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Wild foods (plants and animals) in the *green famine belt* of Ethiopia: Do they contribute to household resilience to seasonal food insecurity?

Daie Ferede Guyu* and Wolde-Tsadik Muluneh

Abstract

Background: The role of wild foods in combating problems of food shortage is paramount. However, existing approaches to combat food insecurity shock have generally focused on reducing vulnerability via increasing productivity of domesticated foods. In contrast, approaches that enhance resilience mainly through wild food sources have been less focused. This study examined the contribution of wild foods to household resilience to food insecurity in the green famine belt of Ethiopia.

Methods: A cross-sectional survey of 220 households was conducted using a structured questionnaire, key informant interviews, and semi-participant observations. Factor analysis was run using SPSS to analyze data. Correlation analysis was used to examine the direction and strength of association between wild foods and the income and food access (IFA), a latent proxy indicator of resilience. Cross-tabulation was also run to determine the proportion of households in each ethno-culture group under each resilience category.

Results: The mean amount of wild foods obtained by households was 156.61 kg per household per annum. This was about 5 % and 9 % of, gross and, net food available from all sources respectively. Wild foods contributed well to household resilience as the factor loading (Factor2 = 0.467) was large enough and were significantly correlated with IFA ($r = 0.174$). Wild vegetables were the most collected and consumed type of wild foods constituting 52.4 % of total amount of wild foods. The total amount of wild foods was smaller than that of domesticated sources of food. The majority of households (38.6 %) reported "reduced source of wild foods" as a reason for this. Smaller proportion of the indigenous (11.2 %) than the non-indigenous (34.1 %) ethno-culture group reported one or more reasons for their lower level of dependence on wild foods.

Conclusion: From the study we concluded that wild foods had important contribution to households' resilience to food shortages and are likely to continue to contribute in the future, this being more to indigenous than non-indigenous ethno-culture group. Therefore, a resilience building policy that incorporates wild foods should be adopted, and research that aims at exploring their current status and future prospect are urgently required.

Keywords: Wild food, Forest, Contribution to resilience, Food-Insecurity, Green famine belt, Ethiopia

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Background

There has been a strong tie between forest and human survival since time immemorial, when homo-sapiens began to emerge on the planet earth. Forests provide both direct uses (e.g. supplying fuel wood, timber, fibers, food, and medicine) and indirect uses (e.g. balancing CO_2 concentration, and protecting erosion) to human beings. More specifically, forests are sources of livelihoods for people. Gathering and hunting wild foods are one among the many livelihood activities provided by forests. In this regard, policy measures that aim at ensuring, sustainable supply of wild foods and, sustainability of forest resources often overlap. In other words, a policy that targets at development of wild foods has direct contribution to sustainability of forest ecosystem.

The economic and medicinal uses of wild foods to human beings have been discussed in the literature. Wild foods constitute an important part of global and household food baskets (Bharucha and Pretty 2010). Nevertheless, their types and extent of use vary from place to place and time to time. Wild foods are perceived by the Lebanese to have practical medicinal values that cure a number of diseases including diabetes, pains in the digestive and urinary tract, anemia, and cancer (Batal et al. 2007). *Spirulina* (i.e. Blue-green algae) has been collected and consumed as supplementary to food obtained from cultivated and domesticated sources in some countries such as Chad and China in addition to using as a source of income by many households (Food and Agricultural Organization, FAO 2008). In South Africa, wild vegetables play important role in combating the challenges of food insecurity (Mavengahama et al. 2013). Rural people of Ethiopia have deep knowledge about wild foods and their consumption both as a regular meal during normal times and as a famine food (Dechassa and Guinand 2000; Debela et al. 2011). They provide irreplaceable nutritional contents and economic values to people who depend on them (Illgner and Nel 2000; Kajembe et al. 2000; Agea et al. 2011). Especially, the role of wild edible plants (WEPs) as supplementary to nutritional requirements, coping food shortages and, emergency (famine) food is clearly shown in Assegid and Tesfaye (2011). In the western part of Ethiopia, specifically in Benishangul-gumuz region (BGR), households (mainly the indigenous ones) were found to resort to depend on wild foods as a coping mechanism to overcome extremely severe poverty and food insecurity conditions (Guyu 2012). Coping mechanisms are one of the defining components of household resilience because having more coping strategies means having more probability of mitigating food insecurity (Alinovi et al. 2008). In this regard, coping via the use of wild foods can be seen as one of the defining components of behavioral shifts into which households flip when exposed to the food insecurity shock. In this study, therefore, household resilience to seasonal food insecurity is measured as the amount of this shock absorbed before flipping into the behavior regime measured in terms of eight latent variables. One of these latent dimensions used for determining the contribution of wild foods to household resilience is the income and food access (IFA) variable measured as a factor solution of seven observable variables (Fig. 2).

The phrase "wild foods" refers to all plant and animal resources that are not domesticated but gathered and hunted from forests and bush-lands for the purpose of human consumption (Bell 1995). This paper extended this definition to include wild edible fish from the rivers. Wilderness can however be seen as a continuum ranging from an entirely 'wild' to 'semi-domesticated' food (Bharucha and Pretty 2010). In this paper, we included only purely wild plants and animals but excluded semi-wild foods from the study. Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life (Canali and Slaviero 2010). In this paper, the sources of food from which food security are ensured include own production, purchase, social and cultural networks, wild foods, and food aids (Guyu 2015). Famine is the concept intimately related with food insecurity. It is often defined as a discrete event that is triggered by food shortages or starvation and results in a sudden flare-up of mass deaths (Devereux 2000). But, this definition of famine has been criticized because deaths during famines are more related to epidemic diseases than starvation. As a result, famines can be divided into three: minor famines causing hunger, severe famines causing destitution, and catastrophic famines resulting in mass deaths (De Waal 1989 cited in Devereux 2000). The famine condition in our study area, also known as green famine belt (Guyu 2015), could be categorized under the minor and severe categories that are caused by starvation, breakout of human and livestock diseases and deaths, destruction of livelihood bases, household destitution and dissolution of family. The authors also believe that "famine that kills" (although not resulting in mass death) even occurs in the *green famine belt* although it requires further empirical investigation. Therefore, green famine is defined as food insecurity conditions that occur under the shadow of favorable natural conditions such as climate (sufficient rainfall, almost absence of drought, and vast fertile agricultural lands), low population pressure, and less resource degradation (Guyu 2015; Ferede and Muluneh 2015). Thus, in this paper

seasonal food insecurity is regarded as a proxy indicator of green famine.

Vulnerability approach is the conventional method of understanding the nature of household food insecurity and famine. However, it has been overtaken by resilience approach (RA) since the seminal work of Alinovi et al. (2008). Following the footsteps of these authors, we also applied RA for analyzing the contribution of wild foods to household resilience to food insecurity. This approach is founded on two broader worldviews: ecological and engineering. Both approaches deal with aspects of stability of equilibria but provide alternative measures of a system's ability to maintain its functions following disturbance (Holling 1996; Alinovi et al. 2009; Sakurai et al. 2012). In both varieties of resilience, vulnerability is regarded as the flip side of resilience (Alinovi et al. 2008) because when a system gradually loses its resilience it becomes more and more vulnerable to changes. The difference between them lies on the paradox between efficiency and persistency, constancy and change, or predictability and unpredictability (Holling 1996).

The engineering definition of resilience that resembles the engineer's desire for "fail-safe" design focuses on the efficiency and assumes constancy and predictability of a system's properties (King 2008). It can therefore be defined as the speed of return to the steady state following a perturbation perceiving a system as existing close to a stable and a near equilibrium steady state (Sakurai et al. 2012). As a result, resilience is measured as the system's resistance to disturbance and speed of return to the equilibrium. Thus, an increased resilience implies the system's ability to bounce back faster after stress, enduring greater stress, and being disturbed less by a given amount of a stress (Martin-Breen and Anderies 2011). Engineering resilience is therefore grounded more of within the theory of positivist tradition, both epistemologically and ontologically (King 2008).

The ecological resilience focuses on the persistency, change and unpredictability, the core idea celebrated by biologists with an evolutionary perspective and by those who search for "safe-fail" designs (Holling 1996). It is a dynamic model that focuses on persistence despite changes in, and unpredictability of, a system's properties (King 2008). It assumes multiple stability domains and is measured by the magnitude of disturbance that can be absorbed before instabilities flip into another regime of behavior (Sakurai et al. 2012). In other words, ecological resilience is the measure of the ability of the system to absorb changes of state variables, driving variables, and parameters (Holling 1973). The ecological resilience model is therefore grounded in constructivist tradition, both epistemologically and ontologically (King 2008). This definition and model is appropriate for analyzing food system that considers households as its sub-system. Due to the fact that food system is a cultural/social-ecological system, it is not a fixed system for which there is equilibrium steady state and for which resilience can assume efficiency, predictability and constancy. Such a system is characterized by persistency, change and unpredictability (Alinovi et al. 2008). Following this theory, some researchers have applied the ecological definition of resilience to analyze household resilience to food insecurity (Alinovi et al. 2009; Ciani 2012; Ferede and Muluneh 2015). In this paper too, we applied the ecological definition of resilience.

In Ethiopia interventions by researchers, policymakers and humanitarian actors have generally focused on cultivated and domesticated sources of food. Particularly, these actors have never considered wild foods' contribution to household resilience. Researchers have largely explored and documented rich indigenous knowledge of ethnobotanical and medicinal values of forest resources in general and wild foods in particular (Dechassa and Guinand 2000; Ermias et al. 2011; Teklehaymanot and Mirutse 2010). Research concerning socio-economic, cultural, traditional and nutritional/food aspects of wild foods (especially WEPs), still lacks adequate attention (Dechassa and Guinand 2000). Policymakers have almost entirely aimed at boosting the productivity of cultivated foods. Humanitarian actors have attempted to improve household access to cultivated food sources through different mechanisms including relief aids. However, such a dependence on food from domesticated sources alone may not address the challenges of food insecurity shocks and enhance the resilience of rural households. This paper examined the contribution of wild foods to household resilience to food insecurity with the following purposes. First, the findings can be used by policymakers to consider wild foods when planning and implementing resilience building programmes as wild foods' development policy involves, per see, strategies that aim at protecting environmental degradation due to deforestation. Second, the study can contribute to the ongoing academic and policy discourses held regarding household resilience to food insecurity and the role of forests in mitigating food shortages.

Methods

Study area

The study was conducted in the green famine belt of Ethiopia taking Belo-jiganfoy district as a case study area. The district is located in southern most part of BGR in western Ethiopia (Fig. 1). It generally represents the green famine belt in terms of environmental and economic characteristics.

According to the 2012 projection (Federal Democratic Republic of Ethiopia-Ethiopian Road Authority, FDRE-ERA 2008), the district consisted of a total population of

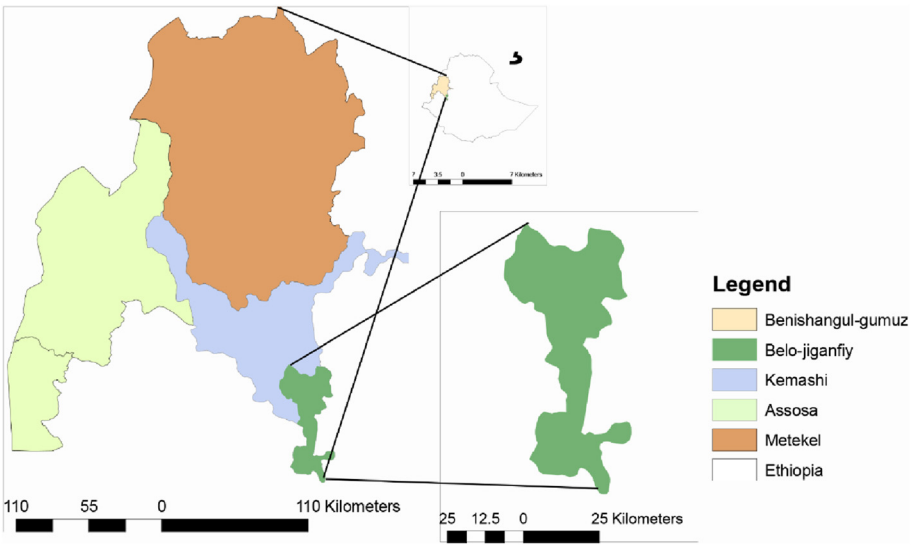

Fig. 1 Location of the study area at National, Regional and Zonal Settings

37471 forming 7347 households with average family size of 5.1. The district has population density of 23persons/km^2. However, due to continuous in-and-out migration of the non-indigenous people, the population size of the district fluctuates from year to year. Berta, Gumuz, Shinasha, Mao and Komo make up the indigenous ethno-culture group of BGR. The Oromo and Amahara ethnic groups are the dominant non-indigenous ethnic groups. With the exception of Shinasha and Komo, all ethnic groups mentioned above live in Belo-jiganfoy district. Economically, the people in the region and hence in the district depend on agriculture. Forests are available better here than other parts (especially northern, eastern and central parts of Ethiopia) although declining from time to time. As a result, they supply wild foods to household that depend on them in addition to cultivated and domesticated food sources. Malaria is the leading cause of human health problem while livestock sector is threatened by several types of diseases. Poor road infrastructure and socioeconomic services are the main challenges to BGR in general and Belo-jiganfoy district in particular (Federal Democratic Republic of Ethiopia-Ethiopian Road Authority, FDRE-ERA 2008).

The district is characterized by plain topography although certain mountainous features and river gorges exist with altitudes ranging between 1100 m and 1450 m above mean sea level. Its climate shows a very hot temperatures ranging from 20 – 25°c during rainy season while the minimum temperature varies from 12 – 20°c according to the relief and seasons (Federal Democratic Republic of Ethiopia-Ethiopian Road Authority, FDRE-ERA 2008). It has vast forest area although declining due to indiscriminate deforestation especially through the recent introduction of land deals in the pretext of large scale agricultural investments. Different types of fauna and flora are found in the forest, which provide different types of wild food for people living in and around it (Table 1).

Sampling procedure and sample size

A cross-sectional survey of 220 households was conducted during the last week of August 2013. The sample size for the study was determined based on the formula suggested by Krejcie & Morgan (1970) cited in Agea et al. (2011). According to this formula 366 households would be statistically representative of the total population in our study area. But, considering the relative homogeneity of households within each ethno-culture group, the sample size was reduced to 220. The selection of sample households followed both non-random and random techniques. First, 3 *kebeles* (the lowest administrative unit of Ethiopia that is larger than a village but smaller than a zone, a zone in turn being such a unit lower than a region) out of 10 in the district were purposively selected based on their distance from district center and road infrastructure. Accordingly, Senne, Say Dalecha and Soge *kebeles* were selected. Second, based on information on the total number of households and ethno-cultures in each *kebele*, households were stratified into two groups: the indigenous and the non-indigenous. Third, the number of sample size in each *kebele* and ethno-culture group was determined through proportional allocation method. Finally, sample households for interview were selected using simple random technique (i.e. lottery method).

Data collection

A questionnaire, key informant interviews, and semi-participant observations were employed to collect data. A structured questionnaire was carefully designed and

Table 1 Partial list of WEPs, their family and local names and, edible parts in BGR

Scientific name	Family name	Local name	Edible part
Acaci negrii Pic. Serm.	*Fabaceae*	Tedecha (Oromo)	Bark
Aframomum alboviolaceum (Ridl.) K. Schum	*Zingiberaceae*	Oula (Gumuz)	Fruit
Ampelocisssus bombycina-(Bak.) Planch.	*Vitaceae*	Astigena (Gumuz)	Fruit
Bedens Prestinaria (Sch.Bip.) Culfod	*Asteraceae*	Assegetsiya (Berta)	Leaf
Bridelia Scleroneura Muell. Arg.	*Euphorbiacea*	Haragjello (Berta)	Fruit
Crassocephalum rubens (juss.ex Jacq.)	*Asteraceae*	Shekaadona (Berta)	Leaf
Cymbopogon caesiu (Hook. & Arn.) Stapf	*Poaceae*	GnieeraWoni (Berta)	Inflore
Justicia ladanoides Lam.	*Acanthaceae*	Aelangiya (Gumuz)	Leaf
Leonotis nepetifolia (L.) R. Br.	*Lamiaceae*	Angesho (Berta)	Nectar
Ochna leucophloeos Hochst. ex A. Rich.	*Ochnaceae*	Anddha (Gumuz)	Fruit
Olea capensis subsp. macrocarpa (C.A.Wright.) Ve.	*Oleaceae*	Bulumtsee (Berta)	Fruit
Oxytenanthera abyssinica (A. Rich.) Munro.	*Poaceae*	Enta (Gumuz)	Shoots

Adapted from Ermias et al. 2011 (90–122), Wild Edible Plants in Ethiopia: A Review on their Potential to Combat Food Insecurity

administered to respondents through oriented local enumerators and face-to-face techniques as most of them were not able to read and write. Some households who are able to read and write were given the questionnaire to fill it themselves with some assistance from enumerators. The questionnaire was used to collect data regarding the amount of food obtained from both agricultural produce, wild foods, perceived factors affecting dependence on wild foods, and different variables used to estimate household resilience. Key informant interviews were held to secure information about the types of wild foods, the local peoples' dependence on them, and their economic and medicinal values. For this purpose, informants were selected from villages and offices of the districts' department of agriculture and food security. Semi-participant observations had been conducted by the corresponding author of the paper in 2013 until the households had begun to harvest and consume the immature crops such as maize. The objective was to record and understand the types of wild foods and frequency of hunting and gathering them and to understand which ethno-culture group was much engaged in these activities.

Data analysis

Both quantitative and qualitative methods were used to analyze data in a mixed-methods fashion as this paradigm underpins the study. Accordingly, the objective data from questionnaire were first analyzed and interpreted, and then substantiated by data from qualitative sources (i.e. key informant interviews and semi-participant observations) in a sequential way.

Multivariate techniques (i.e. factor analysis and optimal scaling), correlation, and descriptive analysis including cross-tabulations were used to examine the contribution of wild foods to household resilience. For this purpose, statistical package for social sciences (SPSS) version 19 was employed. RI was estimated using the above multivariate techniques based on a number of observed variables iteratively as suggested by Alinovi et al. (2008). These techniques generated eight latent dimensions, IFA indicator being one of them. In fact, some of the observed variables, for example, Household Food Insecurity Access Scale (HFIAS), Coping Strategies Index (CSI), kcal, and dietary diversity scores (DDS) were determined through a complex procedure before running relevant multivariate techniques. The models of multivariate analysis were tested for their appropriateness before deciding to interpret the results. They were tested for sampling Adequacy, sphericity and problems of multicolliniarity and singularity using Kaiser-Meyer-Olkin (KMO hereafter), Bartlett's test of sphericity, and the value of determinant (R^2) respectively. Based on the criteria suggested by Field (2005), all tests showed that the models were appropriate. That is, the sample from which data were collected was adequate (KMO = 0.631), the Bartlett's test of sphericity was significant ($p < 0.001$), and there were no problems of both singularity in the R-matrix and multicollinearity ($R^2 = 0.221$). As a rule of thumb, the KMO statistics should be >0.50 for adequate sample, Bartlett's test of sphericity that shows $p < 0.001$ shows significant level that in turn shows that there is no problem of identity matrix, R-matrix ($R \geq 0.9$) shows problem of singularity, and for multicollinearity to exist, the determinant (R^2) of the correlation matrix should be > 0.00001 (Field 2005). Overall, the multivariate models were appropriate with the data available for the study. As a result, the first factor produced was quite meaningful and used as a latent variable as it fulfils most requirements

mentioned above. All latent dimensions were estimated and determined if and only if they fulfilled these requirements. IFA indicator was one of them through which we examined the contribution of wild foods to household resilience to food insecurity.

All sources of wild foods were used to calculate for each household. This value of wild foods and six other observed variables were analyzed using principal axis factoring method to estimate the IFA index. The variables include HFIAS, kcal, income, CSI, saving, and DDS. The factor analysis generated three factors with eigenvalues greater than 1. The tests of KMO and Bartlett's statistics suggested that the first factor could be used as a representative indicator of IFA. But, the examination of Scree plot suggested that the third factor should be dropped from further analysis because the slope between it and the second factor was gentle and allowed the use of the first and second factors only. However, as the variance explained by both the second and third factors was relatively large enough, three of them were maintained in further estimation process. The three factors together explained about 68 % of the total variance in IFA (Table 2). Correlation analysis was also run in order to examine the magnitude and direction of relationship between each variable and the IFA indicator. Data obtained from key informants and field observations were carefully organized and analyzed to supplement the quantitative results.

Analytical framework

Most variables and latent indicators of resilience are adopted from Alinovi et al. (2008). Few variables such as wild foods, aspiration, and cultural bond were included based on the local context. Amount of wild foods obtained by households from different sources forms the base of the study. Wild foods' contribution to resilience is measured through IFA indicator. IFA is a variable constructed as a composite index of seven variables including wild foods. It is assumed that wild foods are used as, both observed variable constituting the IFA and, latent variable measured from different sources. The overall analytical framework is given below (Fig. 2).

Table 2 Amount of food available from wild and domesticated/cultivated sources[a]

Food Source	Amount produced (kg)					
	Total	% of Total	Mean	Std.	Min.	Max.
Cultivated food*	692277	95.26	3147	2368	0.06	13115
Wild foods	34453	4.74	157	169	0.00	685
Total	726730	100.00	3303	2280	0.06	14610
Net available food	377725	51.98	409	293	0.06	1959

NB: meat of 1 antelope on average = 25kilogram; 1bird on average = 0.5kilogram
1 kg fish = 10fish; 1 'medeb' cattle meat on average = 10 kg
[a]includes own produce, grain purchased and grain borrowed

In order to secure a reliable and valid data, ethical issues were well addressed. The informed consent of each respondent was obtained and their confidentiality was built before the actual interviews were conducted. This was done prior to their participation by explaining the purpose of the study, dispersion of the results, participant rights and risks.

Results and discussion

Amount of wild foods gathered and hunted by households

The study showed that surveyed households had household size of 922.81 in adult equivalent (ADE) with mean size of 4.20. As shown in Table 2, on average surveyed households gathered and hunted 156.61 kg of wild foods per annum/household. This was very small when compared to the average amount of food obtained from agricultural produce (i.e. 3146.7 kg). This constituted about 5 % of the total food obtained from all sources and about 9 % of the net available food for surveyed households during the year. This result is similar with the findings of a study in Tanzania, the sub-Saharan Africa country, where wild fruits constituted about 11 % of food consumed by studied households (Kajembe et al. 2000). Although small in amount, wild foods also contributed well to household resilience to food insecurity (Table 5) as some wild foods have better nutritional contents than cultivated foods. In this regard, semi-participant field observations and key informant interviews showed that most households (mainly the indigenous) did not miss either wild or semi-wild food in their daily meals mainly during summer (rainy season) of Ethiopia. This finding is similar with a previous study in southern Ethiopia where the daily meals of most people comprised an element of wild food (both WEPs and WEAs) during certain periods of the survey year (Dechassa and Guinand 2000). Another previous study indicates that wild foods often have higher contents of important minerals and vitamins than cultivated plant foods (Milton 1999). In similar interpretation, wild foods in our study area had considerable importance in household resilience to food insecurity.

At least three reasons can be mentioned for collection and hunting of small amount of wild foods. First, data were collected on purely wild sources of food (i.e. the semi-wild foods were not considered). Had semi-wild foods been considered, the contribution of wild foods would have been much higher than what was found from purely wild sources. Second, perhaps most households did not report hunting wild animals due to fear of legal prohibitions. This idea goes in line with a previous study which states that most often in a given survey the

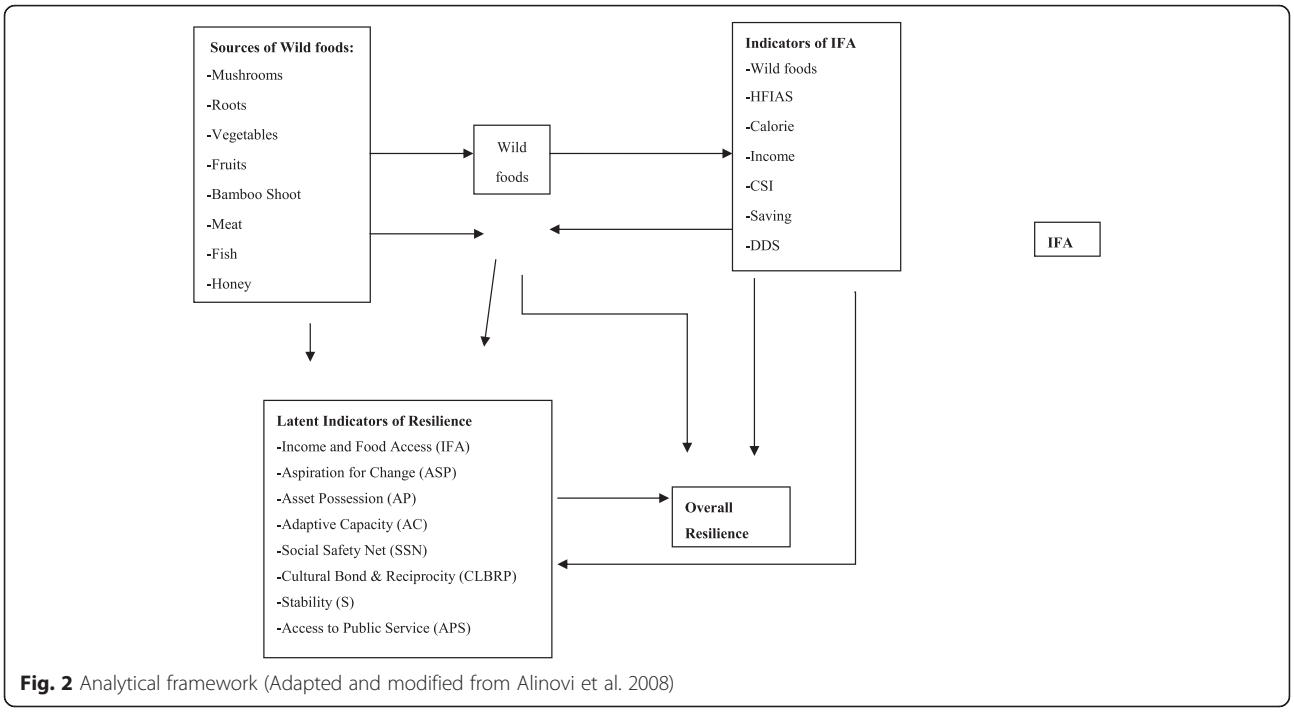

Fig. 2 Analytical framework (Adapted and modified from Alinovi et al. 2008)

amount of wild foods are under-reported perhaps due to hunting forest or bush meat is illegal (Bharucha and Pretty 2010). Third, presently hunting and gathering are perceived as traditionalism and inferiority so that many households might have reserved themselves from fully reporting the amount of wild foods they obtained. By implication if these reasons were removed, the actual amount of wild foods reported by the households would have been considerably higher than what they reported during the survey and their contribution to alleviating nutritional inadequacies and enhancing resilience too.

Household food insecurity and resilience statuses

The study showed that large proportion of households was less resilient to seasonal food insecurity (Table 3). On the resilience-vulnerability continuum, 60 %, 19.1 %, 17.2 % and 3.7 % of households were vulnerable, moderately resilient, resilient and highly resilient respectively. This shows that only 40 % of households were resilient to food insecurity at different levels. Ethno-culture distribution by resilience category showed that more households in the indigenous (65.3 %) than those in the non-indigenous (40.2 %) were vulnerable or less resilient to food insecurity. In contrast, the majority of households in the non-indigenous (62.5 %) were highly resilient to food insecurity than those in the indigenous group (37.5 %). This implies that perhaps the number of resilience-enhancing variables (other than wild foods) was much higher for the non-indigenous than for indigenous households.

The analysis of the resilience-vulnerability continuum shows that 60 % of households in both ethno-culture groups were vulnerable to food insecurity. This finding is higher than the level of food insecurity in Ethiopia where on average about 44 % of households were food insecure (Haan et al. 2006). It is almost the same as the results in BGR. Food insecurity status in BGR as a whole where the study area is located and in Bullen district located in BGR was 58.1 % (Benishangul-gumuz Region [BGR] 2004) and 58 % (Guyu 2014) respectively. One parallel data used to analyze food insecurity in Belo-jiganfoy district based on measure of kcal revealed that 71.8 % of households were food insecure (Guyu2015; Ferede and Muluneh 2015). This study also indicated that food insecurity was more severe in the *green famine belt* than in the drought-prone and high population density areas of the country. For example, while 60 - 71 % of households were food insecure in Belo-jiganfoy district, about 21.09 % (Messay 2013) and 42.3 % (Tsegay 2009) of households were food insecure in the central Ethiopia (Nonno district, Shewa) and in northern Ethiopia (Tigray region), the former being high population density area and the later being drought-prone area. In this regard, the traditional focus on drought-prone and high-density areas of Ethiopia by overlooking famines masked by green environmental conditions in the western half of the country may not bring long-lasting solutions for household food insecurity. This implies that researchers and policy makers must equally focus on the green famine belt if all-encompassing and sustainable solutions to food insecurity problems are to be brought.

Table 3 Household resilience status by resilience category and ethno-culture group

Ethno-culture Group	Within ethno-culture/ resilience category	Household Resilience Status				Total (%)
		Vulnerable (RI < 0.10, %)	Moderately-res. (0.10 ≤ RI < 0.25, %)	Resilient (0.25 ≤ RI < 0.50, %)	Highly-resilient (RI ≥ 0.50, %)	
Indigenous	Within-ethn	65.3	18.2	14.0	2.5	100
	Within-resil	59.8	52.4	44.7	37.5	55
	Total	35.9	10.0	7.7	1.4	55
Non-indigenous	Within-ethn	53.5	20.2	21.2	5.1	100
	Within-resil	40.2	47.6	55.3	62.5	45
	Total	24.1	9.1	9.5	2.3	45
Total	Within-ethn	60.0	19.1	17.3	3.6	100
	Within-resil	100.0	100.0	100.0	100.0	100
	Total	60.0	19.1	17.2	3.7	100

Contribution of wild foods to household resilience to food insecurity via IFA

The IFA index was estimated as average score of the three factors generated through factor analysis (Table 4). The three factors together explained about 68 % of the total variance in IFA. The following simple empirical model was used to estimate IFA:

$$\text{IFA} = 0.3644 \times \text{Factor1} + 0.1617 \times \text{Factor2} + 0.1534 \times \text{Factor3}$$

The results of factor analysis indicated that the contribution of wild foods to IFA was large enough (Table 5). The proportion of variance accounted for in wild foods by the rest of the variables (as indicated by initial communality = 0.170) and by the factors in the factor solution (communality after extraction = 0.226) were acceptable. Accordingly, 17 % of the variance in wild foods was shared by the rest of the variables. This shows that wild foods were associated with the rest of the variables in the process of detecting the structure towards estimating the IFA index. Similarly, 22.6 % of the variance in wild foods was shared by the factors generated in the factor solution indicating their moderate contribution to IFA. The factor loading of 0.467 as captured by Factor2 showed that wild foods had significantly contributed to IFA. This goes in line with a previous finding by Dechasa and Guinand (2000) in southern Ethiopia where wild food constituted daily meals for the majority of households.

The result of correlation analysis showed that there was direct and significant association between wild foods and IFA (r = 0.174) (Table 5). This shows that a unit increase in wild foods increased the IFA score by 0.174. In fact all variables except DDS were significantly correlated with IFA. The relatively lower coefficient (r) was perhaps due to the fact that data collected for this paper was based on purely wild foods intentionally ignoring the semi-wild ones.

Type of wild foods and their contribution to household resilience

The study identified eight major types of wild foods consumed in the study area (Table 6). This may help to

Table 4 Results of factor analysis: Factors in the factor solution and the statistics

Statistics	Factors in the Factor Solution			
	Results	Factor1	Factor2	Factor3
Initial Eigenvalues	Total	2.55	1.13	1.07
	Variance (%)	36.44	16.17	15.34
	Cum. (%)	36.44	52.60	67.94
Extraction Sums of squared Loadings	Total	2.20	0.68	0.56
	Variance (%)	31.41	9.71	7.94
	Cum. (%)	31.41	41.11	49.05
Rotation Sums of squared Loadings	Total	1.63	1.17	0.63
	Variance (%)	23.29	16.76	9.01
	Cum. (%)	23.29	40.04	49.05

Extraction Method: Principal Axis Factoring

Table 5 Communalities, factor loadings and correlation coefficients (*r*) with IFA

Indicators of IFA	Communalities		Factors & Loads			Correlation (*r*)
	Initial	Extraction	1	2	3	
WEFs (quintal/hh/year/)	0.170	0.226	−0.055	0.467	−0.070	0.174[a]
HFIAS scores	0.535	0.952	−0.880	0.343	0.245	−0.457[a]
Kilocalorie/ADE/day	0.486	0.573	0.741	−0.035	0.150	0.743[a]
Income/ADE/year	0.324	0.424	0.405	−0.339	0.381	0.402[a]
CSI Score	0.363	0.733	−0.181	0.836	−0.047	0.287[a]
Saving (birr/ADE/year)	0.229	0.498	0.324	−0.151	0.609	0.581[a]
DDS (No. meal/hh/day)	0.049	0.027	−0.040	−0.002	0.158	0.051

Extraction Method: Principal Axis Factoring
[a]Significantly correlated

emphasize, when formulating policy and strategies for intervention, on relevant ones that were frequently consumed. In the sub Sahara Africa, for example, in South Africa, wild vegetables have important contributions to household food security mainly among the poor in rural areas (Mavengahama et al. 2013). This seems true in our study area where 52.4 % of the total amount of wild foods came from wild vegetables. The amount of wild vegetables was about 5 times higher than the second and third large contributors: wild fruits and roots, each constituting 11.6 % and 10.6 % respectively. This goes in line with a previous study conducted in semi-arid part of Ethiopia where WEPs were found to play significant role in household food security (Debela et al. 2011). The fact that wild vegetables were easily obtainable and palatable as well as they have good taste and are also important sources of vitamins (Kajembe et al. 2000) implies that they had contributed to households' nutritional security. Wild fruits and roots were reported by 55.9 % and 49.9 % of households. They were followed by the amount obtained from wild meat (7.7 %), mushrooms (5.9 %), fish (5.6 %), bamboo shoots (3.6 %), and honey (2.8 %). These were reported by 46.4 %, 60.5 %, 48.2 %, 29.5 % and 25 % of households respectively.

A previous study indicated that in some African countries significant portion of protein is obtained from wild meat. For example, in Cameroon more than 98 % of animal protein consumed came from bush meat (Muchaal and Ngandjui 1999). In contrast, our study showed that wild meat was very small (7.7 % of the total amount of wild foods) although large proportion (46.4 %) of households reported their dependence on it. Another previous study indicated that 41 % of surveyed plants in Debub Omo Zone belonged to vegetables (Teklehaymanot and Mirutse 2010). This was less than our finding (i.e. 52.4 %) showing that dependence on wild vegetables was high in the western than the southern Ethiopia. The study showed that larger proportion of households in the indigenous ethno-culture group reported their dependence on wild foods than the non-indigenous ones (Table 6). Honey was reported only by indigenous group because, as field observation showed, almost all non-indigenous households that reported honey production depended on traditional beehives rather than depending on wild source. A previous study indicated that the range of animal species eaten by man includes birds and their eggs, insects, rodents, fish, and larger mammals and the nutritional content of wild meat is comparable to domestic meat (Kajembe et al. 2000). By implication,

Table 6 Amount of wild foods by type and % of households depended on them

Types of wild foods	Amount (kg)	% of total amount (%)	Households reported their dependence on wild foods (of 100 %)		% of households depended on WEF (*N* = 220, %)
			Indigenous (%)	Non-indigenous (%)	
Mushroom	2095.25	5.9	75.9	24.1	60.5
Roots	3595.95	10.4	89.9	10.1	49.5
Vegetables	18043.50	52.4	73.8	26.2	64.1
Fruits	3982.30	11.6	79.7	20.3	55.9
Bamboo shoot	1235.30	3.6	98.5	1.5	29.5
Meat	2647.70	7.7	80.4	19.6	46.4
Fish	1915.00	5.6	76.4	23.6	48.2
Honey	968.00	2.8	100.0	0.0	25.0
Total	34453.10	100	55.0	45.0	100.0

although the amount of wild foods was much smaller than food from domesticated sources, their role in combating nutritional insecurity was high in our study area.

Local perception on human health and wild foods Nexus

There was a strong believe, mainly by the indigenous people, that wild foods have better capacity to maintain good health conditions for those who depend on them. They attributed the recent increased incidence and frequency of sickness of their family members to the shortage of wild foods. Regarding this, a key informant in Soge village stated the following: "The cause of my sickness is the shortage of wild foods, especially meat. Formerly, wild animals were easily obtained in our back yard, killed easily, and eaten. Today, one must walk 3 to 4 h to see an antelope because the land is deforested," (Mr. Mesha, April 2013). This is similar with the findings of a previous study on collectors in Botswana who often travelled 100 km in order to obtain caterpillars for food (Illgner and Nel 2000).

Mesha was an elderly man (belongs to Gumuz ethnicity, one of the indigenous ethno-culture groups) in his 60s who had been persistently sick due to what is locally known as *berd-beshta,* literally means sickness due to cold weather condition. Mesha and his older son, Tesfaye Mesha, visited many health centers and hospitals for treatment. But, Mesha had not recovered from his sickness. The researchers tried to understand the reasons based on the way the father and his son perceived it. Both believed that lack of wild meat caused the sickness explaining that formerly one did not miss at least a dried wild meat in kitchen. The reasons for decreased consumption of wild meat, according them, were two. First, wild animals had been forced to migrate far into remote areas due to increased deforestation. Second, hunting the available mammals had been banned legally although people had continued to practice it in a hidden manner. The perceived medicinal values of wild foods reported in our study area go in line with the findings of many previous studies. A previous study conducted in Lebanon showed that wild foods were perceived to cure most diseases of human beings (Batal et al. 2007). Another study showed that blue-green algae were used as a source of both food and medicine in Chad and China (FAO 2008). Similarly, another study showed that many chronic diseases affecting humans in modern technologic societies were related to declining and altering trends in traditional diets including wild foods (Milton 1999). Therefore, we can generalize that local people's perception of wild foods in the study area corresponds with the perception of many people around the world who depend on forest for food. However, scientific investigation of the curative ability of the wild foods is still awaiting further research.

Perceived factors determining Household's dependence on wild foods

Households were asked about their perception about factors that determined the level of their dependence on wild foods (Table 7). The factors were proposed after field observations and key interviews were conducted with some villagers and office workers of the district. The large proportion (38.6 %) of households perceived *reduced source* as a reason for their low level of dependence on wild foods. This was followed by *it was not our culture* (20 %), *hunting and gathering are legally banned* (19.5 %), *wild foods have currently vanished* (17.8 %) and *crop produced is enough* (12.3 %). The overall observation of these finding indicated that households had the desire to continue to gather and hunt wild foods but the amount they obtained was very low due to the above reasons.

The study also revealed that there were differences between the ethno-culture groups about the perceived factors. As indicated in Table 7, 4.1 % of households in the indigenous group as compared to 8.2 % of them in the non-indigenous group reported that crop produced was enough so that they were less dependent on wild foods. Overall, lesser proportion of the indigenous (11.2 %) than the non-indigenous (34.1 %) ethno-

Table 7 Perceived factors determining dependence on wild foods by ethno-culture group

Reasons for Low level of Dependence on wild foods ($N = 220$)	Ethno-culture Group				Total	
	Indigenous		Non-indigenous			
	No.	%	No.	%	No.	%
Crop Produce is enough	9	4.1	18	8.2	27	12.3
Reduced Source of wild foods	31	14.1	54	24.5	85	38.6
Hunting & gathering are legally banned	14	6.4	29	13.2	43	19.5
Wild foods have currently vanished	12	5.5	26	11.8	38	17.8
It is not our culture	2	0.9	42	19.1	44	20.0
Total frequency (Responded *yes*)	68	11.2	169	34.1	237	21.5
Grand total frequency (*yes* + *no*)	605	55.0	495	45.0	1100	100.0

culture groups reported one or more of the five reasons for their low level of dependence on wild foods. This implies that perhaps indigenous households were engaged in gathering and hunting all times of wild foods while the non-indigenous often practice these activities following food insecurity shocks.

Conclusion

This paper examined the contribution of wild foods to household resilience to food insecurity in the *green famine belt* of Ethiopia taking Belo-jiganfoy district as a case study area. Although the amount gathered and hunted was very small, the high level of factor loading and significant correlation show that wild foods had considerably contributed to household resilience to food insecurity. The fact that more than half of the wild foods were obtained from wild vegetables implies that they were more abundant than other types during the survey year. The study also revealed that while the contribution of wild foods to human health is significant, the declining dependence on them had caused some health problems which cannot be cured through modern medical treatments, which is also similar with the understanding of forest communities around the world. Although the indigenous households were more actively engaged in wild food collection and hunting, more non-indigenous households (62.5 %) than the indigenous group (37.5 %) were resilient to food insecurity. This implies that perhaps the number of resilience-enhancing practices (variables) other than wild foods was higher for the non-indigenous than for indigenous households. The fact that the majority of households (56.4 %) reported *reduced sources of wild foods (38.6 %)* and *wild foods have currently vanished (17.8 %)* as reasons for their low level of dependence on wild foods implies that households in the study area wanted to rely on wild foods for making their living but such a desire was affected by diminishing and vanishing sources of wild foods. Generally, we concluded that wild foods contributed to household resilience to food insecurity although the amount reported was much less than what was eye-witnessed during semi-participant field observations. Thus, we recommend that a policy that integrates strategies that can ensure sustainable food security and forest development (and hence wild foods) should be formulated and implemented if the overall national goal of ensuring food security is to be achieved.

Abbreviations

ADE: Adult equivalent; BGR: Benishangul-Gumuz Region; CSI: Coping strategies index; DDS: Dietary diversity score; HFIAS: Household food insecurity access scale; IFA: Income and food access; KMO: Kaiser-Meyer-Olkin; RA: Resilience approach; RI: Resilience index; SPSS: Statistical package for social sciences; WEAs: Wild edible animals; WEPs: Wild edible plants.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

The corresponding author conceived the study and supervised data collection, performed statistical analysis, and drafted the manuscript. Both authors critically read and revised the draft manuscript and approved the final version.

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