

Nutrition-Sensitive Agriculture in Ethiopia: Effects of Production and Livelihood Diversification on Dietary Diversity of Women of Reproductive Age in Southwestern Oromia, Ethiopia

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Abstract

This study examined the effects of agricultural production and livelihood diversification on women's dietary diversity in southwestern Oromia, Ethiopia. Data were collected from women of reproductive age in 355 households. Descriptive statistics and binary logistic regression were used to analyze the data. Approximately 45.6% of women reached their minimum dietary diversity requirement. Production diversification, household contact with development agents and the use of improved technologies like cooking machines, refrigerators and crop storage positively influenced women's dietary diversity. The findings imply that development practitioners, offices of agriculture, nutrition and health sectors at different levels could prioritize these factors to enhance the dietary diversity of women.

Keywords: Dietary diversity, Ethiopia, Livelihood diversification, Nutrition sensitive agriculture, Production diversification, Women

Introduction

Food self-sufficiency and the consumption of diverse food are the aims of all individuals, households, and national and international nutrition strategies. Agriculture and nutrition are intrinsically interlinked. To these ends, worldwide commitment and interest in supporting nutrition through nutrition-sensitive agriculture (NSA) are growing across multiple sectors of developing countries (Ruel *et al.*, 2018). Many African countries are implementing nutrition-sensitive agriculture strategies that aim to increase the availability of nutrient-dense foods by maximizing agriculture's contribution to nutrition (Ruel *et al.*, 2017). Nutrition-sensitive agriculture is an approach that seeks to ensure the production of a variety of affordable, nutritious, culturally appropriate and safe foods in adequate quantity and quality to meet the dietary requirements of populations in a sustainable manner (FAO, 2017)

Ethiopia launched the country's first National Nutrition Program (NNP) in 2008 with the goal of ensuring that all Ethiopians are able to achieve adequate nutritional status in a sustainable way (Kennedy *et al.*, 2015). Since then, a number of NSA programs and strategies, such as the Scaling Up Nutrition

(SUN), the Sequota Declaration of 2015, which was in line with Sustainable Development Goals (SDGs), the second Growth and Transformation Plan (GTP II), the Productive Safety Net Program (PSNP), the Agriculture Growth Program (AGP) and Sustainable Undernutrition Reduction (SURE), have played a significant role in the country. Despite significant progress over the past two decades in the country, the contribution of agriculture to human nutrition has been inadequate (Degye *et al.*, 2013), indicating that previous agricultural strategies, programs, and projects have not fully emphasized agricultural production diversification as a means of diet diversification.

To this end, the use of the NSA is prioritized as an effective approach for improving Ethiopian nutritional status through agriculture. The NSA strives to ensure year-round availability, access and consumption of diverse, safe and nutritious foods; sustain agriculture; and overcome malnutrition and its consequences. It is often assumed that livelihood diversification, which is the adoption of income-earning activities outside the range of conventional crop and livestock enterprises associated with agriculture, would enhance the income of smallholder farm households and thereby their capacity to obtain access to food or crop diversification to be a good strategy to improve nutrition, but the evidence is mixed (Sibhatu and Qaim, 2018). Estrada-Carmona *et al.* (2020) reported that on-farm production diversity is perceived as an effective approach for improving smallholders' dietary diversity and nutrition. Nonetheless, their finding was contested by Sibhatu and Qaim (2018) after analyzing 45 original studies that indicated a positive but small average marginal effect of production diversity on dietary diversity. On the other hand, there is a growing consensus that rural livelihoods should not be based only on agricultural production Chapman and Tripp (2004); hence, rural households are looking for more diverse opportunities to increase and stabilize their consumption needs and to enhance their livelihoods (Ellis, 2000). The findings of Abera *et al.* (2021), who piloted projects in southwestern Ethiopia, indicate that engaging in a mix of various portfolios of activities, including agricultural production, is the prioritized solution suggested to ensure food and nutritional security, reduce poverty and improve welfare in rural areas.

Traditionally, it is believed that the rural economy is purely agriculture-based and off-farm activities as a low-productivity sector (Barrett *et al.*, 2001). Sibhatu *et al.* (2015) suggested that increasing on-farm diversity is not always the most effective way to improve dietary diversity in smallholder households. Thus, rather than only focusing on what households produce (i.e., what food groups do they grow), attention should also be given to what they do to obtaining the diverse types of food they consume. Numerous studies (Hirvonen and Hoddinott, 2017; Sibhatu *et al.*, 2015) have investigated the relationship between agricultural production and dietary diversity, whereas many other empirical studies

(Woldemariam *et al.*, 2015; Endalifer *et al.*, 2021; Aliwo *et al.*, 2019) conducted in the country and in the study areas have focused on general factors associated with dietary diversity (Jebessa *et al.*, 2019). However, studies capturing the status of agricultural production diversification and non-agricultural livelihood activity diversification and their influence on women’s dietary diversity parameters from the NSA perspective are rare.

The lack of timely and comprehensive information on nutritional status across critical life stages and its determinants is a bottleneck that hinders the effectiveness of nutrition-sensitive interventions. The contribution of this study is twofold. First, it expands on the available literature by investigating the status of agricultural production diversification, non-agricultural livelihood diversification, and dietary diversity of women of reproductive age in the study areas. Additionally, this study unpacks the effects of agricultural production diversification and non-farm livelihood diversification on the dietary diversity of women of reproductive age. This is very useful given that women in the study areas face social and cultural barriers to obtaining equal access to their male counterparts (Hiruy *et al.*, 2023). Second, the study was conducted in one of the United Nations Educational, Scientific and Cultural Organization (UNESCO) registered biosphere areas, which is described as “resource rich but livelihood poor” that is dominated by traditional agriculture characterized by low productivity. Therefore, this study aimed to examine the effects of production and livelihood diversification on dietary diversity of women of reproductive age in the context of nutrition sensitive agriculture in the study area. To understand the relationship among the different factors, the conceptual framework of the study was presented in Fig 1.

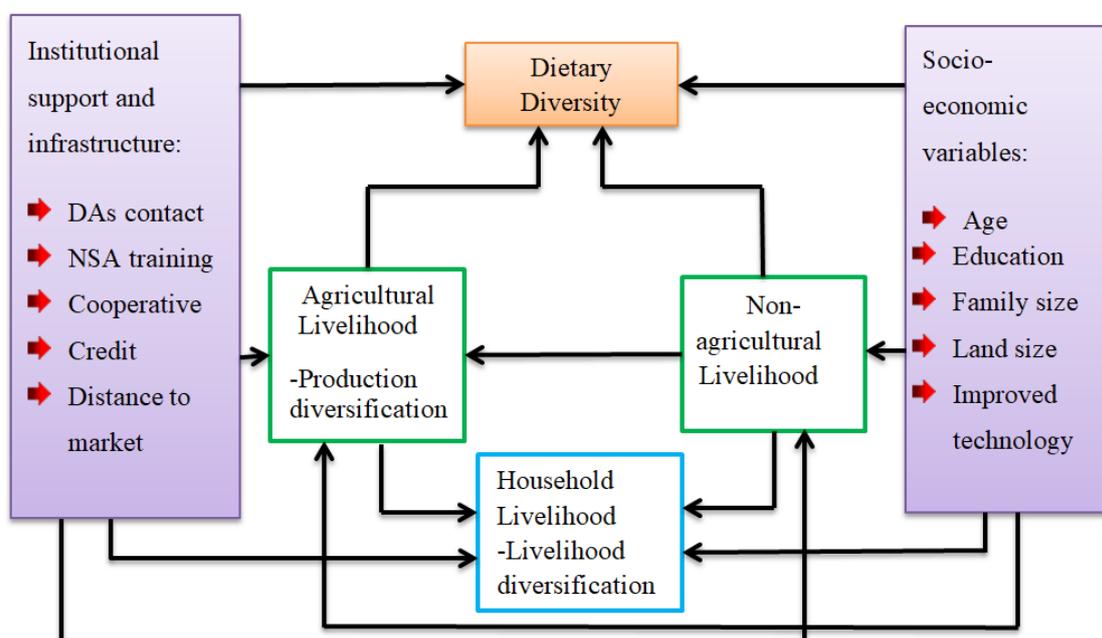


Figure 1: Conceptual Framework (Source: Author’s Conceptualization)

Materials and Methods

Study Area

The study was conducted in two selected districts, Yayu in the IluAbabor Zone and Chora in the Buno Bedele Zone of southwestern Oromia, Ethiopia (Fig. 2). The IluAbabor and Buno Bedele zones were selected based on their suitability to study the nexus between production and livelihood diversification and women's dietary diversity from the perspective of NSA. These two zones are also part of the Yayu Coffee Forest Biosphere Reserve (YCFBR). This study targeted the YCFBR because mixed and diversified resources as well as different livelihood activities, such as agricultural and non-agricultural activities, are abundant in the study area.

The YCFBR was registered by the United Nations Educational, Scientific and Cultural Organization (UNESCO) in 2010 as a biosphere reserve for the in situ conservation of wild Coffee Arabica, and it covers approximately 168,000 ha (Gole *et al.*, 2009). The area is also of cultural and historical significance since it possesses many archaeological sites, ritual sites, caves and Gaba waterfalls.

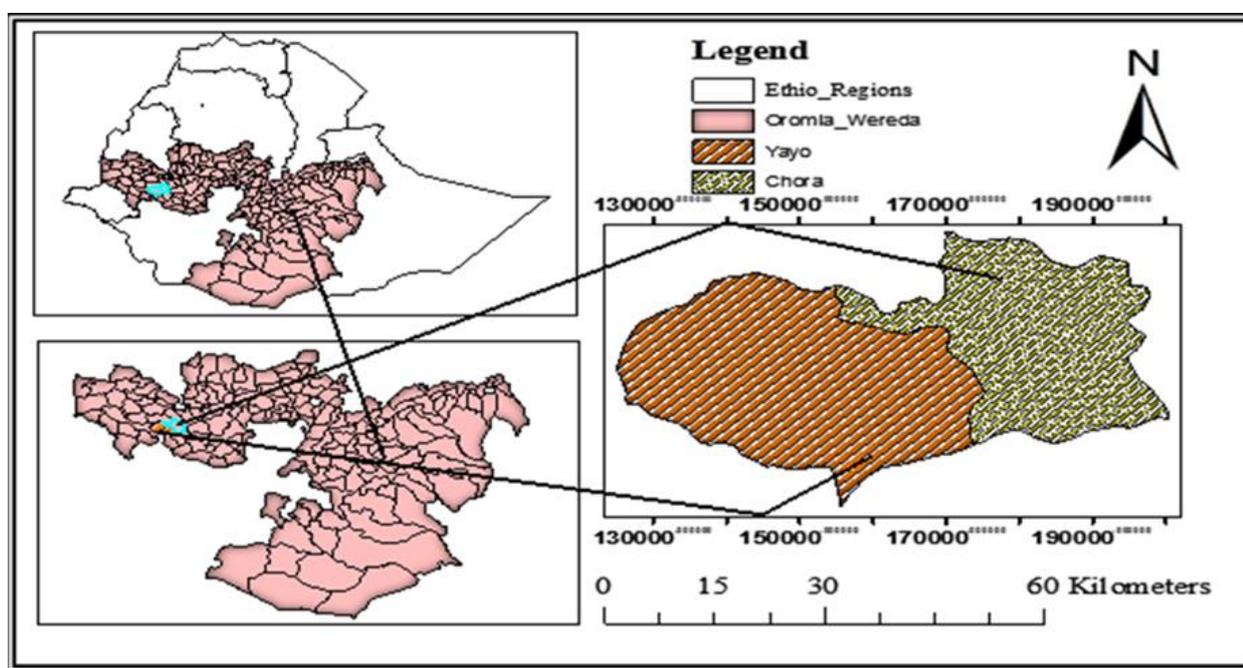


Figure 2: Map of the Study Areas; Source: Own Sketch

Study design and data

A cross-sectional research design was used to collect data from a number of respondents at a time to generate information and address the specific objectives. This study targeted all smallholder farming households with women of reproductive age (15 to 49 years old) who lived in the study area for at least one year prior to the assessment. A multistage sampling procedure was used to identify the respondents. In the first stage, the IluAbabor and Buno Bedele zones were purposively selected because they are rich

in diverse resources and agricultural and non-agricultural livelihood activities. Two districts, Yayu from the IluAbabor zone and Chora from the Buno Bedele zone, were selected for the YCFBR. Second, to ensure representation, all kebeles (where the kebele is the lowest administrative unit in Ethiopia) in the two districts were stratified into three groups: highland, midland and lowland agro-ecologies, in consultation with the respective district agricultural experts. Then, two kebeles were randomly selected from each stratum. Then, the list of households in each of the six selected kebeles was collected, and the households with reproductive-aged women were identified. Finally, 355 households were randomly selected from the list following a probability proportional to the population size of households in each kebele.

The data were collected using a structured questionnaire consisting of four main sections: socio demographic characteristics, land and agricultural production, non-agricultural livelihood activities plus other sources of income, and food- and consumption-related questions. The quantitative data were collected from 355 women of reproductive age at their private places. The questionnaire was prepared in English and then translated to the local language, *Afaan Oromoo*. Prior to data collection, the questionnaire was pretested with similar households that were not part of the final sample. The data were collected by eight enumerators. All of them are researchers in different departments at Bedele Agricultural Research Center. Even though they are familiar with the study area and data collection process, half-day training was provided on May 13, 2022, by the researchers on data collection procedures, ethics in data collection, and each section and question of the questionnaire to ensure data quality. The survey lasted an average of 45 minutes. Prior to data collection, ethics approval was obtained from Jimma University College of Agriculture and Veterinary Medicine Research and Ethical Review Board with the letter of ethical clearance (Ref. No.R/GS/6762022).

To triangulate the findings from the quantitative data, qualitative data were collected from six focus group discussions (FGDs) at their respective kebeles, and eight key informant interviews (KIs) were conducted with district agricultural experts, kebele administrations, development agents (DAs) and health extension workers (HEWs). FGD topics were used to facilitate one focus group discussion (FGD) that consisted of six women of reproductive age in each kebele. The KIs were conducted using a key informant interview checklist at district-level agricultural offices for district-level experts, kebele-level farmer training centers for DAs, health post offices for HEWs and kebele administration centers for kebele managers.

Measurements

The production diversity was measured by counting the number of crops and livestock species produced by the farm households. The species richness or count indicator does not discriminate crops based on how much land they occupy; rather, it considers trait differences to be the most important element for diversity. Hence, the non-weighted count of all crop and livestock species produced on a farm as one measure of production diversity was used for this study. Similarly, livelihood diversity was measured using a simple count index, which provides a parsimonious approach to examining diversity in livelihood activities, as illustrated in existing studies (Minot, 2006; Michler and Josephson, 2017; Waha *et al.*, 2018). Accordingly, different livelihood activities engaged in by women of reproductive age and their families in the study areas were grouped into productive activities such as on-farm (crop and livestock), off-farm, non-farm and nonproductive sources of income such as public transfer and remittance.

Women's dietary diversity was assessed through qualitative 24-h dietary recall data. Using a multiple-pass method, mothers were first asked to spontaneously recall all dishes, snacks, drinks, and other foods they had consumed from the time they woke up to the same time of the following day. At the second pass, women were asked to describe the exact composition of all dishes they had eaten. For each food item or beverage consumed by the respondents, the enumerators probed for additional details on food items such as consumption time (breakfast, lunch, dinner, mid-morning or afternoon snack), place of consumption (home, away from home), and method of cooking (boiling, frying, stewing or raw).

Food items were coded directly in the field by the enumerators and under the close supervision of the researchers and classified into a predefined list of 16 food groups, which were later further aggregated into 10 food groups (FAO, 2016): 1) grains, white roots and tubers, and plantains; 2) pulses (beans, peas, and lentils); 3) nuts and seeds; 4) dairy; 5) meat, poultry, and fish; 6) eggs; 7) dark green leafy vegetables; 8) other vitamin A-rich fruits and vegetables; 9) other vegetables; and 10) other fruits. The 24-h recall of women's information was used to generate a dietary diversity score, which is a continuous variable ranging from 1 to 10 food groups, and the minimum dietary diversity of women (MDD-W) was derived as a dichotomous variable that equals 1 if the woman consumed at least 5 different food groups during the past 24 h and 0 otherwise.

Women who achieve minimum diet diversity (consuming foods from 5 or more food groups) are expected to have a greater likelihood of meeting their nutrient needs than women who consume foods from fewer food groups. Using a dichotomous indicator with an established cutoff value makes it possible to calculate the prevalence of women who achieve minimum dietary diversity, which has

important operational implications. Based on the minimum dietary diversity for women (MDD-W), the respondents were classified as having either high or low dietary diversity status by considering a number of demographic, socioeconomic and institutional factors that are expected to influence the dietary diversity of women of reproductive age in the study area.

The variable types, units of measurement, expected signs and important citations used for hypothesizing the direction of the effects of individual and household demographic and socioeconomic characteristics, and infrastructure and institutional factors are summarized in Table 1.

Table 1. Summary of variable type, measurement, hypothesis and important literature used for determining their effects on dietary diversity

No	Variables	Type	Unit of measurement	Expected Sign	Major citations
Dependent variable:					
	Women dietary diversity score	Dummy	= 1 if high dietary diversity and 0, otherwise		
Explanatory variables					
1	Production diversification	Continuous	Number	+ve	(Tesfaye and Tirivayi, 2016)
2	Livelihood diversification	Continuous	Number	+ve	(Harris-Fry <i>et al.</i> , 2015)
3	Age	Continuous	Years	+ve	(Jebessa <i>et al.</i> , 2019)
4	Family size	Continuous	Number	-ve	(Huluka and Wondimagegnhu, 2019)
5	Education level	Continuous	Years schooling	+ve	(Fanzo <i>et al.</i> , 2017)
6	DAs contact	Continuous	Number	+ve	(Gondwe <i>et al.</i> , 2017)
7	Land size	Continuous	Hectare	+ve	(Kiboi <i>et al.</i> , 2017)
8	Market distance	Continuous	Kilometer (km)	+ve	(Belew <i>et al.</i> , 2017)
9	NSA training	Dummy	1 if they attend and 0 otherwise	+ve	(Tesfaye and Tirivayi, 2016)
10	Use of improved technology	Dummy	1 if they used and 0 otherwise	+ve	(Harris-Fry <i>et al.</i> , 2015)
11	Cooperative members	Dummy	1 if they are members and 0 otherwise	+ve	(Adjimoti and Kwadzo, 2018)
12	Access to credit	Dummy	1 if they Accessed and 0 otherwise	+ve	(Ahmed and Abah, 2014)

Source: Summarized from empirical review.

Data Analysis

All analyses were conducted using STATA version 15. Descriptive statistics such as frequency, percentage, mean, and standard deviation; inferential statistics such as t tests and chi-square (χ^2) tests;

and logistic regression were used for data analysis. The descriptive statistics were used to describe the statuses of production, livelihood and dietary diversity as well as the household demographic and socioeconomic, infrastructure and institutional characteristics, whereas inferential statistics were used to compare those variables between households with high dietary diversity and low dietary diversity. Given that the dependent variable was binary, logistic regression was used to analyze the effects of production & livelihood diversity & other factors on the dietary diversity of women of reproductive age.

Results

Table 2 presents the summary statistics of the continuous variables. It provides the status of production and livelihood diversification, individual and household demographic and socioeconomic characteristics, and infrastructure and institutional factors that are expected to affect women's dietary diversity and compares them between women with high and low dietary diversity. The mean production diversification (crop and livestock production) for the average households was 5.7, with a non-farm livelihood diversification of 0.7. The average age of the respondents was 31 years, with an average education level of 3.6 years, average family size of 4.8 adult equivalents, average land holding size of 1.1 ha, average contact with the development agent of 1.4 and average distance from the nearest market of 8.8 kilometers.

Significant differences were observed between women with high and low dietary diversity with respect to production diversification. The independent t-test results showed that the mean production diversification for women with high dietary diversity (6.5) was significantly greater than that for those with low dietary diversity (5.0), whereas there was no difference in terms of non-farm livelihood diversification. Women with high dietary diversity are also slightly older than those with low dietary diversity. Households of women with high dietary diversity have significantly larger land sizes (1.3 ha) than their counterparts (0.9 ha). Additionally, households with women of high dietary diversity have greater contact with development agents (1.8) than households with women of low dietary diversity (1.2).

Table 2. Summary statistics of continuous variables of factors affecting the dietary diversity of women of reproductive age (n= 355)

Variables	All sample households		Low DD		High DD		Mean Difference	t-value	p-value
	Mean	SD	Mean	SD	Mean	SD			
Production diversification	5.7	3.62	5.0	3.33	6.5	3.79	-1.50	-3.97	0.00***
Livelihood diversification	0.7	0.98	0.7	1.03	0.6	0.90	0.08	0.81	0.42
Age	30.9	8.75	30.2	8.47	31.8	9.03	-1.62	-1.74	0.08*
Education	3.6	3.42	3.6	3.43	3.6	3.43	0.04	0.10	0.92
Family size	4.8	1.86	4.8	1.90	4.8	1.81	-0.03	-0.14	0.89
Land size	1.1	1.45	0.9	1.04	1.3	1.79	-0.41	-2.70	0.01***
DAs contact	1.4	1.65	1.2	1.57	1.8	1.70	-0.62	-3.55	0.00***
Distance to market	8.8	5.68	8.6	5.65	9.1	5.72	-0.48	-0.79	0.43

*** $p < .01$, * $p < .1$, denote significance at the 1% and 10% probability levels, respectively.

Source: Survey result and author's computation

Table 3 presents the summary statistics of categorical variables and compares them between women with high and low dietary diversity. The results indicated that only 19.4% of the respondents participated in at least one of the training related to production, livelihood and dietary diversity. Approximately 15.8% of them used time- and energy-saving technologies, 7.6% were cooperative members, and 5.6% had access to credit.

Some significant differences were observed between women with high and low dietary diversity. Although not statistically significant, a greater proportion of women with high dietary diversity (21%) participated in the training than women with low dietary diversity (18.1%). A greater proportion of women with high dietary diversity (24.1%) than women with low dietary diversity (8.8%) used improved time- and energy-saving technologies. The difference between the two groups was significant ($X^2 = 15.45$, $df = 1$, $p < 0.001$). Similarly, a greater proportion of women with high dietary diversity were cooperative members (11.1%) than women with low dietary diversity (4.7%) ($X^2 = 5.21$, $df = 1$, $p < 0.05$).

Table 3. Descriptive statistics of dummy variables of factors affecting the dietary diversity of women of reproductive age

Dummy variables		Status of Dietary Diversity		Total	X ² - value	
		Low dietary diversity	High dietary diversity			
NSA training	No	158(81.9%)	128 (79%)	286 (80.6%)	0.00***	
	Yes	35 (18.1%)	34 (21%)	69 (19.4%)		
Technology	No	176(91.2%)	123 (75.9%)	299 (84.2%)		
	Yes	17 (8.8%)	39 (24.1%)	56 (15.8%)		
Cooperative	No	184(95.3%)	144 (88.9%)	328 (92.4%)		0.02**
	Yes	9 (4.7%)	18 (11.1%)	27 (7.6%)		
Credit	No	184(95.3%)	151 (93.2%)	335 (94.4%)	0.39	
	Yes	9 (4.7%)	11 (6.8%)	20 (5.6%)		
Total		193(100%)	162 (100%)	355 (100%)		

*** $p < .01$, ** $p < .05$, denote significance at the 1% and 5% probability levels, respectively

Source: Authors' computation from survey (2022)

The status of production and livelihood diversification and dietary diversity

The status of production diversification

Crop production

A summary of the proportions of households participating in the production of different crops is presented in Table 4. More than 90% of the study samples were crop producers. The produced crops were grouped into five groups: cereals, pulses, vegetables, fruits and cash crops, where about 79.4% of the respondents were cereal crop producers, 76.3% were cash crop producers and 44.5% were fruit producers. 5.1% and 14.9% of the respondents produced pulses and vegetable crops, respectively. The cereal crop species produced by the respondents were maize, sorghum, teff, wheat, barley and finger millet; pulses such as faba beans, peas and haricot bean; vegetables such as cabbage, potato, sweet potato, taro and hot pepper; fruits such as banana, avocado, mango, papaya, orange, lemon, Kashmiri, pineapples, gishta and jackfruit; and cash crops such as coffee, khat and sugarcane.

Table 4. Categories of crops produced by the respondents in the study areas (N= 355)

Crop production	Percentage (%) of respondents
Cereals crops	79.4
Pulses crops	5.1
Vegetables crops	14.9
Fruits crops	44.5
Cash crops	76.3

Source: Authors' computation from survey (2022): *The total percentage (%) of the respondents was greater than 100 due to multiple responses or the existence of households that produced the same crop species in the study area.*

Livestock production

The livestock species produced in the study area were cattle (ox, milking cow, calve), equines (donkey, mule, horse), small ruminants (goat, sheep), poultry (chicken) and apiculture (honey beehives). Three-fourths (75%) of the respondents owned livestock, whereas the remaining 25% did not. Chicken, milking cows and oxen were among the major livestock produced by the sampled households, being produced by 52.1%, 36.6% and 35.8% of households, respectively, whereas mules, donkeys and horses were among the least livestock species owned by the respondents. Surprisingly, only 8.2% of beekeepers lived in the study area given the availability of diverse flora in the biosphere, which makes it suitable for bee-keeping; hence, this percentage is expected to be high.

Table 5. Respondents' livestock ownership in the study areas (N=355)

Types of Livestock holdings	Percent (%) of respondents
Oxen	35.8
Milking cows	36.6
Calves	29.3
Donkey	3.9
Horses	7
Mules	0.8
Goats	10.1
Sheep	31
Chickens	52.1
Beehives	8.2

Source: Author's computation from survey (2022). *The total percentage (%) of the respondents was greater than 100 due to multiple responses or the existence of households that produced the same crop species in the study area.*

The status of off-and non-agricultural livelihood diversification

Table 6 summarizes the status of respondents' engagement in off-farm income-generating activities. The respondent households were engaged in different income-generating activities beyond agriculture, which were grouped into off-farm and non-farm activities. Public transfers and remittances were other sources of income for the respondents. Off-farm is all activities away from one's own farm property and includes payments for labor in kind/exchange or cash on others' farm. The study used off-farm activities interchangeably with wage employment, in which the employer can give orders to the employee toward their agreement for a predetermined duration. Accordingly, the three common wage employment activities in which the respondents were engaged included harvesting coffee (25.4%), removing weed from coffee and khat (11%), and harvesting maize and teff (8.7%). These wage employment activities are common for resource-poor and medium-sized households in the study area.

Table 6. The status of respondent engagement in off-farm income-generating activities (N=355)

Off-farm income generating activities	Percentage (%) of respondents
Coffee harvesting	25.4
Coffee and khat weeding	11
Maize and teff harvesting	8.7

Source: Authors' computation from survey (2022)

Table 7 presents the status of respondents' engagement in non-farm income-generating activities. Non-farm activities are activities outside the agricultural sector, regardless of location. It could be at-home or away-from-home. In this study, non-farm activities were self-employed, and the five non-farm activities in which respondents engaged were petty trade, handicrafts, charcoal selling, urban house rent and permanent employment in formal sectors. Some of the respondents strived to secure an alternative means of earning income, and 18.3% of the households were engaged in the pursuit of these non-farming activities. The dominant non-farm activity was petty trade, in which approximately 12.1% percent of women were engaged, followed by handcrafting (4.3%) and urban house renting (1.4%).

Table 7. The status of respondent engagement in non-farm income-generating activities (N = 355)

non-farm income generating activities	Percentage (%) of respondents
Petty trade	12.1
Hand crafting	3.4
Urban house renting	1.4
Charcoal selling	0.8
Government employee	0.6

Source: Authors' computation from survey (2022)

Table 8 presents a summary of the public transfers and remittances received by the respondent households. In the study area, 4.3% of the households received different types of public transfers or other sources of income. For this study, public transfer included monetary support, wedding gifts and compensation that households received at their localities. Accordingly, 3.4%, 0.6% and 0.3% of the respondent households received monetary support, wedding gifts and compensation, respectively. Only 0.8% of the respondents received remittance from relatives abroad.

Table 8. The types of public transfers and remittances received by respondents prior to the study (N=355)

Types of public transfer and remittance received	Percentage (%) of respondents
Monitory support	3.4
Wedding gift	0.6
Compensation	0.3
Remittance	0.8

Source: Authors' computation from survey (2022)

Dietary diversity status of reproductive-aged women

A woman's dietary diversity score (WDDS) was generated from 24-h recall consumption data. It is computed by adding the number of food groups consumed by the woman over the reference period. For this study, different food items consumed by the respondents within 24 h were recorded, and then all food items were classified into ten food groups following (FAO, 2021) and Bekele (2022), who classified food groups based on nutritional composition rather than botanical composition.

The dietary diversity results showed that starch staples were the major sources of diet and commonly consumed food by the respondents. As demonstrated in Table 9, 100% of women consumed grain food groups such as flatbread made from either sole or mixed of teff, maize and rice; bread made from maize and wheat; maize porridge; boiled macaroni, pasta; barley soup and kolo (roasted barley); potato and sugarcane. Majority (97.7%) of the respondents consumed different types of vegetables, such as beetroot and tomato, in the form of shiro, onion, hot pepper and/or 'Koch-Kocha' (made by grinding green hot pepper), followed by pulses/legume food groups, such as faba beans, peas, haricot-bean, and lentil, either in the raw or roasted form or in the form of shiro, accounting for approximately 96.3%, whereas nuts and seed food groups, such as oil made from sunflower, sesame and olive and groundnut, were widely consumed. This indicated that among the ten classified food groups, women in the study area consumed only four food groups, forcing most respondents to fall below the recommended dietary diversity threshold. Meat and poultry; eggs; vitamin A-rich fruits and vegetables such as ripe mango; other fruits such as fresh avocado, banana and orange; and dark green leafy vegetables such as leafy vegetables and dairy products (milk, soft cheese, yogurt/curd and butter) were among the food groups that a smaller proportion of the respondents consumed.

Table 9. The types of food groups consumed by WRA from highest to lowest (N=355)

Types of food group consumed	Percentage (%) WRA
Grain food group (G-1)	100
Other vegetables food group (G-9)	97.7
Pulses (Legumes) food group (G-2)	96.3
Nuts and seeds food group (G-3)	95.5
Dairy (milk and milk products) food group (G-4)	26.8
Dark green leafy vegetables food group (G-7)	16.3
Other Fruit food group (G-10)	7.9
Vitamin A rich fruit & vegetables food group (G-8)	7.3
Eggs food group (G-6)	4.2
Meat, poultry and fish food group (G-5)	2.8

Source: Authors' computation from survey (2022)

Approximately 45.6% of women attained high dietary diversity, while the remaining women fell below the recommended dietary diversity cutoff point (Table 10). This study's results agree with those of

Mohamed (2017), who reported that 30% of Ethiopian households had low dietary diversity (consuming 3 or fewer food groups per week). The proportions of women with dietary diversity attainment across their residents’ districts vary slightly. While 47.5% of the population in Chora had high dietary diversity, 44.2% of the population in Yayo district had high dietary diversity. However, the difference was not statistically significant ($X^2 = 0.386$, $df = 1$, $P = 0.534$).

Based on agroecologies, 53.8% of the women residing in the highlands had achieved high dietary diversity, whereas 40.5% and 41.9% of the women in the midlands and lowlands, respectively, had achieved high dietary diversity, while only 40.5% of the women in the midlands and 41.9% of the women in the lowlands had achieved high dietary diversity. This indicated that women’s dietary diversity status declines as we move from the highlands to the lowlands. The observed difference was statistically significant between agroecologies ($X^2 = 5.614$, $df = 2$, $P = 0.060$). This might be attributed to the better suitability of the highland areas than midland and lowland areas in terms of agricultural production and livelihood diversification, which improved the dietary diversity of women. This finding is consistent with the results of studies conducted in different parts of Ethiopia (Sibhatu et al., 2015; Workicho *et al.*, 2016; Assaye, 2018; Huluka and Wondimagegnu, 2019).

Table 10. The status of dietary diversity in the WRA by district and agroecology

Districts	The status of dietary diversity		Total	p-value
	Low dietary diversity	High dietary diversity		
Chora	83 (52.5%)	75 (47.5%)	158 (100%)	.534
Yayu	110 (55.8%)	87 (44.2%)	197 (100%)	
Total	193	162	355	
Agro-ecologies				
Highland	60 (46.2%)	70 (53.8%)	130 (100%)	.060*
Midland	97 (59.5%)	66 (40.5%)	163 (100%)	
Lowland	36 (58.1%)	26 (41.9%)	62 (100%)	
Total	193	162	355	

Source: Survey result and author’s computation (2022)

The effect of production and livelihood diversification on the dietary diversity of women of reproductive age

Table 11 presents the results of the binary logit regression. Before a logistic regression model was run to describe the relationship between a binary response variable and predictors, the model goodness of fit was assessed. Two of the most common methods for assessing model goodness of fit are the Pearson chi-square and residual deviance statistics. Both measure the difference between observed and model-predicted outcomes, while a lack of good model goodness of fit is indicated by higher test values, signifying a larger difference. Accordingly, chi-square tests were employed to assess how well the

independent variables explained the outcome variable. If the p-value for the overall model goodness of fit statistics is less than 0.05, then there is evidence that at least one of the independent variables contributes to the prediction of the outcome. Therefore, the p-value (0.000) for the overall model goodness-of-fit statistics shows that there is at least one predictor that explains the outcome or response variable (dietary diversity). The chi-square of the regression model indicates the overall goodness of fit of the model, and it was statistically significant at the 1% probability level. The Wald test statistics ($\chi^2(12) = 41.250$) also confirmed that the model fulfilled the conditions of good fit.

After the model goodness of fit was checked, the issues of multicollinearity and correlation were tested by using the variance inflation factor (VIF) and correlation matrix for continuous and dummy variables, respectively. The VIF falls between 1 and 5, suggesting that there is no problem of multicollinearity and no correlation problems for any of the explanatory variables used in the model. Overall, the results from the logistic regression model analysis indicated that production diversification, development agent contact (DA) and the use of improved technologies positively and significantly influenced the dietary diversity of women of reproductive age. Livelihood diversification had no significant effect on dietary diversity in the study area.

At the 1% probability level, production diversification has a positive and significant effect on women's dietary diversity. The marginal effect of the variable indicated that other factors remaining constant, such as the production of one additional crop or livestock species, increased women's probability of consuming diverse food groups or being in the high dietary diversity group by 3%. It is more likely that production diversification by smallholder farmers enhances their dietary diversity because of the ample amount of smallholder farmers produce consumed at home. Agricultural extension agent (DA) contact positively and significantly influenced women's dietary diversity at the 5% probability level. The marginal effect showed that one-day additional contact with DAs per year increases the probability of women having high dietary diversity by 4%. The use of improved technologies also has a positive and significant effect on women's dietary diversity at the 1% probability level. The marginal effect indicated that women in households that used improved technologies such as cooking machines, refrigerators and crop storage are more likely to increase their dietary diversity by 24% compared to women who are members of households that do not use those improved technologies.

Table 11. Binary logistic regression analysis results for factors affecting the dietary diversity of women of reproductive age

Explanatory variables	Coefficient	dy/dx	Standard error	t-value	p-value	Sig
Production diversification	0.12	0.03	0.04	3.07	0.00	***
Livelihood diversification	0.01	0.00	0.12	0.08	0.94	
Age	0.02	0.00	0.02	1.06	0.29	
Family size	-0.11	-0.02	0.08	-1.35	0.18	
Education level	0.01	0.00	0.04	0.15	0.88	
Land size	0.02	0.00	0.10	0.17	0.87	
DAs contact	0.17	0.04	0.07	2.34	0.02	**
Mark distance	0.02	0.00	0.02	0.90	0.37	
NSA training	-0.41	-0.09	0.32	-1.30	0.20	
Use improved technology	1.08	0.24	0.34	3.13	0.00	***
Cooperative membership	0.52	0.12	0.49	1.06	0.29	
Access to credit	-0.23	-0.05	0.53	-0.44	0.66	
Constant	-1.46		0.67	-2.17	0.03	
Mean dependent variable	0.456		SD dependent variable		0.499	
Pseudo R-squared	0.084		Number of observation		355	
Chi-square	41.250		Prob > chi2		0.000	
Akaike criteria (AIC)	474.174		Bayesian criteria (BIC)		524.511	

*** $p < .01$, ** $p < .05$ denote significance at the 1% and 5% probability levels, respectively.

Source: Model output from our own survey, 2022

Discussion

Using cross-sectional data and a logistic regression model, this study analyzed the effects of production and livelihood diversification on the dietary diversity of women of reproductive age in southwestern Oromia, Ethiopia. The study revealed that households in the study area had moderate production and dietary diversity, indicating that production diversification had a positive association with dietary diversity, as the majority of rural households consumed what they produced. A positive correlation between production diversification and women's dietary diversity suggests that specializing in the production of one single crop or livestock and then trading the yield does not increase the household probability of consuming diverse food as much as production diversification might. Evidence of positive associations between farm production diversity and the dietary diversity of farming households has also been reported in studies by Dillon *et al.* (2015) and Kumar *et al.* (2015) in Zambia and Nigeria.

The findings showed that a small proportion of the households were engaged in different off- and non-farm income-generating activities. This indicated that agricultural livelihoods dominate other non-agricultural activities. Hence, engagement in diverse livelihood activities had no significant effect on dietary diversity of women of reproductive age. The association between livelihood diversification and dietary diversity of women of reproductive age did not conform to the findings of Abera *et al.* (2021), who piloted projects in southwestern Ethiopia, indicate that engaging in a mix of various portfolios of

activities is the prioritized solution suggested to ensure food and nutritional security, reduce poverty and improve welfare in rural areas.

However, even if it is not significant, it does not mean that non-agricultural activities had no contribution to rural households' living standards, particularly for resource-poor families that strive to respond to food shortages instead of diversified diet consumption. Regular supervision and technology provision via improved extension services provided by development agents can also improve households' probability of producing diverse food groups and raising diverse livestock, which in turn improve women's income and dietary diversity. This result was in line with the findings of Ibrahim *et al.* (2009) and Rehima *et al.* (2013), who confirmed that contact with development agents and access to extension services are associated with the spread and adoption of improved technologies because of facilitating technical guidance, credit availability, input supplies, access to market information and building the capacity of farmers, which are directly pertinent to production diversification.

Improved technologies can enhance the flexibility of respondents to produce, store, consume and exchange more food groups across seasons; hence, the use of improved technology improves women's probability of having diversified diets. The results of the present study conform with the findings of others (Tesfaye and Tirivayi, 2016). Other studies have indicated that dietary diversity is determined by various factors, including the past consumption behavior of the community, traditional habits and extent of technology related to food production, processing, preparation and storage (Jones *et al.*, 2014; Ng'endo *et al.*, 2016). Therefore, it is important to emphasize improved technologies used for food crop storage, preparation and preservation to achieve and maintain dietary diversity throughout the year. Facilitating women toward cooperative membership can benefit women of reproductive age in terms of access to reliable information and improved agriculture-supporting technologies.

The strength of our study is that it expands the literature on the effects of agricultural production diversification and non-agricultural activity diversification on the dietary diversity of the disadvantaged group, women of reproductive age, in the context of nutrition-sensitive agriculture. Previous studies have extensively explored the nexus between production diversification and dietary diversity, with less attention given to the effects of non-agricultural activity diversification.

The study had some limitations. One of them was related to the time of data collection. The data were collected during the rainy season, when households grow a variety of crops, which could slightly increase the reported production diversification and dietary diversity compared to those in the dry season. The second limitation was related to using cross-sectional survey that is unable to capture

seasonal differences in production diversification and dietary diversity in the study area. Finally, considering the diversity of Ethiopian population in terms of religion, ethnicity, agro-ecological climate and socioeconomic conditions, the selected respondents may not represent all the people in the country. As such, the research does not claim to provide conclusive findings on the effect of production and livelihood diversification on women's dietary diversity in the other parts of Ethiopia.

Conclusion

Agricultural and non-agricultural livelihood activity diversifications are a central means of living for the majority of households in the study area. There is moderate production diversification compared to other parts of Ethiopia. The main reason is the dominance of cereals and cash crops over the other crops in terms of area coverage and job creation for the majority of landless and resource-poor households. The low production and non-farm activity diversification status observed in the different agroecologies of the study areas requires collaborative work through practical intervention, such as agroecology-based introduction of non-farm income-generating activities and improved crop and livestock varieties, to reverse the low status of production, livelihood and dietary diversity in the area.

In the study area, production diversification, contact with development agents and the use of improved technologies that support women triple role such as *cooking machines, refrigerators and crop storage* improved dietary diversity, while livelihood diversification had no effect on dietary diversity. The positive effect of production diversification on women's dietary diversity is in line with the authors' expectation and suggests that production diversification is better than specialization to a single crop or livestock to increase the household probability of consuming diverse food in general and the dietary diversity of women of reproductive age in particular. The findings imply that development practitioners and concerned government sectors at different levels, as well as other relevant stakeholders, had better follow a gender-sensitive approach and prioritize these factors influencing dietary diversity in the study area to enhance the implementation of nutrition-sensitive agriculture and thereby improve nutrition.

Though the current study had shade some light on the association among production and livelihood diversification, it has been depicted that the current study had limitations. To overcome these limitations, we suggest that future studies collect longitudinal data from a broader geographic area to disentangle the effects of production and livelihood diversification from the effects of the factors related to seasonal and geographic variations.

Declarations

Ethics approval and consent to participate

The tools and methodology for this study were approved by the Jimma University College of Agriculture and Veterinary Medicine Research Ethical Review Board (Ref. No.R/GS/6762022). Informed consent was obtained from all individual participants included in the study.

Consent for publication

Not applicable

Availability of data and materials

The data for this study are available from the authors upon reasonable request

Competing interest

The authors declare they have no competing interests.

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Author contributions

All the authors contributed to the study conception and design. All authors participated in material preparation. SA led the data collection, analyzed the data and wrote the first draft of the manuscript. KD and FM supervised SA and commented on the previous versions of the manuscript. All the authors have read and approved the final manuscript.

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References

- Abera, A., Yirgu, T. & Uncha, A. (2021). Determinants of rural livelihood diversification strategies among chewaka resettlers' communities of southwestern ethiopia. *Agric. Food Secur*, 10, 1-19.
- Adjimoti, G. & Kwadzo, G. (2018). Crop diversification and household food security status: Evidence from rural benin. *Agric. Food Secur*, 7 (1), 1–12.
- Ahmed, F.F. & Abah, P.O. (2014). Determinants of food security among low-income households in maiduguri metropolis of borno state, nigeria. *Asian J. soc. Sci. Humanit.*, 3, 20-35.
- Aliwo, S., Fentie, M., Awoke, T. & Gizaw, Z. (2019). Dietary diversity practice and associated factors among pregnant women in north east ethiopia. *BMC Res Notes*, 12, 1-6.
- Assaye, A. (2018). *Determinants of rural household dietary diversity: The case of bambasi district benishangul gumuz regional state, ethiopia*. Haramaya university.
- Barrett, C.B., Reardon, T. & Webb, P. (2001). non-farm income diversification and household livelihood strategies in rural africa: Concepts, dynamics, and policy implications. *Food Pol.*, 26, 315-331.
- Bekele, T.H. (2022). *Ethiopian food-based dietary guidelines: Development, evaluation, and adherence monitoring*. Wageningen University.
- Belew, A.K., Ali, B.M., Abebe, Z. & Dachew, B.A. (2017). Dietary diversity and meal frequency among infant and young children: A community based study. *Ital. J. Pediatr.*, 43, 1-10.
- Chapman, R. & Tripp, R. Background paper on rural livelihood diversity and agriculture. AgREN electronic conference on the implications of Rural Livelihood Diversity for Pro-poor Agricultural Initiatives, 2004.
- Degye, G., Belay, K. & Mengistu, K. (2013). Measuring diet quantity and quality dimensions of food security in rural ethiopia. *J. Deve. Agric. Econ*, 5, 174-185.
- Dillon, A., McGee, K. & Oseni, G. (2015). Agricultural production, dietary diversity and climate variability. *J.Dev. Stud.*, 51, 976-995.
- Ellis, F. (2000). The determinants of rural livelihood diversification in developing countries. *J. Agr. Econ.*, 51, 289-302.
- Endalifer, M.L., Andargie, G., Mohammed, B. & Endalifer, B.L. (2021). Factors associated with dietary diversity among adolescents in woldia, northeast ethiopia. *BMC Nutr*, 7, 1-8.
- Estrada-Carmona, N., Raneri, J.E., Alvarez, S., Timler, C., Chatterjee, S.A., Ditzler, L., Kennedy, G., Remans, R., Brouwer, I. & den Berg, K.B.-v. (2020). A model-based exploration of farm-household livelihood and nutrition indicators to guide nutrition-sensitive agriculture interventions. *Food Secur.*, 12, 59-81.
- Ezeanyeji, C. & Maureen, I. (2019). Foreign portfolio investment on economic growth of nigeria: An impact analysis. *Int. J. Acad. Manag. Sci. Res*, 3, 24-36.
- Fanzo, J.C., Downs, S., Marshall, Q.E., Pee, S.d. & Bloem, M.W. (2017). Value chain focus on food and nutrition security. *Nutrition and health in a developing world*. Springer.
- FAO. (2016). Minimum dietary diversity for women: A guide for measurement. *Rome: FAO*, 82.
- FAO. (2017). Nutrition-sensitive agriculture and food systems in practice: Options for intervention. Rome.
- FAO. (2021). *Minimum dietary diversity for women: An updated guide to measurement-from collection to action*, Food and Agriculture Organization.
- Gole, T.W., Feyera, S., Kassahun, T. & Fite, G. (2009). Yaya coffee forest biosphere reserve nomination form. *Ethiopian MAB National Committee, Addis Ababa*.
- Gondwe, T.M., Alamu, E.O., Musonda, M., Geresomo, N. & Maziya-Dixon, B. (2017). The relationship between training farmers in agronomic practices and diet diversification: A case study from an intervention under the scaling up nutrition programme in zambia. *Agric. Food Secur*, 6, 1-7.

- Harris-Fry, H., Azad, K., Kuddus, A., Shaha, S., Nahar, B., Hossen, M., Younes, L., Costello, A. & Fottrell, E. (2015). Socio-economic determinants of household food security and women's dietary diversity in rural bangladesh: A cross-sectional study. *J. Health Popul. Nutr.*, 33, 1-12.
- Hiruy, H.N., Barden-O'Fallon, J., Mitiku, F. & Millar, E. (2023). Association of gender-related factors and household food security in southwest oromia, ethiopia: Evidence from a cross-sectional study. *Agric. Food Secur*, 12, 26.
- Hirvonen, K. & Hoddinott, J. (2017). Agricultural production and children's diets: Evidence from rural ethiopia. *Agr. Econ.*, 48, 469-480.
- Huluka, A.T. & Wondimagegnhu, B.A. (2019). Determinants of household dietary diversity in the yayo biosphere reserve of ethiopia: An empirical analysis using sustainable livelihood framework. *Cogent Food Agric*, 5, 1690829.
- Ibrahim, H., Rahman, S., Envulus, E. & Oyewole, S. (2009). Income and crop diversification among farming households in a rural area of north central nigeria. *Agro-Sci.*, 8.
- Jebessa, G.M., Sima, A.D. & Wondimagegnehu, B.A. (2019). Determinants of household dietary diversity in yayu biosphere reserve, southwest ethiopia. *Ethiop. J. Sci*, 12, 45-68.
- Jones, A.D., Shrinivas, A. & Bezner-Kerr, R. (2014). Farm production diversity is associated with greater household dietary diversity in malawi: Findings from nationally representative data. *Food Pol.*, 46, 1-12.
- Kennedy, E., Tessema, M., Hailu, T., Zerfu, D., Belay, A., Ayana, G., Kuche, D., Moges, T., Assefa, T. & Samuel, A. (2015). Multisector nutrition program governance and implementation in ethiopia: Opportunities and challenges. *Food Nutr Bull*, 36, 534-548.
- Kiboi, W., Kimiywe, J. & Chege, P. (2017). Determinants of dietary diversity among pregnant women in laikipia county, kenya: A cross-sectional study. *BMC Nutr*, 3, 1-8.
- Kumar, N., Harris, J. & Rawat, R. (2015). If they grow it, will they eat and grow? Evidence from zambia on agricultural diversity and child undernutrition. *J.Dev. Stud.*, 51, 1060-1077.
- Michler, J.D. & Josephson, A.L. (2017). To specialize or diversify: Agricultural diversity and poverty dynamics in ethiopia. *World Devel.*, 89, 214-226.
- Minot, N. (2006). *Income diversification and poverty in the northern uplands of vietnam*, Intl Food Policy Res Inst.
- Mohamed, A.A. (2017). Food security situation in ethiopia: A review study. *Int. J. Health Econ. policy*, 2, 86-96.
- Ng'endo, M., Bhagwat, S. & Keding, G.B. (2016). Influence of seasonal on-farm diversity on dietary diversity: A case study of smallholder farming households in western kenya. *Ecol. Food Nutr.*, 55, 403-427.
- Rehima, M., Belay, K., Dawit, A. & Rashid, S. (2013). Factors affecting farmers' crops diversification: Evidence from snnpr, ethiopia. *Int. J. Agric.Sci.*, 3, 558-565.
- Ruel, M.T., Quisumbing, A.R. & Balagamwala, M. (2017). Nutrition-sensitive agriculture: What have we learned and where do we go from here?
- Ruel, M.T., Quisumbing, A.R. & Balagamwala, M. (2018). Nutrition-sensitive agriculture: What have we learned so far? *Glob Food Sec*, 17, 128-153.
- Sibhatu, K.T., Krishna, V.V. & Qaim, M. (2015). Production diversity and dietary diversity in smallholder farm households. *Proceedings of the National Academy of Sciences*, 112, 10657-10662.
- Sibhatu, K.T. & Qaim, M. (2018). Farm production diversity and dietary quality: Linkages and measurement issues. *Food Secur.*, 10, 47-59.
- Tesfaye, W. & Tirivayi, N. (2016). The effect of improved storage innovations on food security and welfare in ethiopia. *Acc. Fin.*, 31, 40.

- Waha, K., Van Wijk, M.T., Fritz, S., See, L., Thornton, P.K., Wichern, J. & Herrero, M. (2018). Agricultural diversification as an important strategy for achieving food security in Africa. *Glob. Change Biol.*, 24, 3390-3400.
- Woldemariam, A., Yusuf, M., Beyen, T. & Yenit, M. (2015). Factors associated with dietary diversity among hiv positive adults (≥ 18 years) attending art clinic at mettema hospital, northwest ethiopia: Cross-sectional study. *J AIDS Clin Res*, 6.
- Workicho, A., Belachew, T., Feyissa, G.T., Wondafrash, B., Lachat, C., Verstraeten, R. & Kolsteren, P. (2016). Household dietary diversity and animal source food consumption in ethiopia: Evidence from the 2011 welfare monitoring survey. *BMC public health*, 16, 1-11.