

# **Drivers of Rural Income Diversification in Developing Countries: Case Study of Burundi**

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## **Author's contribution**

*The sole author designed, analyzed and interpreted and prepared the manuscript.*

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## **ABSTRACT**

The significance of rural income generation is obvious for rural well-being enhancement and rural development in particular and widely national development. The research carried on income pattern analysis enabling to detect the ways to achieve the rural income generation enhancement and so far, the rural development and rural well-being improvement. The discussions about income diversification aim have mainly been divided on one hand in income maximization household objective by increasing output, on the other hand, risk and seasonality of income management. Nevertheless, in all cases, income diversification has been seen as an income increasing factor of income, poverty reduction, and well-being enhancement. The study findings shows that The income level is quite different by sources of income of household, a high income level is achieved in beekeeping at level of 5134.04 thousand BIF, but only 5% of households are involved in beekeeping, whereas the lowest income average is realized in livestock selling, 12.88 thousand BIF and 83% of households benefit from the income of livestock selling. The income from agriculture is also low, it is 112.1 thousand BIF and 100% of the 2,560 households surveyed are involved in agricultural income generation. It is also shown that there is a high share of agricultural income in the total rural income, 67% of rural income is from agriculture. The income diversification level was calculated by using the Berry index. The average Berry index of 0.06 shows a low-income diversification level in the rural households of Burundi. The analysis of income diversification by

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considering the household income diversification index has proven a higher income for household that their income sources are diversified. The household average income for the household with sources of income diversified is 2.7 times higher than those with one source. The analysis of determinants of income diversification participation realized using probit model has shown that household income, agricultural household landholding, the age of household head, belonging to agricultural producers' organization, reading skills at least of the national language, and access to market positively induce the income diversification participation, while female household headed status and the non-governmental organizations interventions negatively impact the income diversification participation. The intensity of income diversification analysis done by Tobit model shows that income diversification intensity is positively influenced by household income level, producers' organization participation, access to market, age of household head and negatively affected by the female household headed status, and non-governmental organizations interventions. Based on the findings of the study, the following recommendations and policy implications are possible to improve the rural well-being and poverty reduction by increasing rural income through income diversification facilitation. The research findings showed that rural income diversification is positively related to market access. The policy aiming at rural income enhancement by increasing rural income source diversification might take into consideration the increasing availability of the market and linkages of rural households to the market by any means. The increase in the market orientation of the rural household might be achieved by increasing the availability of the market information system. Policy making might focus on increasing factors that increase the market orientation decisions of rural household by the increase of the rural market place, making market information available and enhancing the transport means of rural products. The policy targeting rural income enhancement and sources of diversification should be achieved by reducing the vulnerability of young farmers and households headed by females by supporting rural young farmers and female farmers. The increasing economic empowerment of young farmers and female headed households should be promoted. The policy makers should also focus on increasing education skills at least the reading skills of the national language of rural farmers since reading skills have been proven to have a positive influence on rural income source diversification. The adult literacy programs might continue and try to reach the majority of rural uneducated farmers.

*Keywords: Rural income diversification; agricultural household model; berry index,*

## **1. INTRODUCTION**

### **1.1 Literature Review**

#### **1.1.1 Income diversification determinants**

Income is linked to development and often measured as income per capita. It is used to catch the development level of a country or an area. Barr [1] defined income as the consumption and savings opportunity gained by an entity within a specified timeframe. It is expressed in many cases in monetary units. For household and individuals, income is the sum of all the wages, salaries, profits, interest payments, rents and other forms of earnings received at a given time [2].

Income diversification is defined as the adding of new income generating activities. In rural areas, income diversification could be operated by income generation in or off the agricultural sector. Ellis [3] described rural income diversification as the process by which a rural

household tries to construct progressively a complex portfolio of activities in order to increase resilience and enhance the standard of living.

Rural generating activities and income diversity have been argued to be potential driving forces for rural economic growth by the additional income generation and production and consumption linked to agriculture, industry, and services [4-6]. International Labor Organization (ILO) [7] argued that rural economic diversification, both within agriculture and non-agricultural activities, has significant potential in poverty reduction and in increasing coping mechanisms in face of crop failure or price volatility, enhancement of food and securing the livelihood of rural households.

Diversification is referred to the expansion of the range of rural activities outside the farm and is considered as a dynamic adaptation process due to the pressures and opportunities [3]. FAO and World Bank defined diversification as an increase in farm income or income variability reduction

realized by the expansion of farm household activities through the exploitation of new or existing market or non-market opportunities including wages unemployment in the local non-farm sector and the exploitation of natural resources [8]. Diversification may come out as calculated household strategy or forced response to crisis and could be considered in both situations as a safety net for the rural poor or as a method of rural wealth increasing [9].

Currently, there is evident acceptance and recognition of the key role of economic diversification through the growth of the rural non-farm economy as a response to a productive agricultural sector and is highly considered as a significant driver for structural transformation in developing countries [7].

### **1.1.2 Income diversification analysis approaches**

Theoretical literature distinguishes different approaches of diversification analysis. The core element of differentiation is the base of diversification determination. The diversification could focus on asset, income, or activity [10].

According to Barrett et al. [10] and Adebayo et al. [11], assets are defined as factors that permit the direct or indirect generation of income or somehow return. The asset-based diversification analysis is explained by the portfolio theory. In this theory, diversification is the solution and the choice of economic agents to income maximization, risk, and income variability minimization [12] (Markowitz, 1959).

In the assets and income diversification based analysis approach, the focus is on the production function and its components, the role of assets in production capability of household and represents in somehow the household capacity to diversify based on the fact that economic activity is the ex-ante production flows of asset services and further income being the ex-post flows of incomes.

For that, the roles of market and product values are overriding. The market oriented and sector efficiency concepts are linked to the asset-based diversification concept. The assets diversification based analysis approach relied on diversification explained in the portfolio theory in which the assets are considered as the objects of agent's choice decision with the income maximization or minimization, risk reduction or both. Barrett et al.

[10] criticized the analysis of diversification based on the asset-based approach due to fact that firstly, it is not easier and always possible to allocate a productive asset to a particular activity while the assets are used across activities and so, it is not easy to add up assets in a single activity. Secondly, due to the difficulty of getting the right value of assets consequently to insufficient asset market development system observed in developing countries, they stated that in asset diversification analysis, assets must be considered as the vector of physical quantities and not as single money valued aggregate. This somehow makes difficult and even impossible to fully capture patterns of household's diversification activities of all income generating activities and non-gained income option.

The activity-based diversification analysis approaches are grounded to the economic activities run by the household and in this case, criticized to ignore the non-economic based income earned by the household as remittances and non-monetary transfers [10]. In case the research wants to ignore non-economic activity-based income, the diversification patterns analysis based on household economic activities diversification could be adopted as a suitable measure, but in this case the diversification patterns could be underestimated since the source of income from non-economic activities and labor allocated to non-economic activities are excluded [13].

The income-based analysis is based on the output of the process while the activity-based analysis focuses on a variety of economic activities carried out by the household. The income-based analysis approach argued for an analysis of income diversification, by comparison, the value of any household income including non-activity-based income gaining such as transfer and remittances. The income-based diversification analysis approaches have been qualified to be more suitable for income diversification analysis due to the fact that the main objective of household diversification economic even non-economic activities are motivated by the income maximization or stabilization or both and enable to correct the inconsideration of the asset and activity-based diversification approaches [3,10]. Additionally, income is the end outcome of income generating activities, which guides productive and non-productive asset allocation and non-earned income options as transfer and it is easier to convert in-kind payments into money metric

considering the higher development for goods markets compared with asset market [10]. In addition, income is widely used in poverty and household wealth measurement.

### 1.1.3 Diversification of income measurement

Measuring income diversification is done on assets, activities, and income collecting data. There are a lot of methods used in income diversification measurement and the most common and easily understood measures are levels and shares of income. In these methods, the report is based on the amount of income gained from each source of income or some groups of sources of income such as farm versus non-farm income, share of total income procured by each source of income [14,15,13]. The hypothesis in these cases is the higher share of non-farm income shows high income diversification and less vulnerability to income generating activities shocks from specific sources of earning. The usage of the methods of diversification measurement could be used based on the asset allocation to different economic or productive activities (crop production, livestock, etc.). This measurement has been criticized for its inapplicability to many sorts of income sources. It is somehow not easier to interpret for disaggregate levels with these sort of measurements. At the disaggregate level, the usage of one or more composite indexes has been adopted, such as the Gini index which measures the area under the Lorenz curve as the comparison shares of areas in case of perfect equally distribution of all variables (income, asset, and activities) and this is mainly used for income equity measurement [16].

In the same consideration of composite indexes, the usage of an inverse of Herfindahl-Hirschman index, the Berry index and the entropy measure of diversification (Mishra, *et al.*, 2010; Mcnamara - Weiss, 2005) is noticed. These composite indexes are expressed in the general form developed by Hannan and Kay (1997) which is

$$D = (\sum_{j=1}^n m_j^\alpha)^{1/(1-\alpha)} \text{ for } \alpha \geq 0 \text{ and } \alpha \neq 1$$

where D is the index of diversification,  $m_j$  is the share of the  $j^{\text{th}}$  income source and n is the number of income sources,  $\alpha$  indicates the diversification parameter which represents the weight of the number of income sources versus the evenness in the distribution of income shares. The higher the value of  $\alpha$ , the more important the emphasis in the distribution of

income. The maximum limit value of the index for any  $\alpha$  value is the income sources number and the minimum limit value is 1, which is attained when there is only one source of income in household while the maximum limit is attained for a situation where the shares of incomes sources are equally distributed in household income composition.

Precisely,  $\alpha = 0$  indicates the diversification by simply taking in consideration the number of sources of income, and if  $\alpha = 1$ , the index becomes the entropy index ( $d_e$ ), which is expressed using the following formula:

$$D_E = \sum_{j=1}^n s_j \ln\left(\frac{1}{s_j}\right).$$

If  $\alpha = 2$  the index becomes the inverse of Herfindahl-Hirschman index expressed in this formula  $D_{HH} = \sum_{j=1}^n s_j^2$  and the revised format of the Herfindahl-Hirschman index is the Berry index or Simpson index of diversity  $D_B = 1 - \sum_{j=1}^n s_j^2$ , the index takes a value of 0 if the household has one source of income and the higher the value of the Berry index, the higher the number of sources of income in the household.

Ginevicius [17] introduced a diversification indicator, namely,  $d_g$  that considers the changes in the number of unrelated income sources. The Ginevicius index is calculated by using the formula  $D_G = 1 - \frac{1}{\sum_{j=1}^n \frac{1-s_{max}}{1-s_j}}$  with  $s_{max}$  determining the largest income share.

In case of single household income source, the higher the value of the diversification index, the greater the number of income sources diversified in the business.

### 1.1.4 Why income diversification?

Some scholars argued that in developing countries market imperfection and production risks are mainly considered for the household in diversifying their income source [18-20].

It has been stipulated that this above situation leads to the inseparability of consumption and production of the household. The maximization of production by minimization of input or maximization of output decisions of households are combined with these of maximization of consumption utility and minimization of expenses in rural household, especially in no highly linked

to the market economy. It can be assumed that the attainment of a certain level of surplus between production –consumption leads to market linkage of rural economy if the external socio-economic factors of household and market are favorable and initiatives lead to the economic development of the household.

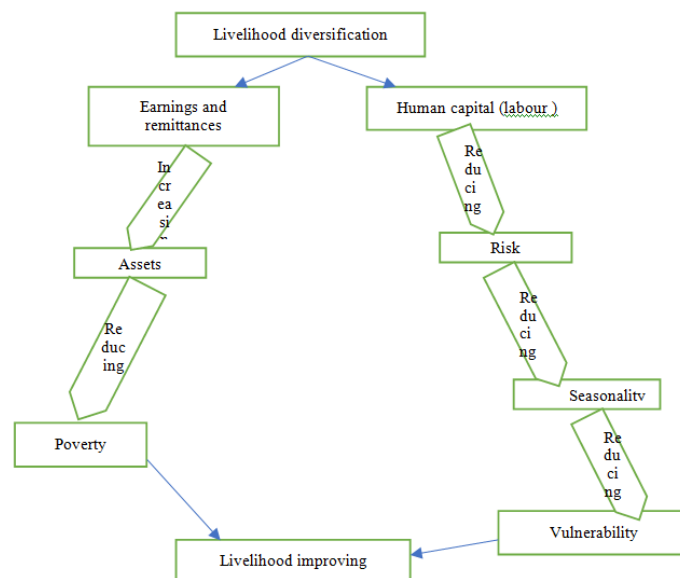
If diversification is linked to the minimization of expenses in household consumption and development of autarchy of household, it may be a sign of livelihood deteriorations caused by the collapse of the economy. Besides, in case of diversification linked to maximization of output, it may be a sign of success in attaining improved economic conditions by securing livelihood and the process of open market participation of household [9]. The determination of the type of cause and effect of diversification requires the consideration of the social relation, income and asset level, opportunities and location of farm households [9]. Barrett et al. [10] argued that the farm household diversification into non-farm activities is due to labor or land returns diminution or time variation from market failures as credit market or frictions (e.g. for mobility per entry into high return niches), from ex-ante risk management and from ex-post coping with adverse shocks.

Factors as incompleteness or imperfection or absence of markets (e.g. for land, labor, credit, or insurance) could lead the household allocation of its assets to the low returning activities [21,22].

Barret et al. [10] explained off-farm household motivations of income diversification by seasonal and interpersonal aggregation income, diminishing returns to productive assets, markets opportunities, economies of scope, risk reduction and coping with shocks possibilities as push factors.

In all cases, diversification of income leads to the increase of household income, well-being, and mitigated risk situation. The benefit of income diversification could be well revealed in the benefits of livelihoods diversification. Ellis and Allison [23] demonstrated the benefits of livelihood diversification and its significant role in poverty reduction strategies in developing countries as indicated in the figure below.

Diversification of income contributes to improving household livelihood by the enhancement of human capital across improving skills, innovation and experience. Diversification of income could also help to reduce the impacts of risks from disasters and shocks, seasonality of income and increase household resilience capacity (Fig. 1) [23]. Additionally, it enables strengthening the household ability and possibility to boost their economy and enlarge the economic activities and also intensify their key economic activities such as agriculture due to the fact that the ability to afford adequate input is strengthened.



**Fig. 1. Positive attributes of livelihood diversification**

Source: Ellis and Allison [23], p. 13.

### 1.1.5 Determinants of income source diversification

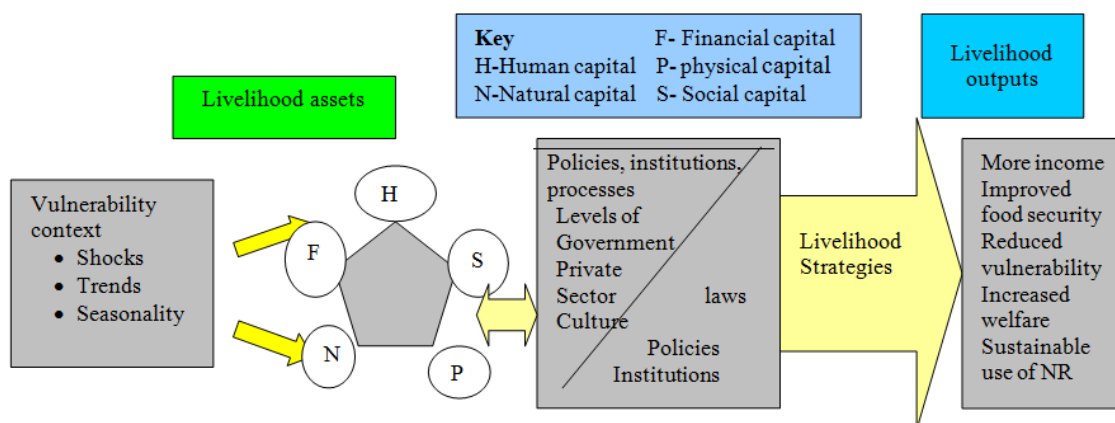
There are various social, infrastructural, environmental and economic factors which could be focused on in explaining the reason for household income and activity diversification. The analysis approaches to determining household income diversification as a livelihood diversification strategy are classified as asset-based and insurance diversification analysis approaches [24].

In the asset-based diversification analysis approaches, the degree and level of diversity in a farm household income combinations are considered as an indicator of diversity in the resources or assets it has. For example, a household that holds a large plot of land compared to its labor will be willing to engage its labor force in cultivation and for the one that has a large amount of relative labor to farmlands will be expected to specialize its economic activities in wage labor and then if a farm household possesses some land but it is not able to exploit fully using its labor it will be expected to diversify its income from its own cultivation to wage labor.

Regarding the asset-based diversification analysis approach, income diversification determinants may be analyzed through the core livelihood strategy analysis edited by DFID [25]. This analysis framework provides an understandable and complex approach permitting an overall analysis and understanding of interrelations in livelihood production [26]. It provides a clear guidance to understanding the context within which people live, the assets available for them and strategies used take in

consideration the institutions and policies in their living environment and the outcome achievement strategies within the situation [25]. The analysis of income diversification strategies of the household may focus on the analysis of the context in which the household lives (of policy setting, politics, history, agro ecology, and socio-economic conditions), analysis of the combination of household resources (different types of capital), strategies and outcomes [27].

On the other hand, the insurance-based diversification theory argues that the farm household is pushed and constrained to diversify its activities by income failures and shocks. Regarding the household demand for any form of insurance in this income stress and risky situation, diversification of income sources is considered as a source of insurance. The level of need for the diversification of income sources as a form of insurance is determined by the degree of risk affects the farm household and this may also negatively affect the degree of access to other ways of settling and coping with shocks and risks [24]. In this insurance-based diversification theory the diversification of income strategies of household is considered as a survival strategy against high seasonality, disaster and shocks, risks, assets shortage and poverty [28]. But it is in contradiction with the main consideration of the asset-based diversification theory in which expansion choices of income sources and opportunities to improve the income level and living standards is considered as the rationale behind income diversification strategies. Some researchers consider that the income diversification is led mainly from necessity versus constraints [3,9].



**Fig. 2. Livelihood strategy analysis framework**

Source: DFID, [25]

The main consideration of seasonality as income diversification determinant is based on the fact that it causes mismatching of farm household income flows and consumption, so the diversification of sources of income tries to smooth the household consumption level. The other reason for the consideration of seasonality as a factor of income diversification is the discrepancy in return of seasonal labor in non-farm and off-farm activities in the labor market, consequently, a seasonal change of labor occupation from lower to higher wages paying labor occupation and across different agricultural zones in order to stabilize household income [3,9].

Davies and Hossain [29] mentioned among the determinants of household income diversification the heterogeneity of labor markets due to variance in the household gender, location, technical skills and cultural differences. The importance of this role of the labor market is strengthened by the labor marginal productivity differences among the possible economic activities in the areas. Some researchers as Reardon [30] proved that the diversification of income sources in developing countries is explained by the low accessibility of household to credit and the farm is participating in either on-farm or off-farm activities in order to earn cash that could substitute the credit market failure and or high cost of credit available in the financial intermediaries and institutions. Even if some research [31] asserted that household involvement in income diversification activities is generated by the household cash need for consumption rather than the generation of income for the investment needed to boost future production and productivity. Nevertheless, it is stated that households that have one or small plot of land diversify their income sources for survival while the income diversification by households with the plot of land and other resources targeted savings and capital accumulation [9].

Malmberg and Tegenu [32] argued that the diversification of income strategies, executed by households due to population pressure caused by an increase in population especially in developing countries, is in relation with the decreasing of marginal productivity labor caused by the increased of the number of household members and, consequently, labor available by the household and so some of members of the household shift their occupation and are

expected to diversify and engaged in the non-farm and off-farm activities.

Adebayo et al. [11] in their study on the determinants of income diversification among farm households in Kaduna State in Nigeria using Tobit regression model obtained results that show that the significant variables that increase income diversification strategies of farm households were educational level, farm size, membership of cooperatives and non-farm income while farm size decreases the income diversification of households with the highest elasticity of 0.41. This study suggests the need for the provision of basic infrastructure in the farming communities to increase their non-farm activities.

It has been proven that the income diversification plays a role in rural poverty reduction. Many studies focused on income determinants and its diversification. Wanyama et al. [33] studied the determinants of income diversification strategies amongst rural households in maize based farming systems of Kenya using the Tobit and Logit models. Their conclusion showed that the majority of farms are engaged in cash cropping but with off-farm income supplementation, meanwhile there was evidence of opportunities for farmers in cash cropping and non-farm activities. The pricing and inefficiency in production and marketing were the negative factors for poverty and food insecurity reduction.

In addition, lack of capital makes the diversification of income difficult and the household with bigger farm size were more likely to participate in the non-farm sector than those with illiterate or low educated household heads.

Démurger et al. [34] analyzed the rural household decisions on income diversification in the townships of Northern China and they concluded that the diversification both within farm activities and off-farm activities played an important role in increasing rural household income and the driving factors of rural income diversification were land availability, household assets, position and working resources. They pointed out the existence of a clear gender and age bias in access to off-farm activities that are mostly undertaken by male and the young people.

Fadipe et al. [35] analyzed income determinants among rural households in Kwara state, Nigeria using primary data from a structured questionnaire from 90 randomly selected

households using multiple regression. The results of their study showed that farm income is the most important source of income for rural households in the study areas for 57.9% of the total household income. The main determinants of income identified were the level of education of the household head, farm size and access to electricity and gender of the household. They recommended integrating these variables in rural development policies for improving the quality of life of rural people.

Su and Heshmati [36] analyzed the determinants of income and income gap between urban and rural China using the ordinary least squares, conditional quantile regression and blinder – oaxaca decomposition methods of Chinese health and nutrition surveys and household data. Their results showed that education and occupation were the essential determinants of household income level. It is shown that these two factors exerted heterogeneous effects at different percentile of the income distribution, and in urban areas education was more valued for high-income earners and specialized or tertiary education was more profitable for the poorest households. They also concluded that individual attributes, especially the level of education and type of occupation explained the income gap, which increased from 2000 to 2004 and decreased from 2004 to 2009.

Ibekwe [37] analyzed the determinants of income among farm households in Orlu agricultural zone of Imo State, Nigeria, and the study determined the average annual income of farm household of 60,197.8 nairas, per capita income of 7,524.7 nairas and the GINI coefficient of 0.488. The results of income regression showed that the variables of extension services, property, farm size, income from pension, hours spent on farm income from handcraft education of household head, income transfers and age were positively in correlation with farm household income.

Tesfaye [38] analyzed the determinants and the effects of income diversification in rural Ethiopia with data of survey using the double censored Tobit model. The study showed that human capital, education, access to credit and other private assets helped increase the engagement of the household in income diversifying activities. The existence of access to credit and savings are the other variables that have an impact on household's ability to diversify income and these policies that aim to enhance income diversification needs to consider these different

factors that affect the lives of rural household by affecting their income diversification strategy.

Aikaeli (2014) analyzed empirically the determinants of income in Tanzania using generalized least squares technique and data from the 2005 Tanzania rural investment climate survey in order to assess the impact of socio-economic and geographic factors on the income of rural household and communities. The results of the study showed that the level of education of head, size of household, labor force, acreage of land use and ownership of a non-farm rural enterprises positively impact rural income and that the income was lower in female-headed households than in male headed households. It is also seen that at community level, the greater use of telecommunications, which increases access to market information and road infrastructure improvement positively affect rural income. The rural income increase was also positively dependent on sufficient rainfall.

Bartolini et al. [39] analyzed the explaining determinants of the on-farm diversification in the Tuscany region and argued that on-farm diversification toward multifunctional activities strengthened territorial and social cohesion and rural areas and that the relations between farm-household diversification and rural economies are central in the process of multi-functionality and in the provision of public goods through agricultural activities. They stipulated that from a "micro" point of view on-farm diversification activities can represent a relevant share of farm income applying the count model to explain the number of on-farm diversification activities implemented by the farms in Tuscany. They concluded that the high number of agricultural holding did not apply any diversification activity and they used the two-step model as the first step to simulate the adoption of diversified strategy as a binary variable and secondly, a model analyzing the diversification intensity determinants among farms that have decided to diversify their activities. The results of the study showed that the location near the main touristic areas as well as the vicinity to urban markets are important determinants of on-farm diversification intensity.

#### **1.1.6 Empirical model of income generation analysis and diversification determinants**

The agricultural household model (AHM) is appropriate to study the income determinants in



rural areas in developing countries, especially in Burundi, based on the aspects of integration in a single decision-making institution, the decisions regarding production, consumption and reproduction over time.

The rural households in developing countries could be at most semi-commercialized due to the fact that even if they are integrated in the market, at least a small portion of their production is consumed by the households and also some labor force time allocated to the household production [40].

The agricultural household model (AHM) takes its origin in Chayanov's findings and conclusion about the Russian rural peasant economy in the 1920s. Chayanov [41,9] argued that the size and the demographic structure of the household are the determinants of its resource allocation decision making in the absence of the labor market.

Subsequently, the model has been illustrated in new home economics integrating the process of time allocation with the market access consideration, and in which the household is considered as a production and utility maximizer unit [42].

Households combine the production, consumption and labor allocation decision making with the maximization of the utility and production subjects to the constraints of prices, income and time, and in this case a household is considered as a single decision maker for the maximization of a single utility function that represents the joint welfare of its members [9]. This objective of maximizing the single utility function of household welfare combining production, consumption and time allocation is possible in the existence of the labor market.

The agricultural household model is based on the utility function defined in terms of household members' consumption subject to budget constraints with the incorporation of production into the assets [43]. As stated by Singh et al. [18], Low (1986), Ellis [9] and Huffman [44], the household utility function is expressed as follows:

$$U = U(X_a, X_m, X_l),$$

where  $X_a$  represents its own agricultural production consumption,  $X_m$  indicates the goods purchased from the market and  $X_l$  is leisure.

The maximization of this household utility is subject to cash income constraint:

$$P_m = P_a(Q_a - X_a) - P_l(L - F) - P_vV + E$$

where  $P_m$  indicates the prices of good purchased from market,  $P_a$  represents prices of staple,  $Q_a$  indicates the household production staple,  $P_l$  is the market wage,  $L$  designates the total labor input and  $F$  symbolizes the family labor input,  $V$  represents variable input such as fertilizer,  $P_v$  indicates the variable input market price, and the  $E$  represents any non-farm income.

The household also faces a time constraint due to the fact that it is not possible to allocate the time needed to all activities regarding that the time available is less than needed for household activities.

$$T = X_l + f$$

where  $T$  represents the total household time stock,  $X$  indicates the leisure time, and  $f$  represents the family's labor input.

The household, as production unit, also faces a production constraint representing the relationship between inputs and farm output:

$$Q_a = Q(L, V, A, K)$$

where  $L$  represents the total labor input,  $V$  indicates the variable input such as fertilizer and seed,  $A$  is the fixed quantity of land and  $K$  indicates the fixed stock of capital of the household.

The equilibrium function is expressed as follows:

$$P_m X_m + P_a X_a + P_l X_l = P_l T + E + \pi$$

where  $P_m X_m$  indicates the value of market purchased good,  $P_a X_a$  represents the value of the household purchase of its own output,  $P_l X_l$  represents the household purchase of its own labor in the form of leisure, and  $P_l T$  represents the value of the household stock of time,  $E$  indicates the nonfarm income and  $\pi$  represents the farm profit measured in the difference between value of production and input utilized.

We can assume that farm profit is measured following the equation below:

$$\Pi = P_a Q_a(L, V, A, K) - P_l - P_v V$$

Some assumptions have to be fulfilled for the model [18,45]

1. The perfect substitution of hired labor and farm labor.
2. The household is able to sell its own labor at certain wage on the market (it is the main difference between this model and the one shaped by Chayanov in which he considered the labor market inexistent).
3. Household is price taker for the labor, goods purchased and goods sold.
4. Possibility of production of one crop.

Considering these specifications, it is clear that the households may make choices concerning the consumption level of the total labor, commodities purchased and these produced by themselves, input such fertilizers to maximize their utility. The first order conditions obtained by maximizing the household utility function are subject to the combined constraints:

$$(P_m X_m + P_a X_a + P_l X_l = P_l T + E + \pi) \text{ gives}$$

$$Q_i = Q_i(L_i^*, K_i^*)$$

$$\Pi_i = P_i Q_i^* - W L_i^*$$

$$Y^* = \sum \Pi_i^* + WT$$

where  $\pi_i^*$  represents the maximum profit obtainable from activity  $i$  and  $Y^*$  represents the total income (sum of profit and household stock of time),  $L_i^*$  indicates the labor requested for the accomplishment of the activity  $i$  and  $W$  is the wage.

In the model, income is endogenous and depends on the decisions of production realized considering the profit effect and the difference between this model and the simple consumer model is that households have to make selection of combination of goods that permits the maximization of their utility subject to full constraint and the prices of consumption goods (labor purchased and sold, prices of purchased goods and goods sold).

The agricultural household model has been used in studies concerning the household decision making and time allocation including farm and non-farm activities by many kinds of research [9,s38].

The agricultural household model has also been used in the analysis of policy affecting the price

of input and goods impact on the household welfare and other policies such as off-farm labor supply decisions, nutrition policy, downstream growth and income streams and migration and savings [45]. Escobal [46] has used the agricultural household model in the income diversification analysis and this model perfectly suits the studies on household time or budget allocation as it is for non-farm and farm income generation activities. The household has the objective to maximize its utility subject to the set of constraints (e.g. cash constraints, existing technologies of production for farm and non-farm activities, exogenous prices for inputs, labor, and goods) and the household equilibrium is obtained by the maximization of its utility function taking into consideration all these constraints.

The first order conditions of the household equilibrium function as developed by Singh et al. [18] and later by Escobal [46] enables to get a system of supply and demand functions suitable for the analysis of the determinants of income diversification concretely using the reduced form of the equation stated by Escobal [46] in the following form:

$$S_{ij} = f(P; Z_{ag}; Z_{nag}; Z_k; Z_h; Z_{pu}; Z_g)$$

where  $S_{ij}$  is the net farm and non-farm income shares,  $p$  indicates the vector of exogenous input and output prices and  $Z$ -vectors represents the different fixed assets available to the household and specifically  $Z_{ag}$  represents the farm assets,  $Z_{nag}$  indicates the non-farm assets,  $Z_k$  represents the financial assets,  $Z_h$  indicates the human capital assets,  $Z_{pu}$  indicates the public assets, and  $Z_g$  represents the other key assets of the area.

The sustainable rural livelihood strategies analysis framework presented in the section of determinants of sources income permit the selection of specific variable assets for the analysis of determinants of diversification of income.

The same equation has been used in the analysis of the household decision to engage in income generating activities [19,10,22,47,48] and income diversification level [49,22,47,48,50,51] and the shares of farm and non-farm income in total income [49,46,14,51].

## 2. MATERIALS AND RESEARCH METHODS

### 2.1 Sources of Data

The data used in the study are from the microdata of national agricultural survey 2011-2012 collected by the National Institute of Social and Economic studies. The used data in the analysis are those collected for the crop season B which lasts from March to June 2012, in which 52.2% of the national agricultural production is produced.

The data were collected using the multistage sampling methods. The data collection was carried out on the agricultural variables (agriculture input and output), and socio-economic and infrastructural situation of the community, the livestock and other income sources. The data collection does not consider the fruit and vegetable and agricultural production under state management firms and per urban agricultural production.

There were 16 rural provinces excluding the capital of the country for data collection by the National Institute of Social and Economic studies, and using multistage sampling and cluster sampling. Data collection was realized for 2560 households in which 160 households were interviewed for each of the 16 provinces. Each province was divided into 20 areas of enumeration of 4 hills and in these 4 hills 20 villages. Ten households were selected using the systematic draw method with equal probability. The questionnaire was administered to 8 households while the other 2 were reserved for replacement households.

### 2.2 Research Methods

#### 2.2.1 Analysis of income diversification methods

Income diversification analysis is realized using the agricultural household model, the equation of analysis derived from agricultural household model is

$$S_{ij} = f(P; Z_{ag}; Z_{nag}; Z_k; Z_h; Z_{pu}; Z_g)$$

where  $S_{ij}$  is the net farm and non-farm income shares,  $p$  indicates the vector of exogenous input and output prices and  $z$ -vectors represents the different fixed assets available to the household and specifically  $Z_{ag}$  represents the farm assets,  $Z_{nag}$  indicates the non-farm assets,  $Z_k$

represents the financial assets,  $Z_h$  indicates the human capital assets,  $Z_{pu}$  indicates the public assets, and  $Z_g$  represents the other key assets of the area.

The income diversification index used in the study is the revised format of the Herfindahl-Hirschman index which is the Berry index or Simpson index of diversity expressed in the following formula:

$$D_B = 1 - \sum_{j=1}^n s_j^2,$$

The index takes the value of 0 if the household has one source of income and the higher the value of the Berry index, the higher the number of sources of income in the household.

This index was chosen due to the fact that it takes into consideration both number of income and the distribution between different income sources [52,53].

In the analysis of the determinants of income diversification using the agricultural household model, we could have some households which have a single source of income and in this case  $S_{ij} = 0$ . This necessitates specific methods of analysis. The process of participation in non-agricultural income generation activities has two stages of household decision the first stage concerns to decide whether or not to participate in non-farm activities and the second stage of the decision concerns the level of diversification.

As stated by Armemiya (1985), it is fundamental to make all important decision and analyses using an appropriate statistical tool to handle such pile of zero observations in order to get the unbiased estimates.

Among adequate econometrics methods to deal with these double stages of decision, double hurdle models exist, which correct the problems of considering both the intensity of diversification and probability of diversification in the same stage as assumed in the analysis by Tobit models. The double hurdle model was first used by Cragg [54] and allows to deal with the assumption that zeros and positive values come to form the same data generating process. It is also adequate in this study to explain the process of household off-farm income generation diversification and the intensity of diversification of their income since that it is divided into two separate types of decisions: a) diversification of income sources (diversification or not and b) intensity of diversification.

In this case, for a household it is analyzed twice, firstly participation in income diversification which could be given the value 1 if  $S_{ij} > 0$  or 0 if there is one source of income and  $S_{ij} = 0$ . Thereafter, the analysis of determinants of intensity of diversification of sources of income is realized for only the potential participant in income diversification. The advantage of this decomposition is that it enables to analyze differently the factors of income diversification and the factors that determine the level of income diversification.

The double hurdle model is composed of two equations

$$Y_1 = X_1 D_1 + \mu_1 \text{ (with } Y_1 \text{ taking value 0 if } S_{ij} = 0 \text{ and 1 if } S_{ij} > 0 \text{)}$$

$Y_1$  represents probability of household to diversify its sources of income and takes value 0 if  $S_{ij} = 0$  and 1 if  $S_{ij} > 0$  of income diversification,  $X_1$  indicates a set of explanatory variables that determine the decision of household to diversify its sources of income,  $\mu_1$  is the random error and  $S_{ij}$  indicates the income diversification index. The estimation of parameters is realizable using Probit model.

The second equation analyses the determinants of the income diversification intensity of income sources by households that participate in income diversification patterns, whose  $S_{ij} > 0$  and

$$Y_2 = X_2 D_2 + \mu_2 \text{ (with } Y_2 = S_{ij} > 0 \text{)}$$

where  $Y_2$  indicates the level of income diversification in household  $i$  and  $X_2$  represents the set of explanatory variables that determine the level of household income diversification,  $D_2$  represents the coefficients related to the explanatory variables and  $\mu_2$  is the random error of the model. Based on that  $S_{ij}$  is bounded ( $0 < S_{ij} < 1$ ), the appropriate econometric model is the Tobit, which permits to get coefficients of parameters for such truncated regression.

### 3. ANALYSIS OF INCOME DIVERSIFICATION DETERMINANTS IN BURUNDI

#### 3.1 Description of the Socio-economic Factors of Rural Household

The analysis of income diversification has been done on the sample of agricultural rural

household in Burundi, the variables used in the analysis are chosen based on Agricultural Household Model explained in chapter 2.

$$S_{ij} = f(P; Z_{ag}; Z_{nag}; Z_k; Z_h; Z_{pu}; Z_g)$$

where  $S_{ij}$  is the net farm and non-farm income shares,  $p$  indicates the vector of exogenous input and output prices and  $z$ -vectors represents the different fixed assets available to the household and specifically  $Z_{ag}$  represents the farm assets,  $Z_{nag}$  indicates the non-farm assets,  $Z_k$  represents the financial assets,  $Z_h$  indicates the human capital assets,  $Z_{pu}$  indicates the public assets, and  $Z_g$  represents the other key assets of the area.

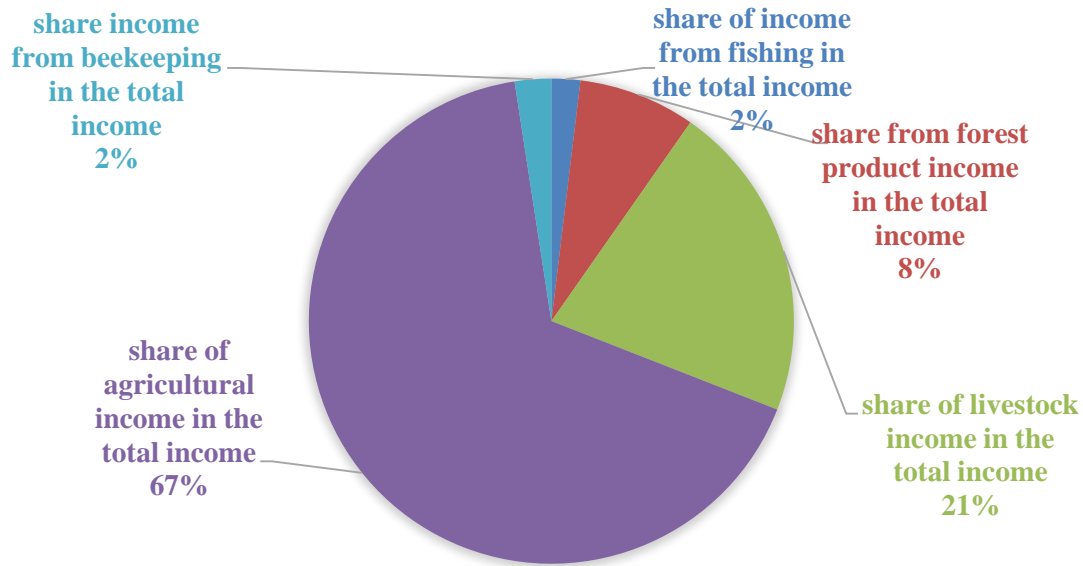
#### 3.1.1 Description of household's socio-economic characteristics

##### 3.1.1.1 Agricultural farms income sources

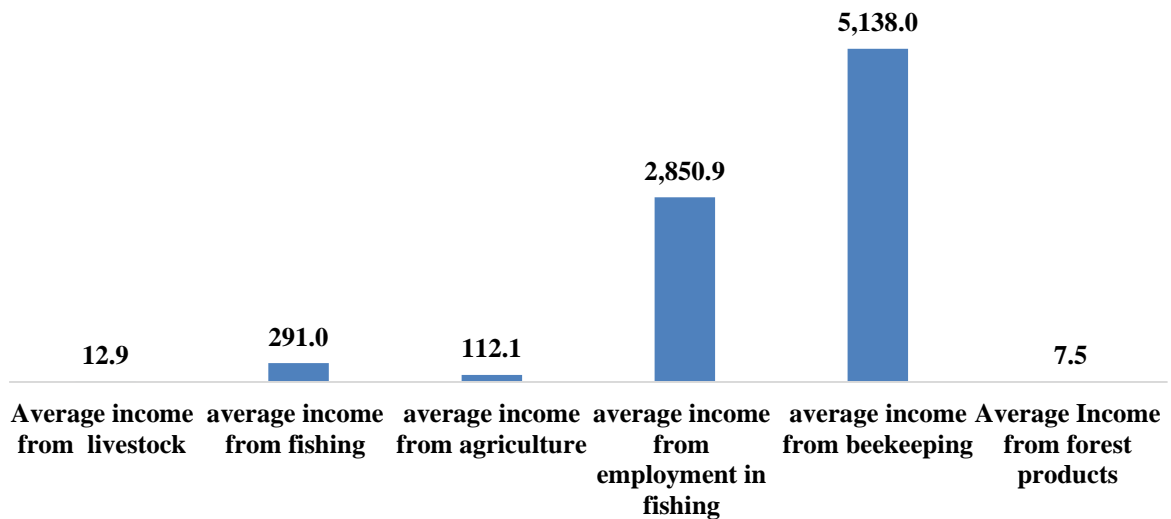
The rural household average income in crop season B 2012 is estimated to 249.5 thousand Burundian Francs, a high relative variability between households; the relative standard deviation is 569%, which illustrates a high household income disparity.

The description of source of household income shows predominance of agricultural income in the rural household income (Fig. 3).

The analysis of income generating activities in rural areas in the crop season B 2012 shows that the high average income is realized in beekeeping 5138.04 thousand BIF, meanwhile only 5% of 2560 surveyed households are involved in beekeeping. The average income from agricultural production is among the lowest followed by livestock income, and forest product income with income average respectively of 112.10 thousand BIF in agriculture, 12.879 thousand BIF in from livestock, and 7.45 thousand BIF for income from forest products. 83% households benefit from livestock income generation activities while this proportion is 36% for forest products and 1% for fishing.



**Fig. 3. Share of income sources in the agricultural households, crop season B 2012 (%)**  
 Source: editing by author from Burundi national agricultural survey database 2011-2012, crop season B

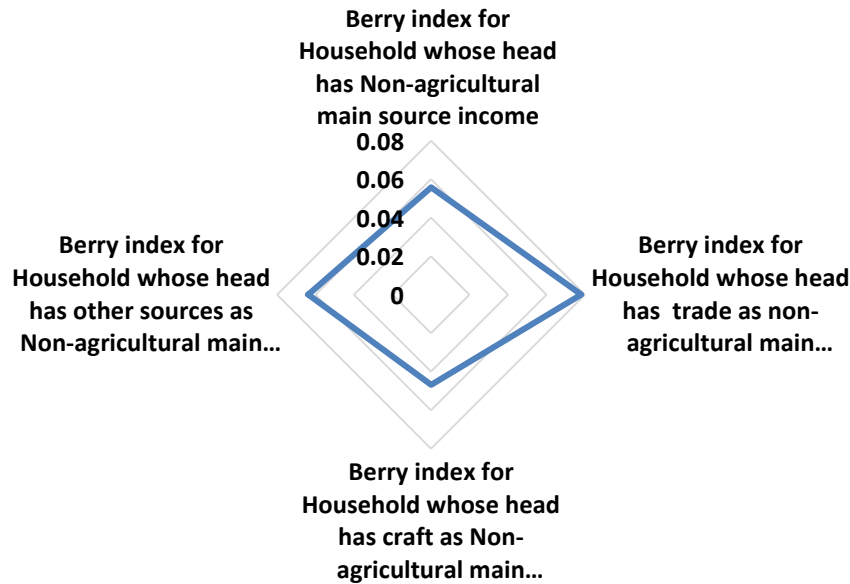


**Fig. 4. Variability of income level by rural income generation activities (thousand BIF)**  
 Source: editing by author from Burundi National Agricultural Survey database 2011-2012, crop season B

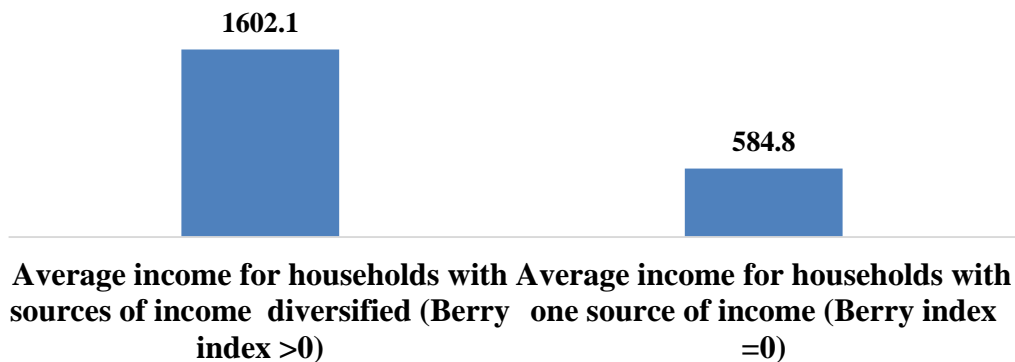
**Table 1. Descriptive of income diversification index**

Variable	N	Mean	Std. Dev.	Minimum	Maximum
Berry index	1256	0.063	0.142	0	0.656

Source: editing by author from Burundi National Agricultural Survey database 2011-2012, crop season B



**Fig. 5. Berry Index by the main sources of non-agricultural income of household head**  
 Source: editing by author from Burundi National Agricultural Survey database 2011-2012, crop season B



**Fig. 6. Average income by household income source diversification (thousand BIF)**  
 Source: editing by author from Burundi National Agricultural Survey database 2011-2012, crop season B

**Table 2. Model summary**

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Iteration 0:	log likelihood = -619.56302
Iteration 1:	log likelihood = -587.92315
Iteration 2:	log likelihood = -577.24975
Iteration 3:	log likelihood = -577.11268
Iteration 4:	log likelihood = -577.11267
Probit regression	
Number of obs = 1150	
LR chi2(21)	= 84.90
Prob > chi2	= 0.0000
Log likelihood	= -577.11267
Pseudo R2	= 0.0685

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Source: editing by author from Burundi National Agricultural Survey database 2011-2012, crop season B

**Table 3. Model Summary**

Tobit regression	
Number of obs =	1151
LR chi2(16) =	34.01
Prob > chi2 =	0.0054
Log likelihood =	-504.44211
Pseudo R2 =	0.0326

*Source: editing by author from Burundi National Agricultural survey database 2011-2012, crop season B*

### 3.1.2 Income diversification of rural household analysis

#### 3.1.2.1 Income diversification index

Income diversification index is calculated using the Berry index, a high value of  $D_B$  close to 1 indicates a high diversity of sources of income, and the value close to zero shows concentration of income or less sources of income.

The formula of Berry index is  $D_B = 1 - \sum_{j=1}^n s_j^2$ ,

It is observed in the rural areas a low level of income diversification; the level of income diversification is estimated to 0.063. It means that the sources of rural income are not highly diversified. The analysis of diversification intensity by the main sources of non-agricultural income shows that the households whose heads are not involved in any other main sources of non- agricultural income have slight lower diversified sources level ( $D_B=0.056$ ) than those with trade and other sector as main sources of non-agricultural income.  $D_B$  is respectively the highest for those with trade as main sources of no agricultural income (Berry index =0.078) while it is 0.064 for households with heads involved in other main income activity other than trade or craft industry. The lowest Berry index is observed in the households whose heads main sources of non- agricultural income is craft industry (Berry index =0.056) (Fig. 4).

It has been noticed that the income level is widely different between these households with income sources diversified than those with only one source of income. The average income for the households with diversified income sources (average income =1602.1 thousands BIF) is 2.7 times higher than these with one source of income (average income the household with one source of income =584.8 thousands BIF) (Fig. 6). Unfortunately, only 296 (23.6%) of household have income sources diversified while 960 (76.4%) has only one source of income.

#### 3.1.2.2 The determinants of income diversification participation decision

The explanatory variables have been selected based on the agricultural household model theory. The analysis of the Binary probit regression results shows that the model is significant (LR Chi<sup>2</sup>(21) = 84.90 and Prob > Chi<sup>2</sup> = 0.0000) which is significantly lower than 0.01). The number of observations is 1150 and is quite sufficient for binary probit regression and the model have converged at 5 iteration log likelihood (Table 2).

Diversification participation is analyzed by using the Probit model. The results revealed that the coefficients linked to the total household income and agricultural holding land by household are significant at level of 1% and have a positive effect on the income diversification, while the coefficient linked to the age of household head is significant at level of 5% and participation of head of household in producers' organizations, reading and writing skills of head of household, access to local marketplace, which stands 3 times a week are significant at level of 10%.

All these variables have positive marginal effect whereas the existence of non-governmental organization or local organization is significant at level of 10%, sex of household whether is female is significant at level of is significant at level of 5%, These variables have negative average marginal effect on income sources diversification participation.

#### 3.1.2.3 Income sources diversification decision and household income level

The Probit model estimate shows that the household income is increasing and having a positive marginal effect on diversification of income sources in the household. The household income increases of BIF10,000 increases the probability of the household decision to diversify its sources of income by 43.2%. This probability is high. The analysis of income level by

household income source diversification status has already shown that the household income's sources are diversified 2.7 times higher, than those, that do not diversify their income sources.

#### *3.1.2.4 The agricultural holdings and income diversification*

The income diversification decision is positively influenced by the agricultural land area of household. The average marginal effect of land is 0.097, which indicates that an increase of agricultural land area of a household of 1 hectare increases the probability of household to diversify its income's sources by 0.097. This positive marginal effect of household landholding on income diversification indicates the importance of agricultural asset in rural income generation in Burundi, where 67% of rural income in the crop season B was from agriculture. The small average holding per household of 0.2838 hectares per household combined to the high shares of agricultural income in the rural income make rural agricultural population more vulnerable and unable to invest in other sector. It can be preferable to raise agricultural efficiency in order to increase the level of agricultural production per hectares.

#### *3.1.2.5 The impact of age of head of household on income source diversification of household*

The age of household has a positive impact on the probability of household to diversify its sources of income. The increase of one year the age of household head increases the probability of the household to diversify its sources of income for 0.0000399. The positive impact of age of the household on income diversification decision represents the importance of experience of agricultural holders in rural income generation and the vulnerability of young farmers.

#### *3.1.2.6 Income diversification decision and producers' organization of heads of households*

The income diversification decision is positively impacted by the household head's participation in producers' organization. The belonging to producers' organization increases the probability of income sources diversification decision by 0.076, which is high. The producers' organizations enable the rural farmers to get aware of economic incentives of local economy structure.

#### *3.1.2.7 Income diversification decision and access to market*

The access to local market that stands 3 times a week has a positive impact on income sources diversification decision. The access to marketplace for 3 times a week increases the probability of household to diversify its sources income by 0.157. The access to local marketplace which is linked to the possibility of the household participating in local trade of local products enables the market orientation household decision. Access to local market increases the possibility of household to boost the rural income. The increase of local trade enables the change of the structure of the local economy, and change from autarchy economy to market-oriented economy of rural households.

#### *3.1.2.8 Reading and writing skills and income diversification decision*

The results of the profit model show that the household whose head is at least able to read the national language increase the probability to diversify its sources of income. The household whose head is at least able to read increases the probability to increase of the household to diversify its income sources of 0.09. The skills in reading and writing enable an easy transfer of knowledge and ability to use the acquired knowledge in income generation activities management.

The analysis of risks and prospection of future opportunities which influence the involvement in new income generation activities may be linked to the ability to get the easily the necessary information facilitated partially by the reading and writing skills.

#### *3.1.2.9 Non-governmental organizations and income sources diversification*

The probability of income diversification is negatively influenced by the existence of non-governmental organization in the community. The negative average marginal effects of (-0.050) indicates that the presence of non-governmental organizations decreases the probability to diversify the income sources. This can be explained by the fact that non-governmental intervention mainly targets poorer rural areas than others. It is noticed that the rural income average is 1.5 times less in the areas where the non-governmental organization intervention is run than these where the non-governmental organizations do not intervene.



The average income is 240.65 thousand BIF for the areas, where non-governmental organization interventions are run, while the average income is 384.8 thousand BIF for the rural areas, where non actions of NGO are done, respectively.

### 3.1.2.10 Gender vulnerability and income diversification decision

It states a negative effect of gender on income diversification decision. The female status of head of household makes the household less able to diversify its income sources. The household whose head is female has fewer possibilities to diversify its sources of income. The average marginal effect linked to the sex of head of household is negative and significant. Household female headed status is linked to the decrease of 0.093 the probability of household to diversify its sources of income. This could be linked to high involvement of female in social activities which have less monetary value, like housework than monetary income generation activities.

### 3.1.2.11 The analysis of the determinants of income diversification intensity

The analysis of the level of income diversification is analyzed using the Tobit model, the dependent variable is the Berry index and the explanatory variables are selected based on the Agricultural Household Model. The estimates of the model are computed by Stata13 software.

The results of the model estimation show that the overall model is significant at level of 1%. The number of observation is 1,151, which and the overall model is significant at level of 1% since  $LR\ Chi^2(16) = 34.01$  and the  $Prob > Chi^2 = 0.0054$  which is under 0.01.

The analysis of the results of Tobit regression model shows that the variables total income, reading skills of the national language at least, belonging to producers' organization, access to local market 3 times a week are significant at level of 10% and age of household head is significant at level of 5% and has a positive impact on intensity of income diversification, whereas the coefficients linked to the female sex of head of household and the existence of non-governmental organization interventions are negative and significant at level of 1% and 5%, respectively.

The increase in the income of the household of 10,000 thousand BIF may consequently induce an increase in income diversification of 0.05. As

the income generation activities need economic investment, the increase in the level of income of household enables a household to increase its propensity to invest and diversify its portfolio.

The participation in agricultural producers' organizations by the household head increases the income diversification intensity by 0.11. The belonging to agricultural producers' organization increases the management skills and awareness to economic opportunities of rural people.

The accessibility to market for rural products increase the level of income diversification, the access to local market that stands 3 times a week enables rural households to increase their level of sources income diversification of 0.2, which indicates about that 0.2% of new income generation activities are created due to the increase of 1% the access to local market for 3 times a week in rural areas. The access to marketplace at rate of 3 times a week influences the openness and structure change of local economy.

The increase in intensity of diversification of incomes is slightly also explained by the increase of age of the household head. The increase in the age of head of household of 1 year could lead to an increase in income diversification intensity of 0.003. It may be connected to the experience, which increases the ability and competence of income generation activities management and high predictability of economic opportunities.

The reading and writing skills of the national language increase the intensity of involvement in rural income generation activities. An increase of 1% of households whose head is able at least to read the national language influences an increase in income sources diversification intensity of 0.14%.

The income sources diversification is negatively affected by the level of non-governmental organization. An increase in non-governmental organization interventions of 1% is related to a decrease of 0.07%.

The income source diversification intensity decreases with the increase of household's being female headed, an increase of 1% of the number of households female headed is related to a decrease of income sources diversification of 0.16%. This could explain the social limitation of female in participation in income generation

activities and predominance of time allocated to social activities without monetary income.

#### **4. CONCLUSION AND RECOMMENDATIONS**

The significance of rural income generation is obvious for rural well-being enhancement and rural development in particular and widely national development. The research carried on income pattern analysis enabling to detect the ways to achieve the rural income generation enhancement and so far, the rural development and rural well-being improvement. The study carried on income diversification in Burundi is realized with the above-mentioned aim.

The discussions about income diversification aim have mainly been divided on one hand in income maximization household objective by increasing output, on the other hand, risk and seasonality of income management. Nevertheless, in all cases, income diversification has been seen as an income increasing factor of income, poverty reduction, and well-being enhancement.

Among the income diversification analysis model, the agricultural household model is stated to be adequate for analyzing rural income patterns in developing countries where household's decisions of production, consumption, and time allocation are combined in order to maximize the complete household utility. The income diversification is mainly in rural areas realized with a target of income level increases and household utility maximization.

The income level is quite different by sources of income, a high income level is achieved in beekeeping at level of 5134.04 thousand BIF, but only 5% of households are involved in beekeeping, whereas the lowest income average is realized in livestock selling, 12.88 thousand BIF and 83% of households benefit from the income of livestock selling.

The income from agriculture is also low, it is 112.1 thousand BIF and 100% of the 2,560 households surveyed are involved in agricultural income generation. It is also shown that there is a high share of agricultural income in the total rural income, 67% of rural income is from agriculture.

The income diversification level was calculated by using the Berry index. The average Berry index of 0.06 shows a low-income diversification

level in the rural households of Burundi. The Berry index bounded with 0 indicates a situation where households have one source of income and 1 marks the highest level of income diversification.

The analysis of income diversification by considering the household income diversification index has proven a higher income for household that their income sources are diversified. The household average income for the household with sources of income diversified is 2.7 times higher than those with one source.

The analysis of determinants of income diversification participation realized using probit model has shown that household income, agricultural household landholding, the age of household head, belonging to agricultural producers' organization, reading skills at least of the national language, and access to market positively induce the income diversification participation, while female household headed status and the non-governmental organizations interventions negatively impact the income diversification participation.

The intensity of income diversification analysis done by Tobit model shows that income diversification intensity is positively influenced by household income level, producers' organization participation.

Access to market, age of household head and negatively affected by the female household headed status, and non-governmental organizations interventions.

Based on the findings of the study, the following recommendations and policy implications are possible to improve the rural well-being and poverty reduction by increasing rural income through income diversification facilitation.

The research findings showed that rural income diversification is positively related to market access. The policy aiming at rural income enhancement by increasing rural income source diversification might take into consideration the increasing availability of the market and linkages of rural households to the market by any means. The increase in the market orientation of the rural household might be achieved by increasing the availability of the market information system. Policy making might focus on increasing factors that increase the market orientation decisions of rural household by the increase of the rural

market place, making market information available and enhancing the transport means of rural products.

The policy targeting rural income enhancement and sources of diversification should be achieved by reducing the vulnerability of young farmers and households headed by females by supporting rural young farmers and female farmers. The increasing economic empowerment of young farmers and female headed households should be promoted.

The policy makers should also focus on increasing education skills at least the reading skills of the national language of rural farmers since reading skills have been proven to have a positive influence on rural income source diversification. The adult literacy programs might continue and try to reach the majority of rural uneducated farmers.

## CONSENT

As per international standard or university standard, respondents' written consent has been collected and preserved by the author(s).

## COMPETING INTERESTS

Author has declared that no competing interests exist.

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## APPENDIXES

Table 1. The description of the variables of the study

Variables	Description
Sex of household head (dummy variable)	The sex of head of household indicated the gender of head of household and is dummy variable ( female of males
Reading / writing skills of the Kirundi of head of household	the reading and writing skills of national language is evaluating the ability of household to read or/ write the national language, it is linked to the ability to get written information by himself , it's a categorical variables with 3 categories , able to read, able to read and write and unable to read and write
Reading / writing skills of foreign language of head of household	the reading and writing skills of foreigner language is evaluating the ability of household to read or/ write the any foreign language , it is linked to the ability to get written information by himself in any other language , it's a categorical variables with 3 categories , able to read, able to read and write and unable to read and write
Membership of producer' organization ( head of household)	It assesses the participation of agricultural producer's organization. It is a dummy variable and takes 0 if 's organization, and 1 if it is the head of household is member of producers organizations
Benefiting of extension (head of household)	It assesses the access to extension services and it is dummy variable (yes =1 if the head of household is benefiting of extension services, no= 0 if the head of household is not benefiting of any extension services.
Head of household has got credit in the last 3 years (dummy variables )	It assesses the access to credit in the last 3 years, it is a dummy variable. It takes value 0 if the household head have not got any credit it the last three years otherwise it is yes= 1
A road passes through the village	It assesses the access to road in the village and it is dummy variable (yes =1 and no =0)
Road in good condition in the community	it assesses how is the road available is and it is facilitation of communication capacity (it is dummy variable yes =1 , no=0)
Access to local market	It assesses the access to local market centers and the capability to sell the output and participate in local trade, it is a dummy variable (yes =1 and no=0)
Accessibility of agricultural extension services in the community	It concerns the availability of agricultural extension services in the community and it is dummy variable (yes =1 or no =0) yes =1 if the agricultural extension services are available in the local community (village)
Existing of Non-governmental organization or local associations in the community	It concerns the interventions of non. governmental organizations in the local community, it is a dummy variable (yes =1 if any intervention is realized by non-governmental organizations in the local community or village or no =1 otherwise)
Existing of producers 'organization in the community	It assesses the existence of producer's organizations run in the community and it is dummy variable , yes =1 if producer's organizations exist in the local community no=q otherwise
Existing of selling shop of fertilizers in the community	It concerns the availability of chemical fertilizers sellers in the local community or village , it is a dummy variable, yes =1 if there is fertilizers seller in the village no=0 otherwise
Access to agricultural loan in the community ( dummy variable)	It concerns the access to agricultural credit in the community and assesses if the any program or institutions provide agricultural credit to the inhabitants of the village, it is a dummy variable (yes =1 , no =0)

Variables	Description
The distance to the extension center	It assesses the access to the nearest extension center and it is categorical variables, the categories are :Less than 5 kilometers, distance Between 5-10 kilometers, distance Between 10-20 kilometers, distance Above 20 kilometers
Age of household's head	It concerns how old is the household head in years , which could shows the accumulation of human and financial assets reliable for running economic activities, it is measured in number of years
Size of household	It concerns the number of people living in the household and is measured in number
Household income	It measures the total income of all member of household and it measured in Thousand Burundian International francs, the national currency unit.
Landholding per household	It is the area of household landholding and it is measured in hectare.
Agricultural production	It is the total of household agricultural production in equivalent cereals, fruit and vegetables are not included.

Source: editing by author from Burundi National Agricultural Survey database 2011-2012, crop season B

**Table 2. Description of explanatory variables of the Probit model, Tobit model and stochastic frontier analysis**

Variables	Categories	Frequency	Percent
Sex of household head ( dummy variable)	Males	1086	86.5%
	Females	170	13.5%
Reading / writing skills of the Kirundi of head of household	Reading only Kirundi	81	6.4%
	Reading and writing Kirundi	744	59.2%
Reading / writing skills of the Kirundi of head of household	Reading skills of Other language only	90	7.2%
	Reading and writing ( other language)	247	19.7%
	No one of them	919	73.2%
Belonging to Producer 'organization ( head of household	No	1103	87.8%
	yes	153	12.2%
Benefiting of extension (head of household)	No	1145	91.2%
	Yes	111	8.8%
Head of household has got credit in the last 3 years ( dummy variables )	no	1185	94.3%
	Yes	71	5.7%
A road pass through the village	NO	77	6.2%
	Yes	1157	93.8%
good road in the community	No	240	20.7%
	Yes	918	79.3%
Access to local market	No	790	64.4%
	Yes	437	35.6%

<b>Variables</b>	<b>Categories</b>	<b>Frequency</b>	<b>Percent</b>
Accessibility of agricultural extension services in the community	no	129	10.5%
	Yes	1103	89.5%
Existing of Non-governmental organization or local associations in the community	no	693	56.3%%
	yes	539	43.8%%
Existing of producers 'organization in the community	no	233	18.9%
	yes	998	81.1%
Existing of selling shop of fertilizers in the community	no	934	75.8%
	yes	298	24.2%
Existing of fertilizers sellers in the village	No	934	75.8%
	yes	298	24.2%
Access to agricultural loan in the community ( dummy variable)	no	2240	89.2%
	Yes	272	10.8%
The distance to the extension center	Less than 5 kilometers	1616	64.5%
	Between 5-10 kilometers	480	19.2%
	Between 10-20 kilometers	288	11.5%
	Above 20 kilometers	120	4.8%

Source: editing by author from Burundi National Agricultural Survey database 2011-2012, crop season B



**Table 3. Measures of fit for profit of diversification participation**

Measures of Fit for probit of BERRY INDEX Probit	
Log-Lik Intercept Only:-619.563 D(1125):1154.225	Log-Lik Full Model: -577.113 LR(21): 84.901 Prob > LR: 0.000
McFadden's R2: 0.069 Maximum Likelihood R2:0.071 McKelvey and Zavoina's R2: 0.327 Variance of y*: 1.486 Count R2:0.783 AIC: 1.047 BIC: -6774.232 (Indices saved in matrix fs_mod1)	McFadden's Adj R2: 0.028 Cragg & Uhler's R2: 0.108 Efron's R2: 0.080 Variance of error: 1.000 Adj Count R2: 0.057 AIC*n: 1204.225 BIC': 63.097

Source: editing by author from Burundi national agricultural survey database 2011-2012, crop Season B

**Table 4. Estimates of income diversification participation**

Variables	Coefficients	z	P> z	Average marginal effect	z	P> z
agricultural land area per household in Hectares	0.3429251**	2.34	0.019	0.096506**	2.35	0.019
total household income in thousands of BIF	0.0001419***	5.33	0.000	0.0000399	5.49	0.000
age of head of household in number of years	0.0056274 **	1.84	0.065	0.0015837**	1.85	0.064
sex of household head ( dummy variables male vs female)	-0.3290492 **	-2.34	0.019	-0.092601**	-2.35	0.019
participation in PO of head of household (dummy variable yes or no)	0.271046*	1.65	0.099	0.0762778*	1.66	0.098
benefiting of extension by household head (dummy variable yes or no)	-0.1006153	-0.52	0.606	-0.0283152	-0.52	0.606
household head has got credit (dummy variable yes or no)	-0.0732888	-0.39	0.694	-0.0206249	-0.39	0.694
size of household	0.0101567	0.56	0.579	0.0028583	0.56	0.579
Reading and writing skills of household's head of national language						
reading and writing skills of national language by household's head (dummy variable yes or no)	0.3448635*	1.81	0.071	0.0907036 *	2.03	0.043
household's head does not have any skills in reading and writing national language	0.168163	0.87	0.386	.0410586	0.91	0.362
Reading and writing skills of household's head of foreign language						
reading and writing skills of national language by household head	-1.52	-1.52	0.128	-0.0761036	-1.45	0.146

Variables	Coefficients	z	P> z	Average marginal effect	z	P> z
household head does not have any skills in reading and writing in the national language	-0.0955179	-0.57	0.568	-0.0283467	-0.56	0.577
access to road in the community	0.3304477	0.46	0.642	0.0929946	0.46	0.642
road available is in good condition	-0.1704249	-1.62	0.105	-0.047961	-1.63	0.104
Access to local marketplace						
market stands for 2 times a week	0.2162203	1.15	0.251	0.0590357	1.19	0.233
market stands for 3 times a week	0.5191248*	1.96	0.050	0.1569277*	1.89	0.059
market stands every day	-.1272915	-0.54	0.589	-0.0300562	-0.54	0.589
no access to local marketplace	.1593486	0.93	0.353	0.0425598	0.98	0.328
access to agricultural loan in the local community	.1021121	0.76	0.448	0.0287364	0.76	0.447
existence of agricultural producers organization in the local community	-.1427117	-1.24	0.214	-0.0401619	-1.25	0.213
existence of the intervention of non-governmental organization in the community	-0.1780519*	-1.93	0.053	-0.0501074*	-1.94	0.053
_cons	-1.182801	-1.43	0.154			

Note: \*\*\* significant level at 1%, \*\* significant level at 5%, \* significant level at 10%, Source: editing by author from Burundi National Agricultural Survey database 2011-2012, crop season B

**Table 5. The estimates of parameters of Tobit model of income sources diversification intensity in Burundi**

Variables	Coefficients	t	P> t
total household income in Thousands of BIF	5.08e-06*	1.76	0.078
age of head of household in number of years	0.0027453 **	2.26	0.024
sex of household head (dummy variables male vs female)	-0.155635***	-2.74	0.006
Reading and writing skills of household head of national language			
reading and writing skills of national language by household head (dummy variable yes or no)	0.1412026*	1.83	0.068
household head does not have any skills in reading and writing national language	0.0928097	1.18	0.237
reading and writing skills of household head of foreign language			
reading and writing skills of national language by household head (dummy variable yes or no)	-0.0683644	-0.96	0.336
household head does not have any skills in reading and writing national language	-0.0268834	-0.41	0.682
participation in Producer Organization of head of household (dummy variable yes or no)	0.110737*	1.69	0.091
benefiting of extension by household head (dummy variable yes or no)	-0.0276301	-0.36	0.722
household head has got credit (dummy variable yes or no)	-0.052929	-0.7	0.481
road available is in good condition	-0.0551902	-1.34	0.182

Variables	Coefficients	t	P> t
Access to local marketplace			
market stands for 2 times a week	0.0750315	0.99	0.322
market stands for 3 times a week	0.201564*	1.95	0.052
market stands every day	-0.0222985	-0.24	0.811
no access to local marketplace	0.054179	0.78	0.433
accessibility to extension of the community	0.0645403	1.07	0.284
size of household	0.0019986	0.27	0.784
existence of the intervention of non-governmental organization in the community	-0.0778872 **	-2.22	0.027
_cons	-0.3958274**	-2.46	0.014
/sigma   42.72497 .0222099 38.36725 47.08268			
Obs. summary: 887 left-censored observations at BERRY INDEX <=0			
264 uncensored observations			
0 right-censored observations			
Note: *** significant level at 1%, ** significant level at 5%, * significant level at 10%, Source: editing by author from Burundi National Agricultural Survey database 2011-2012, crop Season B			

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