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Agro-Biodiversity in Nexus to Economic Welfare of Households in Haramaya District, Ethiopia

Ahmed Mohammed[a,*], Guled Tofick[b] and Ayanle Igge [c]

[a] *School of Agro-Business and Agricultural Economics, Haramaya University*
[b] *Department of Rural Development , College of Dryland Agriculture, Jigjiga University*
[c] *Department of Rural Development , College of Dryland Agriculture, Jigjiga University*

ABSTRACT

Though enormous researchers conducted their study on biodiversity and agrobiodiversity at the international and national levels, they found significant differences in their results. Thus, this paper aimed to identify the link between agro-biodiversity and the economic welfare of households in Haramaya district. Data for this study were collected from primary and secondary sources. Primary data were collected from 189 randomly selected sample households, and secondary data were obtained from various sources. The data were analyzed using the multinomial probit model. The econometrics results of this paper also pointed out that out of the 12 independent variables incorporated in the multinomial probit model method of estimation, the number of independent variables, age of household, educational level of household, active labor size, access to credit, access to extension service, access to information, live stock holding, and access to irrigation were found to affect the link between the agro-biodiversity and economic welfare of households in Haramaya district. In addition, this paper identifies the link between agro-biodiversity and economic welfare of households in Haramaya district only. Thus, it further calls-up other researchers and academicians to made further study on the link between agro-biodiversity and economic welfare as a whole nation, Africa, and other continents. .

Key Words: Multinomial Probit, Agro-biodiversity, Economic Welfare, Haramaya District

1. Introduction

Agrobiodiversity is the variety and variability of animals, plants and micro-organisms that are used directly or indirectly for food and agriculture including crops, livestock, forestry and fisheries. It is the result of the interaction between the environment, genetic resources and management systems and practices used by culturally diverse people. It comprises the diversity of genetic resources (varieties, breeds) and species used for food, fodder, fibre, fuel and pharmaceuticals (FAO, 1999). It is the outcomes of natural selection processes and the careful selection and inventive developments of farmers, herders and fishers over millennia. Many people's food and livelihood security depend on the sustained management of various biological resources that are important for food and agriculture.

* Corresponding author:Ayanle Igge: igge2018@gmail.com

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The genetic resources for food and agriculture, includes: harvested crop varieties, livestock breeds, fish species and non domesticated (wild) resources within field, forest, rangeland including tree products, wild animals hunted for food and in aquatic ecosystems; non-harvested species in production ecosystems that support food provision, including soil micro-biota, pollinators and other insects such as bees, butterflies, earthworms, greenflies; and non-harvested species in the wider environment that support food production ecosystems.

There are several distinctive features of agrobiodiversity: first, agrobiodiversity is actively managed by male and female farmers; second, many components of agrobiodiversity would not survive without this human interference; local knowledge and culture are integral parts of agrobiodiversity management; third, many economically important agricultural systems are based on 'alien' crop or livestock species introduced from elsewhere. This creates a high degree of interdependence between countries for the genetic resources on which our food systems are based; fourth, as regards crop diversity, diversity within species is at least as important as diversity between species; fifth, because of the degree of human management, conservation of agrobiodiversity in production systems is inherently linked to sustainable use preservation through establishing protected areas is less relevant; and sixth, in industrial-type agricultural systems, much crop diversity is now held ex situ in gene banks or breeders' materials rather than on-farm.

The role of agrobiodiversity includes; increase productivity, food security and economic returns, reduce the pressure of agriculture on fragile areas, forests and endangered species, make farming systems more stable, robust and sustainable, contribute to sound pest and disease management, conserve soil and increase natural soil fertility and health, contribute to sustainable intensification, diversify products and income opportunities, reduce or spread risks to individuals and nations, help maximize effective use of resources and the environment, reduce dependency on external inputs, improve human nutrition and provide sources of medicines and vitamins and conserve ecosystem structure and stability of species diversity (Thrupp, 2000).

Agrobiodiversity is a subset of general biodiversity pertaining to agriculture. It can be defined as "the variety and variability of animals, plants and micro-organisms at the genetic, species and ecosystem levels that sustain the ecosystem structures, functions and processes in and around production systems, and that provide food and non-food agricultural products" (FAO, 1999). It is managed by farmers, pastoralists, fishers and forest dwellers, agrobiodiversity provides stability, adaptability and resilience and constitutes a key element of the livelihood strategies of rural communities throughout the world (Galluzzi et al., 2011). Agrobiodiversity is central to sustainable food systems and sustainable diets. The use of agricultural biodiversity can contribute to food security, nutrition security, and livelihood security, and it is critical for climate adaptation and climate mitigation(Frison et al., 2011; Mijatović et al., 2013; FAO, 2008).

Contributions from agrobiodiversity to food and agriculture are usually categorized by their contribution to ecosystem services. Ecosystem services are the services provided by well functioning ecosystem to human wellbeing. They are usually clustered into four broader categories: provisioning (direct provision of goods such as food and water), supporting (the services that are needed for agriculture to be healthy, such as soil), regulating (regulating natural processes needed in agriculture such as pollination, carbon capture or pest control), or cultural (recreational, aesthetic and spiritual benefits).

Agro-biodiversity's contribution to provisioning services is mainly for providing food and nutrition. Food biodiversity is "the diversity of plants, animals and other organisms used for food, covering the genetic resources within species, between species and provided by ecosystems" (Kennedy et al., 2017). Historically at least 6,000 plant species and numerous animal species have been used as human food. This number is considered to be decreasing now, resulting in concerns about long-term diet diversity. Food biodiversity also covers subspecies or varieties of crops. Many species which have been overlooked by mainstream research are rich in micronutrients and other healthful components (Hunter et al., 2015; Padulosi et al., 2013).

Other provisioning services from agrobiodiversity are the provision of wood, fibre, fuel, water and medicinal resources. Sustainable food security is linked to improving the conservation, sustainable use and enhancement of the diversity of all genetic resources for food and agriculture, especially plant and animal genetic resources, in all types of production systems (Thrupp, 2000). It makes several contributions to regulating services, which control the natural processes needed for a healthy agro-ecosystem. Pollination, pest control and carbon capture are examples. 75% of the 115 major crop species grown globally rely on pollinators (Klein et al., 2007).

Agro-biodiversity contributes to the health of pollinators by: providing habitat for them to live and breed; providing non-chemical biological options for pest control; providing a symbiotic relationship of constant flower production, with crops flowering at different times. It contributes to pest control by: providing a habitat for pests' natural enemies to live and breed in; providing wide genetic diversity which means it is more likely that genes contain resistance to any given pathogen or pest, and also that the plant can evolve as pests and diseases evolve (Jarvis et al., 2008). Genetic diversity also means that some crops grow earlier or later, or in wetter or drier conditions, so the crop might avoid attacks from the pest or pathogen (Gurr et al., 2003). It also contributes to carbon capture if used as part of a package of agro-ecological practices, for example by providing cover crops which can be dug into the land as green manure; maintaining tree stands and hedgerows; and protecting the integrity of soils so that they continue to house local microbes.

Farmers and breeders can use genetic diversity to breed varieties which are more tolerant to changing climate conditions and which combined with practices like conservation agriculture, can increase sequestration in soils and biomass, and reduce emissions by avoiding the degrading of farmlands (Ortiz, 2011).

Agrobiodiversity is central to cultural ecosystem services in the form of food biodiversity, which is central to local cuisines worldwide. It provides locally appreciated crops and species and also unique varieties which have cultural significance (Wang et al., 2016). It is threatened by changing patterns of land use (urbanization, deforestation), agricultural modernization; Westernization of diets and their supply chains (Carrington, 2017).

Agrobiodiversity loss leads to genetic erosion, the loss of genetic diversity, including the loss of individual genes and the loss of particular combinations of genes (or gene complexes). Genetic vulnerability occurs when there is little genetic diversity within a population of plants. This lack of diversity makes the population as a whole particularly vulnerable to disease, pests, or other factors. The problem of genetic vulnerability often arises with modern crop varieties, which are uniform by design (Elsner, 2014).

Attempts to safeguard agrobiodiversity usually focus on species or genetic level of agrobiodiversity. Conservation of genetic diversity and species diversity can be carried out ex situ, which means removing the materials from their growing site and looking after them elsewhere, or in situ, which means that they are conserved in their natural or cultivated site (Dulloo et al., 2010). While these two approaches are sometimes pitted against each other as either or both have merits.

The dimensions of agricultural biodiversity can be identified as: first, genetic resources for food and agriculture; second, components of biodiversity that support ecosystem services upon which agriculture is based. These include a diverse range of organisms that contribute, at various scales; third, abiotic factors, such as local climatic and chemical factors and the physical structure and functioning of ecosystems, which have a determining effect on agricultural biodiversity and fourth, socio-economic and cultural dimensions. Agricultural biodiversity is largely shaped and maintained by human activities and management practices and a large number of people depend on agricultural biodiversity for sustainable livelihoods.

General objective of the study was to identify the link between agro-biodiversity and economic welfare of the households in Haramaya district by assessing different determinants and indicators that can shows the economic welfare of a given society by considering the standard of living, optimal allocation of economic resources, income source diversification, soil and water conservation and growing drought tolerant crops which can be realize the economic welfare based on agrobiodiversity activity performed in the study area.

2. Materials and Methods

The study was conducted in rural kebeles of Haramaya district of East Hararghe Zone of Oromia National Regional State, Ethiopia. It is located in the eastern part of Ethiopia, 505 km away from Addis Ababa the capital city of Ethiopia. The Haramaya district is bordered on the south by Kurfa Chelle, on the west by Kersa, on the north by Dire Dawa, on the east by Kombolcha, and on the southeast by the Harari Region. Geographically the district is located between at 41°59’58"N latitude and 09°24’10" E longitude. The district has 34 rural and 2 urban *kebeles*.

The district lies between 1900 to 2450 m.a.s.l. These altitudinal ranges gave the district Dega, Woinadega and kola agro-ecological zones. The mean annual rainfall is 74.1mm, with mean annual temperature of 16.90c. The topography of this district ranges from 1400 to 2340 meters above sea level; the highest points include Dof and Jeldo. The major river is the Amaresa; bodies of water include Lake Haramaya. A survey of the land in Haromaya shows that 36.1% is arable or cultivable, 2.3% pasture, 1.5% forest, and the remaining 60.1% is considered built-up, degraded or otherwise unusable. The total populations of this district were 271,018, of whom 138,282 are men and 132,736 are women; 50,032 or 18.46% of its population were urban dwellers and the rest were rural inhabitants. The Livelihood of households in the district depends on survival way of farming. The production system is traditional and subsistence with limited types of annual crops and perennial crops are grown in the study area, namely sorghum, maize, groundnut, vegetables and chat.

Table 1: Distribution of sampled households by sample *kebeles*

Name of *Kebeles*	Total Households	Sample size	Percentage
Gobe Chala	800	62	32.5%
Haqa Fila	978	75	40%
Kerensa Sherif-Kelid	673	52	27.5%
Total	2451	189	100%

In the process of data collection, both qualitative and quantitative types of data were collected from primary and secondary source. Primary data was collected by using four main tools: focus group discussion, key informant interviews, direct observation of the area, and house hold survey to complement the primary data. While secondary data was also be generated from various sources, former conducted research, official website, unpublished documents and publication of government offices such as district agricultural offices.

2.1. Research Design

In order to achieve the objective of this study, cross-sectional survey design was used to gather data at one point in time from the households in the study area. Across-sectional survey design can be examine current attitudes, beliefs, options or practices these attitudes, beliefs and options was sever to investigate the ways in which individuals think about issues, whereas practices was help to know the actual behaviors of research participants. The researcher preferred this design because it was helps to get the desired information with low costs or expense and takes a short period for administering the survey and collecting the information.

2.2. Sampling Technique and Sample Size

The district has 34 rural *kebeles* and two towns. These *kebeles* were stratified into three agro climatic zones; highland, midland and low land by encompassing three *kebeles* (one from each agro-ecology). Haqa Fila from the low land (Kola), Gobe Chala from the highland (dega) and Kerensa Sharif-Kalid from midland (Woinadega) were selected for determining the link between agro-biodiversity and economic welfare of the households in Haramaya district. From the three selected **kebeles**, the households required for this study purpose were randomly selected. The desired number of sample household was determined by using a formula developed by Yamane (1967). To determine the required sample size at 93% confidence level, with a 0.7 degree of variability and 7% level of precision, the following formula was used.

$$n = \frac{N}{1 + N(e^2)} \quad n = \frac{2451}{1 + 2451(0.07^2)} = 189 \tag{1}$$

Where n is sample size, N is the number of household and e is the desired level of precision. As 2451 households are living in the three sample *Kebeles*.

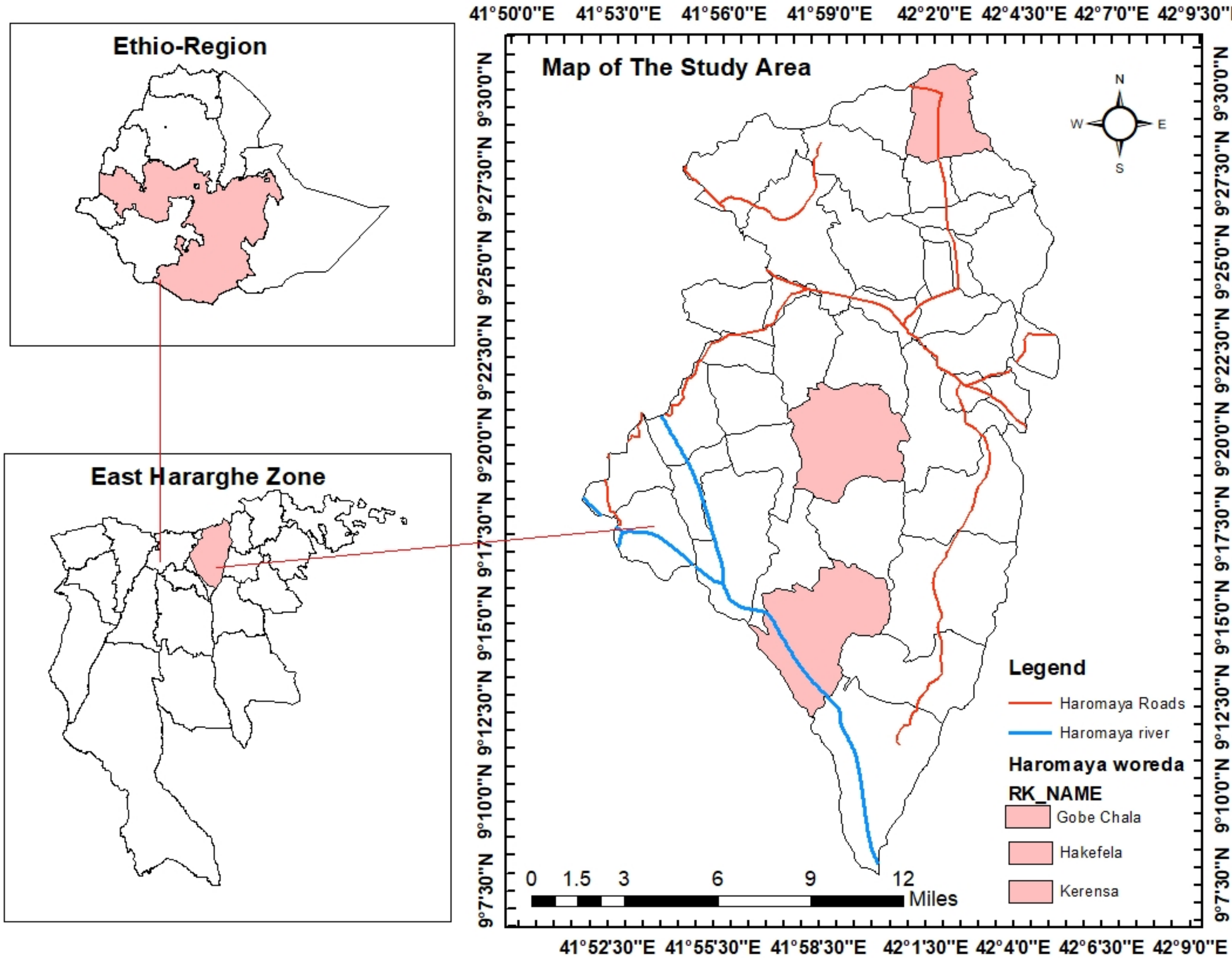

Figure 1: Study Area

Source: GIS based construction

2.3. Method of Data Analysis

Many households are more likely to adapt a mix of strategies to deal with the agro-biodiversity activities in the process of realizing the issue of its own needs especially the food issue. Analytical approaches that are commonly used in such studies involving multiple choices are the multinomial logit (MNL) and multinomial probit (MNP) models. Therefore, the multinomial probit model was used in this paper to identify the link between agro-biodiversity and economic welfare of the households in the study area. The researcher formulating the multinomial probit model which has one dependent variables (adapt to agro-biodiversity strategy to realize the economic welfare) with five outcomes, y1 (optimal allocation of resources), y2 (standard of living), y3 (income source diversification), y4 (soil and water conservation) and y5 (Growing drought tolerant crops).

3. Results and Discussion

Multinomial probit model was employed to estimate the parameters of the explanatory variables expected to determine the link between agro-biodiversity and economic welfare of the households in the study area presented in Table 2. The goodness-of-fit was tested by the Log likelihood ratio (LR) test. The result showed that Wald chi2is 423.21 and prob > chi2 = 0.00. This means that X^2 is statistically significant and the model displays a good fit. The Pseudo R^2 of the model is 0.73, implying that 73% of the variation in the adapt of strategies of agro-biodiversity in the process realizing the economic welfare of the household in the study area was explained by the 12 explanatory variables included in the model. This verifies that the model has a good fit to the data and explained significant non-zero variations.

This model employed to identify the determinants that shows the relationship exist between the agro-biodiversity and economic welfare of household in the by using the cross-sectional data from 189 sample households. Accordingly, variables hypothesized to have influence on the household's economic welfare in relation of agro-biodiversity were fitted in the model. The results of the multinomial probit model showed that out of 12 variables included in the model, eight variables were statistically significant. Namely; access to information, Livestock holding, Access to credit, formal extension services, household education level, the age of the household head, household farm size and household income presented in (Table 2).

Age of the household head: The survey result indicated that the age of the household head had positively impact to optimal allocation of resources, income source diversification and soil and water conservation as an indicator or determinants to economic welfare in relation to agro-biodiversity in the study area and significant at 5%, 5% and 1% probability level, respectively (Table 2). The positive sign showed that age of household head increases the probability of economic welfare and agro-biodiversity relation in the process of realizing the need of household in the study area.

Household educational level: It was a significant determinant to income source diversification at 5% probability level. Household education level and income source diversification in the process of economic welfare were positively correlated, implying that educated households are expected to adopt new agro-biodiversity activities which directly leads to economic welfare based on their awareness of the potential benefits of the proposed (Table 2).

Active labor size: As expected, active labor size had positive and significant relationship with optimal allocation of resources and soil and water conservation as an indicator of economic welfare in the study area at 5% probability level. The positive sign showed that the probability of optimal allocation of resources and soil and water conservation were high for households where active (productive) members are greater than inactive (unproductive) members (Table 2).

Extension contact: It had positive relationship with growing drought tolerant crops and soil and water conservation to agro-biodiversity in relation to economic welfare and significant at 5% and 10% probability level, respectively. However, access to extension contact had positive impact on households to agro-biodiversity in the process of realizing the economic welfare of the households in the study area (Table 2).

Access to credit: It had negative and significant influence on the probability of income source diversification as economic welfare measures at 10% significance level respectively (Table 2). That means an increase the accessibility of credit leads to an increase in the probability of household to perform different agro-biodiversity activity to realize the economic welfare of the households in the study area.

Livestock holding (TLU): It had negative and significant influence on the probability of soil and water conservation as economic welfare measures at 10% significance level (Table 2). That means an increase in livestock holding by one leads to an increase in the probability of household to lose agro-biodiversity activity to realize the economic welfare of the households in the study area.

Access to information: is one of the most important variables that affect the economic welfare of the households in the study area. The household, who have access to information related to economic welfare gained via agro-biodiversity, can get a higher probability of implementing the activity options. Access to information had a positive effect on households to use income source diversification and soil and water conservation as an indicator or determinants of economic welfare and significant at 5% probability level (Table 2).

Access to irrigation: It had positive relationship with growing drought tolerant crops and negative relationship with standard of living to agro-biodiversity in relation to economic welfare and significant at 10% probability level. However, access to irrigation had positive impact on households to adopt new agro-biodiversity in the process of realizing the economic welfare of the households in the study area (Table 2).

The result of the post estimation (marginal effect and the likelihood probability) showed that the likelihood of households to use optimal allocation of resources, standard of living, income source diversification, soil and water conservation and growing drought tolerant crops were 16.69%,22.32%, 15.25%, 28.92% and 16.82%, respectively.(See Table 3)

4. Conclusion

This paper aimed at identifying the link between agro-biodiversity and economic welfare of households in Haramaya district by assessing different determinants and indicators that can shows the economic welfare of a society. The link between agro-biodiversity and economic welfare of the study area is influenced by a number of factors. Among the factors that can influence on the link of agro-biodiversity activity and economic welfare of households of the study area; the age of the household head had positively impact to optimal allocation of resources, income source diversification and soil and water conservation as an indicator or determinants to economic welfare, household education level and income source diversification in the process of economic welfare were positively correlated, active labor size had positive and significant relationship with optimal allocation of resources and soil and water conservation as an indicator of economic welfare, access to extension contact had positive impact on households to agro-biodiversity in the process of realizing the economic welfare of the households, an increase the accessibility of credit leads to an increase in the probability of household to perform different agro-biodiversity activity to realize the economic welfare, an increase in livestock holding by one leads to an increase in the probability of household to lose agro-biodiversity activity in the process of realizing the economic welfare, access to information had a positive effect on households to

Table 2: Determinants of the link between agro-biodiversity and economic welfare: Multinomial probit model

	Optimal allocation of resources	Standard of living	Income source diversification	Soil and water conservation	Growing drought tolerant crops
Explanatory Variables	**Coef. PV.**	**Coef. PV.**	**Coef. PV.**	**Coef. PV.**	**Coef. PV.**
Sex	-.136 0.841	-.201 0.526	.210 0.528	-.003 0.999	.041 0.904
Age	.054 0.014**	.0188 0.366	.041 0.036**	.059 0.005***	-.030 0.183
Education	-.048 0.407	-.096 0.103	.118 0.042**	-.022 0.695	.090 0.131
Active labor size	.337 0.019**	-.069 0.610	-.219 0.107	.288 0.042**	.209 0.121
Extension contact	.012 0.949	.175 0.343	-.202 0.184	.027 0.884*	.372 0.048**
Access to credit	.629 0.308	.887 0.112	-1.00 0.084*	.114 0.839	-.436 0.424
Distance from market	-.005 0.841	.014 0.540	.011 0.603	-.026 0.262	-.001 0.956
Cultivated land size	-.341 0.534	-.229 0.644	-.375 0.444	.605 0.233	-.477 0.361
Household farm income	0.02 0.225	-.001 0.354	0.000 0.715	.002 0.196	0.000 0.567
Livestock holding (TLU)	-.323 0.627	.039 0.542	.068 0.275	-.107 0.091*	.0137 0.833
Access to information	-.136 0.373	.124 0.710	.682 0.047**	-.806 0.021**	.235 0.490
Access to irrigation	-.529 0.337	-.917 0.072*	.386 0.460	.531 0.292	.919 0.083*
Constant	.721 0.45	.069 0.941	-1.29 0.157	1.23 0.191	-.102 0.917
Number of observations					189
Log likelihood					-32.33
LR chi2 (19)					423.21
Prob >chi2					0.00
Pseudo R^2					0.73

Note: ***, ** and* significant at 1%, 5%, and 10% probability level of significance Source: Econometric model output

Table 3: The probability of the indicators

Indicators	Likelihood
Optimal allocation of resources	16.69%
Standard of living	22.32%
Income source diversification	15.25%
Soil and water conservation	28.92%
Growing drought tolerant crops	16.82%

Source: Own estimation result

use income source diversification and soil and water conservation as an indicator or determinants of economic welfare and access to irrigation had positive impact on households to adopt new agro-biodiversity in the process of realizing the economic welfare of the households in the study area.

Based on our empirical evidences, a number of policy considerations are suggested. Firstly, the government is advised to allow establishment of households' networks by own freewill in a way it promote their agro-biodiversity activities in the process of realizing economic welfare. The second policy consideration is that the policy makers need to understand the heterogeneity of ago-biodiversity which exist in a nation even within region and district and be able to avoid "one size fits all" approach. Finally, for those households practicing agro-biodiversity activities in district for the sake of realizing economic welfare, the extension advisory services need to emphasize on educating the household especially households about multi-systems income diversification so as to realize the economic welfare.

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Conflict of Interest

The author declares that they don't have conflict of interest.

References

Carrington, D. (2017). Sixth mass extinction of wildlife also threatens global food supplies. report, the guardian uk. Retrieved 20 June 2021.

Dulloo, M. E., Hunter, D., and Borelli, T. (2010). Ex situ and in situ conservation of agricultural biodiversity: major advances and research needs. *Notulae Botanicae Horti Agrobotanici Cluj-Napoca*, 38(2):123–135.

Elsner, E. (2014). Genetic resources and genetic diversity. Google Scholar Retrieved 15 January 2020.

FAO (1999). Multifunctional character of agriculture and land conference, background paper 1. *Maastricht, The Netherlands*.

FAO (2008). Climate change and food security: In climate change, energy and food. *FAO Rome*.

Frison, E. A., Cherfas, J., and Hodgkin, T. (2011). Agricultural biodiversity is essential for a sustainable improvement in food and nutrition security. *Sustainability*, 3(1):238–253.

Galluzzi, G., Van Duijvendijk, C., Collette, L., Azzu, N., and Hodgkin, T. (2011). Biodiversity for food and agriculture. contributing to food security and sustainability in a changing world. *PAR platform, FAO, Rome*.

Gurr, G. M., Wratten, S. D., and Luna, J. M. (2003). Multi-function agricultural biodiversity: pest management and other benefits. *Basic and Applied Ecology*, 4(2):107–116.

Hunter, D., Burlingame, B., Remans, R., Borelli, T., Cogill, B., Coradin, L., Golden, C., Jamnadass, R. H., Kehlenbeck, K., Kennedy, G., et al. (2015). Biodiversity and nutrition. World Health Organistion/Secretariat of the UN Convention on Biological ....

Jarvis, D. I., Brown, A. H., Cuong, P. H., Collado-Panduro, L., Latournerie-Moreno, L., Gyawali, S., Tanto, T., Sawadogo, M., Mar, I., Sadiki, M., et al. (2008). A global perspective of the richness and evenness of traditional crop-variety diversity maintained by farming communities. *Proceedings of the National Academy of Sciences*, 105(14):5326–5331.

Kennedy, G., Lee, W., Termote, C., Charrondiere, R., Yen, J., and Tung, A. (2017). Guidelines on assessing biodiverse foods in dietary intake surveys.

Klein, A.-M., Vaissière, B. E., Cane, J. H., Steffan-Dewenter, I., Cunningham, S. A., Kremen, C., and Tscharntke, T. (2007). Importance of pollinators in changing landscapes for world crops. *Proceedings of the royal society B: biological sciences*, 274(1608):303–313.

Mijatović, D., Van Oudenhoven, F., Eyzaguirre, P., and Hodgkin, T. (2013). The role of agricultural biodiversity in strengthening resilience to climate change: towards an analytical framework. *International journal of agricultural sustainability*, 11(2):95–107.

Ortiz, R. (2011). 12 agrobiodiversity management for climate change. *Agrobiodiversity management for food security*, page 189.

Padulosi, S., Thompson, J., Rudebjer, P., et al. (2013). Fighting poverty, hunger and malnutrition with neglected and underutilized species: needs, challenges and the way forward.

Thrupp, L. A. (2000). Linking agricultural biodiversity and food security: the valuable role of agrobiodiversity for sustainable agriculture. *International affairs*, 76(2):265–281.

Wang, Y., Wang, Y., Sun, X., Caiji, Z., Yang, J., Cui, D., Cao, G., Ma, X., Han, B., Xue, D., et al. (2016). Influence of ethnic traditional cultures on genetic diversity of rice landraces under on-farm conservation in southwest china. *Journal of ethnobiology and ethnomedicine*, 12:1–14.