Scientific Research Publishing

Modern Economy, 2022, 13, 370-396
https://www.scirp.org/journal/me
ISSN Online: 2152-7261
ISSN Print: 2152-7245

Stochastic Model of Rural Agribusiness Supply Chain: A Case Study of Gatsibo District

Exode Rukundo[1,2]

[1]Independent Researcher and Analyst, MSc in Economics, Kigali, Rwanda
[2]Manager for Business Performance and Reporting at MTN Rwandacell Plc, Kigali, Rwanda
Email: rukexo@gmail.com

How to cite this paper: Rukundo, E. (2022). Stochastic Model of Rural Agribusiness Supply Chain: A Case Study of Gatsibo District. *Modern Economy, 13,* 370-396.
https://doi.org/10.4236/me.2022.133021

Received: February 10, 2022
Accepted: March 18, 2022
Published: March 21, 2022

Abstract

The current economy of most developing countries is based on agriculture and its related operations that serve as the main entrance into the emerging industrial transformation. The lookout focuses on the integration of rural areas as drivers of a meaningful part of the land output. The concern has been to curiously follow the changes in the agricultural production environment from a global perspective of the market economy and its integration in the current economic revolution/transformation. The branches of deepening the understanding of this issue enroot in levelling the optimization of the benefit at all extremes of the processes involved in decentralized agribusiness functions. This study is essentially targeting to explain the current agriculture supply chain formula in rural parts of Rwanda for a more competitive equilibrium of the agricultural production planning and inventory and the distribution as the rural market nodes. The methodological intention was to drive a stochastic view of the operational transactions through the flow of the financial means (income from job for consumers and revenues from sales for rice farmers) and the likelihood to switch (respond to one's reactions or actions) to one of the nodes, if any. The results show that the financial security on both parties is not a driver to quicken the transactions or sustain any change in the supply chain and it calls for exogenous factors, in short term, to reverse the trends.

Keywords

Economy, Agriculture, Stochastic, Market, Supply Chain, Model

1. Introduction

According to the World Bank reports, the agricultural development seems to be

one of the most powerful tools to reach the Sustainable Development Goals, SDGs (end extreme poverty, boost shared prosperity and feed a projected 9.7 billion people by 2050). Growth in the agriculture sector is two to four times more effective in raising incomes among the poorest compared to other sectors. Analyses in 2016 found that 65 percent of poor working adults made a living through agriculture. This cruciality is also reflected in the contribution to the economic growth where, in 2018 alone, it was estimated at 4% of global gross domestic product (GDP).

However, whatever the agriculture sectors contribute is at risk: with fragmented supply chains and climate change at the top of the list.

As per the recent reports, agriculture is the main economic activity in Rwanda with 70% of the population engaged in the sector, and around 72% of the working population employed in agriculture. This agriculture is practiced in 2 main seasons, but there comes a third one in marshlands that deals with rice and vegetables. The agricultural sector accounts for 33% of the national GDP. Due to shortage in land availability, the Government of Rwanda is promoting intensification as a strategy to increase production and farmers' incomes. In the long term, the goal is to move Rwandan agriculture from a largely subsistence sector to a more knowledge-intensive, market-oriented sector, sustaining growth and adding value to products. To do so, the Government of Rwanda considers agriculture a catalyst sector and will promote the development of value chains with the stronger links with the private sector. The crops of interest include coffee, dairy, horticulture, and cereals, among others.

Gatsibo district is known for its high yields of grain, livestock, and bananas. It also embraces modern farming practices such as irrigation.

Of recent, the district sees a huge investment attracted by the structure of the district (Gabiro Agribusiness Hub Project, GAHP) and aimed at creating a holistic and commercial agricultural ecosystem by developing modern value chain over an area of approximately 15,600 hectares of arable land with advanced water infrastructure, cutting-edge irrigation systems, high-value agro-processing operations and other agricultural technology activities across the value chain.

According to Jan et al. (2002), a new concept of supply chain development needs to be developed, that not only benefits the private sector but also creates spin-offs that stimulate social, economic, and environmentally sustainable development in the region (employment generation, added value, decreases of product losses, etc.) and urge the public support (e.g. development of the institutional infrastructure) to play an important role to create an enabling environment for private sector development and to take the form of a public-private partnership in a supply chain to share experiences, risks, and bottlenecks.

Though the risks are prominent (environmental, market-related, logistical, operational, and institutional risks) as Steven (2010) says in "Rapid Agricultural Supply Chain Risk Assessment: A Conceptual Framework", one of the measures to tackle this issue is the central role that information sharing plays in between

to make sensitive lumps of the supply chain.

Therefore, the case of rural and small farmers, as it is obvious in Rwanda, necessitates a review of the standpoint, turning from policy stand to production stand to successfully reach the targeted groups.

To operationalize this sector, Jang and Klein (2001) propose the models that consider the strategic decisions of farmers whether to form or join a cooperative, what type of product to produce and how much, determination of when to take a product to the market, capacity decisions, and more precisely whether direct producer to consumer sales in retail markets is a profitable option for small farmers or not, and also the inclusion of the conditions and amounts of such profitability as well as operational decisions such as quantity and pricing strategy to optimize farmers' profits.

Current interference in agribusiness operations intends the valuing of the chain through its cross-cutting procedures and covers the supply chain with the governing terms: power, information, and market. Other aspects must be considered as opportunities laying in these three pillars (Martin & Patrick, 2009).

Under the current 2018-2024 District Development Strategy, 2018-2024, with a PIR (Poverty Incident Rate) of 42.1% (EICV 5) higher than the national rate (38.2%), agriculture has been considered as the main driver as it occupies number one and two on the list of the specific objectives to pursue. As a rural district, the transformational model builds on agriculture and its transformation stages from the aspects of land ownership per family to the commercialization and monetarization of the factory-transformed agriculture production, especially maize and rice.

Gatsibo district has set its general objective to build and strengthen an agro-based economy with a view to making the district an agricultural hub so that it is self-sufficient in food production, have a surplus for the market and create jobs for its people, the goal being to reduce endemic poverty, fight hunger and malnutrition in the district.

Before venturing into the general picture of Rwanda, one would still get curious to understand how the operationalization is being conducted to benefit even the small farmer at the village level and be met in the set timeline.

Agriculture stands still as the main activity for an extensive portion of the Rwandan society. This raised the concern as to which level and in which ways to develop it and align it with other developing sectors of the Rwandan economy. Policies and strategies were put in place to institutionalize this concept and decentralize it to grassroots levels.

Agricultural services have been mainly thought of as subsistence, earning sources to many rural citizens. This is though still considered as an inefficient job in terms of organization, productivity, and exposure to a considerable risk (William, 2010). In addition to this, the undergoing operations in this sector remain a vibrant component of developing economies for a set of reasons: they provide goods and services; they play the role of a reservoir of the individual

upholding market power and finally, they endow with opportunities for optimizing earnings for all partaking agents. Consequently, there are increasing changes in the agriculture productivity environment followed by the lack of its clear relationship with the rising cost and shrinking resources of short product life cycles in a market economy (Benita, 1998).

In the case of Rwanda, particularly in Gatsibo district, where the population is mostly employed in agriculture (70% according to RDB investment opportunities in agriculture online reports), and the sector is the source of income and survival for a large number of populations; the low-income, middle-income, and up-income earners, it should be noted that all this population is, at a certain level, involved in agriculture in diverse ways and it contributes to the sustainable creation of their livelihoods.

However, there are major concerns that serve as a key challenge or problem to be fixed or at least to be explained for policymakers to act accordingly. These concerns resulted from the multifaceted processes of agricultural productivity and transformation, the low participation or lack of involvement in the harmonization and assessment of the sustainability of agricultural service delivery through decentralized affordability, and the need to tackle the restraints of agricultural operations. The purpose is to fix the latter by revisiting or enlightening on the conditions, mechanisms, impacts, and current need to be assured of the established conventional and future development of Rwanda. This is made easy by marrying the ongoing transformation to the desired commercialization by setting a clear protocol to handle the current system dynamics that benefit not only the communities.

The rural social structure not only emphasizes the need for a reduced operational channel to help both farmers and consumers but also reveals a key element in the current economy, an information sharing and management system that is crosscutting as an endogenous factor.

The hypothetical schedule suggests that the rural agriculture operations differ in current market structure.

The general objective of the research is to understand the rural agribusiness operations through the rice supply chain and their impact on the lives of rural involved agents. More specifically, the study focuses on:

1) To explain how the financial viability/security of rice supply-demand forces may sustain the farmers' performance or induce the roles interchangements as a way of reducing channels or building a micro rural supply chain of market crops.

2) To discuss the importance of global investment and information sharing in raising the benefits of rice farmers and quicken the transactions at lower levels.

Studies on the agriculture sector are emerging in recent years. These studies are still giving room for more critics as to the way results are interpreted and recommendations are implemented to benefit the lower levels of agricultural beneficiaries in terms of the agriculture transformation and commercialization.

This presents opportunities to economists, researchers, policymakers, and others to cooperatively provide insights into some hidden dimensions of this issue to guide and to contribute to the national economies through standardized and competitive agriculture sector as the main driver and way of living to all people in developing nations.

Moreover, the strengthening and the empowerment of the agribusiness operations in market crops need a clear protocol to handle the current system dynamics (fragmented market agents), and this research shows who is responsible and at which level between the communities involved in agriculture and those others who are interested in the study findings.

This study wants to shade light into the hypothetical drivers of the revised agricultural supply chain by tapping into the reduced channels that embrace roles-swapping in an era of quickest information sharing and easy and digitalized access to finance.

The study was spanned over a period of one year, with observations along the 3 seasonal harvests. Drawing from the global view, the methodology and contextualization were narrowed down to the Rwandan farmer, in Gatsibo district.

With the time limitations, financial support, and travel challenges due to Covid-19 restrictions, the study started by the end of 2019 and went through 2020.

To perform a pragmatic analysis and provide insightful conclusion in the given circumstances, some second stage parameters were not considered like the post-estimation models, that will serve as the kick in point for further research.

A sample of 142 rice farmers provided the explained parameters (model estimation and switching probabilities together with tests for collinearity and homogeneity) that are constrained to the normality of the results as the agriculture sector, especially rice, is confronted to the current low rice market trends.

The study presentation is structured under the following organisation: introduction, literature review, research methodology, data presentation and interpretations, and general conclusion and recommendations.

2. Literature Review

This study draws from a combination of different realities pertaining to the agricultural sector in Rwanda, especially in Gatsibo district and models of the random operations that occur in agri-business in rural areas. The presentation of the subject of study shows how much of a need to try to mend the gaps in agri-business and quicken the benefits to all involved agents. The rural areas have of recent embraced a modernization process that transforms all aspects of livelihoods, but it lacks, in its primary stages, a clear visibility and understanding of the methods, techniques, operations and initiatives to prioritize as drivers of equilibrium development, the one that places agriculture at the centre of an authentic change as it occupies most of the population in those areas.

The existing strong body of knowledge around agriculture and its interactivity

with different sectors broadens the understanding of this sector from the time of inception through the national mobilization to the enjoyment of the benefits it provides to all stakeholders. According to NEPAD (2013), agriculture is perceived as the driver of economic development in upstream and downstream subsectors in terms of job creation, which is seen by many as the future potential challenge, especially for the exponential growth of the youth. All it was targeting was to fight the food insecurity that has always been a focus to ensure that the continent and the individual countries are healthily sustained by every policy undertaken to address malnutrition, land, and environmental management (Judit, 2007).

So many researchers collaboratively contributed to narrow down the understanding of the agricultural operations, and this helped in the implementation of diverse initiatives and strategies and tried to shed light on the contextualization of the global aspects of agriculture-related matters (Hope Michelson, 2020; Vorley et al., 2008; Judit, 2007). They appealed to diverse methodologies and designed theoretical as well as empirical approaches for further studies. Some invoked chain management as a core no-let item to incorporate into further experimental studies. But who would think of stochastic analytics without alluring the processes involved? According to Brooks et al. (2011), the latter are the random variables that set up a system that evolves in time while undergoing change fluctuations.

Changes are inevitable, real, challenging, and necessary, and constitute the motives that bind the nodes and make them sound relevant to a certain interest as they do to the agriculture sector among many others.

The variance in several developed theories relies in the fact that they are always practical, looking into their applications to the specific addressable interest, and the economists understand this better as the focus is placed on tackling the reality as expressed in the lines of the analysed data.

2.1. Theoretical Literature Review of the Agribusiness Models

Over the recent years, agriculture has been an interest for many stakeholders. Some are making money out of it and others play a bigger role to document, advise and advocate for better strategies around its development. The common denominator is a revamp of the means and markets for an agribusiness-led development. They somehow differ on the ranking of the initiatives to be implemented, and now the question becomes the contextualization and localization of the implementation of policies.

Before emphasizing on different developed models, there is a need to at least throw a light into what this sector is facing now. The eagerness is projected into developing the causality relationships to be able to identify what drives what and at which level of impact.

Some have chosen to dwell on the inclusiveness in agriculture as the main concern of our times and others have gone far to define this inclusiveness as a

driver of innovation, which is seen as the primordial step into any other agro agenda.

The above figuring-out exercise between different scholars and researchers will not be of greater help since the beginning-with-end-in-mind is still left for individual interpretation and actualization. This is where a need comes in to simplify a model that is easily understandable and applicable to many local cases, given the structure of current markets.

2.1.1. Inclusive Agribusiness Models

An Inclusive Business Model is a type of business model that seeks to create value for low-income communities by integrating them into the company's value chain on the demand side as clients and consumers, and/or on the supply side as producers, entrepreneurs, or employees in a sustainable way.

It has been highlighted that the development of agriculture would not be met if there were still some competing forces that hinder the business orientation to target the right products and market or business actors (Kelly et al., 2015).

Organizations that promote IBMs will have different driver entry points depending on their skills, networks, and mandate. Most literature on IBM targets private sector-driven business models, providing guidance, particularly to global companies, on how to engage with small farmers in developing countries. The rationale for the private sector's interest in IBMs will be profit motivated, related mainly with either securing supply or corporate and social responsibility activities, or a combination of both.

FAO's entry point is to work with governments on policy design and best practices, based on normative learning, which is complemented with field learning from smallholders' market access pilot projects. The public sector supports smallholder business models for several reasons. These include raising smallholders' incomes, mainstreaming business and market-oriented production skills, involving the private sector in national development goals, improving food security through the commercialization of food crops, and political obligations.

When implementing value chain projects that focus on strengthening IBMs, FAO mainly works through local NGOs and in close collaboration with governments to engage both producers and buyers.

The inclusive and business elements of an IBM can be competing forces. The "inclusive" element of a business model relates to the constraints of linking smallholders and vulnerable groups to buyers. The "business" element relates to an enterprise's way of doing business and its viability.

Trade-offs sometimes must be made if a business model, inclusive of smaller inexperienced actors, is expected to generate profits and grow. The business element needs business thinking and tools to be mainstreamed to strengthen the competitiveness of business models.

Models driven solely by either the public or private sector can result in poorly coordinated markets if there is little private sector involvement or further mar-

ket exclusion for vulnerable groups if the public sector is not involved.

The principles below guide actors in designing or implementing the upgrading of smallholder-based business models so that they result in competitive models and, at the same time, contribute to poverty reduction and food security.

1) Inclusion of existing value chain actors

2) Inclusion of less endowed actors

3) Inclusion of diverse market outlets

4) Inclusion of right partner mix

These inclusions call for enterprises to revise their internal approaches to value every single penny by promoting a win-win situation between them and buyers. The basic steps for implementing a business model approach are to:

1) Appraise the current business model: compare the separate business models of the farmer organization and buyer.

2) Identify common upgrading priorities: prioritize upgrading needs that are common to both seller and buyer.

3) Design an upgraded business model: design interventions that respond to the common upgrading priorities identified.

4) Measure progress: set indicators to be measured on a continual basis.

Looking into the globalization of agriculture was meant to benefit the high-scale farmers and leave behind the stallholders that are taking this sector into their hands in developing countries. Any investment would not turn into a clear agriculture revolution, unless the low-level institutions innovations are catered for, the business cases are raised from the buyers and the market opportunities are created with a strong support from the local private sector.

According to Kelly et al. (2015), report about Inclusive Business Models shows that these business models describe how any given enterprise, large or small, informal, or formal, does business, markets its products, and sources inputs and finance. The concept of inclusiveness addresses the development constraints of linking commodity-dependent smallholders and small actors to markets by stimulating local business model partnerships that include benefits for smallholder groups and small value chain actors. Of this concept, various types of business models link small farmers to agricultural value chains including traders, farmer organizations, agri-food processors, retailers, and contract farming arrangements with large buyers. Any model that will portray the below criteria qualify to be inclusive in nature:

1) Provides a living wage for vulnerable groups, such as smallholder groups, small enterprises, women- and youth-run enterprises, while also enabling buyers to profit.

2) Uses flexible trading arrangements that make it easier for smallholders or MSEs to supply a buyer, such as cash on delivery, accepting small consignments, providing reliable and regular orders.

3) Supports farmers and small enterprises to establish a stronger negotiation position through skills development, collective bargaining and access to market information and financial services.

4) Builds on the skills and expertise of existing market players, including traders and processors, and promotes value chain collaboration, transparency in pricing mechanisms, and risk sharing.

5) Is scalable in the medium-term so that the numbers of small actors involved can be increased and/or the type of business model can be replicated in other value chains or parts of the sector.

6) Allows for diversified income streams in the long term to enable the dissemination of upgraded skills to the rest of the sector, avoiding overdependence on any single buyer or market outlet.

The success story of the inclusive models has always been its adaptability to realities and context of every region regardless of the times and means. The fact that it incorporates different actors to try to find the balance into the equation of value-for-money and chains-for-life.

2.1.2. Structure-Conduct-Performance Models

The structure–conduct–performance (SCP) paradigm argues that market structure is a determinant of firm conduct, which in turn determines performance. Market structure can be measured by a number of factors such as the number of competitors in an industry, the heterogeneity of products, and the cost of entry and exit.

According to Jason (2021) of The Business Professor (an online newspaper), the structure-conduct-performance model refers to an analytical framework that explains the connection between economic or market structure, market conduct and its performance. This is a concept or model in Industrial Organization and Agriculture Economics that examines and describes the interaction between organisation structure (Agriculture Sector), organizational conduct (Farmers' behaviours in production processes) and organizational performance (output and its commercialization). The structure-conduct-performance model presents a causal theory explanation of these three concepts. It presents, their strengths, characteristics as well as downsides.

1) Structure—this refers to the construction, formation, and the makeup of an industrial organization. It also describes the kind of environment in which an organization or market operates.

2) Conduct—this describes the behaviour or comportment of buyers and sellers to the structure of a market. It also refers to the way buyers and sellers interact with each other and the way they behave.

3) Performance—this refers to the achievement or accomplishment or results of a particular market or industry. Performance variables that are considered in the market include product quantity, product quality, and production efficiency.

However, due to the effects of the behaviours of buyers and sellers on market, it is often difficult to predict market structure. Also, the multiple definitions and extension of markets and its structure make an inquiry into this paradigm more complex. Some studies also establish that the structure of the market will always be determined by the nature of the product and the technology available. Often-

times, people tend to ask when the SCP model becomes useful.

The SCP model is very useful in analysing a non-changing industry; it is also useful in the prediction of the effects of external shock on an industry's profitability. It is useful in the analysis of the response of an industry's structure to price conduct and vice versa. It studies whether structure drives performance and also influences conduct. Also, any inquiry into structure, conduct and performance of an industry or a market makes the SCP model useful. This model can be used to justify consolidation in the industry. It also helps in the analysis of the effects of a more attractive industry structure on the performance of the industry. This is an example of how to analyse the structure, conduct and performance using the SCP model. First is a highlight in structure which includes an analysis of the industry concentration (Herfindal index), minimum efficient scale, the market share pattern, and the ownership of major companies in the industry. Second is a highlight in conduct which reflects why industries compete in prices, services, and product innovation. It also looks at the stability of the conduct and different strategies displayed by players in the market. The notion of good competitors and bad competitors are also explored. Third is a highlight in performance such as return on capital employed, economic profit, shareholders returns and others. It also entails an analysis of factors responsible for certain performances in the industry.

2.1.3. Innovative Agribusiness Models

Over the years, the main concern shifted from inclusiveness. As the exigencies of the times arise, the parameters changed and placed the sufficient market at the top of the drivers. Enough buyers would revolutionize the production processes, hence, lead to the best model of the era. The recent report from FAO (2015) emphasizes on the need to drive innovations that are mainly led by, not the power of the institutions or farmers, but the contract and technology. The later are meant to halt the risks and decrease the operating cost, benefiting all the other actors backward.

To clearly understand this model, the following two major aspects, namely: 1) price risk and its mitigation, and 2) information and communication technologies are developed hereafter.

1) Agriculture price risk and its mitigation

According to FAO (2015) report, price risk mitigation offers an area for contractual innovation. With the advantages of hedging in international futures markets, and with geographic diversification in sourcing, buyers are in a position to mitigate grower price risk in markets where prices exhibit either high volatility or persistently low levels. Research has demonstrated that purchasing agreements that guarantee farmers a minimum price and provide farmers with a measure of price insurance can provide powerful incentives for farmers; farmers in Nicaragua contracting with Walmart proved willing to accept a lower mean price for horticultural products (relative to the traditional market) in a contract that provided a minimum price.

This sort of insurance can be valuable when traditional domestic markets for a contracted commodity are thin—as can be the case with rain-fed horticulture or when the international price exhibits high inter-annual volatility and extended periods in which prices are depressed (coffee and cacao). Price guarantees through contracts have been shown to provide powerful ways to induce investment in production.

2) Information and communication technologies for agriculture

To be able to respond to the crucial issues of limited infrastructures with its associated raise in costs farmers and traders run to acquiring the information to remove that gap. This also helps them to reach important decisions related to agricultural production and marketing. Recent years have seen a range of initiatives to apply Information and Communication Technologies (ICT) to agriculture, especially to problems of information access. Such services can foster a scaling of information delivery, providing diagnosis of crop diseases, facilitating farmer-to-farmer interactions, and supporting interaction between farmers and service providers. Though the information may sound as the main benefit, the Mobile Financial Services (MFS) may second it to highlight the importance of easy access to financial services in a convenient manner. The bigger solution that innovation brought into the value chain is generally to reduce intermediaries and revise the market commander, placing a buyer at the centre of the orbit, with a farmer moving around that orbit within the ICT ions.

2.1.4. The Study Model Selection and Motivations

Through a comparative analysis of the above models that try to include everyone and fights to find the way to balance the nodes though innovations, the time effect is a significant matter to be addressed. The time it takes for actors to respond to the needs of each one in the chain at the very shortest time is still critical. That responsiveness requires an embrace of time factor into the model at once.

Not only time needs to be deeply analysed, the alignment of the drivers with equal weight is needed if the agribusiness operations are to be studied for sustainability.

Placing inclusion, innovation, or smartness of the operations at the same level would help to build a more coherent image of the impact each will have to the lives of every agent in the chain in a given time.

An Inclusion-Smart-Innovation (ISI) model, stochastically built on the relevance of an aspect of timely responsiveness to everyone's activity, would coordinate what should be done by who in ways that optimize the benefits in the shortest schedule to catch up with the advancements of the multifaceted development.

2.2. Empirical Literature Review of Agribusiness Models

In a study conducted in Ghana, the agricultural industry was seen to be a complex system and requires a holistic approach to dealing with root causes of chal-

lenges. This research therefore used systems thinking tools including Casual Loop Diagrams (CLDs) and Bayesian Belief Network (BBN) modelling to develop new structural systems models where stakeholders determined the components and interactions between the Structure, Conduct and Performance (SCP) of the agricultural industry in Ghana using the Evolutionary Learning Laboratory (ELL). The results illustrate how the SCP elements interact together to influence the survival and growth of the agricultural industry among driving forces. The study identifies that the stakeholders adopt several strategies to survive and compete, which lead to the overexploitations of the ecosystem. The results from BBN models indicate that the implementation of systemically determined interventions, policies and strategies could significantly improve the rate of business survival and growth from 58.8% to 73%, while the chances of improving the SCP could be increase from 39%, 28.3% and 36.4% to 80.1%, 55.9% and 62.4% respectively (Kwamina et al., 2016).

A team of researchers (Alexander et al., 2020) from various academic institutions interested in the soundness and importance of the inclusive agribusiness models narrowed it down to aquaculture. They found out that for aquaculture to continue along its current growth trajectory and contribute towards achieving the Sustainable Development Goals, value chains must become more inclusive. Smallholders and other local value chain actors are often constrained by circumstances and market failures in the global aquaculture industry.

Integrating these actors into aquaculture value chains through inclusive business models (IBMs) is often touted as a solution to sustainable and ethical trade and business that can generate development outcomes. A review of 36 papers under seven business models commonly used in agriculture development was used to assess their application in aquaculture value chains in lower-income countries. A global value chain (GVC) analysis is used to unpack the economic and social upgrading objectives of the different IBMs, as well as the types of relational coordination used between actors in the chain to achieve development outcomes. The extent to which these IBMs helped poor actors overcome certain barriers is evaluated with a focus on how they may ensure or be a risk to inclusiveness through the relations and upgrading opportunities evident in their make-up. The analysis found that the majority of the models focused on economic upgrading over social upgrading. Providing opportunities for the latter is key to achieving the inclusive objectives of IBMs. Greater horizontal coordination between actors can create further opportunities for economic upgrading established under vertical coordination with other nodes upstream and downstream in a value chain. There is a need to further contextualize these models to aquaculture systems and develop clear indicators of inclusiveness.

As it has been always a concern and a look-up-to sector, agriculture serves as the main ingredient source to many other sectors in the services as well as manufacturing industries. It generates employment and supplies the consumption chain, thus, impacting all variables of the national output.

The operations that flow from the farmers is reciprocal as it comes back in other forms as income or well-being after changing the lifestyle of many household members. According to Ahmad Baijou (1990), the agricultural sector plays a significant role in any economy in terms of employment, foreign exchange earnings, and supply of major commodities for domestic demand. He goes on to say that it's well explained when one studies holistically its performance, supply and demand characteristics, resource allocation, and pricing system.

2.2.1. Agriculture and Its Impact on the Gross National Output

Is really agriculture an engine for sustainable growth? Who is to argue when the investigations into the causality relationship between the agricultural value added per worker and gross domestic product (GDP) per capita support enormously the hypothesis?

However, this causality is much more relevant in developing countries as agriculture stands as the backbone of their economies.

Policymakers are advised to start considering agricultural sectors as vital tools in their analysis of inter-sectorial growth policies. Though the agricultural sector has not benefited immensely from the growth of the service and commerce sector but its contribution to the economic growth of the economy can never be ignored (Sertoğlu et al., 2017).

2.2.2. Agricultural Operations and Its Feasible Progress in Developing Countries

Agricultural operations mean the raising and harvesting of their crops or livestock by farmers or ranchers, their exchange between farmers or ranchers, or the transportation of implements of husbandry to or from farmers or ranchers by persons engaged in the business of selling or repairing such implements.

These operations consist of:

1) the growing or harvesting of crops from soil (including forest operations) and the raising of plants at wholesale nurseries, but not retail nurseries, or the raising of fowl or animals for the primary purpose of making a profit, providing a livelihood, or conducting agricultural research or instruction by an educational institution, or 2) agricultural crop preparation services such as packinghouses, cotton gins, nut hullers and processors, dehydrators, and feed and grain mills. Agricultural crop preparation services include only the first processing after harvest, not subsequent processing, canning, or other similar activities. For forest operations, agricultural crop preparation services include milling, peeling, producing particleboard and medium density fibreboard, and producing woody landscape materials.

When curiosity is placed on the interdependence of these operations, that is when their contribution to national economic development is seen as well as their requirements to boost the agricultural production and develop other sectors at a controllable span, banking, transport, retailoring businesses, cooperatives, and export.

The joint partnerships of both private and public sectors are crucial though many farmers own their land. It contributes to environmental protection and expands the support to fight against the four big problems:

1) Obtaining an explicit emphasis on agriculture

2) Appropriating adequate funds

3) Developing the government's institutional capacity

4) Knowing when and how to withdraw from some activities as the private sector grows and modernizes.

For further progress in this regard, a large, widespread, extension service and the field efforts of research can bring substantial growth when both political and business environments meet over the sustainability of the results as to when and how to implement and monitor the strategies that are proposed. The reduction of the gap between the explicit role of government with respect to agriculture and its explicit role in the industrial or service sectors is regarded as one way to quicken the replacement of the nodes into the orbit and the integration of concerned parties become smooth to remove completely the unbalanced economic development that is still holding developing countries into the circle (John, 2017).

2.2.3. Studies on Agricultural Supply Chain Management

Supply Chain Management (SCM) in general implies managing the relationship between businesses responsible for the efficient production and supply of agribusiness products from farm level to consumers, to reliably meet consumers' requirements in terms of quantity, quality, and price.

For efficient supply chain management, four (4) key elements are considered such as integration, operations, purchasing, and distribution. Each relies on the others to provide a flawless direction from plan to completion as affordably as possible.

All the above elements are crosscutting into the below four (4) stages of supply chains that drive them from being an evolution into a network.

Stage 1: Supply Management.

Stage 2: Supply Chain Management.

Stage 3: Supply Chain Integration.

Stage 4: Demand-Supply Network Collaboration.

The studies that were carried out in this domain put first the idea of finding the main paths to improve the overall agricultural performance and customer satisfaction by improving product or service delivery to the consumer with an emphasis on the involvement of Movement and Storage (M&S) of all materials (raw material, work in progress and finished goods.

For example, Pradeep Kumar Mishra & Anjani Sinha, in their study say that the supply chain from farm to fork consists of multiple layers of intermediation, mostly without any qualitative value addition. This makes the chain inefficient, resulting in costlier food products for consumers. Their review points out the need to have a fresh look at the supply chain management with a view to im-

prove marketing efficiency and enhance farmers 'price realization without increasing the price paid by the consumers (Pradeep & Anjani, 2010).

The understanding of the interchangeability and linkage of the variables led to a conclusion of introducing ICT through processes that ensures both quantity and quality are respected with a reasonable price on both physical and virtual/online markets.

The recent models are now looking into the agri-business risk mitigation which implies a clear grasp of the information structure that guides the choice and practices of the nodes and shift a view from the supply into value chains to claim a bigger portion of the local and international markets.

3. Research Methodology

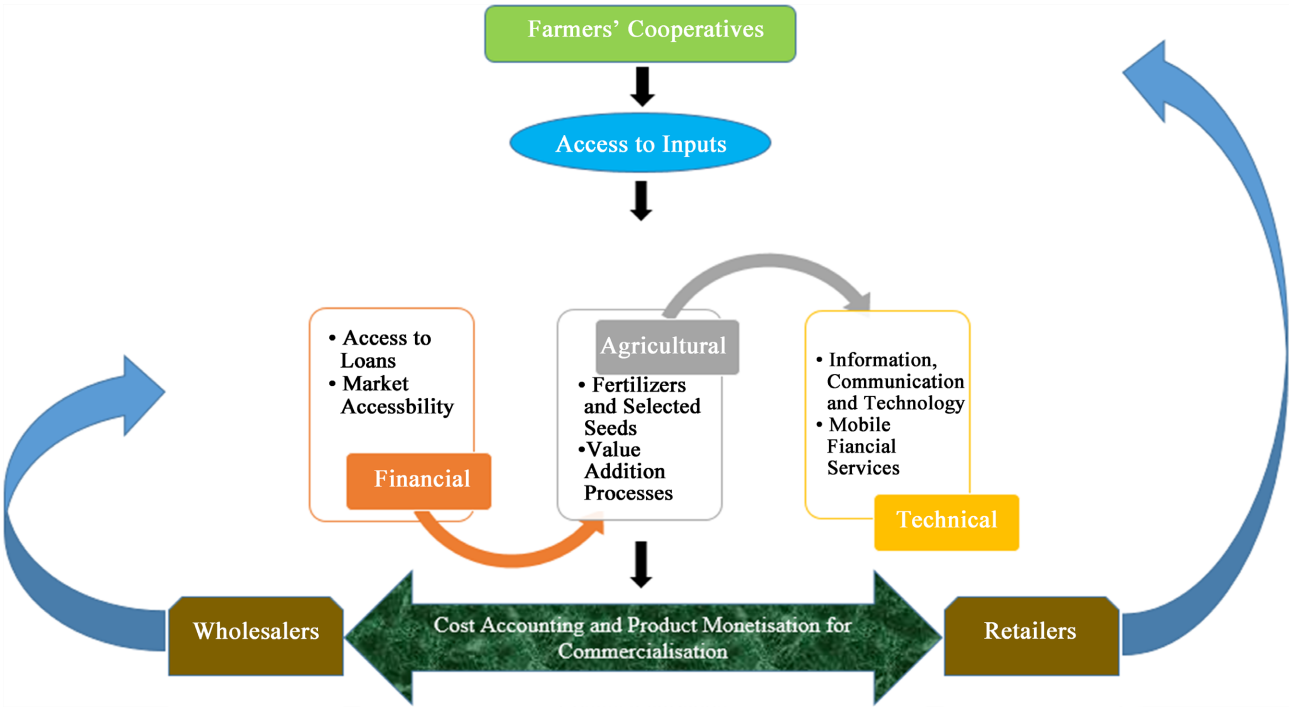
Any discipline requires a specific body of methods, rules, and hypothesized assumptions employed to make any analysis or inquiry into a particular matter under investigation, that is a methodology. It carries in itself a series of processes that range from design, sampling, data collection, data mining, and processing to the interpretation of the findings. The concerned chapter here shows that way that the intended approaches match the hypotheses and the logic that governs the whole procedure to the end.

This study works as an investigation done with the intention of discovering new combinations of mathematical and statistical analytical research techniques based on primary data and secondary data from national databases on variables of interest. This will assist in a better inference about the population dynamics along the chain. It is designed to portray a set of agriculture-related variables in examining this issue of maximizing profits on both consumer and supplier in a decentralized way through the streams of a global and competitive market.

The stochastic model has been chosen to trail the agribusiness operational connections. The aim is to investigate how the included parameters induce the overall changes in the chain. To understand the location of each node, optimization is of core play in explaining the dynamics over and through the network, as displayed in **Figure 1** below.

In this research, both qualitative and quantitative techniques are exploited because of an additional need to understand the relationship between variables when both methods are invoked. The study departs from the "what" that focuses on the quantification of the aspects under inquiry to the "how" and "why" for more comprehensions and to highlight differences and variety within the flow of agricultural operations.

Referring to the purpose of the study, the analysed data are drawn from various sources, primary data are gathered through the questionnaires filled in during the field visits to farmers' households. The quantitative data are of great privilege, collected in using a questionnaire with key questions as the focus and a set of particular questions tailored to serve as support to the principal ones, and this through a monitored interview. Apart from that observation, secondary



Source: Author.

Figure 1. Conceptual framework of agribusiness operations.

data, from reports, books, and scientific articles, contributed a lot to shed more light into the field observation for a clear understanding of this concept in times and ways much more informative.

The study used a questionnaire that was split into 2 sections: one for farmers and another one for buyers. The questionnaire was designed to capture the needed information via quantitative variable and one qualitative variable that engaged more on future perceptions and expectations in this area of rice agribusiness.

The participants in the study are the rice farmers, gathered in cooperatives, and present at the sites of work and engaged in different times to abide with measures to fight against Covid-19. These participants have different demographic aspects and are objective and independent in the way they interact in the course of interviews. Doing a stochastic analysis should mean the researcher goes beyond the set of static limits of the district to capture the entirety of the matter. However, a large number of populations in agricultural activities with limited possibilities in time (effects of Covid-19 that require medical precautions), of the study led to a Cochran's sampling in the sectors of the district where the study has to be conducted. The working age farmers in the Eastern Province (where Gatsibo District is located) is 1,106,000 as per the recent results published by the National Institute of Statistics of Rwanda (NISR, 2018). According to EICV4, 77.3% of Gatsibo District population are employed by agriculture sector including the wage farm (13.6%) and independent farmers (63.7%). Weighing this wage farming percentage to the basket contribution of rice in Gatsibo of 4.07% to a total population of 433,997, we end up finding the ad-

dressable target would be 2402 rice farmers.

The formula would be as below:

$$n \geq \frac{NS^2}{N\delta^2 / z_{\alpha/2}^2 + S^2}$$

$$n \geq \frac{2402 * (0.1 * 0.9)^2}{2402 * \frac{0.05^2}{1.96^2} + 0.09^2} \geq 141$$

Thus, with an acceptable margin error of 5% and the confidence level of 95% (with a response distribution of 90%), the sample size from the 2 sectors (Murambi and Rugarama) would be 142 farmers split equally between the 2 sectors now that they have the same population characteristics (71 in Murambi and 71 in Rugarama).

Stochastic Model Specification

Model specification for state space models is a difficult task as one has to decide which components to include in the model and to specify whether these components are fixed or time-varying. To this cause, a fixed model that analyses the time-responsiveness was chosen to optimize the benefits in the shortest schedule to catch up with the advancements of the multifaceted development (Agriculture-Manufacturing-ICT-Services).

The intention to use this estimation technique is to study the time it takes from one node to supply to another and vice versa and its impact on the behaviours for both engaged parties. This helps to know how the agriculture operations may be driven to see a quick change in the livelihoods of both farmers and consumers.

The concern at stake is now than ever before to understand how the financial flows within time constraints optimize the production/consumption levels of the two partners in this reduced model (farmers and consumers). The intent is to consider a supply chain with two (2) nodes (operations). And the goal is to explain this connectivity with the intention of maximizing the profit in an equilibrium competitive market. To ease the understanding and analysis, we consider that, at some points of ceteris paribus, node *Farmer (Field production)* establishes a relationship with node *Consumer* in terms of product supply and receives income in return.

Each node represents the corresponding reaction time (in terms of the time it takes to respond to each other's request) X_i, $i = 1, 2$, according to our framework, and the arrows stand for financial operations movements through the delivery time at a particular node. This induces the production distribution to be the function of delivery time. The financial security is explained as the total income applied to each category of responded and the time variable is set as times in a month it takes to supply or demand the rice from the market and the quantities that supplied or bought from the market.

If we denote the production by Y_i, the differential of financial security by O_i, and the time exponential by C_i, then our model will be:

$$Y_i = (O_i)C_i$$

This implies that:

$$O_i = \frac{df(X_i)}{df(t_i)},$$

where X_i is the production or consumption at each node and t_i is the velocity expressed in time between nodes.

$C_i = e^{S_i}$, where S_i represents the production time or consumption time at X_i.

The complexity of the interrelated variables of the delivery of agricultural operations and their reciprocity requires the use of Optimization as a clear test that looks into all simulations between and internodes.

Of course, the null hypotheses as drawn from the objectives of the study necessitate some descriptive facts to show the tendency of the observed data and give certain insights on agricultural optimization in regions of interest. A used Markov test is intended to ascertain the statistical significance since it portrays how, in a chain that has both entry and exit points, every path that begins from the start state and ends at the same start can show both the common and uncommon paths in the chain and tries to leave a fit that is covering the whole chain in a higher confidence level.

The collected primary data was entered into SPSS for conversion and analysis. Both SPSS and E-views were used for data analysis. This was after the cleaning process to minimize the errors, ensure credibility, and relevance, and allow inference on the substantial portion of the population agricultural operations.

4. Data Presentation and Interpretations

Since the understanding of the hypotheses requires deeper knowledge about the studied variables, it is of core essence to depart from the empirical analysis and discuss the magnitude of the question under investigation based on the evidence portrayed in this chapter.

The analytics combine all aspects of the variables to be able to explain any correlation or significance of not only the model but the explanatory variables as a whole.

4.1. Demographic and Socio-Economic Characteristics of the Respondents

Any analysis of the below Table 1 factors leaves a picture of the respondents when it comes to their socio-economic stands and guides in further understanding of their behaviour through the agribusiness processes.

4.1.1. Gender Disparity among the Respondents

The gender composition of each category of respondents is in no way dependent to each other as per the results of the chi square test of 0.631 with an Asymptotic

Table 1. Cross table of the demographic variables per respondents' category.

Variables	Categories	Category of Respondent (Farmer)	Category of Respondent (Consumer)	Total
Gender of respondent	Male	36 (54%)	30 (46%)	66
	Female	36 (47%)	40 (53%)	76
Level Of Education	No education	22 (61%)	14 (39%)	36
	Primary	26 (63%)	15 (37%)	41
	Secondary Senior	12 (52%)	11 (48%)	23
	Secondary Complete	4 (18%)	20 (82%)	24
	University	7 (41%)	11 (59%)	18
Ubudehe Household Classes	A & B: Self-reliant	24 (46%)	28 (54%)	52
	C & D: Self-reliant but benefit from Social Protection	31 (48%)	34 (52%)	65
	E: Very poor	16 (65%)	9 (35%)	25

Source: Data Analysis.

Significance (2-sided) of 0.427. The result would be significant if this value were equal to or less than the designated alpha level (normally 0.05). In this case, the *p*-value is greater than the standard alpha value, so we fail to reject the null hypothesis that asserts the two variables are independent of each other.

To put it simply, the result is not significant—the data suggests that the variables Category of Respondents and Gender are not associated with each other.

4.1.2. Relationship between Socio-Economic Variables and the Category of Respondents

For the sake of understanding the relationship or difference, if any, between our socio-economic variables with the category of respondents, the results show no significance for Ubudehe Household Classes, but they tell us that there is an association between the level of education with the category of respondents (*p*-value is greater than the standard alpha value (0.009 is less than 0.05). This pushes the researcher to draw independence on Ubudehe Household Classes but failing to reject the fact that education is associated to categories of respondents where the most educated tend to be consumers than farmers.

Though some of the socio-economic variables are independent between the two categories and others associated, the average total income they make seems to be that different as per the results of the ANOVA test that puts Sig. values (0.000) of both Education Levels and Ubudehe Household Classes below the alpha value (0.05) in Table 2(a) and Table 2(b). Statistically speaking, the 2 categories of respondents (farmers and consumers) do not have same total income per month.

The outputs of the ANOVA analysis between our group means give the significance values of 0.000 (i.e., $p = 0.000$) for both Education Levels and Ubudehe

Table 2. Chi-Square Tests of Education and Ubudehe Household Classes against the Category of Respondents. (a) Chi-Square Tests (Education * Category of Respondents); (b) Chi-Square Tests (Ubudehe Household Classes * Category of Respondents).

(a)

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	13.596[a]	4	0.009
Likelihood Ratio	14.368	4	0.006
N of Valid Cases	142		

[a]0 cells (0.0%) have expected count less than 5. The minimum expected count is 8.44. Source: Data Analysis.

(b)

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.523[a]	2	0.283
Likelihood Ratio	2.557	2	0.278
N of Valid Cases	142		

[a]0 cells (0.0%) have expected count less than 5. The minimum expected count is 11.41. Source: Data Analysis.

Household Classes, which is below 0.05. and, therefore, there is a statistically significant difference in the mean income between the two categories.

Deepening the accepting of the drivers of this same mean total income for the 2 nodes, major highlights top up the study suggesting that there are key variables that would have turned this aspect down (agriculture income for farmers and salary income for consumers) because their *p*-values are below the alpha value (0.05), but husbandry income, business income, remittances, property rent income and other incomes pushed the total average to be significantly the same. This says a lot about these 2 nodes. Their significant differences reside in their main activities (rice agriculture for farmers and services for consumers).

4.2. Specific Drivers of Rice Farmers Behaviours

The average spent of 79 thousand Rwandan Francs per season with 36.3% on labour, 15.1% on inputs, 13.6% on transport and 12.1% on information sharing show much devotement is placed into this activity. A revamp is realized when one looks into the way transport and information sharing are coming in at the same pace, which was not the case in the previous years. However, though the above show how many farmers are involved in utilisation of the available funds for the growth of their farming activities, the average mean spent on advertisement (126 thousand Rwanda Francs) is way higher, showing a shift to marketing and commercialisation of the output.

The decentralised agriculture revolution is in most cases enabled by different factors. Banks contribute 27% and agriculture income (24%), along with dona-

tions/gifts/subsidies and salaries that bring 18% each as this support is channelled through cooperatives by different agents or stakeholders (NGOs and Government) as shown in Figure 2.

This said, 71.4% of the rice farmers who agreed to be selling their produce to the market, are motivated by the fact that the clientele is sufficient (85.7%) and the consistent availability of the produce to sell/no penury (78.6%). The 50% of the produce that goes directly to retailers and wholesalers indicates the new way the local markets are growing with a need to model their interoperability and future interactions.

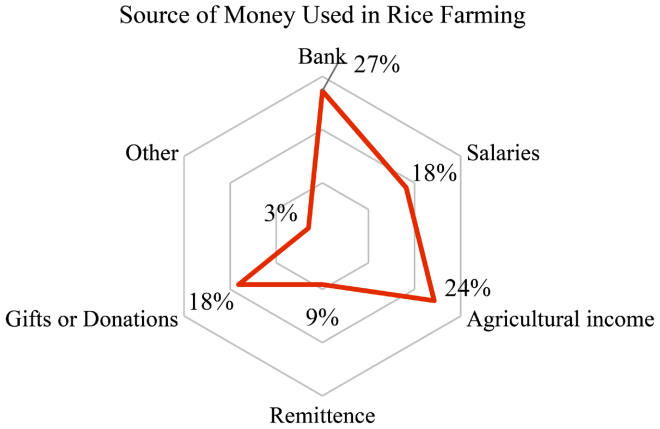
Land ownership, desire for value addition and marketing of the produce are not standing to explain the reason why this farmer or that farmer would be qualifies as poor or rich, rather the aspiration to see a general reversal into the whole processes of agriculture operations. The farmers dictate a compiled and reduced view of the operations to quicken the production, marketing, and market expansion. They believe that information sharing is of a greater role and want it to be driven by the new technologies as phone and internet top the list on the means they use when sharing agricultural information (54.8%).

4.3. A View on the Consumers Performances

The rice consumers who spend on average 5 days working agree to have enough supply when they go to purchase their rice consumption on the market (87.1%). However, they agree that the price keep increasing over time resulting in the rise of the cost when it comes to searching for the new markets (25.8%) and transport (25.8%).

The relief is drawn from the loans they get from the banks (45.2%) and push for the cooperation with the farmers' cooperatives to minimize the cost and get the required demand around (29%).

The local consultancy opened a much collaboration with different agents for the consumers to be protected and informed about the market trends going all the way to secure their demand through retailers/wholesalers (45.1%), markets



Source: Author.

Figure 2. Source of Money used in rice agriculture.

(25.8%) and information sharers (9.7%).

The digital era was not left behind now that 45.1% of the information consumers share is either via internet or mobile phone and it is mainly shared with cooperative (51.6%) in the continuous exercise of creating harmony between the 2 nodes.

The value-for-money thinking is perceived as a key element of the consumers' behaviours. It is mostly driven by the expectation to have organic produce (19.4%), the improvement in the milling processes to have quality product (19.4%), the diversification of the production systems from warehousing point of view to the embrace of new technologies with a clear intervention of framer-consumer partnership frameworks.

4.4. Model Details and Explanation

The 2 essentials nodes of the model would be easily explained when one looks into the convertibility of each node into other node's requirements or needs to keep operating. Any model would not fit this if the probabilities to switch to this or that is not clearly set and explained through a series of intervening elements.

Over the time, the rural interactions in developing world have not been easily differentiated when it comes to professions or income generating activities. This is well put by the correlational aspects of the income from different activities between several segments of the rural communities.

The agricultural operations in rice agribusiness, as minimised as to the 2 stakeholders—farmers and consumers—request a deeper take on which probability it may take to see the supply turning into demand and what it takes to drive the other side of the chain.

The model in Table 3 below portrays the probabilities as per the 2 regimes – 1 being farmers and 2 being consumers.

The equation specification consists of a two-state Markov switching model with 2 switching mean regressors—times in a month it takes to supply or demand the rice from the market and the quantities that supplied or bought from the market.

The coefficients show a multiplicative effect of the variables in the model (total income into times it takes to supply or press a demand of rice in the market). This effect tends to shift by almost a unit into Regime 2 when one wants to understand jump into the level of operations as time goes on.

A clear effect is portrayed by the parameters in the Transition Matix that show a clear tendency when it comes to taking decisions about increase or decrease either demand from consumers or supply from farmers.

The above model, through the transition of matrix parameters, says that an increase in the revenue of farmers would keep them being active and investing in rice agriculture. Whereas this increase in income for consumers over time would reduce their interest in agribusiness, hence decreasing their chance for transferring into farmers though there is a boost in the demand for rice. This is also understood as the response of the consumers by increasing their demand or push

Table 3. Estimation output of the Markov chain model for the quantity supplied or demanded.

Dependent Variable: Category of Respondents Method: Markov Switching Regression (BFGS/Marquardt steps) Included observations: 142 Number of states: 2				
Variable	**Coefficient**	**Std. Error**	**z-Statistic**	**Prob.**
Regime 1				
TOTAL_INCOME	1.38E−06	6.48E−07	2.127850	0.0333
TIME_SUPPLY_BUY	0.156404	0.027811	5.623917	0.0000
Regime 2				
TOTAL_INCOME	3.41E−06	5.71E−07	5.979136	0.0000
TIME_SUPPLY_BUY	0.780970	0.075108	10.39795	0.0000
Common				
LOG(SIGMA)	−0.518908	0.066198	−7.838682	0.0000
Transition Matrix Parameters				
P11-C	3.215378*	0.651085	4.938495	0.0000
P21-C	−3.186289	0.638353	−4.991429	0.0000
Mean dependent var	1.496183	S.D. dependent var		0.501905
S.E. of regression	0.787553	Sum squared resid		78.15025
Durbin-Watson stat	1.925111	Log likelihood		−137.4576
Akaike info criterion	2.205460	Schwarz criterion		2.359096
Hannan-Quinn criter.	2.267889			

Note: Output of EViews on the Estimation Model. Source: Data Analysis.

more of rice agribusiness smooth operations through various investments). The increase in income (financial security) of either party is not by its own a driving force to quicken the transactions.

With the probabilities in Table 4 below, it becomes clear that there is no significant willingness of either category to switch (the farmers to increase their supply to consumers and consumers to boost their demand) neither keep themselves busy in their farming activities.

This is an indication that the driving force in the chain is the demand force with a combined power from exogenous factors, not the desire to transfer or adopt each other's standards or activity. No change is expected if the market forces are not fully regulated because farmers have self-sufficiency, and it is the reason they are not likely to change into consumers; they already consume a portion of their produce; and consumers ignore the dynamics of the market other than enough supply of the rice they meet at the market.

Comparing the finding to the models in the literature review, it is obvious that

Table 4. Summary for the transition results for the Markov switching probabilities.

Equation: Markov switching probabilities Transition summary: Constant Markov transition probabilities and expected durations Sample: 1 142 Included observations: 142		
Constant transition probabilities: P(i, k) = P(s(t) = k | s(t − 1) = i) (row = i/column = k)		
	1	2
1	0.961409	0.038591
2	0.039685	0.960315
Constant expected durations:		
	1	2
	25.91270	25.19846

Note: Output of EViews on the Summary of Markov switching probabilities. Source: Data Analysis.

neither model serves as stand-alone point. Given that the velocity to turn into either node exist not as an intrinsic will, but a push from other market forces. To drive a sustainable rice market requires an integration of exogenous factors expressed into the time responsiveness of any event in the model, for the sake of an equilibrium in terms of price and production dynamics.

4.5. Discussion of the Obtained Results

Rice agribusiness operations have been the central tendency that all the variables and analyses moved around to identify the contribution they may have on the livelihoods of formers and consumers as the main players in the supply chain. The findings show that the gender is not a determinant or differentiator to being involved in agribusiness, everyone gets attracted, especially in market-oriented agriculture, regardless of their gender. The socio-economic aspects, however, penlight the difference when it comes to the livelihoods of rural inhabitants where the most educated turn to services as revenue generating activities. This, though, does not explain the reason why the household classes are not a differentiator. A reason for the local government to review and update them consistently.

In this era of financial influx and easy information sharing, the farmers' behaviours are not likely to change, at least in short term. The contribution of several partners in the production processes lacks the push from the market side to drive or coordinate the operations that may trigger the backward lead.

The stochastic model identifies that the 2 main drivers of rice agribusiness, farmers and consumers, are not likely to act in favour or time responsiveness and financial abilities to drive and increase the flow of the transactions between them. There is a need to regulate this market on both supply and demand side, the latter being a priority. This is highlighted as including other nodes in the

supply chain that play a big role on the market needs such as quality, price and timely availability of the produce.

5. General Conclusion and Recommendations

This study took on modelling the stochastic agribusiness supply chain between the two (2) key nodes: farmers and consumers. The intention was to look into what drives the production or consumption given the times and the financial means of the two segments when it comes to rice agriculture. The analysis focused on 2 sectors: Rugarama and Murambi of Gatsibo District. They were selected as they might present a certain meaningful sample. A stochastic model was developed to ascertain of the probability of switching from one node to another vis the pipeline of revenue and times it takes to supply or demand per month per each category of respondents. The conclusion and recommendation are hereby synthesized according to the hypotheses of the research.

The rural agriculture operations consider differences in the current market structure. This means the study investigates whether the financial viability of the farmers is responding to the current requirements of the competitive market. It is easeful to think that the access to finance is not a drive for more supply as shown in the model of probabilities. Rather, the demand, whether from direct consumers of retailers/wholesalers would push for a significant switch.

The characteristics of the supply-demand law imply the decentralized global investment in order to reach efficiency gain. In a market that is driven by the demand, creating a consistent demand through market expansion and/or value addition would not only cut the raising costs on consumer side but also trigger the regular production. The mentioned activities require huge investments that will see local milling and factories built, regional agriculture consolidation implemented, strong Farmer-Consumer Partnerships cemented and moreover, the additional operations in the model smoothed.

The level of information sharing is enough to speed up agricultural transactions. Looking into the 2 categories of respondents, there is a common trend in embracing communication as a way to operationalize their activities. But there is a divide on the digital where the consumers consume and share more of the digital news/online content.

This can be seen as a good start as the information is directly shared with the farmers' cooperatives in the process of building strong ties with the supply side. It is thought of creating an easy uptake and raise expectations that will remove the divide in the near future and set sustainable trends in both supply and demand.

Based on the findings of this study, the following recommendations were proposed: 1) Government intervention to strengthen and sustain the rice market (supply and demand forces), local and regional, for rice farmers. 2) Consistent exposure to new technologies in rice agriculture throughout all the processes to respond to the current and future demands in quality and quantity. 3) Clear commercialization of the rice production with the involvement of other stake-

holders to invest not only in storage but also in other infrastructures and innovations like local rice mills, roads, ICT services and decentralized financial services. Bundling financial support to market education on the diverse opportunities linked to rice agriculture for individuals and communities. 4) Researchers need to incorporate more additional nodes/operations in the model to grasp a set of extended realities around this growing value channel and its impact on the economy.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

References

Alexander, M. K., Froukje, K., Steven, M. C., Malcolm, C. M. B., Claire, D., Chadag, V.M., Sharon, S., Manjurul, K., Oai, L.C., Michael, J. P., William, D., Fred, W., Sven, G., Nhuong, T., Wayne, R., & David, C. L. (2020). *A Review of Inclusive Business Models and their Application in Aquaculture Development* (p. 3). University of Stirling.

Baijou, A. (1990). *A Stochastic Agricultural Price Analysis Model of the Moroccan Agricultural Sector*. Doctoral Thesis, Oklahoma State University.

Benita, M. B. (1998). Supply Chain Design and Analysis: Models and Methods. *International Journal of Production Economics, 55,* 281-294. https://doi.org/10.1016/S0925-5273(98)00079-6

Brooks, S., Gelman, A., Jones, G., & Meng, X.-L. (2011). *Handbooks of Modern Statistical Methods: Handbook of Markov Chain Monte Carlo*. CRC Press.

FAO (2015). *Inclusive Business Models—Guidelines for Improving Linkages between Producer Groups and Buyers of Agricultural Produce*. By Kelly S., Vergara N. & Bammann H. Rome, Italy.

Jan van R., Sabine W., & Dave M. B. (2002). *Agri-Supply Chain Management: To Stimulate Cross-Border Trade in Developing Countries and Emerging Economies*. World Bank.

Jang, W., & Klein, C. M. (2001). *Supply Chain Models for Small Agricultural Enterprises*. Department of Industrial and Manufacturing Systems Engineering, University of Missouri Columbia.

Jason, G. (2021, July 1). Structure Conduct Performance Models—Explained. *The Business Professor*. https://thebusinessprofessor.com/lesson/structure-conduct-performance-model-definition/

John, W. M. (2017). *Agricultural Development and Economic Transformation; Promoting Growth with Poverty Reduction*. Palgrave Studies in Agricultural Economics and Food Policy.

Judit, K. K. (2007). *Agri-Environmental Management and Rural Development: Hungary after EU Accession* (p. 36). Faculty of Agricultural Economics and Rural Development, University of Debrecen, Agroinform Publishing House.

Kelly, S., Vergara, N., & Bammann, H. (2015). *Inclusive Business Models—Guidelines for Improving Linkages between Producer Groups and Buyers of Agricultural Produce*. Food and Agriculture Organization of the United Nations.

Kwamina, E. B., Nam, C. N., & Ockie, J. H. B. (2016). *Systemic Approach to Examine the*

Structure, Conduct and Performance Model of Agriculture in Africa, Evidence from Ghana (p. 5). Business School, The University of Adelaide.

Martin, W., & Patrick, L. (2009). *Using Value Chain Approaches in Agribusiness and Agriculture in Sub-Saharan Africa: A Methodological Guide. Tools that make value chains work: discussion and cases*. The World Bank

Michelson, H. C. (2020). *Innovative Business Models for Small Farmer Inclusion. Background paper for The State of Agricultural Commodity Markets (SOCO) 2020*. Food and Agriculture Organization of the United Nations.

NEPAD (New Partnership for Africa's Development) (2013). *Report on Agriculture in Africa, Transformation, and Outlook*. New Partnership for Africa's Development.

NISR (National Institute of Statistics Rwanda) (2018). *EICV5 Main Indicators Report: The Fifth Integrated Household Living Conditions Survey 2016/17*. National Institute of Statistics Rwanda.

Pradeep, K. M., & Anjani, S. (2010). *Supply Chain Management of Agricultural Commodities through Electronic Spot Exchanges*. SCM of Agricultural Commodities through NSEL.

Sertoğlu, K., Sevin, U., & Festus, V.B. (2017). The Contribution of Agricultural Sector on Economic Growth of Nigeria. *International Journal of Economics and Financial Issues, 7,* 547-552.

Steven, J., Paul, S., & Colin, A. (2010). *Rapid Agricultural Supply Chain Risk Assessment: A Conceptual Framework*. The World Bank

Vorley, B., Lundy, M., & MacGregor, J. (2008). Business Models That Are Inclusive of Small Farmers. In *FAO and UNIDO as Background to the Global Agro-Industries Forum*. Food and Agriculture Organization of the United Nations/Centre for Agriculture and Bioscience International.

William, W. (2010). *Farming, Financing, and the Global Marketplace: Evolving Agricultural Supply Chains*.