

## Analysis of the Impact of Patchouli Cultivation on Rural Household Income in Burundi

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### Abstract

### Original Research Article

This article aimed to show the potential to economically promote the essential oil sector in Burundi with a view to contributing to improving the standard of living of rural households. We have already referred to those operating patchouli cultivation in the province of Cibitoke. Data were collected from 94 patchouli-producing households chosen randomly and purposively. The statistical analysis of the data showed that the contribution of patchouli income to the agricultural income of the farmers surveyed is non-negligible via its average contribution amounted to 11.4% to the total income of rural households and this crop itself occupies 3rd place after banana contributed 31% and cassava with a rate of 19%. In order to study the existing links between the overall income of rural households with the income coming from the different practicable income-generating crops, we used the estimation of the Pearson correlation coefficient test and the results obtained showed us that the model is overall significant because certain variables are statistically and positively significant and interpretable while the other variables are statistically positive but are not significant. It is appropriate for the stakeholders involved to take appropriate measures to achieve the valorization of the essential oil sector in Burundi because it has been observed that it plays a significant role in human life.

Keywords: Essential oils, patchouli, household income.

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## INTRODUCTION

The cultivation and utilization of aromatic plants boasts a rich history, extending back to ancient civilizations across the globe (Evans, 2009). In recent years, there has been a surge in interest within the perfume and medicinal plant industries due to the recognition of their diverse therapeutic properties. These properties include stimulation, antibacterial activity, antiviral effects, and soothing qualities (Lis-Balchin *et al.*, 2003; Onawunmi *et al.*, 2008). Essential oils, in particular, have gained significant popular appeal as safe and cost-effective natural treatment options (Edris, 2007; Buchbauer *et al.*, 2019). This growing interest is reflected in the intensified research efforts undertaken by academic institutions and pharmaceutical organizations. These entities are actively investigating essential oils and their biochemical constituents with the primary objective of identifying the specific biologically active substances responsible for their therapeutic effects (Bakkali *et al.*, 2008; Wong *et al.*, 2018).

Essential oils find dual applications within the food industry. Beyond their well-documented role in flavor enhancement (Sacchetti, 2011), essential oils exhibit significant antimicrobial and antioxidant properties due to their constituent components (Burt, 2004). This unique property allows them to serve as natural preservatives, extending the shelf life of food products.

Essential oils transcend their aromatic appeal, finding valuable applications within the food industry. Their volatile constituents contribute not only to enhanced flavor profiles (Jäger *et al.*, 2016) but also to extended shelf life due to their antimicrobial and antioxidant properties (Burt, 2004). Furthermore, essential oils hold immense promise as therapeutic tools, offering the potential to broaden the scope of conventional medical treatments (Edris, 2007). They can be employed directly as therapeutic agents (Lis-Balchin *et al.*, 2003), or serve as valuable raw materials for the synthesis of bioactive ingredients (Buchbauer *et al.*,

2019). Notably, the diverse properties of essential oils, including anti-infective, analgesic, anti-inflammatory, sedative, antimicrobial, antispasmodic, and antioxidant effects (Carson *et al.*, 2006; Bakkali *et al.*, 2008), make them particularly well-suited for addressing various digestive and infectious pathologies (Le Hir *et al.*, 2009). The antioxidant activity of essential oils is particularly noteworthy in the fight against oxidative stress. This condition arises from an imbalance between the excessive production of free radicals and the body's antioxidant defenses (Rahman, 2000). Essential oils, with their potent antioxidant properties, offer a potential strategy for combating oxidative stress and its associated health complications (Huang *et al.*, 2018).

Beyond their well-known applications in aromatherapy and cosmetics, essential oils hold promise in the medical field. Studies have shown their effectiveness in treating inflammatory diseases (Zhang *et al.*, 2006). Their mechanism of action appears to involve inhibiting the production of inflammatory mediators like histamine, cytokines, and free radicals generated by immune cells (Souza, 2003). This anti-inflammatory property suggests potential for essential oils in managing various inflammatory conditions. Moreover, research suggests cytotoxic properties of some essential oils, making them candidates for cancer prevention. For example, *Nigella sativa* L. essential oil has demonstrated cytotoxic activity against various tumor cell lines in laboratory studies (Inouye & Abe, 2007). In vivo studies further showed its effectiveness in limiting the spread of liver cancer and extending the lifespan of tumor-bearing mice. These findings highlight the potential of essential oils as a complementary or alternative approach in cancer treatment.

Essential oils extend their utility beyond the realm of medicine. They find increasing applications in various industrial cleaning and degreasing tasks. Their use is expanding in areas like mechanical maintenance, metal product manufacturing, aircraft cleaning, and cleaning delicate electronic components (Isman, 2000). This versatility makes essential oils an attractive option for industrial processes due to their effectiveness and potentially eco-friendly nature compared to some traditional cleaning solvents.

The essential oil sector in Burundi presents a significant opportunity for economic growth. Given its nascent stage, the country requires technical assistance to promote the diversification of agricultural products that can be utilized for essential oil production (EDIC, 2004). This approach could contribute to increased income for rural populations by fostering exports of high value-added essential oil products. By focusing on these high-value goods, Burundi has the potential to not only stimulate economic growth but also alleviate poverty, particularly in rural areas.

Burundi seeks to diversify its agricultural sector and capitalize on the growing essential oil market. While essential oils hold promise for economic development (EDIC, 2004), the specific economic impact on rural households remains unclear. Patchouli, a popular essential oil crop, is well-suited to Burundi's climate and has the potential to be a significant source of income for rural communities.

## LITERATURE REVIEW

### *Theoretical Literature Review*

The influence of developing agriculture sector with agricultural performance of high-yielding variety adoption on crop productivity and food security among small-scale farmers can be examined through the lens of several key theories, namely the Modernization Theory (Joseph Stiglitz, 2012), the Dependency Theory (Saskia Sassen, 2016), The Land Question: Access and Sustainability theory (Melissa Leach, 2019), the Institutional theory (Ronald Dore, 2000), the Social Capital Theory and Collective Action (Putnam, Robert D. and Elinor Ostrom, 2010), and the production theory (Dani Rodrik, 2013).

To begin with modernization Theory, this theory suggests that economic development and improved living standards are achieved through the adoption of modern practices, technologies, and institutions. It is also a perspective that highlights the unequal relationships between developed and developing countries in terms of economic and political power. In agriculture, this theory emphasizes how external factors such as trade policies, market fluctuations, and technological advancements can impact local agricultural practices and the overall performance of the sector. It highlights the need for sustainable and equitable practices that address the systemic inequalities and vulnerabilities faced by farmers and rural communities (K. L. Blaxter, 1983).

In the context of patchouli cultivation in Burundi, this theory implies that introducing advanced agricultural techniques and practices can enhance productivity and income for rural households. Modernization may involve using better quality seeds, employing efficient irrigation methods, and integrating mechanized farming. For example, the use of distillation technology to extract patchouli oil can significantly increase the value of the crop, thus boosting farmers' incomes. By shifting from traditional to modern agricultural practices, rural households in Burundi could experience improved yields, better quality products, and greater market access, ultimately leading to enhanced economic well-being.

Furthermore, Dependency theory offers a critique of global economic structures, highlighting how developing countries often remain dependent on developed countries, hindering their development (John c. Moore, 1994). In agriculture, this theory emphasizes

how external factors such as trade policies, market fluctuations, and technological advancements can impact local agricultural practices and the overall performance of the sector. It highlights the need for sustainable and equitable practices that address the systemic inequalities and vulnerabilities faced by farmers and rural communities (Stephan D. and Douglas G., 2014). As in Burundi patchouli cultivation is being exploited in different regions of the country, this theory highlights the risks of dependence on external markets and inputs. If Burundian farmers rely heavily on international markets to sell their patchouli oil or rely on imported fertilizers and pesticides, they could face economic vulnerability due to fluctuations in global prices and supply chains. Dependency theorists would argue for policies that reduce dependence on external actors, such as developing local patchouli oil processing facilities, promoting domestic use, and creating a more self-sufficient agricultural economy. By focusing on local value added and diversifying agricultural activities, Burundi can mitigate the negative effects of economic dependence.

According to the land theory, its issues component focuses on issues of land ownership, access and sustainable use. This concept is essential in agriculture because it affects livelihoods and the sustainability of agricultural practices. The theory emphasizes the need for equitable land distribution, sustainable land use practices, and protection of community and indigenous land rights.

It highlights the importance of addressing the social and environmental impacts of land use and the need for policies promoting sustainable agriculture and equitable access to land (Macdonald *et al.*, 2013).

In Burundi, equitable access to land and secure land tenure are essential for rural households growing patchouli. Secure land rights encourage farmers to invest in their land, adopt sustainable agricultural practices and improve productivity. Without secure access, farmers may be reluctant to make long-term investments, leading to sub-optimal land use and lower incomes. Sustainable land management practices, such as crop rotation and organic farming, are essential to maintaining soil health and productivity over time. Addressing the land issue in Burundi involves the implementation of agrarian reforms, the recognition of customary land rights and the promotion of practices guaranteeing the long-term sustainability of patchouli cultivation, thus improving the income of rural households (PAPAB, 2019).

Institutional Theory examines the role of formal and informal institutions in shaping economic activities and outcomes. It emphasizes the importance of institutional frameworks that support sustainable and equitable practices, such as cooperative farming, community-based initiatives, and policy frameworks that promote agricultural development (Zhixin *et al.*, 2022).

This theory recognizes the dynamic nature of institutions and their components, providing a framework for analyzing the relationships between institutional elements and social context (Dissanayake, 2022). In the case of patchouli cultivation in Burundi, effective institutions can play a pivotal role in improving agricultural performance and incomes. Agricultural policies, research institutions, and extension services are essential for providing farmers with the necessary knowledge, resources, and support. For instance, institutions that facilitate access to credit can enable farmers to invest in better inputs and technologies. Additionally, market institutions that ensure fair pricing and reduce transaction costs can enhance farmers' profitability. Weak or corrupt institutions, on the other hand, can create barriers to market entry and perpetuate inefficiencies. Strengthening agricultural institutions in Burundi is key to supporting patchouli farmers and improving their incomes.

Social Capital Theory highlights the importance of social networks, trust, and norms of reciprocity in facilitating collective action and achieving common goals. It emphasizes the importance of social relationships and networks in facilitating collective action and sustainable agricultural practices. It suggests that social capital can be built through community-based initiatives and cooperative farming practices, which can promote ecological balance and social equity (Hamyana Yana, 2022). In rural Burundi, strong social capital can significantly impact the success of patchouli cultivation by enabling farmers to collaborate, share knowledge, and pool resources. Collective action through cooperatives or farmers' associations can enhance bargaining power, reduce costs, and improve access to markets and inputs. For example, a cooperative of patchouli farmers can negotiate better prices for their produce and purchase inputs at lower costs through bulk buying. High levels of social capital also foster innovation and resilience, as farmers are more likely to adopt new practices and technologies when they observe their peers doing so.

Social networks provide a support system that can help farmers manage risks and recover from adverse events, thereby stabilizing and increasing their incomes.

Finally, Production Theory focuses on the relationships between inputs and outputs in agricultural production, aiming to optimize the production process. It emphasizes the importance of efficient production methods and the use of technology to increase productivity. Production theory suggests that agricultural modernization should be accompanied by the adoption of new technologies and the development of efficient production methods that promote sustainability and social equity (Dennis and Xiaodong, 2010).

For patchouli cultivation in Burundi, this involves understanding how various inputs—such as

labor, land, capital, and technology can be efficiently combined to maximize output. Key concepts include the production function, which models the output produced given a set of inputs, and the law of diminishing returns, which suggests that continuously increasing one input while holding others constant will eventually lead to lower incremental gains. By analyzing production functions, farmers can determine the most effective use of resources to increase patchouli yields and profitability. For instance, investing in better irrigation systems and high-quality seeds can improve yields, while efficient labor management can reduce costs. Understanding and applying production theory helps farmers and policymakers make informed decisions about resource allocation, thereby enhancing the overall performance and income from patchouli cultivation.

### **Empirical Literature Review**

Several Studies have shown that patchouli cultivation plays a major role in increasing the standard of living of rural households, Dipender Kumar (2020) in Indonesia found that patchouli cultivation significantly increased household income compared to traditional crops. Similarly, research by Ms Ramla, Khalidi (2019) in Vietnam demonstrated that patchouli income can contribute substantially to overall household livelihood strategies. However, this income is vulnerable to market fluctuations, emphasizing the need for risk management strategies. Factors influencing income generation include farm size, access to extension services, efficient distillation practices (Smith *et al.*, 2018), and participation in producer cooperatives (Doe and Kumar, 2017).

Labor dynamics within households are also crucial, with women often bearing the brunt of labor and limited control over income generated. Male outmigration can lead to increased female involvement in patchouli production, potentially empowering women but also impacting traditional gender roles. Environmental considerations are critical, with potential drawbacks like deforestation and soil degradation associated with unsustainable farming practices. Promoting organic cultivation methods and sustainable land management practices is crucial for maintaining environmental integrity while maximizing income generation. Future research should focus on the long-term sustainability of patchouli cultivation in Burundi, exploring best practices for environmental protection and resource management, as well as the specific economic viability and market dynamics of patchouli cultivation in Burundi.

Additionally, the social and gendered impacts within Burundian households require further investigation to ensure equitable benefits for all household members. Research by Smith *et al.*, (2018) in Nepal identified farm size, access to extension services, and efficient distillation practices as crucial determinants of income generation. A study by Doe and Kumar (2017)

in India found that participation in producer cooperatives can enhance bargaining power and improve market access, leading to higher income for patchouli farmers. Research by Smith and Johnson (2021) in Madagascar revealed that women often bear the brunt of labor associated with patchouli cultivation, with limited control over income generated. Research by Brown and Williams (2016) in Uganda suggests that male outmigration can lead to increased female involvement in patchouli production, potentially empowering women but also impacting traditional gender roles. A study by Vine Mutyasira, Dana Hoag, Dustin L. Pendell (2018) in Ethiopia suggest that promoting organic cultivation methods and sustainable land management practices is crucial for maintaining environmental integrity while maximizing income generation from patchouli. Further research is needed to assess the environmental impact of patchouli cultivation in Burundi and develop sustainable practices tailored to the local context.

## **MATERIALS AND METHODS**

In our research work, we used the method of descriptive statistics and the latter helped us in describing the field of work and our unit of investigation to better understand the different realities found there in order to be able to analyze the data collected.

Using the Pearson correlation test, we verified the existing correlation between the total income of the agricultural household with the different exploitable agricultural products.

Finally, we moved on to model estimations and their validation and most of the estimations were made with STATA software for the preliminary processing of the study data.

### **Data collection**

This aims to bring together all the literature on modeling the production of essential oils, particularly on forecasting models for patchouli cultivation. For this purpose, the following main sources were identified and visited:

- Bibliographic synthesis: collection of documents with a view to creating a documentary base. These include general works and library briefs as well as various reports and articles published by the various players in the essential oils sector;
- Household survey using a questionnaire as an interview guide, focus group and direct field observations were carried out to fully understand the essential oil sector and its importance;
- The interview: a method of collecting information which we used in oral interviews, individual or groups, with several carefully selected people, in order to obtain information on facts or representations, the degree of which we analyze relevance, validity and reliability

with regard to the objectives of collecting information (Ketele & Roegiers, 1996). As a result, particular attention was paid to the semi-structured interview or the semi-directed interview (Savoie-Zajc, 1997) which is a data collection technique contributing to the development of in-depth knowledge favoring qualitative approaches and interpretative, particularly constructivist paradigms (Lincoln, 1995).

**Choice of sites**

Then, the choice of sites and hills was based on the reports prepared by RUGOFARM showing the structuring of the different patchouli production zones in the province of CIBITOKÉ, the main objectives of which were to analyze, on the one hand, the contribution remarkable of patchouli cultivation on the life of rural households, and on the other hand, the factors determining the choice and sizing of speculations on patchouli farms in this province. Three main criteria governed our choices:

- The production area: this criterion meets the need for representation of the categories retained at the end of the division. It provides sufficient guarantee of reliability and validity of the results.
- The relative importance of patchouli at the village or site level: this importance is assessed from the combination of two parameters, namely the areas exploited and the quantity of patchouli leaves harvested.
- The distance and accessibility of the village or site during the study period: this criterion, which is intended to be realistic, makes it possible to avoid waste of time, resources and unnecessary risks.

Thus, the communes of Murwi, Mugina and Buganda in the province of Cibitoke served as the setting for this study. In total, nine (9) sites or hills were selected.

**Table 1: Distribution of the respondents by production area and by site or hills**

PRODUCTION AREA	AREAS/HILLS	Number of respondents
MURWI	MANEGE	10
	NYEMBESHAGE	5
MUGINA	GITEBE	11
	NYAKAGE	9
	RUBIRIZI	17
	RUSHIMA	21
	RUZIBA	6
BUGANDA	CUNYU	5
	KAGENGWA	10
TOTAL		94

**Sample selection**

This research is intended to be descriptive and analytical. The study was carried out in the province of CIBITOKÉ in the communes of BUGANDA, MURWI and MUGINA where patchouli is much more usable compared to other communes.

For our case, a sample of 94 patchouli farmers is taken. We chose them randomly from the list of patchouli farmers in the study area.

**Measurement of variables and data sources**

With a view to understanding the existing link between overall household income and other sources of agricultural income in rural households in our study area,

we opted to use data collected within the survey conducted among patchouli farmers from a few communes in the province of Cibitoke.

**Description of the study variables and model specification**

Table 1 provides a comprehensive overview of the study's variables. It details both the investigated constructs and their corresponding measurement scales, ensuring clarity regarding how the data was collected. Additionally, the table presents descriptive statistics for each variable, including the mean and standard deviation. These statistics offer an initial glimpse into the central tendency and variability of the data, laying the groundwork for further analysis.

**Table 2: Definition and measurement of variables (n=94)**

Variables	Mean (Std. Dev.)	Definition
Icof	326952,13 (381920,621)	Income from coffee
Iban	1675659,57 (510634,826)	Income from bananas
Ibea	339725,53 (221929,364)	Income from beans
IMz	280457,45 (198188,010)	Income from Maize
IRZ	487234,04 (514177,293)	Income from Rice

Variables	Mean (Std. Dev.)	Definition
Ipatch	868936,17 (465247,554)	Income from patchouli
Ipean	508340,43 (498130,236)	Income from peanuts
Ispot	37659,57 (81944,454)	Income from sweet potatoes
Icass	987127,66 (511004,331)	Income from cassava
Ipo	151914,89 (485987,027)	Income from palm oil
Icol	34361,70 (78161,791)	Income from colocasis
Ohi	5698369,15 (1791763,289)	Overall household income

**The linear correlation coefficient**

The graphic representation only gives an “impression” of the correlation between two variables without giving a precise idea of the intensity of the

connection, which is why we calculate a statistic called a simple linear correlation coefficient, denoted  $r_{x,y}$ .

The estimation of the linear correlation coefficient follows the formula given by equation 1 (Chen, P., Popovich, P., 2002).

$$r_{x,y} = \frac{Cov(x, y)}{\sigma_x \sigma_y} = \frac{\sum_{i=1}^n (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^n (x_i - \bar{x})^2} \sqrt{\sum_{i=1}^n (y_i - \bar{y})^2}} \dots\dots\dots \text{(Equation 1)}$$

With:

Cov (x, y) = covariance entre x et y;  $\sigma_x$  and  $\sigma_y$   $\sigma_x$  = standard deviation of x,  $\sigma_y$  = standard deviation of y; By expanding the previous formula, we obtain equation 2.

$$r_{x,y} = \frac{Cov(x, y)}{\sigma_x \sigma_y} = \frac{n \sum_{i=1}^n x_i y_i - \sum_{i=1}^n x_i \sum_{i=1}^n y_i}{\sqrt{n \sum_{i=1}^n x_i^2 - (\sum_{i=1}^n x_i)^2} \sqrt{n \sum_{i=1}^n y_i^2 - (\sum_{i=1}^n y_i)^2}} \dots\dots\dots \text{(Equation 2)}$$

We can demonstrate that, by construction, this coefficient remains between -1 and 1:

- Close to 1, the variables are positively correlated;
- Close to -1, the variables are negatively correlated;
- Close to 0, the variables are not correlated.

In practice, this coefficient is rarely very close to one of these three limits and it is therefore difficult to offer a reliable interpretation simply by reading this coefficient. In addition, it is only calculated from a sample of observations and not on all values (Richard Buxton, 2008).

**The study of Paired-samples T-Test**

A paired-samples T-test (also known as a dependent T-test) is used to compare the means of two related groups (ResearchGate, 2015). In the context of investigating the impact of patchouli cultivation on rural households' income in Burundi, the test would compare the incomes of the same households before and after they started cultivating patchouli.

This process will help determine whether there is a statistically significant impact of patchouli cultivation on the incomes of rural households in Burundi.

Here is the formula used for a paired-samples T-test:

$$t = \frac{\bar{d}}{S_d/\sqrt{n}}$$

Where:

- $\bar{d}$  is the mean of the differences between the paired observations (income before and after patchouli cultivation).
- $S_d$  is the standard deviation of the differences between the paired observations.
- $n$  is the number of pairs (households).

To conduct a paired-samples T-test, we follow these steps:

**1. Calculate the differences ( $d_i$ )** between the paired observations for each household:  
 $d_i$ =Income after patchouli cultivation–Income before patchouli cultivation:

**2. Compute the mean of the differences ( $\bar{d}$ ):**

$$\bar{d} = \frac{\sum_{i=1}^n d_i}{n}$$

**3. Calculate the standard deviation of the differences ( $S_d$ ):**

$$S_d = \sqrt{\frac{\sum_{i=1}^n (d_i - \bar{d})(d_i + \bar{d})}{n - 1}}$$

**4. Compute the t-statistic** using the formula provided above:

$$t = \frac{\bar{d}}{S_d/\sqrt{n}}$$

5. Determine the degrees of freedom ( $d_f$ ):

$$d_f = n - 1$$

**Presentation of the results**

In this part, we first proceeded to identify the respondents and then analyzed the contribution of patchouli cultivation in increasing the income of rural households. And secondly, we will analyze the place of patchouli in the operating system in order to better detect its contribution to the overall income of a patchouli farmer.

**RESULTS AND DISCUSSION**

**Table 3: Marital situation of respondents according to sex**

		Sexe					
		Feminine		Male		Total	
		Number	(%)	Number	(%)	Number	(%)
Marital status	Single	0	0,0%	1	100,0%	1	100,0%
	Married	8	9,8%	74	90,2%	82	100,0%
	Divorce	1	100,0%	0	0,0%	1	100,0%
	Widower	10	100,0%	0	0,0%	10	100,0%
	Orphan	0	0,0%	0	0,0%	0	0,0%

The table above shows that our respondents were made up of singles, married, divorced, widowed

and orphans. Marries are those who use patchouli more with a rate of 90.2%.

**Table 4: Age range of respondents**

Age range	Frequency	Percentage
Less than 35 years old	7	7,4
35-50 years old	34	36,2
51-65 years old	45	47,9
66-75 years old	6	6,4
Over 75 years old	2	2,1
Total	94	100,0

In our study area, we carried out an age distribution of the respondents according to the groups and the observation is that farmers aged 40 to 60 are

those who cultivate patchouli on a large scale with a rate of 57.4%.

**Table 5: Distribution of the surveyed patchouli growers by educational level**

Level of education	Male	Female	Total
No formal education	15	3	18
Primary education	20	3	23
Secondary education	5	2	7
University education	0	0	0
Others	35	11	46
Total	75	19	94

Out of a total of 94 respondents, 19 farmers, or 28.6%, are women cultivating patchouli while men number 75 farmers, or 71.4% of the total number of patchouli farmers in our study area.

Before going on to analyze the production and cultivation system applicable by farmers in our study area, we first set out to show the number of patchouli plants that rural farmers have in their plot. Secondly, we will show the level of appreciation of patchouli production.

The interest given to patchouli cultivation is today reflected in requests to extend the plots allocated to this crop.

**Table 6: Distribution of patchouli growers by the number of patchouli plants**

Number of patchouli plants	Number of farmers	Percentage
[01-500]	24	26
[501- 1000]	46	49
[1001-1500]	7	7
[1501-2000]	15	16

Number of patchouli plants	Number of farmers	Percentage
[2001-2500]	0	0
[2501-3000]	2	2
Total	94	100

With this table, we note that nearly 82%, or 77 out of 94 of our respondents, have at most 1,500 patchouli plants in their plot. But almost 18% of them, or 17 out of 94 of those surveyed, have at most 3000

patchouli plants. This shows that the production of patchouli leaves depends on the number of plants owned by the farmer. The more patchouli plants there are, the greater the production quantity.

**Table 7: Distribution of surveyed patchouli farmers by the level of income**

Income level in FBU	Frequency	Percentage
Less than 2500000	1	1,10
2500000- 5000000	23	24,50
5000001- 7500000	52	55,30
7500001- 10000000	11	11,70
10000001- 12500000	4	4,30
12500001 and above	3	3,20
<b>Total</b>	<b>94</b>	<b>100,00</b>

The table above illustrates the income bracket of patchouli farmers in our study area, we noticed that those who have a high rate (55.3%) of income are those whose bracket is between 5,000,001 and 7,500 000 Burundian Francs.

On this point, we evaluated the impact of the patchouli sector on the income of rural households. Through this section the emphasis was placed on the contribution of patchouli in improving the standard of living of the population through their homes, the goods purchased, the standard of living of households before the exploitation of patchouli and the level of life with the use of patchouli. The study also focuses on the link analysis between the overall household income and the income from patchouli and other crops, we found that there is a positive link between the household income and the income from different crops as well as patchouli.

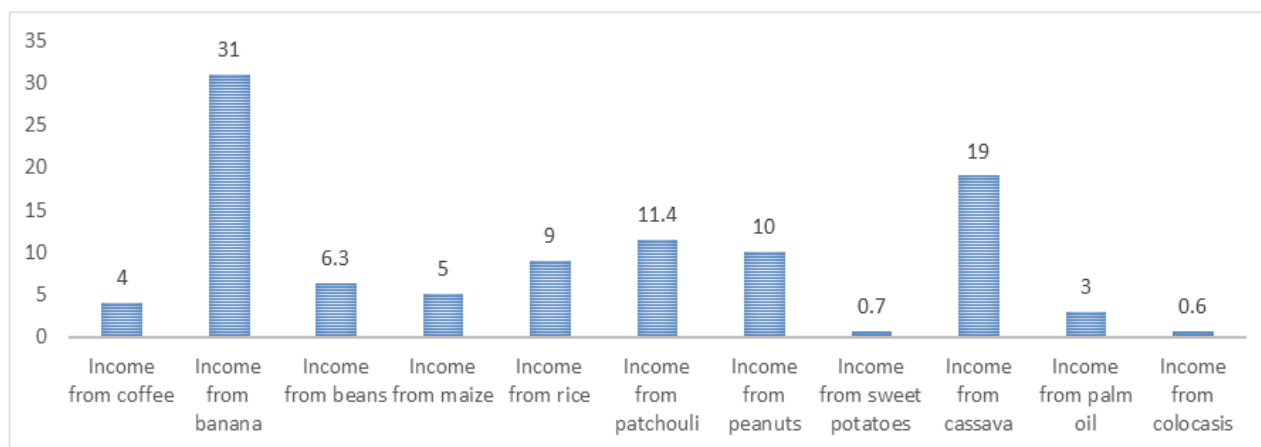
The exploitation of patchouli cultivation is intended for marketing to increase income for

households who practice it and also contribute to meeting the needs of a household.

As already seen previously in the table of representativeness of income source activities at the household level operating patchouli cultivation, we note that income from agriculture and livestock occupies a primordial place in the different sources of income of the farmers surveyed with 79%.

This shows that agricultural monetary income comes from the marketing of agricultural, livestock, etc. production.

Farmers in our study area experience a diversity of crops which fall into the following categories: Food crops (Banana, Cassava, Rice, sweet potato, colocasis, Corn, Beans, peanuts, oil palm) and Cash crops: (the cash crop practiced by the farmers of our place of study is coffee).



**Graph 1: Contribution of each crop as a percentage to overall income households practicing patchouli cultivation**



The following graph highlights that banana cultivation is the main source of agricultural income in a farmer's household with a rate of 31%, 2nd place is occupied by cassava cultivation with a contribution estimated at 19%, the crop that occupies the 3rd place is patchouli with a rate of 11.4%, the 4th is peanut which is more practiced in the different localities of the province of Cibitoke. Thus, peanuts provide a certain contribution to agricultural income with a rate of 10%, the 5th crop is rice with 9%, in 6th place we find the bean crop

providing a rate of 6.3% in the overall income of the household. The 7th place is occupied by Corn which contributes 5%, the other remaining crops contribute at very low rates such as the 8th place occupied by a cash crop practiced by few farmers and the latter has a rate of 4%, in 9th place we find rice cultivation which is also practiced by a small number of respondents with a rate of 3%. In 10th position, we find the cultivation of sweet potato which represents a rate of 0.7% and finally, it is the cultivation of colocasis with 0.6%.

**Table 8: Estimated Pearson correlation coefficient**

		Icof	Iban	Ibea	IMz	IRz	Ipatc h	Ipea n	Ispot	Icass	Ipo	Icol	Ohi
Icof	Correlation of Pearson	1	0,101	0,102	0,139	0,191	-0,028	-	-	-	-	0,063	0,104
	Sig. (bilateral)		0,332	0,330	0,181	0,066	0,786	0,731	0,456	0,973	0,849	0,546	0,320
Iban	Correlation of Pearson	0,101	1	0,034	-	0,046	,270**	0,104	0,090	0,080	0,007	0,034	1,000*
	Sig. (bilateral)	0,332		0,743	0,853	0,659	0,008	0,319	0,388	0,441	0,943	0,746	0,000
Ibea	Correlation of Pearson	0,102	0,034	1	,673**	-	0,131	0,141	,302**	0,045	0,171	-	0,036
	Sig. (bilateral)	0,330	0,743		0,000	0,966	0,207	0,175	0,003	0,666	0,099	0,430	0,727
IMz	Correlation of Pearson	0,139	-0,019	,673**	1	0,024	0,080	0,147	,253*	-	-	-	-0,018
	Sig. (bilateral)	0,181	0,853	0,000		0,819	0,441	0,156	0,014	0,283	0,922	0,205	0,867
IRz	Correlation of Pearson	0,191	0,046	-	0,024	1	-0,036	-	0,014	0,010	-	-	0,052
	Sig. (bilateral)	0,066	0,659	0,966	0,819		0,729	0,488	0,892	0,925	0,381	0,271	0,619
Ipatc h	Correlation of Pearson	-	,270**	0,131	0,080	-	1	,227*	,275**	0,029	0,048	-	,272*
	Sig. (bilateral)	0,786	0,008	0,207	0,441	0,729		0,028	0,007	0,780	0,649	0,415	0,008
Ipea n	Correlation of Pearson	-	0,104	0,141	0,147	-	,227*	1	0,008	,298**	0,002	0,198	0,106
	Sig. (bilateral)	0,731	0,319	0,175	0,156	0,488	0,028		0,940	0,004	0,983	0,056	0,308
Ispot	Correlation of Pearson	-	0,090	,302**	,253*	0,014	,275**	0,008	1	-	,214*	-	0,091
	Sig. (bilateral)	0,456	0,388	0,003	0,014	0,892	0,007	0,940		0,124	0,038	0,684	0,383
Icass	Correlation of Pearson	-	0,080	0,045	-	0,010	0,029	,298**	-	1	0,084	,230*	0,083
	Sig. (bilateral)	0,973	0,441	0,666	0,283	0,925	0,780	0,004	0,124		0,420	0,026	0,427
Ipo	Correlation of Pearson	-	0,007	0,171	-	-	0,048	0,002	,214*	0,084	1	0,084	0,009
	Sig. (bilateral)	0,849	0,943	0,099	0,922	0,381	0,649	0,983	0,038	0,420		0,421	0,931
Icol	Correlation of Pearson	0,063	0,034	-	-	-	-0,085	0,198	-	,230*	0,084	1	0,034
	Sig. (bilateral)	0,546	0,746	0,430	0,205	0,271	0,415	0,056	0,684	0,026	0,421		0,744
Ohi	Correlation of Pearson	0,104	1,000*	0,036	-	0,052	0,272*	0,106	0,091	0,083	0,009	0,034	1
	Sig. (bilateral)	0,320	0,000	0,727	0,867	0,619	0,008	0,308	0,383	0,427	0,931	0,744	
** . The correlation is significant at the 0.01 level (bilateral).													
* . The correlation is significant at the 0.05 level (bilateral).													

Through this table, we have noted that at the 1% threshold, there is a correlation between income from different cultures and overall household income.

Concerning the crop subject to our study, at the threshold of 1% and 5%, patchouli has a significant

correlation with the different crop incomes of patchouli growers with a rate of 20.72% in the overall household income. Then, banana cultivation is significantly correlated with a rate of 100% in household income.

**Table 9: Comparison of the mean household income with patchouli and household without patchouli**

	Paired-samples t test				t	ddl	Sig	
	Average	Standard deviation	Mean standard error	95% confidence interval of the difference				
				Lower				superior
Household income - Household income excluding patchouli	127085,106	40296,925	4156,310	118831,498	135338,715	30,576	93	***

The average difference is worth 127085.106. Thus, this value represents the average difference between the household income and the household income excluding patchouli. In other words, households earn on average 127,085.106 monetary units more when patchouli is included in overall income.

The results demonstrate a statistically significant and substantial difference between overall household income, including and excluding patchouli. Households benefit from significantly higher incomes when patchouli is included in their farming system. The high t-value and extremely low p-value confirm that this difference is very unlikely to be due to chance, thus reinforcing the conclusion that patchouli has a significant impact on overall household income.

## DISCUSSION

Many studies have been carried out on the essential oil sector such as those of the essential oil sector State of the art, impacts and socio-economic issues which were centered on the potential of this sector for the extent and its diversity of application sectors as well as its impact on the global market by R.Bessah, El. Hadi Benyoussef (2014). This study provides an overview of the actors, activities, working times, costs and strategies of producers for the production of essential oils. The results of this study make it possible to make a comparison of the impact of the essential oil sector through its lucrative potential in development and economic growth.

The essential oil sector has the advantage of being an activity requiring available labor creating jobs likely to reduce poverty at the level of rural households.

This sector can also provide additional income for local populations and effectively contributes to the development of niche markets.

An operator in the essential oil sector has a higher income. This is why the production of essential oils plays an important role as a financial engine. Some data from this study were used to model the strategies of production systems and the origin of farmers' income, as was done by Fourcin (2014). This study greatly inspired us through our study to analyze the level of contribution of the patchouli sector to household income, and the results found among respondents in our study area showed us that income from patchouli has contributed

significantly to increasing the standard of living of farmers.

In a study entitled Exploitation of the sector of four (4) medicinal plants (Fenugreek, Chamomile, Eucalyptus, Thyme) for therapeutic purposes conducted by D. Lydia, M. Oudene (2017), they raised the obstacles they encounter and which delay the modernization of the sector, such as those of market control by the informal sector, the absence of relationships or synergies between the actors, the lack of laboratories. They finally stipulated that the revival of the essential oil sector requires its support by the public authorities as a sector that creates research and jobs, especially in isolated areas on the one hand, the most efficient players and who working legally must organize themselves to reduce the importance of the informal sector on the other hand.

## CONCLUSION

In conclusion, the essential oil sector is a sector that drives economic growth and has the potential to create decent employment likely to reduce poverty and improve the standard of living of rural households. This activity, with high added value, can generate income from local populations and enable the development of niche markets.

Our work aimed to analyze the potential to increase the income of rural households through the economic development of the essential oils sector in Burundi. Some lessons can be learned about this sector based on the results of our research which was based on the cultivation of patchouli exploited by certain households in the province of Cibitoke.

Generally speaking, the development of agro-food industry with high added value in Burundi should be a priority so that the country can increase the export of products such as patchouli essential oil, an oil which can significantly increase the income of the rural population and the State can also benefit from it through tax revenues as well as foreign exchange.

The market for essential oils, especially patchouli, would be both a source of money for farmers to increase the income of agricultural households practicing this patchouli culture and a source of foreign currency for the country which will also allow the maintenance of the balance of the trade balance.

This allows us to confirm that patchouli plays a vital importance in human life given the place occupied by patchouli essential oil among other medicinal plants as well as the strong global demand for medicinal plants by pharmaceutical companies which grows from day to day.

In our research, we noticed that the cultivation of patchouli contributes to the macroeconomic level, this evaluation would take place through taxes levied by public administrations and which enter into state revenue. The importance that this culture brings on the macroeconomic level is not limited to tax revenues but also job creation and the reduction of poverty, especially in rural areas.

We finally noticed that the contribution of patchouli cultivation at the microeconomic level is remarkable because it allows agricultural households to earn additional income which adds to the overall income of rural households, and it allowed also to satisfy certain needs such as the purchase of livestock, access to health care, the schooling of their children, the purchase of necessary materials as well as the improvement of their homes.

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