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Solar-Powered Parboiling Rice Machine and its Relevance to Sustainability

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Abstract. Given that rice stands as one of Africa's most widely consumed cereals, serving as a primary dietary energy source, both its production and demand have seen a steady rise over the years. In line with other sub-Saharan African nations, Guinea has witnessed a surge in rice consumption, driven by various factors, particularly the significant energy challenges it faces, compounded by the fact that approximately 70% of its population lacks access to electricity. The prevalent reliance on firewood for boiling paddy rice has significantly contributed to deforestation, as there is a growing demand for fuelwood and various forms of wood fuel for energy. This study seeks to explore the reasons behind the reluctance of people to embrace climate action with solar-powered parboiling rice machines (SPPRM). It also aims to identify the underlying causes of this disinterest. Based on the conducted survey, a total of 500 residents in the Basse-Guinée region were sampled, revealing that a significant majority (92%) of the respondents are already aware of the environmental impacts associated with their daily cooking activities. The results further indicate that approximately 25% of the respondents were unable to adopt new machine technology due to a lack of government consumption subsidies, while the remaining 45% cited a lack of access to new machines as the primary hindrance. Consequently, the study concludes that, despite the potential benefits that could arise from adopting SPPRM for sustainable development, financial barriers and limited access to the machines pose significant challenges for the respondents.

Keywords: Rice, Food security, Energy, Sustainability, SPPRM, Guinea

Introduction

According to the World Bank (2014), Asian and African countries have utilized approximately 80% of the global biomass in rice production. When comparing the two continents, the consumption of biomass has gradually decreased in Asian countries, declining from 65% to 59%. In contrast, in sub-Saharan Africa (SSA), biomass consumption has significantly increased from 23% to 31% (Okudaje *et al.*, 2023).

Cooking fuel and machines are used in cooking rice. It is pertinent to note that the first generation of cooking machines used more wood such as traditional cooking stoves, which gave rise to deforestation and indoor air pollution. Sadly, this has resulted to six million premature deaths because of indoor air pollution (World Health Organization, 2021).

Indeed, the second generation has embraced the use of improved cookstoves, which demand less wood. Recent studies highlight that the Safe Access to Fuel and Energy (SAFE) initiative has afforded women additional time to dedicate to student studies and income-generating activities (World Food Program, 2016). Notably, the third generation opts for solar-powered cookstoves, replacing wood with solar energy.

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This paper investigates the multifaceted relevance of parboiling rice in the African context, specifically examining its implications for poverty, hunger, and malnutrition. The subsequent section underscores the transformative impact of improved rice varieties, notably NERICA and ARICA, developed by CGIAR scientists, in addressing poverty and enhancing food security across 16 African countries. These varieties, characterized by early maturity, higher yields, and resistance to environmental stressors, have already uplifted the incomes of 8 million people above the international poverty line of $1.90 a day and brought food security to 7.2 million individuals. In a region where 43% of the population lives in poverty and 22% faces food insecurity, the adoption of these improved rice varieties presents substantial potential for poverty reduction and improved livelihoods (Agbugba *et al*., 2021).

As the discussion unfolds, the paper delves into the historical and dietary significance of rice in sub-Saharan Africa, underscoring its evolution as a vital staple crop. Traditional cereals such as maize, millet, or sorghum demanded more labor-intensive processing, making rice a more convenient and swift meal, especially in the rapidly urbanizing landscape where time for home-based food processing diminishes.

The paper underscores the escalating demand for rice, growing at a rate of 4% annually, while production grapples to keep pace with a growth rate of 3.3%. The importance of improved rice varieties, such as NERICA and ARICA, in meeting this demand is evident. These varieties offer high-quality grain that competes effectively against imports and contributes to the overall food energy needs of over 750 million people in the region.

Moving forward, the discussion shifts to the economic potential of improved rice varieties, extending beyond the conventional focus on supply and demand. Dr. Arouna underscores the need for a robust seed value chain to ensure the availability of quality seeds for farmers. This gap presents an opportunity for capacity development and job creation, particularly for farmers and SMEs involved in seed production. The integration of certified seed value chains can lead to economic development, especially in a region where a significant proportion of youth faces unemployment or underemployment. This strategic initiative aligns with the broader objective of promoting economic growth and fostering a sustainable rice sector across the continent (CGIAR, 2019).

The final section of the paper introduces the GEM parboiling system, an innovative and environmentally friendly solution sponsored by the African Development Bank's Feed Africa Initiative. The GEM technology, designed by AfricaRice, addresses the challenges associated with traditional parboiling methods, such as laborious processes, time inefficiency, and environmental concerns like deforestation and pollution from rice husk disposal.

The GEM system demonstrates considerable economic and environmental advantages, including reduced steaming time, minimal post-harvest losses, and significant savings in firewood consumption. The successful implementation of GEM in various African countries, such as Benin, Côte d'Ivoire, Niger, and Nigeria, has not only enhanced the economic viability of rice parboiling but has also generated positive impacts on the livelihoods of over 68,300 parboiled rice value chain actors (CGIAR, 2021a).In conclusion, this paper elucidates the comprehensive impact of parboiling rice in Africa, weaving together aspects of poverty alleviation, food security, dietary preferences, economic development, and environmental sustainability. The integration of improved rice varieties and innovative parboiling technologies emerges as a powerful strategy to address the intricate challenges associated with rice production and consumption in the region, paving the way for a more resilient and prosperous future.

Literature Review

GEM Technology

Rice continues to be imported into Guinea, constituting 40% of the country's rice consumption. This percentage has remained constant for over 20 years, characterized by a traditional parboiling system used to produce barabarai rice. This system is less productive and environmentally harmful, particularly in the Basse Guinee region, known for its numerous mangroves. Research conducted by Anenberg and colleagues points out that improved cookstoves still face constraints, such as the continued use of firewood for cooking, with the primary goal of reducing the amount of firewood used rather than replacing it (Anenberg *et al*., 2013). The solar-powered rice machine not only brings about environmental benefits by eliminating the need for firewood but also offers additional co-benefits aligning with the Sustainable Development Goals (SDGs).The necessity of adopting solar-powered rice processing technology, especially the GEM (Grain quality enhancer, Energy efficient, and durable Material) system, is emphasized by its profound impact on gender equality in the context of rice parboiling in West and Central Africa.

The traditional parboiling process, mainly carried out by rural women, has been characterized by labor-intensive, unsafe, and inefficient methods. It relies on significant amounts of firewood and water, resulting in the production of low-quality rice. The GEM technology, developed by CGIAR researchers at AfricaRice, addresses these challenges by incorporating energy-efficient and durable soaking tanks, clean cooking stoves, and a labor-saving device. This innovation significantly improves work safety for women parboilers.

The adoption of GEM has been shown to yield economic benefits, with women parboilers experiencing an additional $200 per ton of rice parboiled compared to traditional systems. Additionally, they achieve a higher output rate of up to 25 tons of high-quality milled rice per month. Furthermore, GEM technology introduces cost efficiencies by reducing expenditures on firewood, enhancing process speed, and eliminating the need for fuel in the case of Mini-GEM, which utilizes rice husks, a by-product of rice milling. This technological advancement not only presents economic advantages but also addresses critical health and environmental concerns.

The reduction in steaming time, along with the elimination of blackening of parboiling vessels, contributes to a safer working environment for women, diminishing risks associated with heat burns, smoke exposure, and physical strain from heavy load lifting. The internal rate of return (IRR) for GEM is notably higher at 70%, in stark contrast to the 14% associated with traditional methods, further emphasizing the transformative potential of this solar-powered rice processing technology in fostering gender equality, economic empowerment, and sustainable rice production practices in the region (CGIAR, 2021b).

Theoretical Framework

Governments may be influenced by the policy choices of other countries' governments. This is the theory of policy diffusion. In contrast, state capacity theory insists that governments' capacity matters, especially financial capacity, for adopting and implementing certain measures.

Policy Diffusion Theory

During times of uncertainty, such as a pandemic outbreak, governments may adopt policies observed in other countries. In essence, policy diffusion occurs due to external factors like the policies of other nations. Elkins and Simmons attempt to uncover the reasons behind clustered decisions using a conceptual framework. They posit that policy diffusion can occur through either adaptation or learning (Elkins & Simmons, 2005). In the case of adaptation, one

government's policy choices alter the conditions upon which other governments base their decisions.

By aligning with most actors, a government may gain a certain degree of legitimacy. Additionally, this alignment can confer credibility to certain practices. In other words, other actors may provide incentives for the adoption of specific policies. Obinger and colleagues offer insights into other forms of policy diffusion, such as coercion and competition types. In the competition type, observed in labor market policies, if one country initiates a policy to reduce labor costs for a comparative advantage, other countries tend to follow suit. Coercion type policy diffusion may occur due to supranational regulations, such as the integration process of the European Union, or as a result of power asymmetry resulting from financial aid, such as conditional loans from the International Monetary Fund or World Bank (Obinger *et al.*, 2013).

Simmons and Elkins focus on the factors that led to the adoption of liberal economic policies in different countries. They hypothesize that learning from policy diffusion can occur for three possible reasons: success, communication, and cultural reference groups. Firstly, they suggest that governments may adopt policies from the best-performing economies. Secondly, they propose that increased sharing of information from the external environment leads to policy adoption. Lastly, they posit that the adoption of certain policies can be explained by cultural similarities among states. Based on the evidence, they discover that policy transitions occur due to international economic competition and the adoption of policies from socioeconomic peers (Simmons & Elkins, 2004).

Fiscal Space

Fiscal space refers to the capacity of a country to utilize its finances for fiscal policies aimed at stimulating the economy or recapitalizing the financial sector. In exploring the relationship between financial distress and the prior debt-to-GDP ratio, a panel regression of distress and high-employment surplus was conducted.

Various types of fiscal measures exert different effects on aggregate demand, as noted by Pietro and colleagues (Pietro *et al.*, 2020). On one hand, increased transfers or tax cuts to companies stimulate the aggregate consumption of households and the investment of firms. On the other hand, the expansion of government expenditures directly raises aggregate demand.

State Capacity Theory (SCT)

State capacity can be defined as the ability to extract financial resources. States lacking this capacity tend to focus more on collecting trade-relevant taxes, as suggested by Besley and Persson. They also emphasize that three capacities—legal capacity, fiscal capacity, and collective capacity—all impact the development outcome of a country (Besley & Persson, 2014). Legal capacity is defined as guaranteeing legal rights to support market activities. Collective capacity refers to governments' actions to enhance the market, such as supplying public goods or limiting inequalities by regulating externalities. Fiscal capacity can be defined as investments made to support tax collection. The authors assert that all three capacities are in a positive feedback loop, influencing development outcomes, and the resulting outcomes affect the degree of state capacity.

It must be underscored that a country with stronger fiscal rules recovered better from the Great Financial Crisis in 2008 and was able to use its fiscal space for a stimulus package during the COVID-19 pandemic. The author provides evidence that countries with greater fiscal space could aggressively implement stimulus packages, as they have less long-term debt and can use it for fiscal policies later. The author concludes that countries need stricter fiscal rules to follow, in order to maintain a certain scale of fiscal space (Michael Hutchison, 2020).

Path Dependency

This theory implies a dependency on certain paths, providing stability or continuity to specific policies (Strambach & Halkier, 2013).

Herzberg's Theory of Two-Factor Motivation

Also known as the motivation-hygiene theory, this theory evaluates job satisfaction among employees. Eliminating hygiene factors is crucial; simultaneously, companies must provide factors that motivate employees to remain at their current workplace and be satisfied with their work (Alshmemri *et al.*, 2017).

Concluding Insights

In summation, there are three stakeholders outside households that influence household decisions: Community, State and Regional actors. Regional actors can influence a state through policy diffusion. If a state possesses the capacity to eliminate adverse conditions that act as barriers to policy adoption (Hygiene factor), it can take corrective measures.
Following that, community actors can intervene to enhance households' capacities in utilizing products like the solar-powered parboiling rice machine or facilitating households' actions to engage in climate action (Willingness). These motivator factors aim to break the path dependency of using outdated machines that harm the environment.

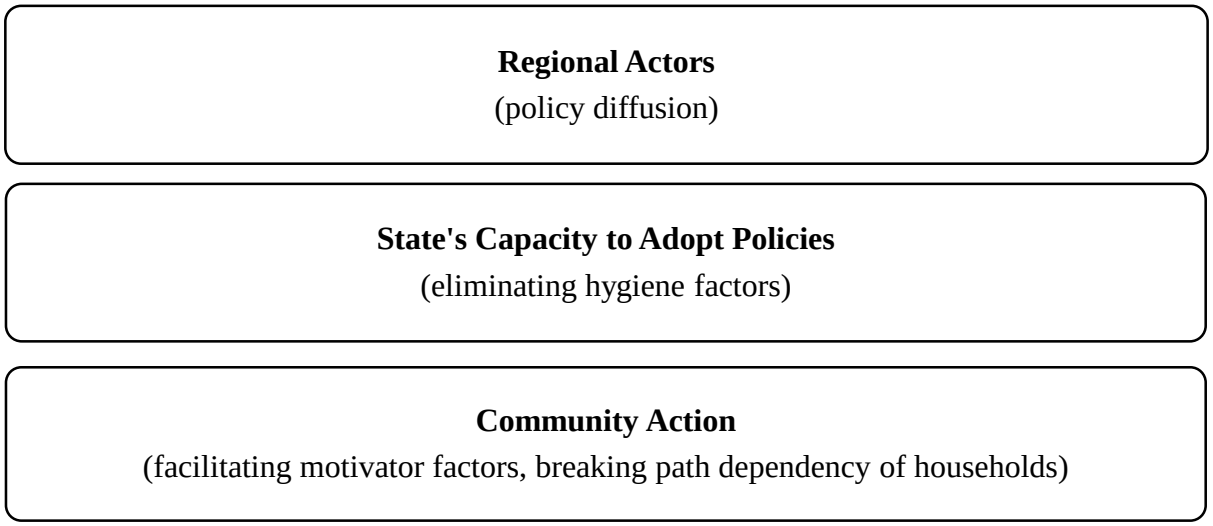

Figure 1: Three stakeholders influencing household decision
Source: Authors' Initiative

Research Aim

The study investigated why people are not engaging in climate actions using solar-powered rice machines and how it can be done successfully by finding the root cause.

Research Methods

In the Basse-Guinée region of Guinea, the village of Koba is inhabited by a population of 500 residents. For this study, a sample size of 197 respondents was determined, and data collection was conducted through interviews and surveys. The sampling technique employed for this study was the snowball sampling method.

Results and Discussion

Results

This section attempted to present results as well as discuss the research findings. Figure 2 presents the environmental impact of the current parboiling method.

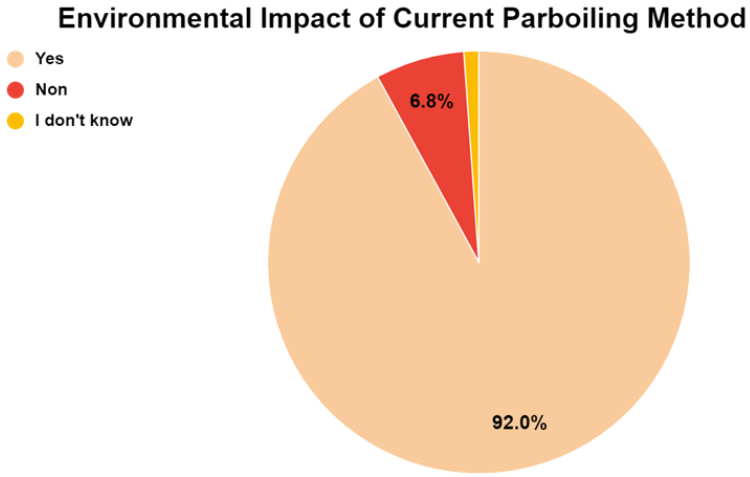

Figure 2: Environmental Impact of Current Parboiling Method
Source: Authors' Initiative

Awareness of impacts of their daily cooking activities

In the village of Koba, situated within the Basse-Guinée region of Guinea and inhabited by a population of 500 residents, a judiciously determined sample size of 197 respondents was enlisted for a comprehensive study on the environmental ramifications of Barabarai rice farming. Employing the snowball sampling method, data acquisition transpired through meticulous interviews and surveys.

The discerned outcomes of this investigation manifest a conspicuous environmental impact attributable to extant farming methodologies, with a noteworthy 92.0% of respondents attesting to such consequences. The primary environmental detriments identified encompass deforestation and indoor air pollution. In juxtaposition, a minority of 6.8% reported an absence of perceptible environmental repercussions, while an indeterminate fraction of respondents asserted a lack of certainty regarding the environmental consequences inherent in their farming practices.

These findings portend a compelling imperative to address environmental exigencies precipitated by Barabarai rice farming in the studied community. The implications extend beyond immediate remedial actions, emphasizing the imperative for the implementation of sustainable agricultural practices and the cultivation of heightened ecological awareness among the populace.

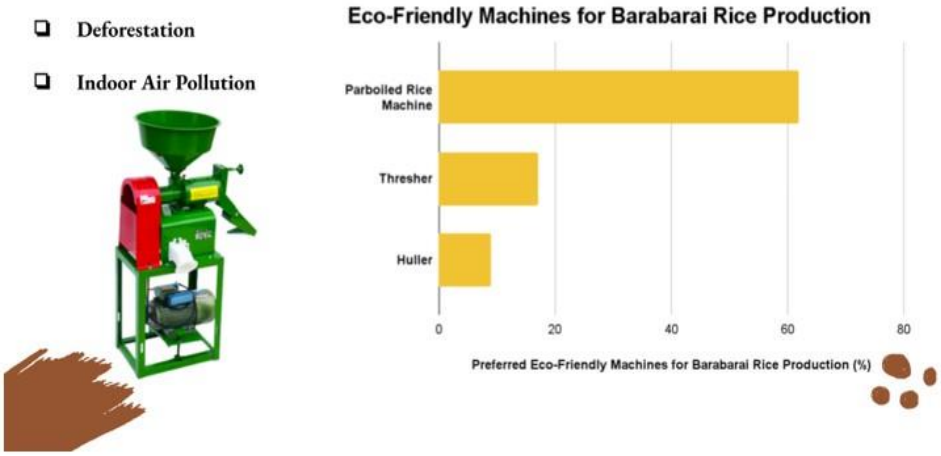

Figure 3: Eco-friendly machines for Barabarai rice production
Source: Authors' Initiative

In the village of Koba, situated within the Basse-Guinée region of Guinea and characterized by a population of 500 residents, a purposive sample size of 197 respondents was methodically engaged in an investigative study, employing the rigorous snowball sampling methodology. The primary focus of this inquiry was directed towards the attainment of the third objective, specifically the identification of eco-friendly machinery conducive to the optimization of Barabarai rice production. The resultant data revealed some salient outcomes meriting scholarly attention.

Among the respondents subjected to the survey, a substantial majority, constituting 61%, expressed a pronounced inclination towards the adoption of parboiled rice machinery as opposed to alternative modalities, such as threshers and hullers. In contrast, a distinct minority, comprising 19%, manifested a preference for thresher machines, while 15% articulated a proclivity for hullers. The discerned predilection for the parboiled rice machine assumes noteworthy significance as it substantiates a collective aspiration among the farming populace to address environmental exigencies, particularly in the domains of deforestation and indoor air pollution.

The preference for the parboiled rice machine is indicative of a strategic alignment with sustainable agricultural practices, emblematic of the community's conscientious endeavors to harmonize augmented rice production with ecological preservation. This proactive decision underscores the community's commitment to the adoption of environmentally friendly technologies as a pivotal means of realizing heightened agricultural productivity while simultaneously mitigating ecological challenges inherent in conventional rice farming methodologies.

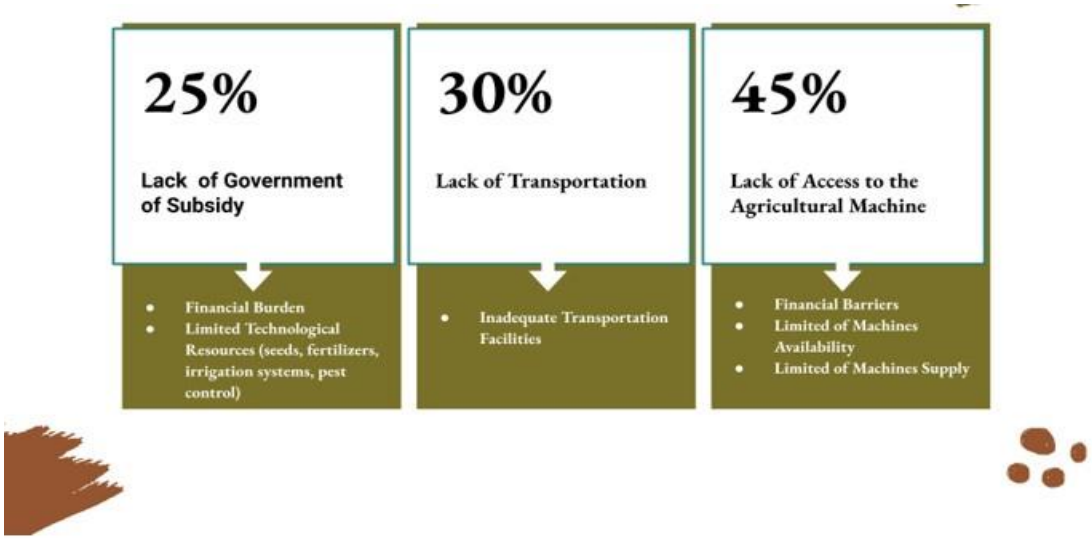

Figure 4: Reasons why people cannot adopt new machine
Source: Authors' Initiative

The empirical investigation carried out in the village of Koba, situated within the Basse-Guinée region of Guinea, has provided clear insights into the determinants of diminished Barabarai rice production. Primarily, the identified factors contributing to this agricultural predicament include the conspicuous absence of government subsidies, resulting in onerous financial burdens and the curtailment of technological resources, constituting 25% of the ascertained causative factors.

Furthermore, inadequate transportation facilities were found to account for 30% of the contributory elements, highlighting infrastructural deficiencies. Most notably, a significant 45% of respondents elucidated the impediment of restricted access to essential agricultural

machinery. This limitation was explained by financial barriers, coupled with a dearth in the availability and supply of requisite machinery.

The exigencies elucidated by these empirical findings present a compelling call to action for comprehensive interventions. Mitigation strategies require multifaceted approaches encompassing governmental support mechanisms, strategic infrastructural development initiatives, and interventions designed to augment agricultural mechanization. Alleviating financial burdens, ameliorating technological deficits, and bolstering transportation infrastructure emerge as pivotal facets of this imperative agricultural policy framework. This scholarly inquiry underscores the need for judicious policy formulations and targeted interventions to address the multifarious challenges hampering Barabarai rice production in the village of Koba.

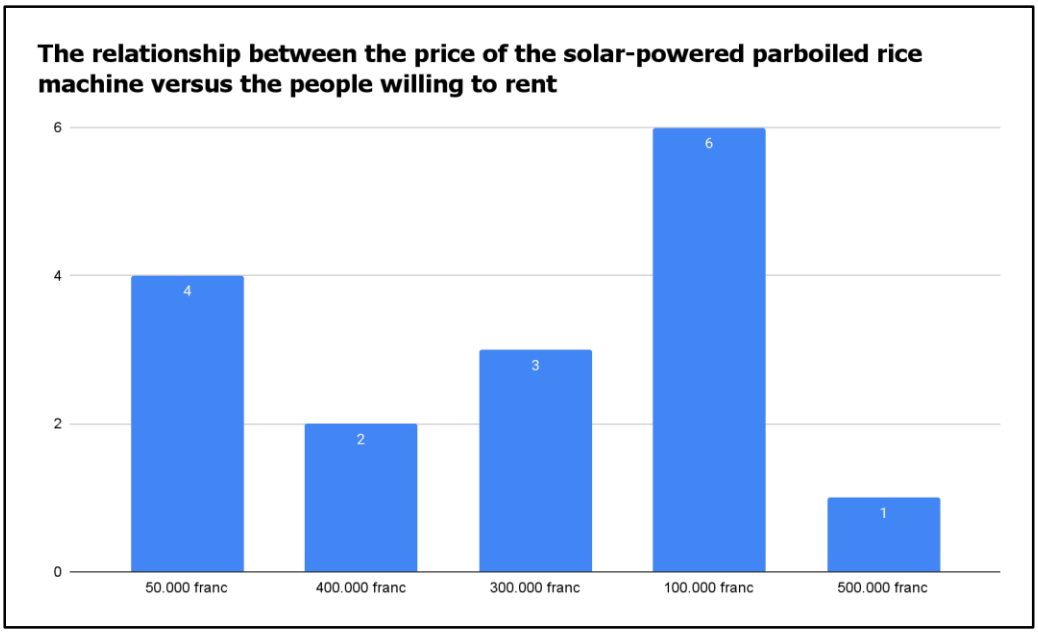

Figure 5: Relationship between the price and willingness to Rent
Source: Authors' Initiative

As a result of the data collection, it has been observed that the Barabarai rice farmers are in dire need of the solar-powered parboiled rice machine to boost their production and combat deforestation. This necessitated the active involvement of all stakeholders in the data collection process. The study highlights the crucial requirement for the solar-powered parboiled rice machine in Barabarai rice production within the Basse Guinee region of Guinea.

The current study affirms the findings regarding the respondents' willingness to rent the solar-powered parboiled rice machine at 100,000 Guinean francs per day. This willingness is attributed to the machine's perceived environmental, social, and economic sustainability for Barabarai rice farmers in the Basse-Guinée region of Guinea. Consequently, farmers in the Basse Guinee region would be able to rent the machine, as indicated by all respondents expressing confidence in its functionality within the Basse-Guinée region.

According to World Bank reports, as of 2018 and 2019, 43% of Guineans were living below the national poverty line (World Bank, 2014). This implies that a significant portion of families faces extreme poverty. While they exhibit a willingness to pay, it is essential that any financial commitment aligns with their ability to pay. Applying energy ladder theory and energy stacker theory, three distinct cases can be elucidated:

i. Willingness to pay > Ability to pay: Maintain the status quo;
ii. Willingness to pay = Ability to pay: Transitioning cooking methods (ascending the

energy ladder);

iii. Willingness to pay < Ability to pay: Maintaining in the upper part of the energy ladder.

When we lack the ability to pay for what we desire, we remain at a lower level of the status quo (Energy ladder). Then, when our ability matches the price, we can switch cooking methods. If we are fortunate enough to stay at the level of our income, we can sustain the use of better technology (sustaining in the upper part of the energy ladder). However, the ability to pay can fluctuate due to the risk of losing a job or income. Afterward, we revert to using inferior cooking methods like firewood.

Discussion

Concept of Sustainability

Sustainability can be defined as the ability of systems to prevent risks from evolving into dangers, created by social, economic, and environmental changes, while maintaining their homeostasis.

Applying this to our case, it can be described as follows: the ability of food systems within households to avert risks such as hunger and social and environmental risks (price volatility in cereals due to the inability to adapt to climate changes; economic risk, including a lack of financial resources to sustain household food systems, leading to income loss) and to maintain homeostasis (continuing daily consumption of rice without interruption).

From the perspective of Brain Re-engineering Concept and Reimagination (BRECR), Agbugba (2023) described sustainability from the progressive dimension of amalgamating perception change, mentation or ideation and entrepreneurship, technology integration, continuous viability of systems (sustainability) in a circular economy flow, as well as equality in public policy. The BRECR strategy is veritable and a solution for rebranding food and agricultural systems and engaging youths through entrepreneurship development (Agbugba and Isukul, 2020).

Primary Condition and Secondary Condition

There are four pillars of food security: Access, Availability, Utilization, and Stability. These pillars can be employed to explain the primary and secondary conditions necessary for achieving Sustainable Development Goals (SDGs) (World Bank 2023).

The primary condition requires access to solar-powered machines from the market and available solar power (Onomu *et al.*, 2020). Subsequently, the secondary condition involves utilizing the solar-powered rice machine in a stable and continuous manner. Following this, we can realize benefits in production and consumption, but first, we need to understand what sustainability means.

Possible Sustainable Development Goals (SDGs) for Production

In the production phase, we use sustainable energy (SDG 7.2), leading to primary effects such as reduced indoor air pollution (SDG 3.9), time savings for women in cooking (SDG 5.4), as they don't need to cut firewood, and environmental preservation, eliminating the need to cut wood as fuel (SDG 13.b). In detail, according to Okello and colleagues, women, more than men, suffer from indoor household air pollution during cooking, being exposed to pollutants (Okello *et al.*, 2018).

For the consumption phase, utilizing sustainable energy (SDG 7.2) helps solve hunger as a primary effect (SDG 2.1), leading to improved educational attainment for children due to the absence of hunger (SDG 4.5). There are two primary risks: a strong primary risk involving social and environmental factors beyond household control, and a weak primary risk - economic risk, which households can manage using solar-powered rice machines. Two conditions exist: primary conditions, which involve accessibility to cookstoves and availability of cooking fuels, beyond household control, and secondary conditions, utilizing machines continuously, which households can control.

Different effects emerge in the production and consumption processes. In consumption, the primary effect is alleviating hunger (SDG 2.1), while the secondary effect is improved educational attainment (SDG 4.5). In production, the primary effect is renewable energy production (SDG 7.2), with secondary effects including climate action (SDG 13.b), reduced air pollution (SDG 3.9), and the achievement of gender equality (SDG 5.4).

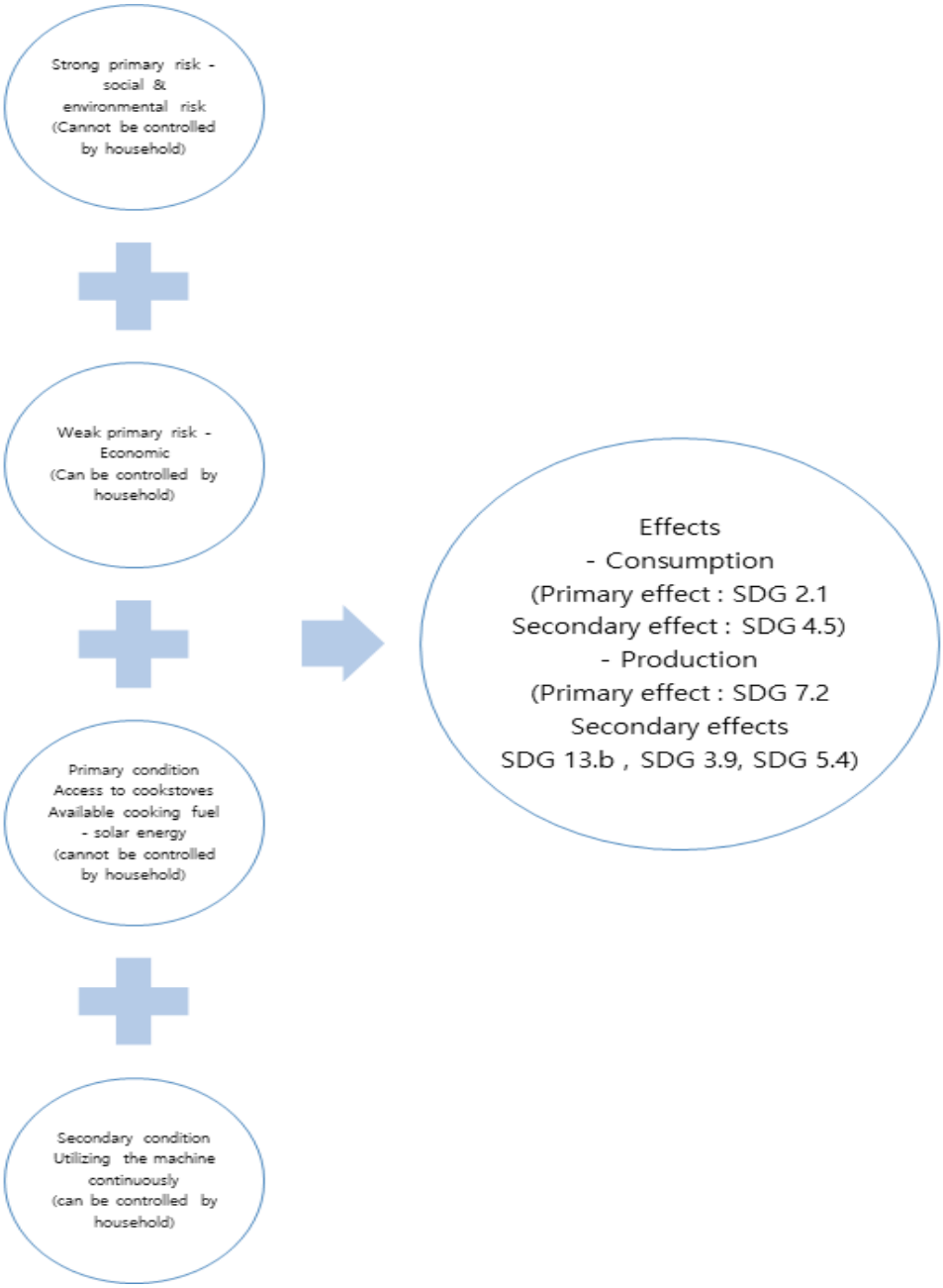

Figure 6: SDGs achievement
Source: Authors' Initiative

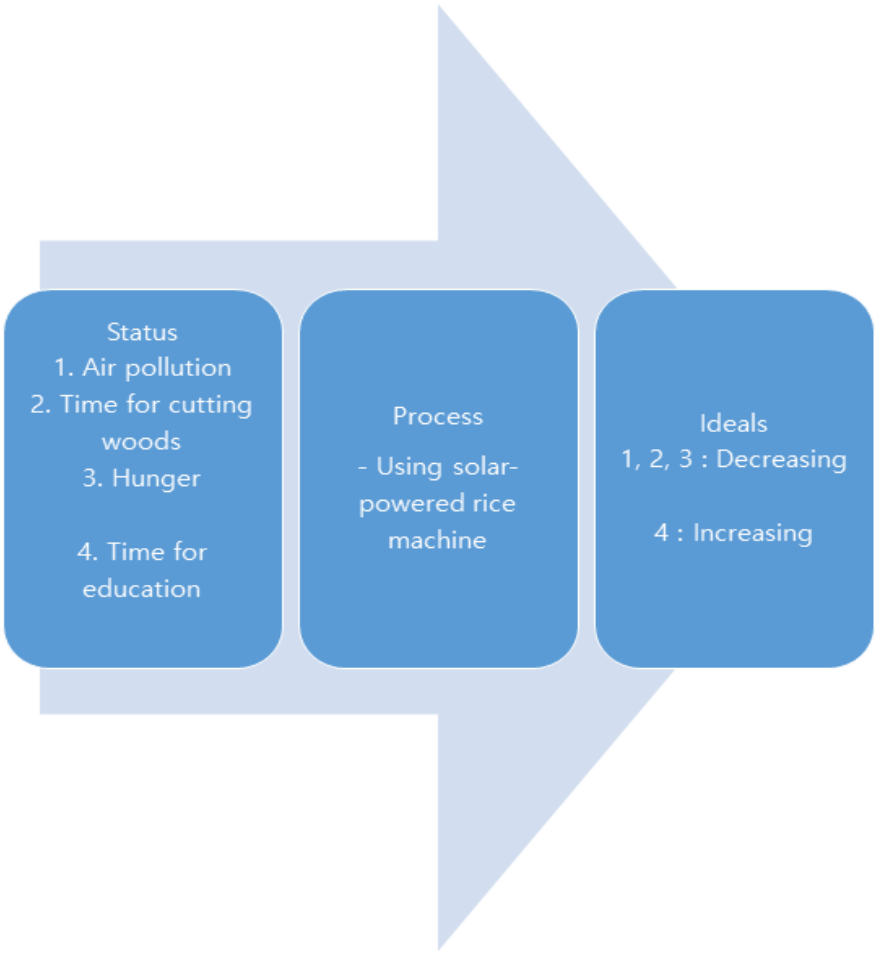

Figure 7: Direction of SDGs achievement
Source: Authors' Initiative

Currently, indoor air pollution arises when we cook rice using firewood. The time spent on cutting wood and experiencing hunger can be diminished by employing a solar-powered rice machine. Furthermore, the hours available for educating children can be extended with the use of a solar-powered rice machine.

Energizing Economic Growth: A Multi-Faceted Exploration of Solar-Powered Rice Processing in Guinea

According to World Bank data, 43% of Guineans live below the national poverty line by Year of 2018 and 2019. In order to energize economic growth, the following aspects are highlighted: economic impact assessment, investment and funding strategies; job creation and income distribution; infrastructure development; export potential and trade balance; and risk mitigation and economic resilience.

Economic Impact Assessment

This study lays the groundwork for a comprehensive analysis of the economic implications of transitioning to solar-powered rice processing in Guinea. By investigating potential contributions to the GDP, we can quantify both the direct and indirect effects on key economic sectors. For instance, an increased adoption of solar-powered machines can stimulate growth in the technology manufacturing sector, generating job opportunities. Additionally, an assessment of the potential surge in productivity and income resulting from this technological shift will provide valuable insights into its overall economic stimulus and GDP growth potential.

Investment and Funding Strategies

To ensure the successful implementation of solar-powered rice processing technology, innovative investment and funding strategies must be explored. Identifying viable financing mechanisms, such as public-private partnerships or international grants, will help create a sustainable financial framework. Policymakers can then use these insights to develop financing models that attract investments aligned with the long-term economic benefits of the technology. Leveraging expertise in designing financial instruments can further assist in structuring deals that benefit both investors and Guinea's economic growth.

Job Creation and Income Distribution

Expanding on the economic potential highlighted in the paper, a detailed analysis of job creation is essential. Quantifying the direct and indirect employment opportunities in manufacturing, distribution, and maintenance of solar-powered machines will showcase the positive impact on income distribution and poverty reduction. This, in turn, fuels consumer spending and stimulates economic activity, ultimately contributing to GDP growth.

Infrastructure Development

Addressing inadequate transportation facilities as a barrier presents an opportunity to emphasize the broader impact of infrastructure development. Proposing strategic investments in transportation networks not only facilitates technology adoption but also positively influences various economic sectors. Improved infrastructure can enhance the efficiency of the supply chain for solar-powered rice machines, contributing to economic growth in the Basse-Guinee region and beyond.

Export Potential and Trade Balance

Examining the export potential of solar-powered rice processing technology is crucial for assessing its impact on Guinea's trade balance. Analyzing the feasibility of exporting these machines to neighboring countries can contribute to foreign exchange earnings and diversify the export base. This export-oriented perspective aligns with broader economic strategies, presenting an opportunity to position Guinea as a leader in sustainable agricultural technologies and positively impacting GDP.

Risk Mitigation and Economic Resilience

A section on risk mitigation and economic resilience can enhance the strategic planning aspect of the paper. Identifying economic risks associated with technology adoption and proposing mitigation strategies strengthens the economic sustainability of the initiative. This could involve creating financial safety nets, insurance mechanisms, or contingency plans to navigate unforeseen challenges. Demonstrating how the adoption of solar-powered rice processing aligns with broader economic resilience goals will fortify the case for integration into Guinea's economic development strategy, contributing to overall GDP growth and stability.

Conclusion

While many respondents in Guinea are cognizant of the environmental impact associated with their daily cooking activities and recognize the potential developmental benefits of using solar-powered parboiling rice machines (a form of climate action), a significant financial gap persists between reality and ideals. Therefore, the following questions can be explored further. Firstly, can we achieve other Sustainable Development Goals (SDGs) as well? We can investigate whether this rice machine contributes to the accomplishment of other SDGs. Secondly, how can we encourage the continuous usage of this machine? To address this goal, we can explore how people use the product and the reasons behind their non-usage or forgetfulness.

Thirdly, there are limitations in using solar-powered rice machines, as outlined by the World Food Program. Interestingly, not all types of food can be cooked using this form of

technology. Although it relies on some renewable energy source, it takes longer than other cookstoves and cannot be used during rainy seasons. Therefore, new research should be conducted to explore how to maximize the advantages and minimize the disadvantages of using the solar-powered rice machine. Hence, the need to examine how community actors contribute to facilitating the use of SPPRM.

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Appendix

Sample Frame Table:

Stakeholders	Population	Sample size	Instruments Used	Number of Participants
Population A: Basse Guinee Rice Farmers	260	156	Surveys https://forms.gle/8QTTWbwUGPLeMWf87	150
Population B: Ministry of Agriculture	14	14	Interview	1
Population C: Koba village hall delegation	38	35	Survey https://forms.gle/8QTTWbwUGPLeMWf87	26
Population D: Agronomist	49	44	Surveys https://forms.gle/8QTTWbwUGPLeMWf87	20
Population E: AfricaRice	N/A	N/A	Existing data https://www.africarice.org/about-us; https://www.africarice.org/sdg, https://www.africarice.org/gem-rice-parboiler, https://www.africarice.org/post/when-women-take-the-lead-in-improving-income-and-nutrition;	N/A

Total number of participants: 197

Data Collection

Primary Data: The collection of primary data will involve conducting surveys with key stakeholders in the rice sector in Guinea, comprising farmers, women engaged in parboiling, rice millers, rice traders, and government officials.

Secondary Data: The acquisition of secondary data will be from academic articles, reports, and other pertinent documents sourced from AfricaRice.

By engaging these stakeholders and employing various data collection instruments, such as surveys, online meetings, onsite research, academic articles, and other relevant documents, the study aims to amass comprehensive data and perspectives on the impact of rice farming on deforestation in the Basse Guinea region of Guinea. The specific focus will be on Barabarai rice production in the village of Koba, where Barabarai rice is cultivated on 120,000 arable lands, according to the region's mayor.

Survey:

https://forms.gle/YFTpAL8znJxpc3kN9

Transcribed Data and Coded format:

https://colab.research.google.com/drive/1ushimwrKqVeBUxTjgUUbzHGeHmCwGCIH#scrollTo=_RBla9kgcAmb

Google Spreadsheet:

https://docs.google.com/spreadsheets/d/1Xhn4TLvULwpXb83j5BNQcjWwKGvax2wvo3tOE9vlHdk/edit?usp=sharing