids. Most food aid is usually delivered through Food-For-Work programs, which help farmers to stabilize production over time (Tables 1 and 3).

In response to rainfall variability, continuous adaptive adjustment (Tables 1-3) is made to the crop production system, namely crop selection (haricot bean, wheat, *teff* or maize), variety choice (early, late or mid-maturing), cropping calendar choice (first or second season), and indigenous *in situ* moisture conservation (furrowing and ridging) to flat cultivation. As a result, adjusting planting time and selecting adapting crop varieties are increasing in recent times. For instance, the *Belg* (first season, usually with light rain) is experiencing more severe dry spells than the *Kiremt* (second and main season). Farmers choose to grow early maturing crop species and varieties under the late onset of rain, with mid maturing or local late maturing varieties under normal seasonal rainfall. Mid and late maturing maize varieties provide yield advantages over early maturing varieties. Yet, because of unfavorable growing condition resulting from frequent dry spells in recent times, the first season gradually becomes less dependable for growing mid

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maturing and late maturing maize. Farmers increase seed rates to increase planting density and crop establishment; and reduce fertilizer rate to reduce its burning effect on germinating seeds, to promote seed germination, establishment, and to reduce the risk of investment in fertilizers following crop failure or yield reduction. New cropping approaches such as diversification has recently increased to spread farm risks. Such practices diversify income and nutrition and minimize crop losses that different crops, for instance haricot bean and maize, are differently vulnerable to rainfall variability. The increasing cultivation of haricot bean, *teff* and wheat during the main season become an adaptive response to reduce these vulnerabilities. The furrowing and ridging in maize method is expanding as an attempt to harvest rainwater and increase soil moisture. About 48 % of the respondents in the CRV cited water harvesting as an adaptation option. Most farmers employed *in situ* soil moisture conservation techniques that increase rainfall infiltration and storage in the soil for crop use [12].

Agricultural extensification (Tables 1-3), which increases farm size, used to be one of the farmers' strategies to ensure sustainable food security and livelihood. It is often practiced by bringing new lands into cultivation, with the perception that more land gives more food. However, this could not serve like the previous times because of limited availability of new land. Agricultural intensification, which raises farm yields on a given plot of land, is a practiced strategy to sustain livelihood pursuits. The continuously increasing population size causes a critical shortage of land, particularly for young members of the community. As a result, the youth take up limited short-term income-generating employment (off-farm income) such as working in small and large private horticulture and floriculture-producing organizations and constructions in the nearby towns such as Ziway.

As a response to the shortage of fodder and to minimize the risks to livestock production, the main strategies included the use of alternative feed sources such as feeding tree branches, conservation of fodder, collection and use of crop residues, and reduction of the herd size [12]. Similar strategies are found to be used by farmers in the current study site (Table 3). Maize stover becomes the major source of livestock fodder. Stubble grazing after harvest is also a supplement. Free grazing of livestock in the cultivated fields is a traditional practice between the harvest of the previous crop and the next sowing. In addition, seasonal migration of livestock to pastoral areas was another strategy to cope with a feed shortage in low rainfall seasons [12] which is also one of the strategies in the current study. Farmers indicated that such migration (Table 3) is a common practice during the cropping seasons because most fields are covered with crops. Apart from that, the recently introduced haricot bean cultivation has been used as an alternative crop to fallow, enabling livestock to feed on the fallows as natural pasture after harvest. This is because most farmers use minimum tillage for haricot bean production and usually do not practice weeding – which promotes the growth of higher weed density and serves as a natural pasture after harvest. Besides increasing soil fertility, haricot bean cultivation provides an economic benefit to the farmers; it demands less traction power for tillage and less labour for weeding. At large, despite the increase in crop yields, the crop diversification practice increases fodder for the livestock, further consolidating the integration of crop production and livestock keeping. However, in spite

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of all of these strategies, prolonged drought sometimes causes the death of livestock, resulting from a disease, and from a shortage of fodder and drinking water.

**Livelihood outcomes**

***Improved farm income and food security***

The use of fertilizers, improved seeds, traditional rainwater-harvesting techniques, as well as improved agricultural practices such as crop rotation and intercropping increased households' productivity, farm income and food security. Nevertheless, high vulnerability to rainfall variability, poor financial capacity to wait for profitable market for outputs and the instability of market prices for outputs remain major constraints for ensuring improved farm income and food security.

***Natural resource management***

Though widespread deforestation and land degradation are continued for decades as a means of agricultural extensification, recent rehabilitation activities such as plantation on degraded lands and area exclosures reduced erosion and improved soil fertility as well other associated natural resources. There is a gradual increase in societal awareness of the role of natural resource management as a response to rainfall variability and land degradation.

***Capability***

There observed an increase in households' skill, experience and knowledge of realizing the impact of deforestation on rural livelihoods and ecosystem services. Besides, there is an increased awareness to use fertilizers, improved seeds, intercropping, and crop rotation for improving on farm income, diversifying human nutrition and food security. Likewise, the impact of having access to better education, road networks, health centers, and extension services on overall sustainable rural livelihoods is well realized. Moreover, there are cohesive social networks for information sharing and managing shocks.

***Vulnerability to climatic shocks***

Households reduce vulnerability to climatic stresses through using adapted crop varieties, agro-metrological information (though such information is less dependable), irrigation (where there is access to water), traditional rainwater harvesting systems, crop rotation and intercropping, migrating livestock, engaging in off-farm income generation. However, the unpredictable and variable seasonal rainfall remains a fundamental constraint to the sustainable use of these adaptation practices. Yet, the recently increasing community-based tree planting programs on most degraded lands somehow reduce vulnerabilities to climatic risks such as periodic flooding and soil erosion.

## CONCLUSION

In the Rift Valley of Ethiopia, unpredictable rainfall, characterized by high intra- and inter-seasonal variability is the major factor intensifying livelihood vulnerabilities to food shocks. In response to this variability, households use different strategies, including choosing seasonally appropriate crop varieties to be cultivated, choosing appropriate cropping calendar and making decisions whether to use external inputs for every cropping season. Moreover, adaptive crop varieties, improved seeds, fertilizer application, intercropping, crop rotation, traditional rainwater harvesting are among the

remaining strategies for adapting to the variable rainfall and for improving farm income, food security and the overall livelihoods. Households use various kinds of indigenous social networks for information sharing and managing livelihood stressors. Resource sharing, migration of livestock, off-farm income generation, and selling small ruminants are some the strategies used for reducing livelihood shocks. Therefore, effective delivery of agricultural inputs, stable market for agricultural outputs, effective governance of natural resources and effective delivery of local ecosystem services are important to ensure the sustainable rural livelihood. This is because the rural livelihood is primarily dependent on agriculture and the management of natural resources. It is recommended that policies, institutions and communities should be integrated in order to reassure household capabilities, and ensure effective governance of natural resources and delivery of local ecosystem services that is resilient to existing natural shocks and stresses for sustainable rural livelihood in the central Rift Valley.

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## CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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**Table 1: Livelihood assets and their characteristics**

| | Assets | Characteristics |
|---|---|---|
| 1. | Human capital (Household endowment) | • There were three groups of households, namely small, medium and large, depending on livestock and poultry size, land size and farm income.<br>• Households' capability varied in terms of generating farm income (income generated from livestock and grain sale) and off-farm income (such as petty trading, handcrafts, hired labor, etc.) and the tendency of visiting health centers, the number of children going to school, the management of the number of food-secure months in a year and the amount of grain produced per season.<br>• Households varied in their education status, skills and experiences of managing agricultural production under various scenarios. They differed in their perception to new technologies (particularly to the use of fertilizer and adaptive crop varieties), and marketing system of their agricultural inputs and outputs.<br>• Households also varied in their household size, hence with different labor sizes for managing agricultural activities.<br>• Differences observed among households in their capacity, skill and knowledge to divert vulnerabilities to the impact of rainfall variability such as extended droughts, sudden flooding, as well as the use of early maturing and drought tolerant crop varieties as coping strategies. |
| 2. | Natural capital | • Households varied in the ownership of livestock (cattle, small ruminants and equines) and poultry size, landholding size (for farming or grazing or pasture) as well soil fertility status.<br>• Households shared similar climatic and other ecological services regardless of locations in the district.<br>• Highly variable seasonal rainfall pattern had a major impact on the sustainability of livelihoods across villages.<br>• Loss of natural vegetation for expanding agricultural farms (extensification) as well as for firewood, charcoal and construction increased land degradation, and the vulnerability to climatic shocks. |
| 3. | Social capital | • Various social networks (such as kinship networks and peer-group networks) operated among the communities.<br>• Networks enabled communities share resources for diverting livelihood vulnerabilities such as extensive droughts, flooding, and shortage of food for human and fodder for livestock (temporary migration to places with relatively better resources and *Hirpha*), as well as when epidemics of human and livestock diseases occurred, etc. |
| 4. | Physical capital | • Households varied in their access to media such as radio or television for information, access to road networks, health centers, schools and market places.<br>• Access to the physical capital varied soundly among the households residing in the different villages. |
| 5. | Financial capital | • Formal saving, credit and insurance arrangements were lacking.<br>• Households differed in their financial capacity to buy and use chemical fertilizers and improved crop varieties.<br>• Households used local moneylenders for financial arrangements for buying chemical fertilizers and improved crop varieties. However, the lenders forced such households to sell their agricultural produce usually right after crop harvest when there is market saturation, hence were subjected to the lowest possible price and economic return for their agronomic produce.<br>• There was no documentation on insurance for health, livestock and crop. |



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**Table 2: Institutions, polices and process, and characteristics**

| | Variables | Characteristics |
|---|---|---|
| 1. | **Institutions** | • The Ministry of Agriculture and Natural Resources, Agricultural Research Institutions, Local and International NGOs, Community-based Organizations, and Universities took responsibilities for increasing agricultural productivities and ensuring sustainable rural livelihoods.<br>• These institutions independently or in concert facilitated the adoption of agricultural technologies suiting local agro-ecological and socioeconomic settings. In particular, these institutions worked on extension services, provision of fertilizers, improved seeds, and other agrochemicals.<br>• Extension workers, who are the closest government agency to communities, were responsible for bridging local communities and institutions. They were responsible for facilitating the supply of agricultural inputs (fertilizers and improved crop varieties), provided agro-metrological information, and seasonally fitting crop varieties.<br>• Institutions involved in diverting various kinds of shocks particularly when such shocks are of large scale and beyond local communities' capability of coping through Food Aid and Safety Net Programs. NGOs, Community-based Organizations and community networks mostly involved in either situation, large or small-scale. The role of extension workers in this regard was found to be substantial.<br>• Public institutions at various levels (district, regional and federal) engaged in building and improving road networks, health centers, market places, and schools. |
| 2. | **Policies** | • Fertilizer application and the use of improved seeds were a key element of the agricultural strategic plan of Ethiopia. These two factors were emphasized in the five-year Growth and Transformation Plan (GTP) of Ethiopia that extended from 2010/11 to 2014/15 to increase the agricultural productivity and as part of achieving the UN Millennium Development Goals (MDGs) of halving the number of poor and hungry in the world by 2015. They are re-emphasized in the second GTP (GTP-II), which is underway, currently (2015/16-2019/20).<br>• Building on achievements from the previous Plan for Accelerated and Sustained Development to End Poverty (PASDEP), and following the Agricultural Development-Led Industrialization strategy, the GTP prioritized intensification of the productivity of smallholder farmers.<br>• Policies were aimed to ensure rapid agricultural growth through strengthening extension services, adopting new technologies and practices that conserve soil and natural resources. |
| 3. | **Processes** | • Institutions were ineffective in practicing formulated policies and in ensuring continuity of policies to ensure sustainability of farmers' livelihoods. |

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**Table 3: Livelihood vulnerabilities, coping strategies and outcomes, and their characteristics**

| | Variables | Characteristics |
|---|---|---|
| **A** | **Vulnerabilities** | |
| 1. | Shocks | • Deforestation and land degradation increased. Frequent and unpredictable drought, flooding, pest and disease were found major factors increasing vulnerability and food shock. |
| 2. | Trends | • Variability in rainfall pattern was found increasing in recent times. |
| 3. | Seasonality | • Seasonality of shock occurrences was mostly unpredictable but its frequency of occurring every two years became common recently. |
| **B** | **Strategies** | |
| 1. | Early maturing seeds and fertilizers, intercropping, crop rotation, traditional water harvesting system | • Early maturing seeds were more adaptive to rainfall variability and droughts. However, they were low yielding, not easily accessible and were expensive.<br>• Though expensive, application of fertilizers was perceived to improve crop yields.<br>• Intercropping and cropping were designed to diversify nutrition, increase income, improve soil fertility and increase adaptability to the varying rainfall.<br>• Households used traditional rainwater harvesting technique (*Dirdaro* and *Shilshalo*) for conserving soil moisture. |
| 2. | Traditional reciprocity, poultry, small ruminants and off-farm income | • Different kinds of reciprocity existed; with *Hirpha* became the most commonly used among members of a kinship network. Women and students depend on poultry for covering smaller expenses. Under extreme shocks, households sell small ruminants for buying foods. |
| 3. | Food Aid and Safety Net Programs and migration | • Under large-scale food shock, the government and NGOs provided Food Aid for the most affected households, followed by a Safety Net Programs to relief them from food shocks. Youth engages in off-farm income generation.<br>• Migrating livestock to neighboring villages (which were not hit by climatic stresses) were found one of the strategies. |
| **C** | **Outcomes** | |
| 1. | Improved food security | • Improved food security, but experienced high vulnerability to rainfall variability. |
| 2. | Improved farm income | • Increased use of fertilizers and improved crop varieties increased households' productivity and farm income. Nevertheless, poor financial capacity to wait for profitable market for outputs and the instability of market prices for outputs were the major constraints for generating sustainable farm income. |
| 3. | Natural resource management | • Increased plantation on degraded lands and area exclosure for reducing erosion and improving soil fertility. Though infant, societal awareness on natural resource management as a response to rainfall variability and land degradation gradually increased.<br>• Increased rehabilitation activities against the widespread deforestation and land degradation, which had continued for longer time for expanding land for agriculture (agricultural extensification). |
| 4. | Capability (skill, experience, knowledge) improved | • Increased households' skill, experience and knowledge of realizing the impact of deforestation on rural livelihoods and ecosystem services, and the use of fertilizers and improved crop varieties on farm income. Likewise, the impact of having access to better education, road networks, health centers, extension services was realized. |
| 5. | Vulnerability to climatic shocks | • Reduced vulnerability to climatic stressors using adaptive crop varieties, agro-metrological information, traditional rainwater harvesting systems, crop rotation and intercropping. It was, however, constrained by the unpredictably variable seasonal rainfall.<br>• The increased community-based tree planting programs on most degraded lands somehow reduced vulnerabilities to climatic risks such as flooding and soil erosion. |

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