ESI Preprints **Not Peer-reviewed**

Economic Influence of the Eucalyptus Sector on Strengthening Financial Stability: An Analysis of Eucalyptus Growers' Perceptions in Burundi

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Approved: 08 July 2026
Posted: 10 July 2026

Cite As:
Niyintunze, S., Manirakiza, D., Maniriho, K., & Karangwa, A., & Niyuhire, M.C. (2026). *Economic Influence of the Eucalyptus Sector on Strengthening Financial Stability: An Analysis of Eucalyptus Growers' Perceptions in Burundi*. ESI Preprints.
https://doi.org/10.19044/esipreprint.7.2026.p140

Abstract

This study analyzes the influence of the eucalyptus sector on the economic resilience of rural households in Burundi, demonstrating that this sector, once perceived solely as a reforestation tool, now constitutes a veritable "living capital" or "green bank." The results reveal a major economic dependence of farmers on this resource, illustrated by a near-perfect correlation of 98% between income from eucalyptus and overall household income. The economic value of the sector is justified by its exceptional versatility, meeting essential subsistence needs while also

integrating into high value-added industrial sectors such as construction, furniture manufacturing, and the extraction of essential oils for aromatherapy. The main argument for its promotion lies in its capacity to transform marginal land into productive assets, enabling families to finance structural investments such as housing improvements, access to healthcare, and children's education. In short, eucalyptus acts as a multidimensional safety net that stabilizes family well-being.

Keywords: Eucalyptus, Economic influence, Global income, Financial stability

Introduction

Eucalyptus, introduced to Burundi during the colonial era, was long perceived solely in terms of reforestation or erosion control. However, it has gradually established itself as a genuine "living asset" for rural households. The eucalyptus sector contributes to economic resilience through three main channels: the production of firewood and construction timber, the sale of power poles, and, more recently, the extraction of essential oils.

Despite its omnipresence in the Burundian landscape, the actual contribution of eucalyptus to overall household income remains underestimated in public policies (Ndayiragije, 2021). How does this sector influence the resilience trajectory of family farms?

The aim of this article is to analyze the impact of eucalyptus adoption and exploitation on the financial recovery capacity of rural households. We hypothesize that eucalyptus acts as a "green bank," enabling households to finance productive investments.

Classical references on risk management in rural areas (Dercon, 2002; Barrett, 2011) emphasize that poor households diversify their activities to minimize the variance in their total income. In Burundi, eucalyptus fulfills this function thanks to its low input requirements and its ability to grow on marginal land (Bigirimana et al., 2019).

In Burundi, the eucalyptus sector is therefore multidimensionally useful, supporting domestic life through charcoal and construction timber, protecting health through its essential oils, and boosting the economy through industrial processing. Eucalyptus has become a pillar of Burundi's resilience, combining energy security and the sustainable use of local natural resources within a framework of sustainable development.

Optimizing Charcoal Production

The importance of eucalyptus in charcoal production in Burundi is part of a major energy security issue, where this tree species has become the main bulwark against deforestation of natural forests. The dependence of

households in Bujumbura on charcoal is so great that demand far exceeds natural regeneration, making eucalyptus a strategic resource due to its rapid growth and stump resprouting capacity (Nduwamungu, 2011). This species is particularly valued because it produces a fuel with a high calorific value, meeting urban cooking needs. As Bailis et al. (2015) highlight in their research on biomass sustainability in East Africa, eucalyptus acts as an economic stabilizer for rural producers, offering a significantly higher energy yield per hectare than less dense native species.

The varietal selection carried out by the Institute of Agronomic Sciences of Burundi has maximized this production potential. By favoring species such as Eucalyptus tereticornis and Eucalyptus camaldulensis, researchers were able to ensure optimal wood density for carbonization. Doran and Wong (2000) demonstrated that the cellular structure of these specific varieties promotes better mechanical resistance of the charcoal, thus limiting losses due to friability during transport to markets.

The usefulness of eucalyptus, however, depends on the efficiency of the processing methods, as traditional carbonization in earthen mounds remains synonymous with energy waste. Adding a central chimney reverses the combustion flow, which not only reduces production time to three days but also increases yield to nearly 25% (Girard, 2002).

Beyond simply producing heat, eucalyptus plays a multifunctional role in the circular economy of coal. The use of metal furnaces and retorts, although more expensive, allows for the capture of pyrolysis gases, an energy efficiency concept supported by the work of Kammen and Lew (2005).

According to Smith et al. (2019), using high-quality eucalyptus charcoal in optimized cookstoves drastically reduces indoor pollution, thus protecting the health of women and children. In short, eucalyptus is emerging not only as the most viable technical solution for charcoal production, but also as a cornerstone of energy resilience in the face of current climate challenges facing the world.

Uses of Eucalyptus in Construction and Furniture

The development of eucalyptus in Burundi marks a major transition from a subsistence economy to a technology-driven industry. Eucalyptus use also extends to construction and furniture. Thanks to its versatility, it is transformed into beams, planks, and rafters with a high yield at sawmills. It can be found everywhere, from the frames of hillside houses to living room furniture in urban centers. It is a robust material that allows Burundi to reduce its timber imports, thus saving valuable foreign currency for the national economy.

However, the adoption of precision sawing and controlled drying techniques has stabilized the eucalyptus fiber, transforming it into a viable alternative to more expensive timber species (Chirko, 2018). This qualitative shift is particularly noticeable in urban centers like Bujumbura, where local crafts are now incorporating industrial standards to meet a growing demand for luxury furniture, proving that technological innovation can transform a common resource into a driver of economic growth.

Specific Therapeutic Applications and Energy Use

Eucalyptus plays a central role in Burundi's rural economy and energy landscape, establishing itself as a strategic resource far beyond its purely botanical attributes. According to Nduwumwami's (2014) work on forest dynamics in the Great Lakes region, this species has become the cornerstone of charcoal production, supplying over 80% of the domestic energy used in urban centers like Bujumbura. This dominance is explained by its rapid growth and high calorific value, characteristics that Husch et al. (2003) had already highlighted as essential for the viability of energy plantations in developing countries.

On an industrial and artisanal level, eucalyptus's contribution to the energy sector is optimized by carbonization techniques which, although traditional, are becoming increasingly modernized to improve mass yield. The use of eucalyptus wood produces charcoal whose molecular structure promotes slow combustion and consistent heat, ideal for household cooking and heating needs (Bailis et al., 2015). In Burundi, this benefit is even more pronounced in high-altitude regions, where the tree serves as a primary fuel. Integrating this species into local agroforestry systems not only ensures energy independence for rural populations but also generates substantial income through the sale of surplus charcoal to provincial markets.

Globulus essential oil, validates the effectiveness of terpene compounds such as eucalyptol (1,8-cineole) in the treatment of respiratory tract infections. In Burundi, this transition to clinical aromatherapy is being driven by actors such as RUGOFARM, STHE, and Karire. Products and others have successfully developed the processing of essential oils from eucalyptus leaves. This professionalization allows for the transformation of a local resource into a high-value product, capable of competing in export markets.

The benefits of eucalyptus extend to the realm of well-being and health safety; inhaling eucalyptus vapors is not limited to olfactory comfort; it plays an active role in reducing inflammation of the mucous membranes (Sadlon and Lamson, 2010). This property is widely exploited in sauna centers in Bujumbura and Gitega, where the essential oil purifies the ambient air.

Finally, eucalyptus plays an essential socio-ecological role by acting as a buffer against deforestation and the cold climate of highland areas. Despite debates about its water consumption, eucalyptus remains the most resilient species for stabilizing soils while providing a vital source of heat during the rainy seasons in the Congo-Nile Divide (Poussard, 2021).

Theoretical Literature

The theoretical basis of this research rests on rural risk management theory and the sustainable livelihoods approach. According to Chambers and Conway (1992), resilience is a household's capacity to cope with a shock without compromising its productive capital. From this perspective, the tree is considered a consumption-smoothing asset. The precautionary savings theory developed by Deaton (1991) stipulates that eucalyptus serves as a liquid asset that can be mobilized for daily needs.

Furthermore, the theory of factor allocation (Chayanov, 1966) explains why Burundian rural households dedicate a portion of their land to eucalyptus plantations despite competition from food crops. This decision is based on the marginal productivity of labor and land. Ellis (2000) argues that diversification into agroforestry reduces the variance in total income. Finally, Von Thünen's land rent theory allows for the analysis of the location of eucalyptus plantations in relation to the markets of Bujumbura and Bururi, directly influencing net profitability for the producer (Nkurunziza, 2020).

Economic resilience, defined by Holling (1973) and adapted to the social sciences by Adger (2000), refers to a system's capacity to absorb disturbances without changing its fundamental state. For a rural household, this translates into stable welfare in the face of shocks. Portfolio choice theory (Markowitz, 1952), applied to agriculture by Fafchamps (2003), suggests that farmers do not only seek to maximize profit, but also to optimize the risk/return ratio. Eucalyptus, although less profitable in the short term than vegetable crops, presents a near-zero risk of total loss, making it a hedging asset.

The literature on rural forestry (Chambers & Leach, 1989) introduced the concept of "Trees as Savings and Security." Unlike seasonal crops that must be harvested when mature, trees can remain standing until an urgent financial need arises. In Burundi, Niyonzima's work (2018) shows that the sale of eucalyptus wood is often correlated with major life events (weddings, funerals) or medical emergencies.

Empirical Literature

Numerous studies in East Africa have demonstrated the positive impact of eucalyptus and agroforestry on incomes. In Ethiopia, Mekonnen et al. (2017) showed that eucalyptus plantations increased average annual

household income by 15% to 25%. In Rwanda, integrating trees into farms has reduced reliance on chemical fertilizers, as timber sales finance the purchase of organic fertilizer (Ndayambaje et al., 2013).

In Kenya, Mwangi et al. (2016) showed that income from eucalyptus plantations enabled households to escape chronic poverty in 15% of the cases studied. In Ethiopia, Mekonnen (2019) established a positive correlation between private woodland ownership and investment in children's education. In Burundi, research by Ndikumana (2022) in the Mugamba natural region highlights that eucalyptus is the main driver of farmers' non-monetary savings.

However, some authors, such as Nzeyimana (2020), qualify these results by pointing to negative externalities on the yields of adjacent crops, which could weaken long-term food security. Manirakiza's (2021) study, using panel data, shows that market access for electricity poles and charcoal is the limiting factor for the profitability of the sector in peripheral provinces.

Research from ISABU (Institute of Agronomic Sciences of Burundi) highlights that high-altitude areas (Mugamba and Bututsi) derive a substantial portion of their monetary income from non-timber forest products and timber. However, controversy remains regarding the environmental impact (water consumption), necessitating a trade-off approach between economic benefits and ecosystem services (Niyitanga, 2022).

Methodology

Our study is conducted in Burundi and adopts a comparative design based on two provinces exhibiting marked agro-ecological and socio-economic contrasts. On the one hand, there is the province of Burunga, characterized by the long-standing introduction of eucalyptus, a species historically integrated into the forest and agricultural landscape. On the other hand, there is the province of Bujumbura, where the dynamics of the eucalyptus sector are strongly driven by urban commercial demand for energy and construction materials.

Figure 1: Geographic scope and framework of the study

Sampling Strategy

The research adopts a mixed-methods approach, combining quantitative surveys and qualitative interviews. The choice of Burunga and Bujumbura provinces is justified by their agro-ecological and socio-economic contrasts. In Burunga province, eucalyptus is an old and integrated part of the landscape, while in Bujumbura (peri-urban areas), the sector is driven by the growing demand for energy and construction materials in the economic capital. Sampling is a two-stage stratified type, with a total of 190 households surveyed. The method used is a two-stage stratified probability sampling:

- First degree (Geographic stratification): Selection of provinces (Bujumbura and Bururi), then subdivision into communes (Bubanza, Bukinanyana, Bururi, Matana).
- Second stage: Random selection of hills within each municipality, then random selection of farming households at the level of each hill.

Table 1: Distribution of respondents operating in the eucalyptus sector by province, municipality and hill

Province	Municipality	Hill	Effective
Bujumbura	Bubanza	Mpinga	23
		Mpishi	20
		Muscat	24
	Bukinanyana	You are the one who protects.	16
		Pepper	18
Bird	Buru	Field	20
		I fought.	17
	Matana	Kivumu	19
		Big	33
Total			**190**

Data Collection

Data collection combines quantitative and qualitative approaches to comprehensively capture the realities on the ground. Primary data were rigorously collected using programmed, structured questionnaires administered face-to-face via the KoboCollect tool. This allowed for geolocation of interviews, control of data entry ranges, and minimization of data entry errors. This data focuses on the socioeconomic characteristics of households, allocated forest areas, production costs, income from the sale of timber and eucalyptus leaves, and well-being indicators such as food consumption scores and self-financing capacity. Secondary data were extracted from the archives of the Ministry of Environment and Agriculture to contextualize the results.

Ethical Authorization

The ethical approval and field access process was conducted in accordance with Burundian regulations to protect participants and ensure research integrity. Prior to the deployment of researchers, the research protocols were submitted to local administrative authorities, including the governors of Bujumbura and Burunga provinces, as well as the heads of the relevant communes and hills, to obtain mission orders and formal authorizations for access to the communities. On an individual level, the principle of free, informed, and verbal consent was strictly adhered to: each household head received a clear explanation, in the local language, regarding the study's academic objectives, the absence of risks or direct financial compensation (the study being conducted without external funding), and the absolute guarantee of anonymity and confidentiality of their responses. No personally identifiable information was stored in the final KoboCollect database, and respondents were entirely free to discontinue the interview at any time.

Econometric Model

To measure the sector's contribution to resilience, we will use the Global Income determinants model, demonstrating that each monetary unit from eucalyptus is fully added to total income.
Model specification:

$$Part_{others}incomes = \alpha + \left(\frac{Inc\_eucaly_t}{Inc\_hhold_t}\right) + \sum \varphi_j \, x_j + \varepsilon \quad (1)$$

Based on the general formulation of total income presented in equation (1), it is appropriate to isolate the specific contribution of the activities forestry to refine OUR analysis . At this Indeed , the overall income of the rural household is broken down into , on the one hand, the gains from the exploitation and sale of eucalyptus products and , on the other hand, all other revenues agricultural . By integrating this specification structural , we can develop OUR model in order to determine specifically the relative share of the eucalyptus sector in the household's overall income . This approach Analytical reasoning leads us to formalize the relationship in the following way :

$$\ln\_inchhold_i = \theta_0 + \theta_1 ln(inc_{tea_i}) + \theta_2 ln(inc_{hortic_i}) + \theta_3 ln\left(inc_{soy_i}\right) + \theta_4 ln(inc_{eucaleav_i}) + \theta_5 ln\left(inc_{woodeucaly_i}\right) + \theta_6 ln(inc_{ban_i}) + \theta_7 ln(inc_{bean_i}) + \theta_8 ln(inc_{mz_i}) + \theta_9 ln\left(inc_{pea_i}\right) + \theta_{10} ln\left(inc_{pean_i}\right) + \theta_{11} ln\left(inc_{swpotat_i}\right) + \theta_{12} ln\left(inc_{pot_i}\right) + \theta_{13} ln(inc_{col_i}) + \varepsilon_i \text{----------(2)}$$

With:

- ln_inchhold $_i$: Logarithm of the total income of the rural household;
- ln(Inc_Tea $_i$) : Logarithm of income derived from tea;
- ln(Inc_hortic $_i$) : Logarithm of income derived from horticulture;
- ln(Inc_soy $_i$) : Logarithm of income derived from soy;
- ln(inc_eucaleavi) : Logarithm of income derived from the leaves eucalyptus;
- ln(inc_woodeucaly $_i$): Logarithm of income wood eucalyptus;
- ln(Inc_ban $_i$) : Logarithm of income derived from bananas;
- ln(Inc_bean $_i$) : Logarithm of income derived from beans;
  ln(Inc_mz $_i$) : Logarithm of income derived from corn;
- ln(Inc_pea $_i$) : Logarithm of income derived from peas;
- ln(Inc_pean $_i$) : Logarithm of income derived from peanuts;

- ln(Inc_swpotat $_i$) : Logarithm of income derived from the potato gentle;
- ln(Inc_pot $_i$) : Logarithm of income derived from the potato;
- ln(Inc_col $_i$) : Logarithm of income derived from colocase;
- ε_i: Error term stochastic;
- θ_0 à θ_{13}: are elasticities.

The Results

Analysis of eucalyptus marketing methods

The eucalyptus sector is distinguished by the diversity of its commercial outlets, allowing for the full utilization of the resource. Sales are primarily organized around three main areas: the wood, used for both construction and energy; the leaves, sought after for the extraction of essential oils with medicinal and industrial properties; and finally, processed products, such as distilled essences. This versatility offers producers strategic flexibility, allowing them to segment their offerings according to local market needs or export opportunities to higher value-added sectors.

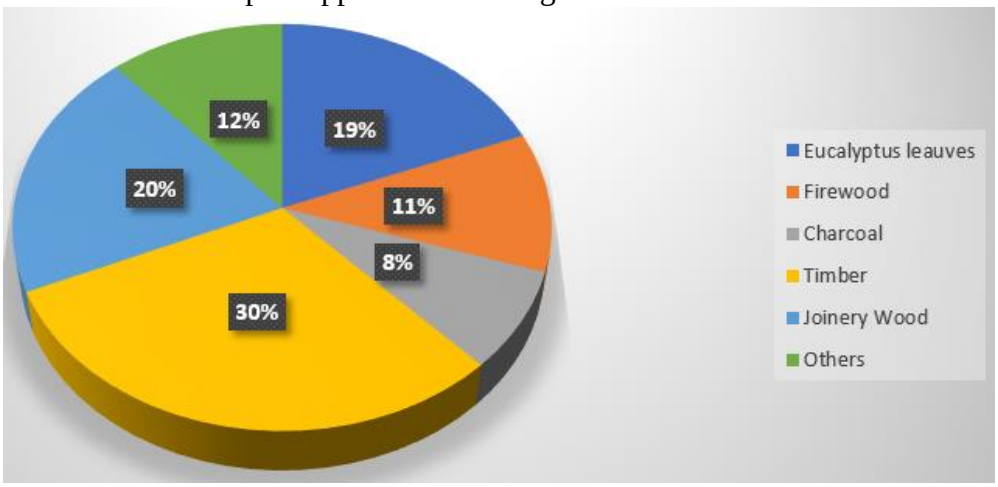

Figure 2: Forms of marketing for eucalyptus

The eucalyptus sector exhibits a notable diversification of commercial outlets. In addition to its primary role, a significant portion of production remains dedicated to energy needs and secondary uses. Firewood and charcoal together account for 19% of sales, illustrating the sector's continued role in domestic fuel supply. This crucial importance of the sector in crafts, industry, and energy demonstrates the great economic versatility of eucalyptus, capable of simultaneously meeting complex industrial requirements and essential subsistence needs for local populations.

Contribution of the eucalyptus sector to rural household incomes

The eucalyptus sector has emerged as a major socio-economic driver, sustainably transforming the daily lives of rural populations by generating stable and diversified income. This sector allows farmers to invest tangibly in their families' well-being. This dynamic translates into an increased capacity to educate children, access better quality healthcare, and improve family housing. Thus, beyond simply producing timber, eucalyptus acts as a catalyst for financial resilience, ensuring a smoother and more sustainable fulfillment of essential family needs (Kouamé, 2022).

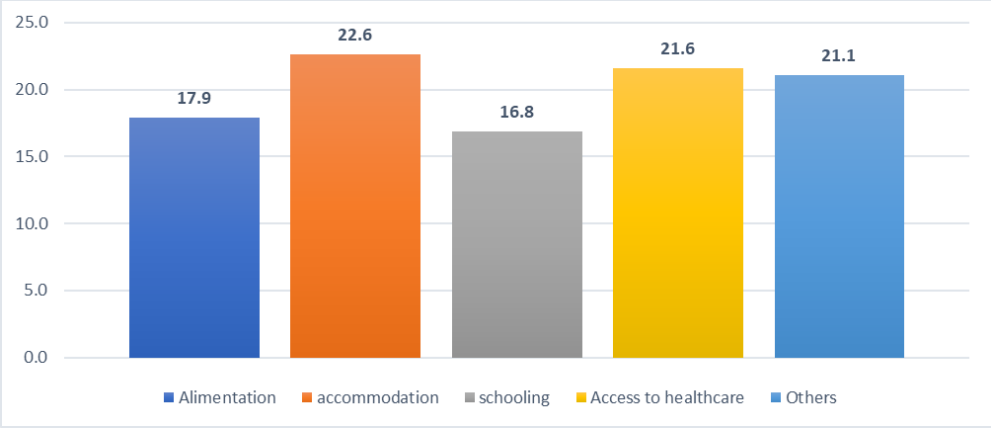

Figure 3: Type of level of improvement in living standards through the eucalyptus sector

Data analysis reveals a balanced distribution of benefits, with investment in sustainable infrastructure and human health playing a prominent role. With 23% of income allocated to housing and 22% to access to healthcare, it is clear that the eucalyptus sector provides fundamental stability for families. These figures reflect households' desire to transform a natural resource into tangible financial security.

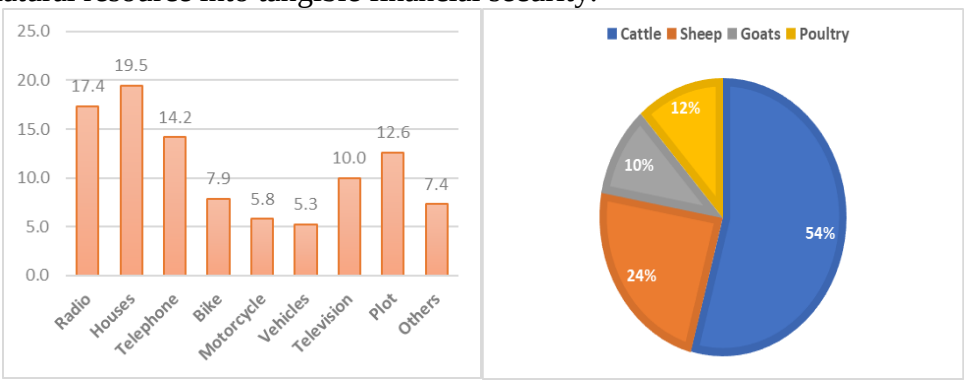

Figure 4: Percentage of beneficiaries of goods acquired following income from eucaliptus

These graphs illustrate how income from eucalyptus cultivation is reinvested by beneficiaries in the acquisition of various material goods and livestock.

Clearly the top priority, with the purchase of houses (19.5%) and radios (17.4%) representing the most frequent investments. This trend is complemented by the acquisition of information and communication technologies, with 14.2% of beneficiaries investing in telephones and 10% in televisions. Land investments and mobility are also significant, with the graph revealing that 12.6% of income is used to purchase land, while means of transport such as bicycles (7.9%), motorcycles (5.8%), and cars (5.3%) are also acquired, albeit more moderately.

Regarding capitalization in the form of livestock, there is a clear preference for large animals, with cattle alone accounting for more than half of livestock investments at 54%. The remaining resources allocated to livestock farming are distributed among sheep (24%), poultry (12 %), and goats (10%). Overall, these data demonstrate the crucial role of eucalyptus as a driver of local economic development, enabling households to secure their assets and sustainably improve their standard of living.

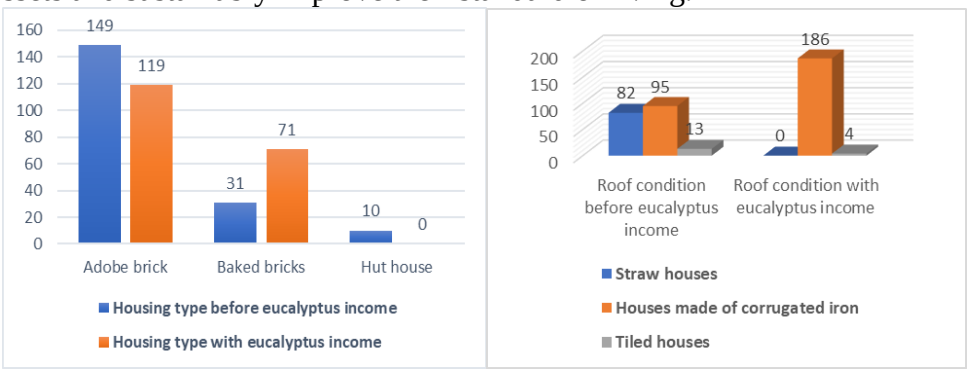

Figure 5: Impact of eucalyptus on the condition of farmers' houses

The findings reveal that income from the eucalyptus sector has significantly improved the housing conditions of the farmers. A major shift towards more sustainable materials is observed, marked by the complete disappearance of hut dwellings. This structural change is accompanied by a radical modernization of roofs, where straw bale houses have been entirely replaced. In short, eucalyptus farming acts as a genuine driver of socio-economic development by enabling families to access more decent and sustainable housing.

Table 2: Multicollinearity Test (VIF)

Variables	LIVELY	1/VIF
Inc_bean	1.71	0.585463
Inc_hortic	1.66	0.600876
Inc_eucaleav	1.56	0.640425
Ink_col	1.52	0.656025
Inc_mz	1.45	0.688291
Ink_pot	1.43	0.701063
Inc_pean	1.34	0.745412
Ink_pea	1.25	0.801755
Ink_ban	1.21	0.824038
Ink_swpotat	1.14	0.876367
Inc_woodeucaly	1.14	0.876597
Ink_memory	1.08	0.926914
Inc_Tea	1.06	0.941416
Inc_soy	1.02	0.978905
Mean VIF	1.33	

Multicollinearity analysis table presents the results of the variance inflation factor (VIF) test for the different sources of agricultural income influencing the resilience of rural households in Burundi. All explanatory variables, including beans (Inc_bean) with the highest VIF of 1.71 and soybeans (Inc_soy) with the lowest at 1.02, show values well below the critical threshold of 10 generally accepted in the econometric literature. With a mean VIF of 1.33, these results guarantee the absence of severe multicollinearity between variables, meaning that each income source, whether eucalyptus (Inc_eucaleav, Inc_woodeucaly), horticulture, or cash crops such as coffee, provides independent and statistically robust information to the model. This structural stability allows us to reliably interpret the specific impact of the eucalyptus sector on overall income and the financial resilience trajectory of family farms without risk of estimation bias linked to too strong an internal correlation.

Table 3: Breusch -Pagan Heteroscedasticity Test

```
  chi2(116) = 183.34
Prob > chi2 = 0.0001

Cameron & Trivedi's decomposition of IM-test

---------------------------------------------------
              Source |       chi2     df       p
---------------------+-----------------------------
  Heteroskedasticity |     184.61    116  0.0001
            Skewness |          .     14       .
            Kurtosis |          .      1       .
---------------------+-----------------------------
               Total |          .    131       .
---------------------------------------------------
```

This table presents the results of the Cameron-Trivedi information test (IM test), a rigorous procedure used to validate the specification of an econometric model by examining the variance of the residuals. The overall test statistic shows a value of 183.34 with 116 degrees of freedom, associated with an extremely low p-value of 0.0001. Focusing on the decomposition, we observe that the component related to heteroscedasticity is the major source of this significance, with a score of 184.61 and an identical probability of 0.0001. This result necessitates the rejection of the null hypothesis of homoscedasticity at the 5% level, thus confirming that the variance of the errors is not constant within the sample of rural households. This instability is typical of rural microeconomic data, where income dispersion can vary significantly depending on farm size or access to resources. To ensure the reliability of statistical inferences and correct this bias, the use of robust standard errors is essential so that the significance tests of the coefficients are not invalidated by this error structure.

Table 4: Performance comparison test of the eucalyptus supply chain versus non-traditional supply chains

Variable	Obs	Mean	Std. dev.	Min	Max
ln_Inc_hhold	190	7.07e+07	3.15e+07	3.09e+07	2.25e+08
ln_Inc_Tea	190	966140	232452.5	70000	2065000
ln_Inc_hor~c	190	1432553	1723958	50000	1.67e+07
ln_Inc_soy	190	1935663	351045.2	72000	3720000
ln_Inc_euc~v	190	453663.2	883634.7	0	6260000
ln_Inc_woo~y	190	5.79e+07	3.05e+07	1.11e+07	2.05e+08
ln_Inc_ban	190	1482189	645216.8	240000	5400000
ln_Inc_bean	190	1088584	1639203	0	1.25e+07
ln_Inc_mz	190	984452.6	1750432	0	1.63e+07
ln_Inc_pea	190	1376842	1764341	0	1.05e+07
ln_Inc_pean	190	525305.3	553489.6	0	1680000
ln_Inc_swp~t	190	206373.7	562227.6	0	3840000
ln_Inc_pot	190	2033866	2695653	0	1.41e+07
ln_Inc_col	190	57489.47	113360	0	568000

Through the results The data found shows that the average earnings from the eucalyptus sector contribute significantly to the overall income of the rural household in our study, far surpassing all other sources of income . agricultural traditional and rent-seeking , such tea , horticulture , bananas or food crops . This massive contribution validates perfectly the role of eucalyptus inasmuch as a true multidimensional safety net capable of stabilizing the financial situation of operators and financing investments structural . These results register in total consistency with the conclusions of several empirical studies led by Mekonnen et al. (2017) who put in evidence a substantial increase in income average annual income of households thanks to eucalyptus plantations . Similarly , research by Mwangi et al. (2016) has

attested that the revenues derived from this essence allow concretely, it helps rural households to escape chronic poverty , proving thus in a global way that this The sector is a universal lever for socio-economic resilience in the face of financial shocks.

Table 5: Linear Regression Model

Source	SS	df	MS	Number of obs	=	190
				F(13, 176)	>	99999.00
Model	1.8719e+17	13	1.4399e+16	Prob > F	=	0.0000
Residual	1.1782e+13	176	6.6944e+10	R-squared	=	0.9999
				Adj R-squared	=	0.9999
Total	1.8720e+17	189	9.9046e+14	Root MSE	=	2.6e+05

ln_Inc_hhold	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
ln_Inc_Tea	1.100713	.0830991	13.25	0.000	.9367145	1.264712
ln_Inc_hortic	.9948466	.014078	70.67	0.000	.9670631	1.02263
ln_Inc_soy	.9854439	.0541756	18.19	0.000	.8785265	1.092361
ln_Inc_eucaleav	1.029023	.0265245	38.80	0.000	.9766758	1.08137
ln_Inc_woodeucaly	.9995876	.000658	1519.09	0.000	.998289	1.000886
ln_Inc_ban	1.03775	.0320064	32.42	0.000	.9745847	1.100916
ln_Inc_bean	.9886133	.0149807	65.99	0.000	.9590484	1.018178
ln_Inc_mz	.989167	.0129339	76.48	0.000	.9636414	1.014693
ln_Inc_pea	.9775487	.0117922	82.90	0.000	.9542764	1.000821
ln_Inc_pean	.989679	.0393762	25.13	0.000	.9119688	1.067389
ln_Inc_swpotat	1.000992	.0357577	27.99	0.000	.9304226	1.071561
ln_Inc_pot	1.006115	.0083257	120.84	0.000	.9896837	1.022546
ln_Inc_col	1.160177	.2046216	5.67	0.000	.7563491	1.564005
_cons	148955.2	153805.8	0.97	0.334	-154585.8	452496.3

The results of the regression model linear presented in the table above, reveal that the revenues derived from the exploitation of eucalyptus , which it whether it concerns the sale of leaves or wood eucalyptus , exert a positive and highly significant influence on the overall income of rural households in Burundi. This crucial contribution of the sector forestry sector financial stabilization confirmed that eucalyptus works as an asset for economic security in rural areas, capable of mitigating the vulnerability of family farms.

However, a 1% increase in income from eucalyptus leaves leads to an increase of approximately 1.03% in overall household income, while a 1% increase in income from eucalyptus wood results in an increase of nearly 1.00% in overall income. The contribution of eucalyptus wood is particularly noteworthy, with an exceptional t-statistic of 1519.09, confirming the massive, stable, and predominant impact of this forest resource on the financial resilience and living standards of family farms compared to other diversified crops.

Table 6: Correlation test of eucalyptus income with overall income

Variables	Correlation	Inc_cof	Inc_Tea	Inc_hortic	Inc_soy	Inc_eucaleav	Inc_woodeucaly	Inc_ban	Inc_bean	Inc_mz	Inc_pea	Inc_pean	Inc_swpotat	Inc_pot	Inc_col	Inc_hhold
Inc_Tea	Pearson correlation	0.071	11	-0.002	-0.039	-0.082	0.004	-0.057	0.009	-0.019	0.023	-0.114	-0.090	-0.083	-0.014	-0.002
Inc_hortic	Pearson correlation	-0,087	-0,002	11	0,059	,246**	0,080	-0,023	,602**	0,117	,169*	0,033	0,064	0,107	0,033	,197**
Inc_soy	Pearson correlation	-0,024	-0,039	0,059	11	0,056	0,026	0,034	0,030	0,051	0,045	0,002	-0,051	0,040	0,052	0,051
Inc_eucaleav	Pearson correlation	0,056	-0,082	,246**	0,056	11	-0,034	-,326**	,189**	0,117	0,102	-0,034	-0,013	,498**	0,122	0,066
Inc_woodeucaly	Pearson correlation	-0,055	0,004	0,080	0,026	-0,034	11	0,043	,189**	-0,035	-0,089	-0,106	-0,050	0,079	-,202**	,980**
Inc_ban	Pearson correlation	0,075	-0,057	-0,023	0,034	-,326**	0,043	11	-0,104	-,215**	-0,140	-0,082	-0,084	-,220**	-,164*	0,005
Inc_bean	Pearson correlation	-0,118	0,009	,602**	0,030	,189**	,189**	-0,104	11	,180*	,154*	0,086	0,133	0,094	0,104	,302**
Inc_mz	Pearson correlation	-0,124	-0,019	0,117	0,051	0,117	-0,035	-,215**	,180*	11	,344**	,322**	,301**	0,089	,411**	0,075
Inc_pea	Pearson correlation	-,169*	0,023	,169*	0,045	0,102	-0,089	-0,140	,154*	,344**	11	,227**	,155*	,150*	,266**	0,026
Inc_pean	Pearson correlation	-0,073	-0,114	0,033	0,002	-0,034	-0,106	-0,082	0,086	,322**	,227**	11	,148*	-0,005	,441**	-0,049
Inc_swpotat	Pearson correlation	-0,060	-0,090	0,064	-0,051	-0,013	-0,050	-0,084	0,133	,301**	,155*	,148*	11	0,000	,177*	0,005
Inc_pot	Pearson correlation	0,053	-0,083	0,107	0,040	,498**	0,079	-,220**	0,094	0,089	,150*	-0,005	0,000	11	,184*	,197**
Inc_col	Pearson correlation	-0,003	-0,014	0,033	0,052	0,122	-,202**	-,164*	0,104	,411**	,266**	,441**	,177*	,184*	11	-0,120
Inc_hhold	Pearson correlation	-0,067	-0,002	,197**	0,051	0,066	,980**	0,005	,302**	0,075	0,026	-0,049	0,005	,197**	-0,120	1,000

These results present a Pearson correlation matrix analyzing the relationships between various sources of agricultural income and total household income (REV men). The most striking observation is the extremely strong positive correlation between income from eucalyptus wood (Inc_woodeucaly) and total income, indicating that eucalyptus is the major economic pillar of this sample, almost single-handedly dictating the evolution of the overall living standards of the households concerned. Conversely, the other variable tea (Inc_Tea), shows correlation close to zero, suggesting that this crop only marginally influences the variability of total income in this specific context.

Discussion of Results

The results of this study confirm that eucalyptus acts as a veritable "living capital," serving as a "green bank" for rural households in Burundi. The near-perfect correlation of 0.980 between income from eucalyptus and total income demonstrates that this sector is the primary driver of farmers'

financial stability. This economic dominance is explained by the tree's versatility, with markets driven by the construction sector (30% of sales) and carpentry (20%), while also ensuring full utilization through the sale of leaves and energic.

On a social level, the sector's impact translates into a tangible and multidimensional improvement in living conditions, perfectly illustrating the theory of economic resilience. The income generated enables a major transition in housing, marked by the shift from traditional huts to baked brick houses, with priority given to housing (23%) and health (22%). Beyond material needs, eucalyptus finances social mobility through education (17%) and guarantees food security for households (18%). Although environmental challenges remain regarding water consumption and competition with food crops, eucalyptus is proving to be an essential safety net, transforming often marginal land into productive assets, thus protecting the human and physical capital of rural communities from economic shocks.

Conclusion

In conclusion, the eucalyptus sector has emerged as a fundamental pillar of economic resilience for rural households in Burundi, capable of financing essential investments such as education and housing improvements. The data reveals a major economic dependence on this resource, with a near-perfect correlation between income from eucalyptus and overall household income, confirming its role as a multidimensional safety net. Beyond the monetary aspect, the full exploitation of the sector, including timber for construction, charcoal for domestic energy, and essential oils for health, transforms a resource once perceived as a mere reforestation tool into a lever for socio-economic growth indispensable to the survival of family farms.

To maximize this impact while ensuring environmental sustainability, policymakers are advised to integrate eucalyptus into rural development strategies by encouraging the modernization of processing techniques, particularly through the adoption of more efficient carbonization kilns to reduce biomass waste. Simultaneously, rigorous dissemination of varietal selection and silvicultural techniques is necessary to limit negative externalities on food crops and soil water resource management. Finally, facilitating producers' access to structured markets, such as those for electricity poles and high-value essential oils, would help stabilize incomes and sustain the poverty escape trajectory of rural communities.

Conflict of Interest: The authors reported no conflict of interest.

Data Availability: All data are included in the content of the paper.

Funding Statement: The authors did not obtain any funding for this research.

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