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Food and income diversification decisions as climate change adaptation strategies: Evidence from Kalfou and Tabalak local governments, Tahoua State, Niger Republic

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The purpose of this study is to evaluate rural household's food and income diversification decisions in face of climate change adaptation strategies using advances in choice-based experiment. Several studies have focused on general and specific food values using the balanced incomplete block design; but fewer studies have been devoted to study rural household food and income diversification decisions via the lens of balanced incomplete Latin square design (BILSD). The BILSD was used to design questionnaire served in data collection. For each question, respondents were asked to choose his best and worst coping strategies. Mixed logit model was used to data. Results reveal that agricultural production, livestock products and remaining stock from previous harvest were the most important sources of food; while the sale of agricultural product followed by the sale of garden product, picking and the sale wild fruits and leafy vegetables, small business, crafting, project transfer, the sale of firewood and straw and the sale of livestock product were the most important sources of income. Results suggest that agricultural production, livestock production and stock from previous harvest and as well as the sale of agricultural product, the sale of garden product, picking and the sale wild fruits and leafy vegetables, small business, crafting, project transfer, the sale of firewood and straw and the sale livestock product are the optimal combination food and income diversification decisions to enhance rural household resilience building capacity. Results finally suggest that collective decision made about food and income diversification decisions is more welfare enhancing that individual decision.

Key words: Food and income diversification decisions, rural household, choice experiment, climate change adaptation strategies.

INTRODUCTION

Rural households have developed and continue to develop various food security and income diversification strategies to cope with the negative externalities of climate change. Food and income diversification

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strategies have been argued to provide the most promising ways to enhance vulnerable rural households' resilience building capacity. Family farming is also important to improve rural households' food security by reducing dependence on market purchases and generating diverse opportunities to increase and stabilize their incomes. However, few studies have focused on how food and income diversification decisions as climate change adaptation strategies affect rural households' welfare. Scientific data are needed to determine the most important food and income combinations capable of guiding policy-makers on how to efficiently assist rural household to maintain their livelihoods when climate change hit. Choice experiment consistent with random utility theory well-rooted in consumer theory will provide a useful insight for the modeling. Behavioral economists hypothesized that our values and well-being are often reflected by our choices. The economic value of these choices is determined by the rate a person is willing to exchange one good for another. This rate is captured in a person's maximum willingness-to-pay to purchase a good or their minimum willingness to accept to sell a good (Lusk and Shogren, 2007). Understanding rural household food and income diversification strategies are keys to evaluate not only the degree of vulnerability, but also to determine which types of assistance rural households generally need to maintain its livelihoods when crises such flood, food shortage, drought and climate change hit.

The value rural household place on food and income diversification is often unknown and subjected to speculation. In addition, simply frequency distributions are used to rank preferences. However, little research is relatively geared towards best-worst scaling in the balanced incomplete Latin square design framework to evaluate and rank these food and income diversification strategies. Although food and agricultural policies produce winners and losers, agricultural economists should take the leadership to assist the policy community with modeling and the computation of the welfare gains and losses as tools in solving conflicts between gainers and losers. In Niger, from 1960 to date, several agricultural policies have been implemented to achieve food security, reduce poverty and increase income. From direct intervention government to boost agricultural productivity via research to self-sufficiency, to food security and as well as poverty reduction, agricultural policies have failed to address primary problems facing rural communities. These policies were unsuccessful because they emphasized on top down approach and little effort is geared towards educating and training rural communities. Therefore, keeping food production and population growth is still a challenge for most developing nations (Mousa, 2000).

Rapid intervention to assess rural households' food, income and expenditure diversification strategies using focus group discussions also called household economy approach (HEA) has been well-studied. In addition, food and income diversification strategies as risk management have been well-documented. However, little research is devoted to study and document the merit of choice-based experiment in developing country setting. Although the balanced incomplete block design (BIBD) has gained popularity as tool to collect best-worst scaling data, its merit is still in its infancy for modeling discrete choice. Furthermore, several studies have focused on general and specific food values for consumers, but fewer studies have investigated disaggregated preference of food, income and expenditure diversification strategies among rural household. This type of information is important in understanding and how to timely channel humanitarian aid to vulnerable rural household and to help maintaining its livelihoods when food crisis resulting from flood, food shortage and climate change hit. The overall purpose of this study is to evaluate rural households' food and income diversification decisions as climate change resilience capacity. Specific objectives include to determine the relative importance of food, income and expenditure diversification strategies and to evaluate whether collective decisions about food, income and expenditure diversification strategies are more welfare enhancing than individual decisions within a given household.

Background on best worst scaling (BWS) method

The use of experimental design in agriculture both in laboratory and field settings to elicit consumers' values and preferences for private and public goods and services has been recently exploded. Thus, economists have argued that demand for goods is affected not only by price of substitutes, complements and income, but also by demographic and climate change. Rural household sources of food, income and expenditure are complex and subjected to fluctuation over time and the modeling of these sources requires knowledge both in experimental design and economic theory. Also, many agricultural economists have recently used the best-worst scaling method to determine the most important strategies developed by rural farmers to increase their resilience against the negative externalities of climate change (Tabbo et al., 2016), which livestock production methods matter most to consumers (Ellison et al., 2017), consumers general and specific food values (Lister et al., 2017; Lusk and Briggeman, 2009), preferences for sustainable agricultural production (Sackett et al., 2013) and eliciting the most important domains of health for health-related quality of life in Singapore (Judy et al., 2018) and introduction to the application of best worst scaling in marketing research (Louviere et al., 2013) and evaluation of improved cowpea variety attributes (Moctar et al., 2018).

The BWS provides better information with fewer

respondents, works better than traditional likert scale and permits to achieve better discrimination among items (Louvriere et al., 2013).

Additionally, household economy approach has been increasingly used to study rural household's livelihoods by classifying household based on wealth groups (very poor, poor, middle and higher income). The first research using HEA is credited to an international organization called Save the Children UK (2009). It has conducted a study aims at understanding household economy in rural Niger (Eijkenaar, 2009).

The main objective of its study is to understand how rural households earn their livelihoods and how they have access to food. To achieve this objective, HEA profiles were conducted in five zones (Dosso district, Tessaoua district 1, Tessaoua district 2, Dakoro district1 and Dakoro district 2). Many researchers hypothesized that the well-being of rural households largely depend on what they buy and sell, what they earn and what they spend and how they cope with bad years. Results from this study revealed that wealth gap did really exist between people in the same communities and this tends to increase with time as resources getting rare and as result of population increase. Results also indicated that cash economy is very important for rural household because this will determine their food security which largely depends on their capacity to buy food on markets on daily or weekly basis. This study is different from our own because simple frequency distribution was used to classify sources of food, income and expenditure across wealth groups and little attention is given to how household preference share for sources of food, income and expenditure change when tradeoffs among these sources are assumed. In addition, Oni and Fashogbon (2013) have used the livelihood approach due to its holistic view and ability to generate disaggregated information in analyzing food insecurity and poverty. Results from ordered probit showed that farming was the predominant livelihood activity of rural households of Nigeria. Results also indicated that female headed households diversify their income and they are more food secure than their male counterparts. They finally concluded that poverty could be reduced when via human capacity building, accessibility to credit facilities and promotion of farming activities are implemented. This study used ordered logit to assess factors influencing rural household poverty level while our study used mixed logit method to evaluate rural households' preferences for sources of food, income and expenditure as climate change adaptations.

Previous studies have frequently used experimentation to study growth parameters of crop and animal in various trials. However, the use of experiments in agricultural development, natural resource economics, health economics, and environmental economics as a tool to not only measure and evaluate preference, but also as a method to separate cause and effect is still in its infancy (Voors et al., 2016). Their study also concluded that experimental studies are not only focusing on empirical testing, but also testing theoretical predictions, assessing impact both at local and community levels and analyzing how advances in technology offering new opportunities to elicit preferences and behavior of agents involved in the field of agriculture. Others studies conducted by Narloch et al. (2013) to investigate at payments for ecosystem services, by Prediger et al. (2014) and Pfaff et al. (2015) to study water scarcity and collective decision using a framed field experiments known as experimental auctions. Furthermore, Akoa Etoa et al. (2016) conducted a study to understand consumer demand for technology upgrading in rice parboiling in Cameroon using a framed field experiment and results revealed that perfections influenced consumer demand; Torero and Viceisza (2016) sought to analyze the degree of trust and the impact of auditing and to determine a potential collusion between firms and third-party auditors using a within-subject study design and they concluded that the presence of a third party significantly increased trust; Iskandar et al. (2016) conducted a laboratory experiments to study compliance with environmental taxes in Indonesia and results indicated that compliance increases with financial rewards, but is diminished by the presence of bribes; Holden and Bruvik Westberg (2016) employed a series of risk experiments to study whether fertilizer use is associated with risk aversion, rainfall levels and variation among agricultural smallholders in Ethiopia and they found that price level, average rainfall and variability influenced demand for fertilizer. Finally, Thunström et al. (2016) studied the impact of the composition of restaurant menus on the demand for meals using a randomized control trial and they found that introducing a healthy food label has no influence on restaurant sales. These studies have revealed that various survey techniques ranging from laboratory to field experiments can be used to elicit preferences and behavior in agriculture, but the contribution of balanced incomplete Latin square design as data collection tool as well as modeling choice experiment data in random utility framework has not been well assessed in agriculture. This study contributes to enrich literature related to choice experiments and climate change.

METHODOLOGY

Data collection method

Data used in this study were obtained from questionnaire designed via the balanced incomplete Latin square design (BILSD). Based on previous studies and direct interview with rural households, 11 food diversification decisions, 13 income diversification decisions and 13 expenditure diversification decisions were compiled and included in this study. The BILSD method was used to create eleven blocks or questions having five food diversification decisions randomly assigned to each. Similarly, the same procedure was used to generate thirteen blocks or questions for income and expenditure diversification decisions, each having four decisions randomly assigned to each. The questionnaire having 11 questions or 11

Table 1. Food, income and expenditure diversification decisions most and least important as climate change adaptation strategies?

Most important	Food diversification decisions	Least important
○	Cash for work	○
○	Donations	○
○	Food aid	○
○	Agricultural production	○
○	Fishing and wild fruits and vegetable harvesting	○
Most important	**Income diversification decisions**	**Least important**
○	Livestock selling	○
○	Livestock product selling	○
○	Agricultural product selling	○
○	Firewood and straw selling	○
Most important	**Expenditure diversification decisions**	**Least important**
○	Taxes	○
○	Clothing	○
○	Production inputs	○
○	Transportation	○

A sample of Best-Worst Scaling format used in the study.

food diversification decisions, 13 questions or income diversification strategies and 13 questions or expenditure diversification strategies was used to collect data from randomly selected rural households. This design is also a form of choice experiment popularly called the best-worst scaling (BWS) first developed by Louvriere and Woodworth (1990). The BWS is used when researchers seek to understand and measure the relative important of each element within a given set. For each question, household head and his family members were asked to choose their most and least important food, income and expenditure diversification decisions. Thus, the household head was individually interviewed while his family members were collectively interviewed.

Study area and sampling method

The study was conducted in three rural counties namely Kalfou, Kehehe and Tabalak, all located in Tahoua Region, Niger Republic. Before starting the data collection exercise from 22 to 26 March, 2016; students in the Faculty of Agricultural Sciences, University of Tahoua, have received training on how to administer, to code and to analyze data from a well-designed questionnaire. The author also explained in detail that the survey is voluntary and that household should be randomly selected to participate in the survey. Our target population includes household head and family members that are randomly selected and interviewed separately. Overall , 196 rural households were randomly selected and interviewed using face to face interview. Table 1 summarizes a sample of questionnaire format included in this study:

Econometric methods

The author analyzed the choice experiment data using the random utility model (McFadden, 1973). In the best worst framework, if there are j options for food diversification decisions, l options for income diversification decisions and m options for expenditure diversification decisions in a questionnaire, then $j(j-1)$, $n(n-1)$ and $r(r-1)$ best worst combinations' possible exist that an individual rural household could select. The author also assumed that each individual rural household is maximizing his utility/welfare by choosing the most and least important sources of food, income and expenditure. Thus, the difference between the two extremes (most and least) consistent with random utility was used for the modeling.

By following Lusk and Briggeman (2009), let β_j, γ_n and α_r represent respectively locations of food j, of income n and expenditure r on specific scale of importance. Thus, the true importance of each individual rural household can be mathematically expressed as follows:

$F_{ij} = \beta_j + \varepsilon_{ij}$ (1) For food diversification decisions
$I_{in} = \gamma_n + \varepsilon_{in}$ (2) For income diversification decisions
$E_{ir} = \alpha_r + \varepsilon_{ir}$ (3) For expenditure diversification decisions

Where, ε_{ij} , ε_{in} and ε_{ir} are respectively random terms for food, income and expenditure and they are independently identically distributed (i.i.d) type extreme values. The probabilities that an individual rural household chooses a given food j, income n and expenditure r as most important and k, o and s as least important in choice for each source are the probabilities that $F_{ij} - F_{ik}$ for food, $I_{in} - I_{io}$ for income and $E_{ir} - E_{is}$ for expenditure are respectively greater than all $J(J-1)-1$, $N(N-1)-1$ and $R(R-1)-1$ differences in choice set (Lusk and Briggeman, 2009). Thus, these probabilities taking on the popular multinomial logit (MNL) form for sources of food, income and expenditure can be expressed as follows:

$$\text{Prob(}\ \text{j choosen as best and k as worst in food set}\ \text{)} = \frac{e^{\beta_j - \beta_k}}{\sum_{l=1}^{J}\sum_{m=1}^{J} e^{\beta_l - \beta_{m\ 1c}}} \quad (4)$$

$$\text{Prob(}\ \text{n choosen as best and o as worst in income set}\ \text{)} = \frac{e^{\gamma_n - \gamma_o}}{\sum_{p=1}^{N}\sum_{q=1}^{N} e^{\gamma_p - \gamma_{q=1}}} \quad (5)$$

$$\text{Prob}(\text{ r choosen as best and s as worst in expenditure set}) = \frac{e^{\alpha_r - \alpha_s}}{\sum_{t=1}^{R}\sum_{u=1}^{R} e^{\gamma_t - \alpha_{m\ 1c}}} \quad (6)$$

The values of β_j, γ_l and α_m parameters can be estimated through maximizing the log-likelihood functions based on probabilities highlighted in equations 4, 5 and 6. Additionally, these estimates can be used to calculate a preference share for each food, income and expenditure. Thus, the preference share for food diversification decisions can be calculated as follows:

$$\text{Share preference for sources of food j} = \frac{e^{\widetilde{\beta_J}}}{\sum_{k=1}^{J} e^{\widetilde{\beta_k}}} \quad (7)$$

Similarly, the same procedure as shown in equation 7 was used to calculate the preference share of income and expenditure diversification decisions. However, due to the main weakness of the MNL model assuming that all individuals place equal weight of importance on each value. In addition, a random parameters logit (RPL) model was estimated because it is capable to accurately approximate any behavior model by relaxing the assumption the independence of irrelevant alternatives and modeling preference heterogeneity (McFadden and Train, 2000). Thus, the RPL model can be generally specified as follows: $\widetilde{F_{ij}} = \overline{\beta_j} + \phi_j \nu_{ij}$,

Where, $\overline{\beta_j}$ and ϕ_j are respectively the mean and standard deviations of β_j in the population, and ν_i is a random term normally distributed with mean zero and unit standard deviation. If the estimated standard deviation $\widetilde{\phi_j}$ is significant, then we conclude that it is random in the survey population. Furthermore, Likelihood ratio tests (LRT) were used to determine whether individual decision and collective decision can be pooled and whether mixed multinomial logit also called random parameter (RPL) model performed better than multinomial logit model (MNL).

Finally, the impact between decisions made by individual household head and those made by others members on rural household welfare was also computed for each food, income and expenditure diversification decision. Thus, the difference in preference share scores under individual decisions and those under collective decisions divided by preference share scores under collective decisions for each source was used to estimate the welfare impact.

RESULTS AND DISCUSSION

This section summarizes results and interpretation from data analysis. Table 2 reports the socio-economic characteristics of our sample respondents. As indicated in Table 2, the majority of the respondents had an average of 43 years with an average income of 39420 FCFA. Most of the respondents were men (85.3%), married (82.3%) and educated (22%). Seventy five percent of respondents reported having climate change information and majority of them had a large family size (61.6%) and a small farm size (68.9%). Table 2 also showed that a significant difference exists for average age ($p<0.001$), gender category ($p<0.001$), marital status ($p<0.001$) and household size ($p<0.001$) between individual and collective decisions for rural household. Additionally, further analyses revealed that these differences did not influence final results and therefore aggregate socioeconomic profiles were presented.

Results from LRT revealed that individual decision and collective decision in a given household could not be pooled across MNL and RPL models. Tables 3, 4 and 5 present respectively results from random parameter logit models for food, income and expenditure diversification strategies. Results from Likelihood ratio tests (LRT) showed that mixed multinomial logit model outperformed multinomial logit model, implying that only estimates from mixed multinomial logit (RPL) were reported in this study.

Lusk and Tonsor (2016) have drawn similar conclusion by studying different models related to how meat demand elastcities vary with price, income and product category. Table 3 presents coefficients for food diversification strategies for both individual and collective decisions made at the household level from RPL model. Coefficients with positive sign were preferred while coefficients with negative sign were discounted. As can be seen in Table 3, regardless of who made decision at the household level (household head or his family member), agricultural production, followed by livestock product and remaining stock from previous harvest were the most important food diversification strategies; while food aid followed by food for work, payment in cash, donation and agricultural loan were the least important food diversification strategies relative to cash for work. Table 3 also presents preference share for each food diversification strategy. Results generally showed that the combination of agricultural product and livestock products and remaining stock from previous harvest captured 87.70 and 93.73% for individual decision and collective decision respectively; indicating that collective decision about food diversification strategies is more welfare enhancing that individual decision. Furthermore, Table 3 reports comparison between individual and collective decisions on rural household welfare. Specific results showed that for agricultural production, collective decision (88.9%) is more welfare enhancing than individual decision (79.83%). Conversely, for livestock products (52.63%) and remaining stock from previous harvest (83.75%), individual decision is more welfare enhancing than collective decision. Our results indicate that agricultural and livestock products as food diversification strategy are more welfare enhancing. These findings are consistent with a recent study reporting that crop production furnishes a basic food source and improve capable to improve farmers living conditions (Wan et al., 2016).

Table 4 reports coefficients, preference share and comparison between individual and collective decisions for income diversification strategies. Table 4 shows that the sale of agricultural product (15.25%) followed by the sale of garden product (11.72%), picking and the sale wild fruits and vegetables (9.57%), small business (8.57%), crafting (7.88%), begging(7.86%), project transfer (7.32%), the sale of firewood and straw (7.35%) and livestock product selling were the most important income diversification strategies in face of changing

Table 2. Summary statistics of surveyed respondents.

Variable	Definition	Mean for individual decision	Mean for collective decision	Mean Aggregate	Individual vs. collective
Age	Age in years	49.443(13.629)	34.426(17.173)	42.013(17.194)	p<0.001
Gender	1 if male, 0 if female	0.929(0.328)	0.776(0.418)	0.853(0.383)	p<0.001
Marital status	1 if married, 0 otherwise	0.903(0.297)	0.741(0.439)	0.823(0.382)	p<0.001
Education	1 if uneducated, 0 if educated	0.796(0.404)	0.763(0.426)	0.780(0.415)	p=0.439
Income	Monthly income in 1000	39.180(23.910)	39.420(36.360)	39.300(30.630)	p=0.940
Household size	1 if size ≤5, 0 otherwise	0.163(0.371)	0.615(0.488)	0.384(0.487)	p<0.001
Farm size	1 if size ≥5, 0 otherwise	0.296(0.458)	0.326(0.470)	0.311(0.463)	p=0.520
Climate change information	1 if yes, 0 otherwise	0.719(0.494)	0.750(0.530)	0.735(0.512)	p=0.554
Sample size	N	196	196	392	

Numbers in parentheses are standard deviations. Income reported in FCFA ($1=500FCFA).

Table 3. Rural household food diversification strategies coefficients based on random parameter logit model (RPL Estimates).

Food diversification	Individual decision		Collective decision		Aggregate decision		Individual share vs collective (%change)
	Estimates	Share (%)	Estimate	Share	Estimate	Share	
Agricultural production	3.564(0.272)**	79.83	4.340(0.355)**	88.9	3.826(0.211)**	83.33	-10.20
Livestock products (milk, meat)	0.780(0.110)**	4.93	1.025(0.122)**	3.23	0.882(0.080)**	4.39	52.63
Remaining stock from previous harvest	0.264(0.109)**	2.94	0.323(0.107)**	1.6	0.286(0.075)**	2.42	83.75
Fish farming and wild fruit harvesting	0.033(0.113)	2.34	0.032(0.117)	1.2	0.024(0.080)**	1.86	95.00
Purchasing	-0.060(0.098)	2.13	-0.033(0.097)	1.12	-0.042(0.068)	1.74	90.18
Food aid	-0.317(0.099)	1.65	-0.312(0.095)**	0.85	-0.383(0.068)**	1.25	94.12
Food for work	-0.438(0.095)**	1.46	-0.453(0.096)**	0.74	-0.373(0.067)**	1.24	97.30
Payment in cash	-0.821(0.104)**	1.00	-0.774(0.106)**	0.53	-0.796(0.073)**	0.82	88.68
Donation	-0.842(0.101)	0.97	-0.973(0.101)**	0.44	-0.899(0.069)**	0.74	120.45
Agricultural loan	-1.522(0.120)**	0.49	-1.604(0.123)**	0.23	-1.538(0.082)**	0.39	113.04
Cash for work	0.00	2.26	0.00	1.16	0.00	1.82	94.83
Number of individuals	196		196		392		
Log-Likelihood	-5441		-5243		-10666		

*, ** denote mean importance level significantly different from cash for work option at 5 and 1% respectively. Numbers in parentheses are standard errors.

climate; while remittances from migrants (3.55%) and the sale of livestock (2.98%) were the least important income diversification strategies relative to income such as hired labor. While results are similar for both individual and collective decisions with regard to income diversification, results from

Table 4. Rural household income diversification strategies' coefficients based on random parameter logit model (RPL Estimates).

income diversification	Individual decision		Collective decision		Aggregate decision		Individual share vs collective share (% change)
	Estimate	Share (%)	Estimate	Share (%)	Estimate	Share (%)	
The sale of Agricultural product	0.994(0.112)**	15.25	0.976(0.109)**	15.31	1.010(0.079)**	15.25	-0.39
The sale of garden product	0.823(0.086)**	11.72	0.650(0.085)**	11.05	0.747(0.061)**	11.72	6.06
Picking and sale wild fruits	0.544(0.076)**	9.57	0.497(0.105)**	9.48	0.544(0.076)**	9.57	0.95
Small business	0.581(0.108)**	8.57	0.408(0.086)**	8.67	0.434(0.065)**	8.57	-1.15
Crafting	0.350(0.055)**	7.88	0.287(0.077)**	8.40	0.350(0.055)**	7.88	-6.19
Begging	0.348(0.058)**	7.86	0.376(0.083)**	7.68	0.348(0.055)**	7.86	2.34
Project transfer	0.276(0.054)**	7.32	0.216(0.075)**	7.46	0.277(0.054)**	7.32	-1.88
The sale of firewood and straw	0.266(0.051)**	7.25	0.258(0.073)**	7.16	0.267(0.051)**	7.25	1.26
The sale of livestock product	0.180(0.058)**	6.65	0.126(0.082)**	6.54	0.181(0.058)**	6.65	1.68
Borrowing	0.051(0.058)	5.85	0.055(0.080)	6.09	0.052(0.058)	5.85	-3.94
Remittances from migrants	-0.448(0.059)**	3.55	-0.504(0.076)**	3.49	-0.448(0.058)**	3.55	1.72
The sale of livestock	-0.622(0.068)**	2.98	-0.692(0.095)**	2.89	-0.623(0.068)**	2.98	3.11
Wages from hired Labor	0.00	5.55	0.00	5.77	0.00	5.55	-3.81
Numbers of individuals	196		196		392		
log Likelihood	-6004		-5972		-11940		

*, ** denote mean importance level significantly different from wages from hired labor option at 5 and 1% respectively. Numbers in parentheses are standard errors.

difference between preference share for individual decision and that of collective decision reveal more information about welfare. Thus, for the sale of agricultural product (-0.39%), crafting (-6.19%), small business (-1.15%) and project transfer (-1.88%), decisions made collectively are more welfare enhancing than decisions made individually. Conversely, the sale of garden product (6.6%), picking and the sale of wild fruits and vegetables (0.95%), begging (2.34%), the sale of firewood and straw (1.26%) and the sale of livestock product (1.68%), decisions made individually are more welfare enhancing than those made collectively. Key results show that agricultural product and garden products selling as income diversification strategies are more welfare enhancing.

These results are consistent with recent studies by Tithy et al. (2017) stating that income diversification has been identified as the most important strategy to raise income and reduce rural poverty. They also added that the level and type of income diversification depends on the accessibility and availability of different income sources. Furthermore, a recent study by Wan et al. (2016) have confirmed that income diversification could assist rural households to reduce the adverse impact of drought, enhance their resistance and resilience to drought, and make their livelihood system more stable. They have reported that income diversification not only is a useful strategy in terms of managing disaster risk and improving social welfare, but also may offer a new perspective for the research of vulnerability, resilience, and adaptive ability of rural social-ecosystem.

Finally, another research by Fentahun et al. (2018) stated nonfarm and off farm activites are the main income diversification strategies in most developing countries. They also show that income diversification such as crop income has the highest share followed by livestock income.

Table 5 presents individual and collective decisions, their preference share and a comparison between these preference shares. As can be seen in Table 5, regardless of individual or collective decisions about expenditure diversification strategies, household equipment (12.16%) followed by clothing (10.57%) and donation (9.76%) were the most important expenditure diversification strategies, while staple

Table 5. Rural household expenditure diversification strategies coefficients based on random parameter logit model (RPL Estimates).

Expenditure diversification	Individual decision		Collective decision		Aggregate decision		Individual share vs collective share (% change)
	Estimates	Share (%)	Estimates	Share (%)	Estimates	Share (%)	
Household equipment	0.435(0.080)**	13.27	0.325(0.082)**	12.31	0.387(0.058)**	12.16	7.80
Clothing	0.293(0.097)**	11.52	0.195(0.083)**	10.81	0.247(0.057)**	10.57	6.57
Donations/gifts	0.108(0.080)**	9.57	0.231(0.087)**	11.20	0.160(0.059)**	9.76	-14.55
Non staple food	-0.001(0.071)	8.58	-0.175(0.076)	7.46	-0.085(0.052)	7.58	15.01
Community commitment	-0.011(0.072)	8.5	-0.110(0.072)	7.96	-0.055(0.051)	7.81	6.78
Communication	-0.057(0.075)	8.12	-0.052(0.073)	8.44	-0.049(0.052)	7.86	-3.79
Staple food	-0.172(0.086)*	7.23	-0.192(0.093)**	7.34	-0.189(0.063)**	6.84	-1.50
Social services	-0.334(0.076)**	6.09	-0.466(0.078)**	5.58	-0.395(0.053)**	5.56	9.14
Transportation	-0.380(0.084)**	5.88	-0.316(0.088)**	6.48	-0.384(0.060)**	5.85	-9.26
Taxes	-0.552(0.078)**	4.95	-0.415(0.077)**	5.87	-0.483(0.055)**	5.09	-15.67
Water	-0.602(0.077)**	4.71	-0.593(0.079)**	4.91	-0.592(0.054)**	4.57	-4.07
Production inputs	-1.050(0.097)**	3.01	-1.184(0.099)**	2.72	-1.104(0.067)**	2.89	10.66
Ceremonies/funerals/festivity	0.00	8.59	0.00	8.89	0.00	8.72	-3.37
Numbers of individuals	196		196		392		
log Likelihood	-6084		-6085		-12147		

*, ** denote mean importance level significantly different from wages from hired labor option at 5 and 1% respectively. Numbers in parentheses are standard errors.

food (6.84%) followed by social services (5.56%), transportation (5.85%), taxes (5.09%), water (4.57%) and production inputs (2.89%) were the least important expenditure diversification strategies.

CONCLUSION AND RECOMMENDATION

Numerous studies have well documented that food and income diversification strategies as climate change adaptation strategies have produced successful stories in changing climate**.** The use of experiments to determine rural households' food, income and expenditure diversification strategies is increasingly gained interest in agriculture. However, there are relatively few studies focused on evaluating rural households' food and income diversification strategies as climate change adaptation strategies. Household economy approach has been widely used to classify household based on degree of vulnerability. It also employs to efficiently target household that could not maintain their livelihoods after crises such flood, climate change, food shortage and drought occurred. However, little research has been conducted to determine rural household food and income diversification strategies as climate change adaptation strategies. The purpose of this study is to determine value rural household on various food, income diversification decisions as climate change hit. Specific objectives are to determine the optimal food, income and expenditure combinations capable of building and maintaining rural household resilience building capacity in face of changing climate and to determine whether decision made individually by rural household is more welfare enhancing than decision made collectively. Based on previous studies related to food and income diversification as well as direct interview with farmers, 11 food diversification decisions, 13 income diversification decisions and 13 expenditure diversification decisions were identified and included in this study. The balance incomplete Latin square design consistent with best-worst scaling approach was used to design questionnaire utilized in data collection, while random parameter model was used to model the choice data.

Results showed that agricultural production

followed by livestock products and remaining from previous harvest were the most important food diversification strategies for respondents surveyed in the study area, suggesting that projects aim at improving agricultural production and livestock products (milk and meat) as food diversification decisions would be more beneficial for farmers. Results also indicated that agricultural product selling followed by garden product selling, picking and selling wild fruits and leafy vegetables, small business, crafting, project transfer, firewood and straw selling and livestock product selling were the most important income diversification strategies in the study area, indicating that welfare of rural household could be considerably improved when projects have been developed and implemented based on these identified most important income diversification strategies. Moreover, results from this study revealed that household equipment followed by clothing and donations were the most important expenditure diversification strategies, implying that most rural household spent a large proportion of their income on household appliances, clothing and donation or gifts. Finally, results suggested that decisions made collectively for food and income diversification strategies are more welfare enhancing than those made individually, while decisions made individually for expenditure diversification strategies are more welfare enhancing those made collectively.

This study suggests that rural household welfare could be improved when the combination of these most important food and income diversification strategies is considered by policy-makers. These results also help to guide decision-makers on how to act faster, more efficiently and effectively in time of crises as well as to plan rural development in the study area. Limitations of this study include considering only one region and failure to stratify respondents based on wealth groups and as well as hypothetical bias associated with choice experiment. Future direction for research is to study the stability of rural household preference for food, income and expenditure diversification strategies over time and across different experimental designs (balanced incomplete block versus balanced incomplete Latin square designs).

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CONFLICTS OF INTEREST

The authors have not declared any conflict of interests.

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