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ANALYSIS OF THE PROFITABILITY OF AVOCADO-BASED AGROFORESTRY VALUE CHAIN IN THE EASTERN PROVINCE OF RWANDA

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ABSTRACT

This study analyzes the profitability of avocado-based agroforestry value chain in the eastern province of Rwanda. This was aimed at investigating the degree to which it is lucrative for the value chain actors. Primary data were collected from 214 producers, 20 traders and 9 consumers. Descriptive statistics and net profit margin (NPM) were used to determine to what extent the avocado-based agroforestry is profitable along its value chain. The study's results show that most of the existing avocado-based agroforestry fruit trees accounting for 86.50% were traditional non-improved varieties that had originated from fellow farmers. The use of fertilizer inputs remains less among the producers where the majority of them (84.30%) don't apply it. The avocado-based agroforestry value chain is lucrative for all involved actors (producers, rural collectors, wholesalers, and retailers). Though avocado is a perennial crop with consecutive investments and returns across years, the study only dealt with the profitability analysis within one year of 2022 for matching the producers' market supply with other value chain actors within the same channels in the same period. Designing and implementing the policies concerning the efficient use of agro-inputs in avocado-based agroforestry production and well-organized market integration will scale up the profitability for producers and traders and improve consumers' needs along the value chain. This study provided useful information for subsequent studies with regard to fruit-based agroforestry value chains.

Key words*:* analysis, profitability, agroforestry and value chain

INTRODUCTION

Globally, meeting the food demand of the rapidly growing population is challenging and requires a profitable and sustainable farming system (Von, 2007). Sub-Saharan Africa (SSA) is the most food insecure and poorest part in the world, where the undernourished population accounts for 39% (FAO *et al*., 2018) due mainly to inadequate farming systems and lack of well-structured agricultural value chains. Nevertheless, Agroforestry was initiated as a viable system for food and tree production to ameliorate food security and generate income for a community (Nair, 1993).[1] According to Molua (2005) and Saidou *et al*. (2021), agroforestry increases and diversifies farm production while protecting and conserving natural resources. Likewise, Njogu *et al*. (2016) asserted that the fruit trees on the farms play a vital role in nutritional diversification and are a significant source of income. Bucagu *et al.* (2012) reported that fruit-based agroforestry had received a little attention. Dave *et al.* (2019) indicated that fruit trees are currently an integral component of the agroforestry agenda.

Rwanda is the most densely populated country in Africa continent (World Bank, 2017). Its agriculture sector is mainly constrained by land scarcity, dependence on rain-fed for the majority of the farmers, and land degradation leading to poverty and food insecurity, especially in rural communities. Moreover, limited agricultural commercialization due to weak output and financial markets remains a concern (Weatherspoon *et al.,* 2021). According to MINAGRI (2018), agroforestry could provide a recovery solution to degraded land, in particular providing essential farm resources including fruits. Besides, Ndoli *et al*. (2021) found that agroforestry has a significant contribution to food security and social welfare improvement through agroforestry product sales revenue.

[1]Agroforestry is defined as "the integration of trees in farming systems and their management in rural landscapes to enhance productivity, profitability and diversity and ecosystem sustainability" (ICRAF, 2013).

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A mapping survey for agroforestry expansion in Rwanda showed that the eastern plateau and savannah are some of the most prioritized agro-ecological zones (Mukuralinda *et al*., 2016). In Rwanda, there are three categories of agroforestry tree species such as timber, fruit, and legume based on their main functions (Bucagu, 2011). The present research focuses on avocado fruit-based agroforestry. Among the fruit tree species-based agroforestry, the avocado (*Persea americana)* is predominant in terms of frequencies across the six agro-ecologies throughout the country (Mukuralinda *et al*., 2016; NISR, 2020; Ndoli *et al*., 2021). Correspondingly, the study by Shumeta (2010) revealed that avocado fruit trees were suitably grown with arable crops like maize as a planned agroforestry system in the southwestern part of Ethiopia. Similarly, Lusike *et al.* (2018) argued that intercropping avocado with other crops like beans, peas, kales, cabbages, maize, and potatoes is possible.

Avocado is grown in Rwanda for local consumption and export. Two most popular improved varieties, namely Hass and Fuerte are exported, mostly with destinations to Dubai, France, Netherlands, and the Middle East (NAEB, 2020). This crop is a good source of income for farmers besides earning foreign currency. Avocado is the second dominant fruit in the country in terms of annual export revenues, with $740,573.00 after sweet banana, which accounted for $1,001,886.00 in the year 2019 (NAEB, 2020).

To ensure the successful implementation of agroforestry system, the concerned development professionals must pay more attention to agroforestry products' marketing efficiency (Ola and Menapace, 2020). According to Agroforestry Network *et al*. (2018), advancing value chains for agroforestry products and services is imperative to enable the actors to generate substantial income. Correspondingly, Mbora *et al.* (2008), Jamnadass *et al.* (2011), FAO (2013) and ICRAF (2013), argued that the profitability of agroforestry value chain could boost through the adoption of improved tree varieties with advanced farm management approaches to comply with high-value market requirements.

Too little is known about the profitability of avocado-based agroforestry value chain in Rwanda and particularly in the Rwandan eastern province. Therefore, this study analyses the profitability of avocado-based agroforestry value chain in the eastern province of Rwanda. According to (Tulsian, 2014), profitability determines the ability of the business enterprise to generate profits from its use relative to revenue and costs. According to Rahman *et al.* (2014), profitability indicates how efficiently a product or plant generates profit for owners.

MATERIALS AND METHODS

This study was carried out in the Eastern Province of Rwanda in Kirehe, Ngoma, and Kayonza Districts. This administrative entity is shared between two different agro-ecological zones, namely the eastern plateau and the eastern savannah. The Eastern Province is the largest in the country with 9,813.00 km^2 out of 26,338.00 km^2 of the country's total area (NISR, 2012). Additionally, it is the greatest area for agricultural production activities nationwide. However, this area is the most constrained by a prolonged drought season. Hence, climate smart agricultural production, including the adoption of fruit-based agroforestry is one of the trusted options to mitigate and resile the drought-based climate change impact in this region. The data used was collected from a random sample of 214 small-holder producers selected from the checklists provided by the local authorities comprising 4240 avocado-based agroforestry smallholder producers as a mother population. The random sampling approach minimizes the bias and ensures that the population is well-represented (Wackerly *et al.,* 2008). For each selected smallholder producer, the number of avocado-based agroforestry trees (young and fruiting) was counted alongside their respective varieties, fertilizer use, and volume of marketable surplus. Subsequently, there was a purposive sampling of 20 traders of avocado composed of 6 rural collectors, 5 wholesalers, and 9 retailers) and 9 consumers of avocado. In this way, information offered by the producers regarding to whom they supply avocado led to select the above-mentioned actors integrated along the same value chain marketing channel. The semi-structured questionnaires with closed-ended and open-ended questions were used to collect the data. For the analysis of data, a value chain map was used. In order to determine the profitability of avocado commodities traded/quintal for every involved actor, the formula of net profit margin was employed. The profitability has several measurements, with exotic names and abbreviations, which entails that there is no a single method to express profitability (Lutz, 2010). Normally, profitability is expressed in the form of a ratio. This study applied NPM as one of the most important profitability metrics. NPM shows the extent to which a net profit is earned as a percentage of revenue received. To calculate NPM, formula 1 was used as follows:

$$\text{NPM} = \frac{\text{NP}}{\text{TR}} \times 100;$$

where NPM is net profit margin, NP is net profit, and TR is total revenue. The NP here is calculated from TR thus; NP = TR – COGS – (TMC + overhead costs), COGS and TMC referring to cost of goods sold and total marketing costs, respectively.

RESULTS AND DISCUSSIONS

Demographic Characteristics of the Respondents

The study found that 77.70% of household heads (HHHs) were males and 22.30% of females. Regarding the households (HHs) members' age groups, 38.90% of the family members were below 16 years, and then 24.60, 31.60, and 4.90% were in the age groups of 16 to 30 years, 51 to 64 years, and 65 years and above, respectively. For the educational level attainment of the respondents, a large number (74.30%) accomplished primary, 10.90, 14.00, and 0.80% had never attained education, attained college, and university, respectively. Table 1 shows the demographic characteristics the respondents in the present study.

Characteristics of Avocado-Based Agroforestry in Selected Sites and Marketing Channels

The total number of surveyed avocado trees was 493, of which 321 were productive. The number of trees owned per household ranged between 1 to 11 and the average number of avocado trees owned per HH was 2.30. Majority (70.80%) of avocado-adopted trees originated from fellow farmers, whereas 9.20, 5.70, and 14.30% originated from government bodies, non-governmental organizations, and local markets sequentially. Most of the adopted avocado fruit-based agroforestry varieties were traditionally non-improved, accounting for 86.50%, and the minority were improved varieties, namely Hass, Ettinger, and Fuertes, which made up 5.20, 4.70, and 3.60%, respectively. The vast majority (84.30%) of avocado-based agroforestry producers do not apply any fertilizer types. Only 9.70, 1.80, and 4.20% of respondents apply farm yard manure (FYM), inorganic fertilizer, the mixture of inorganic fertilizer with FYM respectively. The low agro-input use might be attributed to a lack of avocado-quality planting materials, low awareness of fruit-based agroforestry system management methods, and a lack of access to finance due to the low coping capacity of small-scale producers. These findings are in agreement with others of Agroforestry Network (2020), which revealed that most of the high-quality agro-inputs (planting materials of improved varieties and fertilizer blends) have been adopted in monocropping but not fully adopted in the agroforestry system. These findings are also consistent with the study's findings of Jamnadass *et al.* (2011) who found that most of the current fruit trees-based agroforestry offer low yield with low quality due to inadequacy of improved planting materials and poor farming techniques.

Regarding the marketing channel, Figure 1 shows that there are six marketing channels and the quantity of avocado passing in each channel. Figure 1 shows that producers' marketable surplus is 90.50 quintals (qt.). However, due to post-harvest losses through the marketing process, only 89.32 quintals were traded. The length of the value chain channel (the number of actors involved along the channel) and the volume of marketed avocados are the prominent aspects to characterize the marketing channels. The survey showed the channels as follows:

Table 1: Demographic characteristics of the respondents

Variables	Value chain actors			
	Producers	Traders	Consumers	Average
HHHs by sex (%)				
Male-headed HHs	78.40	77.90	76.70	77.70
Female-headed HHs	21.60	22.10	23.30	22.30
HH members by age groups				
Below 16 years	41.10	36.80	38.80	38.90
16 to 30 years	25.30	29.30	19.10	24.60
51 to 64 years	28.10	30.20	36.50	31.60
65 years and above	5.50	3.70	5.60	4.90
HHHs education level				
None	12.70	9.80	10.30	10.90
Primary	68.50	79.90	74.30	74.30
College	18.80	9.20	14.10	14.00
University	0.00	1.10	1.30	0.80

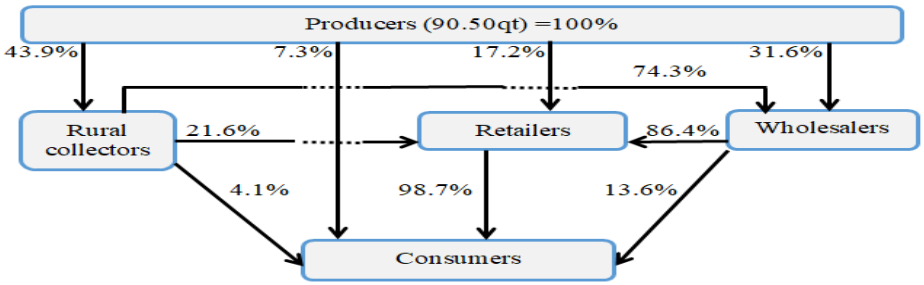

Figure 1: Avocado-agroforestry based market channels in the study area

a) Producers-consumers: This is the shortest marketing channel. It conveys the fewest quantity equal to6.60 qt of traded avocado commodities compared to other channels.

b) Producers-rural collectors-wholesalers-retailers-consumers: This channel is the longest marketing channel and it conveys the biggest volume of avocado equal to 31.29 qt).

c) Producers-rural collectors-retailers-consumers: This channel is the second most important marketing channel considering the volume of avocado (20.59 qt) supplied through it.

d) Producers-wholesalers-retailers-consumers: This marketing channel is third biggest channel and the volume of supplied avocado through it 14.35 qt.

e) Producers-retailers-consumers: This channel is the fourth biggest channel and the avocado volume passing through it is equal to 9.07 qt.

f) Producers-wholesalers-consumers: This marketing channel is fifth biggest channel and the quantity of avocado marketed through it is 7.42 qt.

Profitability Analysis of Avocado-Based Agroforestry Value Chain

The NPM was used in profitability analysis. Table 2 shows the results on profitability analysis. The NPM is (39.20%) for producers, 20.20% for rural collectors, 11.30% for wholesalers and 9.80% for retailers. These results show that the avocado-based agroforestry value chain is profitable for all value chain actors. The results imply that investment in the avocado-based agroforestry value chain is financially viable and can contribute to the improvement of the living standards of chain actors.

CONCLUSION AND POLICY IMPLICATIONS

This study analyzes the profitability of avocado-based agroforestry value chain in the eastern province of Rwanda. It uses the data from a structured survey conducted to the avocado-based agroforestry value chain actors. For the profitability analysis, the technique of Net Profit Margin was applied. The findings show that the main source of avocado planting materials are fellow farmers and most of the existing avocado fruits are non-improved varieties with low fertilizer use. The findings also show that the avocado-based agroforestry value chain is profitable for all chain actors. The NPM is 39.20% for producers, 20.20% for rural collectors, 11.30% for wholesalers and 9.80% for retailers. The research findings suggest that there should be the adoption of avocado planting materials from official sources like governmental agro-research institutes, local NGOs, and other certified seed supplier entities. This could help in shifting the subsistence avocado-based agroforestry value chain to a market-oriented value chain for more profits to value chain actors.

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Table 2: Profitability analysis of avocado-based agroforestry value chain among actors

Particulars (USD qt^{-1})	Value chain actors			
	Producers	Rural collectors	Wholesalers	Retailers
Purchasing price	-	4.87	9.40	15.00
Production cost	0.88	-	-	-
Sac price	0.46	0.46	0.46	0.46
Loading and unloading	0.09	0.09	0.28	0.18
Repacking	-	-	0.18	-
Transport cost	0.74	0.90	0.92	0.46
Sorting and grading cost	0.28	0.18	0.32	0.18
Telephone cost	0.28	0.11	0.46	0.28
Brokerage	-	0.18	0.28	0.23
Wastage cost	0.09	0.18	0.28	0.37
Total marketing cost	1.94	2.12	2.74	2.17
Overhead cost	0.14	0.51	0.60	0.46
Total cost	2.08	2.63	3.34	2.64
Selling price	4.87	9.40	14.37	19.57
NP	1.91	1.90	1.63	1.93
NPM (%)	39.20	20.20	11.30	9.80

Source: Researcher's computations, 2022. 1 USD ≈ 1081.23 Rwandan Francs (Rwf), qt^{-1} . per quintal

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