

## Article

# Intervention Options for Enhancing Smallholder Compliance with Regulatory and Market Standards for High-Value Fruits and Vegetables in Rwanda and Zambia

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**Citation:** Akiri, M.; Mbugua, F.; Njunge, R.; Agwanda, C.; Gurmesssa, N.E.; Phiri, N.A.; Musebe, R.; Kalisa, J.P.; Uzayisenga, B.; Kansiime, M.K.; et al. Intervention Options for Enhancing Smallholder Compliance with Regulatory and Market Standards for High-Value Fruits and Vegetables in Rwanda and Zambia. *Sustainability* **2024**, *16*, 6243. <https://doi.org/10.3390/su16146243>

Academic Editors: Gang Liang, Wenshen Jia and Rui Feng

Received: 2 June 2024

Revised: 10 July 2024

Accepted: 13 July 2024

Published: 22 July 2024



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**Abstract:** Agriculture is vital for economic growth in sub-Saharan Africa. In Rwanda and Zambia, the sector drives economic output, particularly the horticulture sector, which has emerged as a significant contributor to export revenue and employment for resource-poor rural communities. As agri-food value chains become globally connected, there are increasing concerns about food safety and both the social and environmental sustainability benefits of production, which has underscored the need for producers to comply with certain regulatory standards. This paper uses a value chain analysis approach to assess the factors influencing compliance among smallholder fresh fruit and vegetable (FFV) producers in Zambia and Rwanda, and identify practices essential for achieving widespread compliance, to enhance the competitiveness of the sector. The data were gathered from 340 FFV farmers and key informants using structured questionnaires. The results reveal that the value chains for target FFVs are still traditional, predominantly targeting local markets. These markets pose low barriers to entry for smallholders, and often with few safety and quality requirements. As such, there remains a paucity of understanding of market needs and regarding quality and safety standards amongst smallholders, which, coupled with low-input, low-technology farming methods, and inadequate pre- and post-harvest handling, limit the market potential. To bridge these gaps, this study recommends organising farmers into legally recognised entities, to enable access to compliance information, reduce transaction costs, and provide access to high-quality niche markets through public-private partnerships. Countries also need to develop industry codes of practice and quality management systems and support farmers to adhere to them.

**Keywords:** compliance; high-value fruits and vegetables; market standards; sustainability; sanitary and phytosanitary; Rwanda; Zambia

## 1. Introduction

Agriculture stands as the cornerstone of economic growth across sub-Saharan Africa, employing over 52% of the labour force within the region [1]. In Rwanda and Zambia specifically, this sector serves as a pivotal driver of both employment and economic output, with 52% and 59% of their respective labour forces engaged in agricultural activities [2]. In Rwanda, agriculture has demonstrated remarkable consistency in terms of growth, boasting an annual average rate of 5% since 2007, contributing significantly to the national GDP at 25% and serving as a crucial source of foreign exchange, responsible for 37% of the country's

export value in the 2021–2022 fiscal year [3,4]. Notably, the horticultural sub-sector has emerged as a significant contributor to export revenue and employment opportunities for resource-poor rural communities, with vegetable exports alone constituting 57.5% of total agricultural export earnings in 2018–2019 [4]. Conversely, Zambia has witnessed a decline in the agricultural sector's contribution to GDP, dropping from 15.6% in 2004 to a mere 2.73% in 2020 [5]. Despite this, agriculture remains a primary source of livelihood for the majority of the rural population [6], with increasing momentum observed in the horticultural sub-sector. This growth is evidenced by a substantial increase in the production of fresh vegetables, rising from 218,581 tonnes in 2001 to an estimated 368,003 tonnes by 2020 [7].

The rise in demand for fresh horticulture products in both domestic and international markets, particularly in wealthy countries such as the European Union, has led to a rise in interest among national governments and development agencies in developing countries in supporting traders and producers of horticultural products to access these markets because of higher price premiums [8]. Upgrading markets and increasing the commercialisation of horticultural production can enhance farmers' income and spur economic development in rural areas. However, the growth in global trade has increased concerns regarding food safety and quality and the social and environmental sustainability benefits of agricultural production, particularly regarding the production of fresh horticultural produce [9,10]. This imperative extends to addressing demands concerning sanitary and phytosanitary (SPS) aspects, the reduction of risks associated with the use of agricultural inputs (pesticides and fertilisers), public food safety requirements, traceability, workers' safety, and farm management practices, as outlined in private and voluntary standards, such as global good agricultural practices (GlobalGAPs), organic certification, Fairtrade International, and the Rainforest Alliance, among others [10–13]. In both Rwanda and Zambia, the presence of notifiable pests in exported fresh fruits and vegetables (FFVs) above maximum acceptable levels are frequently observed ([https://food.ec.europa.eu/plants/plant-health-and-biosecurity/europhyt\\_en](https://food.ec.europa.eu/plants/plant-health-and-biosecurity/europhyt_en) (accessed on 1 June 2024)), particularly in FFVs from Rwanda. This is a risk to sustainable access to export markets and should be remedied through enhanced compliance with regulatory standards at the production level.

While compliance with standards offers benefits to producers and economies [14,15], smallholder implementation of these standards is affected by multiple factors, which influence their decision to comply. Some studies have reported demographic characteristics, such as the age of the farmer, education level, resource endowment, and membership in farmer organisations, as key factors that influence farmers' decisions to comply with standards [16,17]. Other reported factors include institutional support, infrastructure, and the knowledge level and attitude of producers. Such widespread low compliance with quality and technical requirements by smallholders limits the export potential of FFVs and the competitiveness of the sector [12].

Considering that smallholder farming is the dominant form of agriculture in Zambia and Rwanda, exploring the compliance of small-scale FFV farmers with standards is valuable, especially considering the limited literature on this topic in these target countries. This study aims to fill this gap by identifying factors and practices essential for achieving widespread compliance among smallholder producers of FFVs in Rwanda and Zambia. Investigating smallholder compliance can uncover critical gaps and barriers and provide targeted recommendations for improvement.

This study is justified by the urgent need to improve food safety, market accessibility, and competitiveness for smallholder FFV producers. Smallholder farmers' adherence to food safety standards is crucial for protecting consumer health and gaining market trust, as compliance reduces the risk of contamination and foodborne illnesses. Additionally, smallholder farmers often face significant barriers to entering high-value markets due to stringent regulatory and market standards. Identifying and implementing effective interventions can help these farmers meet the necessary standards, thereby opening up new market opportunities for them and leading to greater economic opportunities. Furthermore, improving compliance with standards supports sustainable agricultural practices,

contributing to the broader goals of environmental sustainability and resilience in the face of market and climate challenges. Additionally, this research offers practical insights and customised recommendations that are unique to the environments in Zambia and Rwanda. The findings will provide valuable insights for policymakers in Zambia and Rwanda, aiding in the development of potential reforms and long-term advisory programmes to support small-scale farmers in adhering to production and market standards.

## 2. Conceptual and Empirical Methods

### 2.1. Value Chain Analysis Framework

This study used a value chain analysis (VCA) framework to analyse the activities involved in delivering FFVs to various consumer markets, and smallholder compliance with regulatory and market standards for FFVs in Zambia and Rwanda, based on both secondary and primary data sources. The underpinning principle in the study was to assess the actors, connections, opportunities, and challenges relating to quantity, on-time deliveries, adherence to standards, and comparative marketing, under different scenarios of GAPs.

Value chain analysis was employed as it enables the systemic assessment of the structure of the value chain, including transactions between firms and value-adding activities of a product from production to sale in the final market, whether local, national, regional, or global [18]. The framework also assesses the dynamics in the value chain, including the role, behaviour, and relationships amongst smallholder farmers, input suppliers, processors, transporters, support services, regulatory institutions, and consumers [19,20]. This analytical perspective is essential for identifying factors influencing smallholder decision-making throughout production and marketing processes. In the case of smallholder compliance with standards, high transaction costs have been mentioned as significantly impacting smallholders' decisions regarding standards adoption [21]. Kassem [12] summarised the main factors influencing smallholder compliance decisions as: personal and economic barriers, awareness and information barriers, institutional-support barriers, and infrastructure barriers.

Value chains operate in a business environment, which can be global, national, or local, that is defined by certain norms, laws, regulations, policies, international trade agreements, and public infrastructure. VCA analysis further looks at these and whether and how the business environment facilitates or hinders the performance of the value chain, identifying areas for improvement [22]. Furthermore, the framework acknowledges the sector-specific characteristics of agricultural value chains, necessitating tailored interventions that fit the unique contexts of the study countries.

This approach helped deepen our understanding of value chain dynamics for the target FFVs in the study countries and guided the formulation of intervention options to enhance smallholder compliance with standards and improve competitiveness in high-value FFV sectors.

### 2.2. Empirical Methods

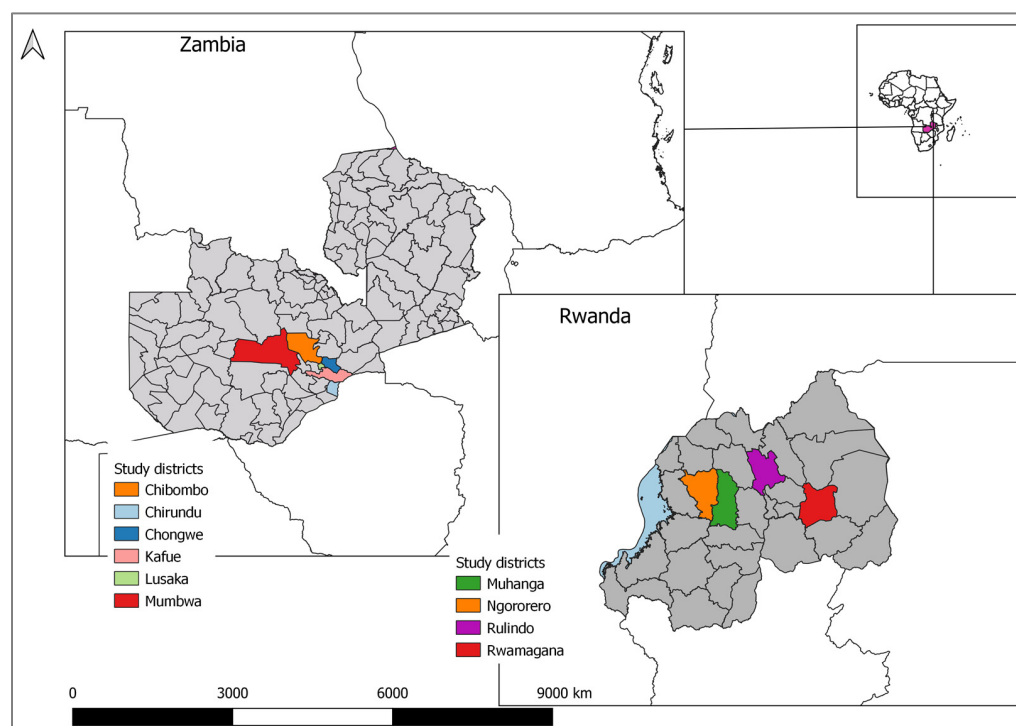
#### 2.2.1. Desk Study

A desktop study was undertaken to provide an in-depth understanding of the existing knowledge and research regarding the compliance of FFV production systems with market and regulatory standards. This involved conducting a thorough examination and analysis of existing peer-reviewed articles and reports, using the Google® scholar search engine, and official industry websites to access other published industry documents and project reports related to market and regulatory standards for FFV horticultural value chains in Rwanda and Zambia. The desk study provided baseline information necessary to identify the key horticultural crops that are imported into Rwanda/Zambia for local, regional, and international markets. It also provided information on existing initiatives regarding the target crops being studied, particularly concerning compliance with standards. Additionally, the desk study provided a transparent view of the target value chains as currently organised, in-

dications of the market compliance requirements, the base practices within the value chains, and the missing link to full compliance with the market and regulatory requirements.

### 2.2.2. Study Area and Value Chains Covered

The study was conducted between November 2020 and January 2021 and covered four districts in Rwanda, namely, Rulindo (Northern Province), Muhanga (Southern Province), Rwamagana (Eastern Province), and Ngororero (Western Province), and six districts in Zambia, namely Chongwe, Chibombo, Lusaka, Kafue, Mumbwa, and Chirundu (Figure 1). These districts were purposively selected from sites where the majority of the target crops were produced. The analysis focused on the local FFV value chains and covered avocados, French beans, fruit banana, hot pepper, and tomatoes, in the case of Rwanda, and avocado, banana, fine beans, rape, tomatoes, and watermelon, in the case of Zambia. Fresh fruits and vegetables are particularly susceptible to contamination, due to their often raw consumption and minimal processing, posing serious public health risks if safety standards are not rigorously adhered to.



**Figure 1.** Map showing study areas (courtesy: Makale, CABI).

The selection of the target crops is driven by several key factors. Avocados are chosen for their agroecological suitability, economic potential, nutritional benefits, and the growing local and international demand, making them a high-value crop. Fruit bananas are a staple crop in Rwanda and Zambia, essential for both food security and income generation. Tomatoes are an essential vegetable, widely consumed in the two study countries. Their significant potential for value addition through processing into sauces and pastes makes them a crucial crop in the local value chain.

In Rwanda, the additional selection of French beans, hot pepper, and pineapple is based on their command of high prices in both local and international markets, and the potential to generate substantial income for smallholder farmers. French beans have strong export potential, especially to European markets. In Zambia, the additional selection of fine beans, rape, and watermelon is similarly well-grounded in economic and market considerations. Fine beans, like French beans in Rwanda, are a valuable export crop, especially to European markets, offering high economic returns per unit area and benefiting smallholder farmers significantly. Rape is selected for its nutritional value, as a leafy

vegetable rich in vitamins and minerals. It enjoys high local demand, making it a reliable crop for farmers. Lastly, watermelon is selected for its popularity and growing consumer demand, which has made it a viable crop for Zambian farmers.

### 2.2.3. Development and Validation of Data Collection Tools

The development of the data collection tools was a consultative process, undertaken by the research team from CABI, RAB, and consultants. The development of the tools was grounded in a solid theoretical framework derived from an extensive literature review on FFV farming practices, market dynamics, regulatory compliance, and challenges within the relevant value chains. The designed tools were shared with industry thought leaders and relevant government entities for validation, before finalising. Comments from these partners were taken into consideration, and efforts were made to harmonise sections of the tools to align them with current industry practices and theoretical underpinnings.

Before full deployment, the tools were pretested [23] through mock interviews with 11 respondents in Zambia and 15 in Rwanda, from different segments of the value chain, to assess the clarity, comprehensiveness, and relevance of the questions. Further, descriptive statistics (mean, standard deviation, variance, and range) were employed to examine the general distribution of the data, providing insights into the characteristics of the data collected and confirming the construct validity. Following the pretesting, adjustments were made to the questionnaire, and a version was developed that was used for training enumerators. This version also formed the basis of the electronic questionnaire, designed using the Open Data Kit (ODK) data collection application.

This was followed by a recap to raise and discuss all the issues observed during the pretest. The team of researchers discussed all the additional issues observed during training and piloting, and developed a final version of the questionnaire that was to be used for data collection. The electronic questionnaire was also updated to reflect the final paper version. However, for Rwanda, the data were collected using paper questionnaires, and an ODK template was employed for capturing this data via the Enketo web platform.

### 2.2.4. Sampling and Data Collection Procedures

Multi-stage sampling methods were used to identify the survey districts and sampling units. The farmers that participated in the interviews were selected using a simple random sampling technique for better representativeness [24]. The overall total sample interviewed was 340 farmers, with 180 farmers in Rwanda and 160 in Zambia (Table 1). To maintain a manageable number of information sources without compromising on representativeness [25], purposive sampling was used to identify key informants among the respective value chain players and to determine the districts in which the study was conducted. Key informant identification was based on the target respondent's professional and working knowledge of the value chains, their willingness to share information, and representation of the various actor categories. Participation in the survey was voluntary and informed consent was obtained from respondents before the start of the interview.

The categories of value chain players covered during the field surveys included farmers, marketing agents, supermarket chains, service providers, competent authorities, and supporting regulatory bodies. Efforts were made to achieve adequate proportional representation of various gender categories. Based on our sampling criteria, the sample size is considered adequate for providing credible information for the study, cutting across various agroecological zones, various target crops, and in regard to the representation of rural and peri-urban farming systems. The farming practices and scales within the given FFV value chains are uniform, and so are the socioeconomic profiles of the producers. The information from the field surveys was also triangulated by key informants within the value chains and supported by an in-depth literature review.



**Table 1.** Distribution of households and individuals sampled in each district by country.

Zambia		Rwanda	
District	Sampled Farmers	District	Sampled Farmers
Chongwe *	4	Rulindo	57
Chibombo	44	Muhanga	48
Lusaka *	5	Rwamagana	61
Kafue	50	Ngororero	14
Mumbwa	27		
Chirundu	30		
Total	160	Total	180

\* Lusaka and Chongwe are peri-urban areas with a very low density of farmers growing the targeted crops, thus small numbers. However, their inclusion was important to understand the value chain structure considering both peri-urban and rural farming communities.

### 2.2.5. Data Collection and Analysis

Structured questionnaires [26] were used to collect data from the selected FFV farmers, complemented by interview guides tailored according to the narrative data and insights from key informants within the agricultural value chain. The data were collected by contracted enumerators. All the enumerators were trained in one location in Kigali and Lusaka in Rwanda and Zambia, respectively, and were sent to collect data in the selected study areas. Field data collection was implemented through face-to-face interviews.

The field surveys were conducted in cooperation with personnel from the Rwanda Agriculture and Animal Resources Development Board (RAB), in the case of Rwanda, and the Ministry of Agriculture and the Zambia Agriculture Research Institute (ZARI), in the case of Zambia. Data were collected on farm characteristics, production practices, production challenges (particularly insect pests and diseases), market requirements, knowledge of existing standards and farmers' ability to comply with them, marketing channels, and market actors.

The survey data were processed, analysed, and organised in tables and charts using Stata 17 and Microsoft Excel 16.0. Descriptive statistics, including frequency counts, percentages, and averages, were used to explain patterns and the general characteristics of each section in the study. Value chain maps were developed to highlight how products flow from raw materials to end markets, and the associated industry functions, market segments, actors, and linkages. Using the value chain framework, the collected data were analysed to reveal constraints within the chain that prevent or limit compliance with standards. This enabled the evaluation of systemic chain-level issues, rather than firm-level problems.

## 3. Results

### 3.1. Socioeconomic Characteristics of the Sampled FFV-Producing Households

The majority of farmers interviewed in both Rwanda and Zambia were male, comprising 71% of the respondents. Men were also the head of most households, being 92% in Rwanda and 79% in Zambia (Table 2). Most of the respondents (79%) were the head of the household, while 17% were the spouse of the head of the household. Nearly all the respondents (91%) practiced farming as their main occupation, while a small amount (9%) had other occupations, including 6% with informal employment and the remainder owning a business. In terms of age category, most respondents were between 35 to 54 years old, with minor variations between the two countries.

In terms of the respondents from Rwanda, 54% of the those that were head of the household were between 35 and 54 years of age, whereas in Zambia, only 50% of the those that were the head of the household belonged to this age bracket. Concerning education, most of those that were the head of the household in Zambia (53%) covered by the study had attained a secondary school level of education and above. In Rwanda, on the other hand, only 27% of those that were head of the household had attained a secondary level of formal education and above.

**Table 2.** Information on the household leadership and the survey respondents.

Characteristic	Variable	Rwanda (%)	Zambia (%)	Overall Sample (%)
Gender of the respondent	Male	78	63	71
	Female	22	38	29
Gender of the HH	Male	92	79	86
	Female	8	21	14
Respondent's relationship to the HH	Head	77	81	79
	Spouse	17	16	17
	Child	4	2	3
	Other	2	1	1
Main occupation of the HH	Farming	88	97	91
	Business	5		3
	Formal employment	7	3	6
Education level of the HH	No formal education	9	3	6
	Primary school	64	44	55
	Secondary school	20	50	34
	Middle-level college	1	2	1
Age of the HH (years)	University	6	1	4
	18 to 24	2	1	2
	25 to 34	13	15	14
	35 to 44	29	19	25
	45 to 54	25	31	27
	55 to 64	21	18	19
	Over 65	10	16	13

HH—head of the household.

The observed difference in age and educational demography between Rwanda and Zambia has significant implications concerning farmers' compliance with regulatory and market standards. Younger farmers have been associated with better compliance in regard to several FFVs and in different countries, including [27] in regard to pineapples, Ref. [28] in regard to general farm productivity, and [29] in regard to vegetables in China. Similarly, the difference in the level of formal education among the FFV farmers in Rwanda and Zambia has implications for the amenability of the two groups of farmers to apply improved production practices and comply with regulatory and market standards. Higher levels of formal education tend to be associated with greater compliance levels. This is demonstrated in the results by [30] in relation to vegetables in Bangladesh, [31] in relation to vegetables in Zimbabwe, and [32] on the impact of financial literacy on compliance with food safety standards in the Guatemalan fresh pea industry. Both age and level of education are known to influence compliance with standards among smallholders, with better compliance being associated with a higher level of formal education and a lower age of the farmer [33]. The disparity in the level of adoption of, or receptiveness to conform to, improved FFV production standards observed between the smallholders in Rwanda and Zimbabwe could partly be explained by the age and educational profiles of the groups. The young and better-educated farmers normally have a more receptive mindset towards improved technologies.

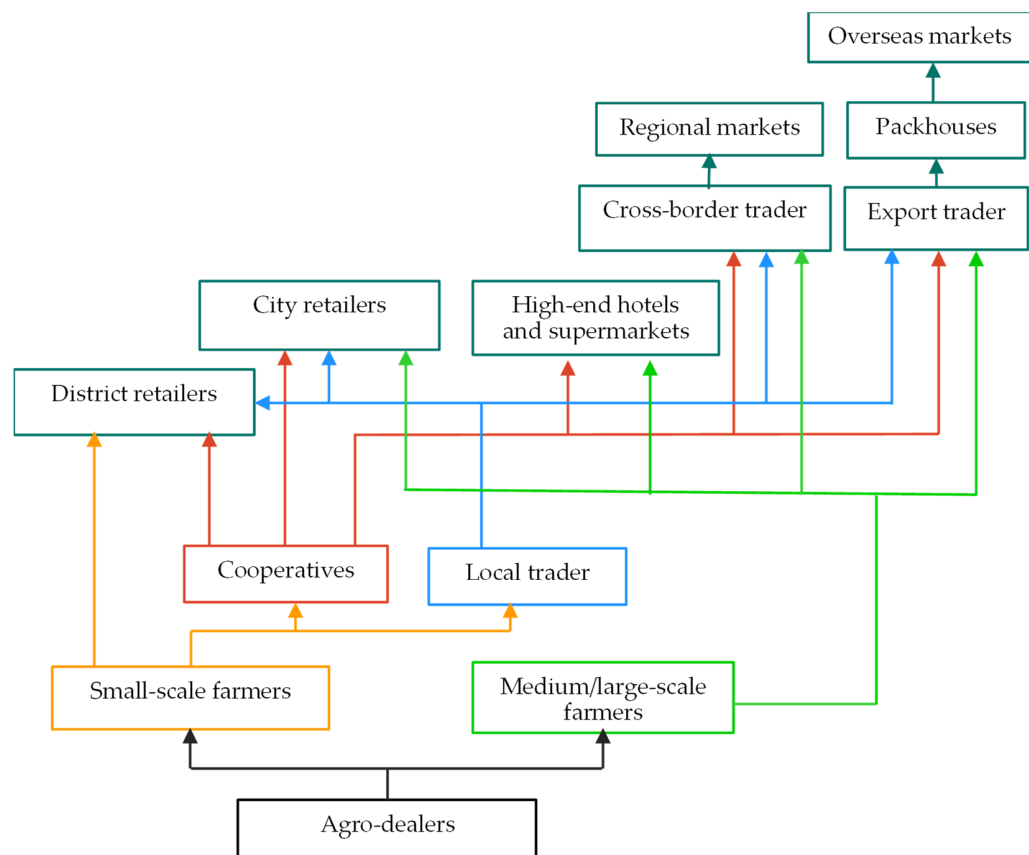
The relatively young age of the farmers, coupled with a good level of education (particularly in Zambia), provides an opportunity for accelerating the adoption of modern farming and product handling technologies, including better prospects for adhering to standards.

### 3.2. FFV Value Chain Organisation and Market Constraints

#### 3.2.1. Rwanda

The FFV value chains in Rwanda involve various key actors, including input supply companies, producers (ranging from small to medium/large farmers), traders (including cooperatives and exporters), vegetable retailers (such as supermarkets and open-air markets), and government agencies like the Ministry of Agriculture and Animal Resources (MINAGRI), the National Agriculture Export Development Board (NAEB), the Rwanda Agriculture and Animal Resources Development Board (RAB), and the Rwanda Coopera-

tive Agency (RCA). These actors are interconnected, both vertically and horizontally, at various nodes within the supply chain (Figure 2).



**Figure 2.** Value chain map for fresh vegetable production in Rwanda.

Most FFV production in Rwanda is small to medium scale, with the average land-holding per FFV farmer being less than 0.5 ha for small-scale farms and slightly above 0.5 ha for medium-scale farms. Although most of the production occurs on owned land, government-owned marshlands are also utilised, albeit subject to regulation. However, productivity levels are generally low, with reported averages significantly below national averages for various crops. For example, the reported productivity level for avocados was 1.46 t/ha compared to the national average of 9.03 t/ha. The French bean average was 1.66 t/ha compared to 7.65 t/ha. Only hot peppers registered higher than average productivity among the sampled farmers, at 4.08 t/ha compared to the national average of 3.1 t/ha. Smallholder farmers primarily sell their produce in local markets or to local traders and brokers who aggregate the produce for sale at the district level or in the capital city of Kigali.

The marketing channels for FFVs are highly unstructured and largely unregulated. There is minimal enforcement of voluntary standards through industry self-regulation and the sanitary and phytosanitary (SPS) standards are not enforced. Farmers are mainly price takers. To overcome this, farmers are increasingly organising themselves into cooperatives. This helps to achieve products in bulk and group marketing of produce by the members, thereby increasing their bargaining power and achieving economies of scale. The observation of standards by smallholders is low or absent, even at the cooperative level, and is mainly limited to quality, as assessed by aesthetic appearance. Even then, there is no differential pricing based on the quality of produce. The pooling of produce through cooperatives allows for wholesale marketing through any of the marketing channels available.

Traders mainly engage in aggregation, sourcing produce directly from smallholders or through cooperatives for sale in central markets. However, they offer little or no premium



prices for higher quality produce, providing minimal motivation for farmers to invest in quality production. Export traders handle substantial quantities of FFVs destined for regional markets, but access to these markets is primarily through informal channels, with physical quality being the main criterion for acceptance. Limited attention is given to SPS issues for produce destined for regional markets. FFV retailers serve as intermediaries between farmers, traders, and local consumers, with quality standards varying based on supply availability and demand. During peak harvesting, usually characterised by a supply glut, retailers enjoy an ample supply of FFVs and are therefore inclined to accept only the produce that meets certain visual quality standards and at cheaper prices. The reverse is true during periods of scarcity, when quality considerations are secondary and prices are higher. Retailers often purchase from traders through the local wholesale/bulk market.

Both the size of the production land and the structure of the market have an impact on the farmers' inclination to comply with GAPs and market and mandatory standards. The farm size can have a significant impact on the application of GAPs and compliance with standards [30]. This is partly because an increased farm size is associated with better financial benefits from food safety improvements [34].

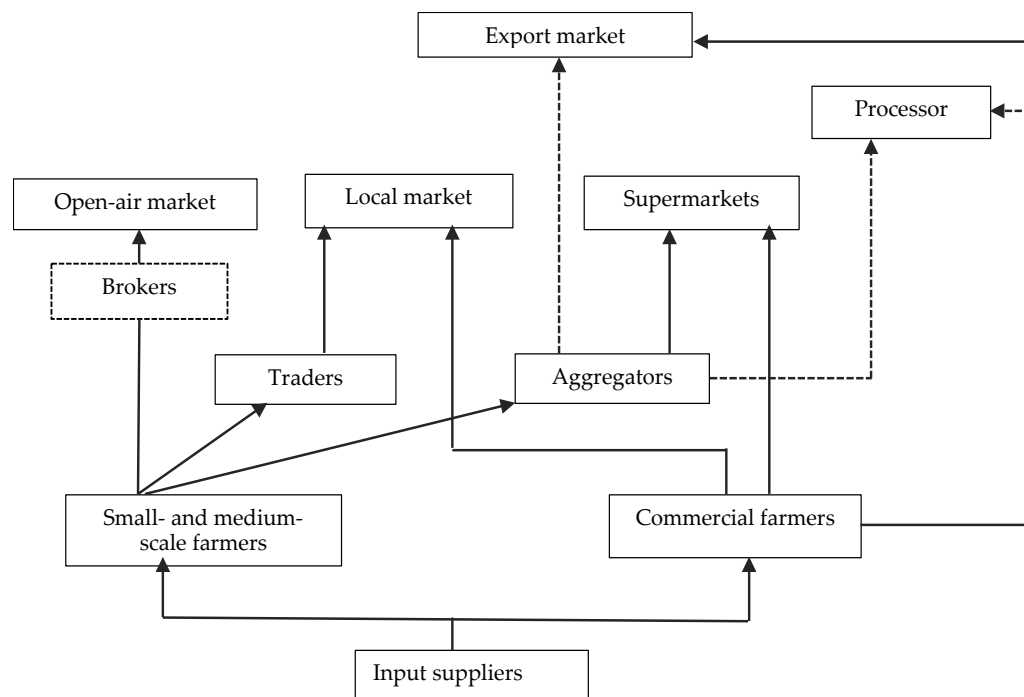
Constraints on market compliance in regard to FFVs primarily stem from challenges faced by smallholder farmers at both the production and market access level (Figure A1). At the production end, smallholder FFV farmers encounter significant hurdles, including deteriorating soil fertility, increased incidence of pests and diseases, and poor post-harvest handling. Inadequate resources to purchase productivity-enhancing inputs and a lack of capacity, skills, and knowledge, hinder the implementation of modern cultivation techniques, particularly those related to addressing these key challenges. For example, a lack of knowledge on mitigating FFV pests and diseases often leads to the improper application of pesticides, resulting in poor quality and potentially unsafe products. Poor post-harvest handling techniques contribute to high losses and the reduced quality of produce. Furthermore, the absence of basic equipment, such as water pumps and pedal pumps for marshland cultivation, as well as limited access to production resources like greenhouses, further restricts the capacity of FFV farmers to engage in off-season production.

Regarding market access, smallholder FFV farmers face challenges due to a lack of information about external market standards and insufficient capacity and skills to meet these standards. As a result, farmers are unable to supply regional markets (except for the Democratic Republic of Congo), due to an inability to meet the set standards and low volumes of FFVs. Poor transportation infrastructure and a shortage of appropriate packaging materials also impede farmers' ability to meet the requirements of exporters, supermarkets, and other high-end, distant markets, such as the market in Kigali, thus limiting their ability to secure premium prices. The problem is compounded by poor market organisation, and farmers' inability to forecast market demand and understand market standards further compound these challenges.

### 3.2.2. Zambia

The key value chain actors for FFV in Zambia, as examined in this study, encompass producers (small, medium, and commercial scale), local traders, retailers, supermarkets, processors, exporters, regulators, and service providers (finance, input supply, extension). These actors are organised, both vertically and horizontally, within the supply chain (Figure 3).

At the primary end of the value chain are FFV farmers, categorised into small, medium, and commercial farmers, based on the size of the land dedicated to FFV production. Smallholders, dominating in terms of the number of people involved, typically have land holdings of up to 5 ha for FFVs. Production by this group is characterised by low-input and low-technology applications, often relying on rain-fed cultivation. While off-season production is limited, nascent irrigation practices are emerging, particularly in areas with access to dambo lands, where soil moisture remains sufficient during dry periods.



**Figure 3.** Value chain map for horticultural crops in Zambia.

Agro-input usage among small-scale farmers is low, often disregarding technical recommendations and risking the inappropriate use of pesticides or unregistered agro-chemicals. Poor access to technical information and inadequate working capital further hinders the application of technical recommendations, contributing to sub-optimal field operations and poor pre- and post-harvest handling. Consequently, the inappropriate use of agro-inputs, sub-optimal field operations, and poor pre- and post-harvest handling, together, lead to low productivity compared to the existing potential, low and inconsistent quality of the resultant produce, increased post-harvest losses, and reduced compliance with standards, including food safety requirements. Therefore, access to formal markets by smallholder FFV farmers is compromised.

The primary market for small-scale FFV producers is unregulated open-air markets, accessed mainly through brokers, adding to the cost of marketing and reducing the returns from FFV farming. Direct access to formal and regulated markets, such as supermarket chains and export markets, is limited due to low production volumes, unpredictability in terms of the supply, and the failure to meet quality standards. This is particularly the case for fruits, whose supply has remained below the demand from organised markets, such as Shoprite, with the gap in supply being met mostly with produce from South Africa and Zimbabwe [35]. The quality of the produce is also often below prescribed mandatory and voluntary standards and is inconsistent within and between lots supplied. Smallholder farmers' production, harvest, and post-harvest handling practices often do not comply with market requirements, including quality standards (size, shape, maturity, colour, consistency), voluntary standards (e.g., GlobalGAPs), and mandatory regulatory standards (e.g., SPSs). Figures A2 and A3 show the primary challenges associated with the production and marketing of FFVs in Zambia.

### 3.3. Production of FFVs

The average land size owned by the sampled FFV farmers was 1.17 ha in Rwanda and 5.76 ha in Zambia (Table 3). Overall, 31% of farmers rented the land, where the average size of rented areas was 0.68 ha in Rwanda and 0.94 Ha in Zambia, at an average cost of USD 107 (USD 138 in Rwanda and USD 24 in Zambia).

**Table 3.** Average allocation of land for FFV production among smallholders in Rwanda and Zambia.

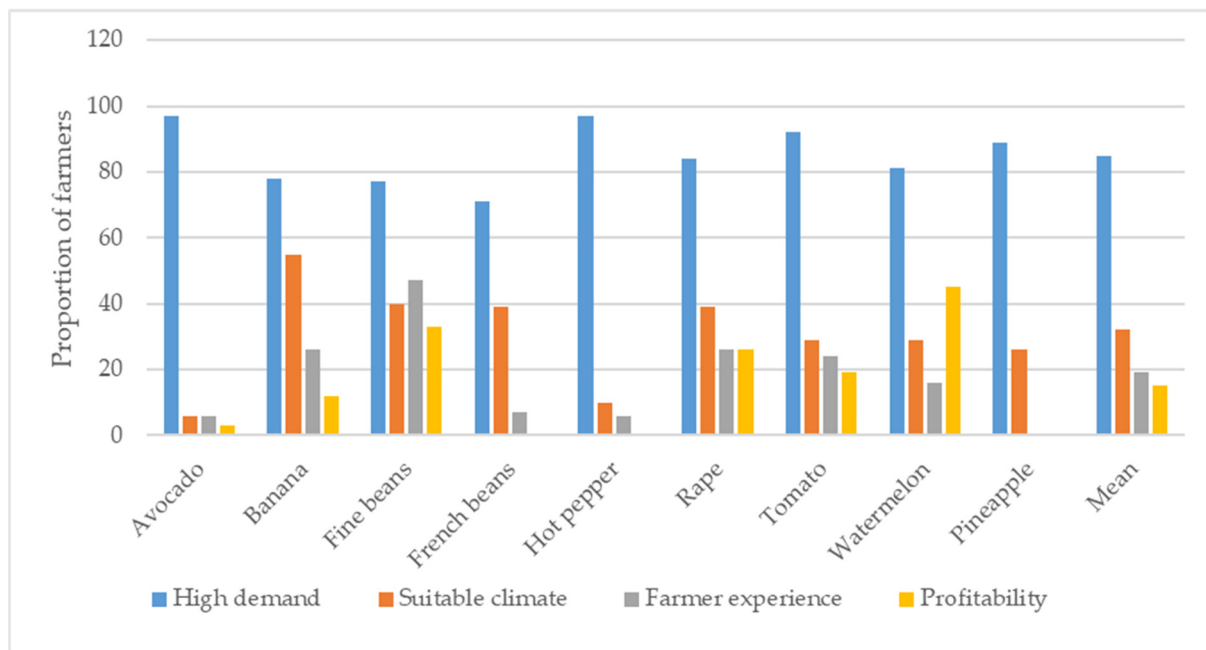
Characteristic	Rwanda	Zambia	Overall Sample
Land access			
Land owned (ha)	1.17 (1.19)	5.76 (8.71)	3.35 (6.47)
Land rented (ha)	0.68 (0.9)	0.94(1.49)	0.75 (1.1)
Area for all crops (ha)	0.95 (0.9)	3.48 (1.73)	2.12 (3.38)
Area for vegetables (ha)	0.41 (1.08)	0.53 (0.74)	0.46 (0.96)
Area for fruits (ha)	0.48 (0.68)	0.79 (0.5)	0.6 (0.63)
Land allocation for selected crops (ha)			
Avocado	1.37 (24.0)	0.79 (1.0)	1.28 (4.5)
Banana	0.52 (2.5)	0.64 (1.0)	0.58 (0.5)
Fine beans	-	0.16 (0.5)	0.16 (0.1)
French beans	0.15 (1.0)	-	0.15 (0.2)
Hot pepper	0.65 (5.0)	-	0.65 (1.0)
Rape	-	0.23 (0.5)	0.23 (0.2)
Tomato	0.37 (2.0)	0.75 (5.0)	0.56 (0.6)
Watermelon	-	0.73 (1.5)	0.73 (0.3)
Pineapple	0.43 (2.0)		0.43 (0.5)

Figures in parentheses are standard deviations.

The production of FFVs in both countries was on a small scale, ranging between 0.4 and 0.5 ha and 0.5 and 0.8 ha in Rwanda and Zambia, respectively. FFV production was nevertheless a major occupation of the surveyed households, judging from the land dedicated to their production as a proportion of the total land holding of households, namely 76.1% in Rwanda and 22.9% in Zambia. Avocado was identified as the crop that occupies the largest proportion of land both in Rwanda (1.37 ha on average) and Zambia, where production was 0.79 ha on average (Table 3). French beans occupied the smallest portion of land for FFV production in Rwanda (0.15 ha), whereas fine beans occupied the least area (0.16 ha) in Zambia.

The preference for the FFVs grown by the farmers depended on several factors (Figure 4). High market demand was the most widespread consideration among farmers in Rwanda. This was followed by the suitability of the climatic conditions for the crop in question and the profitability of the enterprise. Demand for produce was likewise, the most important factor in Zambia. The important part played by demand factors is probably informed by the fact that the produce covered in the study is sold fresh with a high risk of post-harvest loss in the event that there is no immediate sale. This is also the case given that cold storage facilities for the commodities are not available for smallholder farmers. Furthermore, the production system, which is mainly rain-fed, makes demand a key consideration for farmers during peak harvest.

However, the small scale of production of FFVs exhibited in the two study countries has implications for the provision of extension services, financial services, market facilitation and, subsequently, compliance with standards, due to increased transaction costs per farmer. The adoption of GAPs, such as crop rotation and adherence to market and regulatory standards, may also be hindered, as the cost of full compliance with standards could easily outweigh the returns from FFV farming.



**Figure 4.** Factors determining farmer preferences for producing the fruits and vegetables covered in the study, as provided by the respondents.

### 3.4. Compliance with Good Agricultural Practices and Market Standards

#### 3.4.1. Farmer Awareness and Compliance with Good Agricultural Practices

The results revealed good farmer knowledge regarding agricultural practices, particularly conventional good agricultural practices (GAPs) aimed at enhancing crop productivity. In both Rwanda and Zambia, over 60% of respondents mentioned timely land preparation, timely planting, the use of improved seeds, regular weeding, the appropriate use of fertilisers, and the application of the correct pesticides. In terms of crops, tomato farmers were the most likely to apply the identified GAP indicators, with over 87% of farmers reporting the application of all the indicators.

There is a lack of understanding regarding the importance of proper post-harvest handling among smallholder FFV farmers in Rwanda and Zambia. Awareness of post-harvest practices in both countries is primarily limited to grading and sorting. In Rwanda, 99% of the interviewed farmers indicated sorting as an important post-harvest practice, followed by grading, which was identified by 89% of farmers. Other post-harvest practices were either not recognised or mentioned by less than 3% of the farmers interviewed. Similarly, in Zambia, 89% of the interviewed farmers identified grading as an important post-harvest practice, with 81% recognising sorting as important. Inappropriate post-harvest handling leads to low and inconsistent quality of the resultant produce, increased post-harvest losses, and reduced compliance with standards, including food safety requirements. Therefore, access to formal markets by smallholder FFV farmers is compromised.

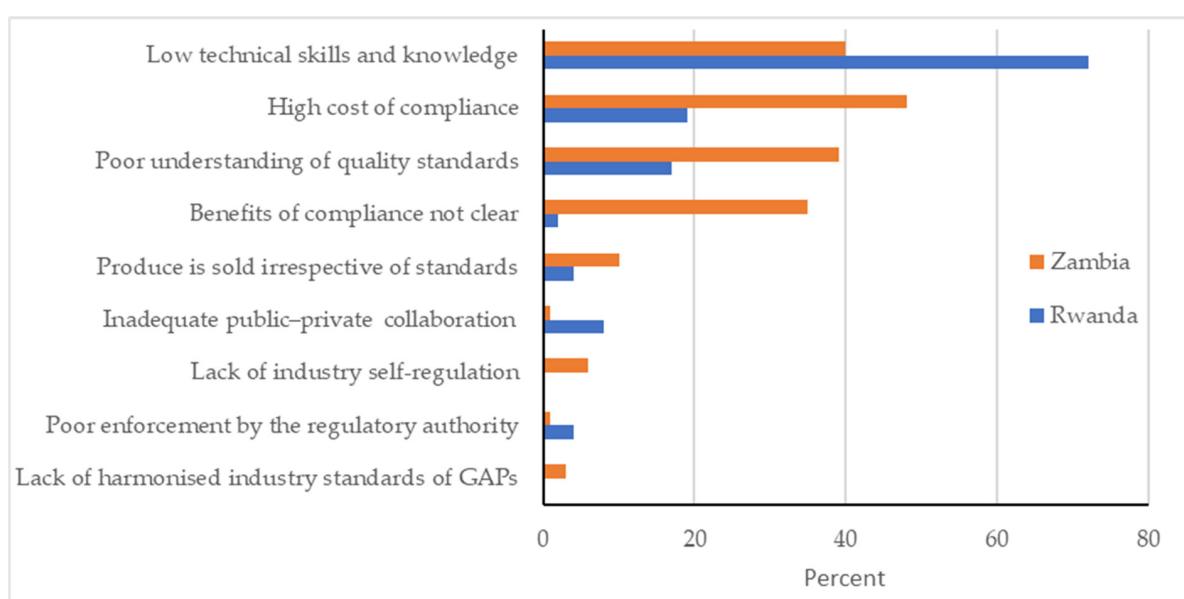
Mapping the level of convergence between the GAP parameters recognised by the farmers and those recommended under GlobalGAP (Table 4) shows that several standards are not well-known to farmers. Farmers showed less awareness of GlobalGAP indicators crucial for food and environmental safety, such as reducing pesticide residue levels in fruits, vegetables, and field crops (FFVs), ensuring the safety of farmers and farmworkers, waste disposal practices, and environmental health. This knowledge gap persists across most smallholders, despite the recognition that issues like pesticide residue levels and traceability requirements pose significant barriers to export markets [36,37].

**Table 4.** Level of convergence between GAP parameters recognised by the farmers and those recommended under GlobalGAPs.

GAP Requirement	Awareness *	
	Rwanda	Zambia
Site selection	X	X
Field history and crop rotation	X	X
Soil fertility management through judicious use of fertilisers and pesticides, regular soil testing	✓	✓
Seed and planting material	✓	✓
Water management	X	X
Availability of integrated pest management plan	X	X
Prudent use of fertilisers, based on recommendations	Partial	Partial
Judicious (safe and responsible) use of crop protection products	Partial	Partial
Correct maturity stage at harvesting and in hygienic conditions	Partial	✓
Proper post-harvest handling practices to preserve quality and safety	Partial	✓
Appropriate waste disposal practices	X	X
Worker health, welfare, and safety	X	X
Accurate and updated records of all farming activities, inputs used	X	X
Documentation and recordkeeping	X	X
Regular training for farm workers on GAPs, including hygiene, safety, and environmental practices	X	X
Maintenance of traceability information	X	X
Traceability requirement	X	X

\* ✓ = farmers aware; X = farmers not aware; Partial = farmers aware of some aspects of the GAP.

Several factors were identified as barriers to compliance with production standards (Figure 5). Low technical skills and knowledge of farmers regarding the standards and the high cost of compliance were the most important barriers to compliance in both Rwanda and Zambia. This was followed by poor farmer understanding of the standards in both countries and a lack of information on the benefits associated with compliance in the case of Zambia. A lack of awareness and knowledge of the standards among smallholders has indeed been identified as a major barrier to compliance in terms of FFVs in other countries [12,38–41]. Similarly, [16,21] noted that the high cost associated with compliance is a deterrent for smallholder farmers to work towards certification schemes.

**Figure 5.** Main barriers to compliance with market and regulatory standards among farmers of selected fruits and vegetables in Rwanda and Zambia.



Transitioning smallholder FFV producers to full compliance with standards, therefore, requires a gradual approach that integrates awareness campaigns into capacity-building programmes. This process can enhance farmers' skills and knowledge, particularly in areas where they currently lack emphasis, such as judicious pesticide use, waste disposal, worker health and safety, and recordkeeping. Awareness programmes should also focus on the financial benefits of adhering to market standards, such as product differentiation, which can lead to niche demand and better pricing. Awareness programmes need to integrate approaches that combine hands-on learning, such as field days, innovation platforms, village-level demonstrations, farmer field schools, and agricultural shows, with approaches aimed at reaching a certain scale, such as text messaging services and smartphone applications and radio broadcasts. Additionally, producing and disseminating fit-for-purpose information materials on key aspects of production, post-harvest handling, and market practices, can significantly improve awareness and compliance.

### 3.4.2. Awareness of and Compliance with Market Standards

Except for hot pepper and, to some extent, French beans, in the case of Rwanda, producers of all the other four FFVs covered in the study indicated poor or a lack of awareness regarding regulatory and market standards (Table 5). A complete lack of awareness was registered among producers of avocado and tomato, whereas 93% of pineapple and 97% of fruit banana farmers indicated a lack of awareness of regulatory and market standards for the commodities.

**Table 5.** The proportion of farmers aware of regulatory and market standards for the target crops. N/A—not applicable.

Target Crop	Rwanda	Zambia
Avocado	0	100
Fruit banana	3	10
French beans	21	N/A
Hot pepper	45	N/A
Tomato	0	24
Pineapple	7	N/A
Fine beans	N/A	47
Rape	N/A	26
Watermelon	N/A	34

Conversely, while farmers were largely aware of the market requirements, their knowledge was limited to the group of standards that are required in local and regional markets, where most of the products are consumed. In Zambia, the awareness of regulatory and market standards among farmers varied widely. The highest level of awareness was among avocado farmers, while it was the lowest for fruit banana farmers.

The low level of awareness of the regulatory and market standards among smallholder farmers in Rwanda could be attributed to several factors. Among the farmers interviewed in Rwanda, the level of education was low, with only 27% having a secondary and tertiary education level. The land sizes on which the FFVs are grown are small, leading to low commercialisation. Most FFVs are sold through informal market outlets, where market standards and regulations are less evident and enforcement less stringent.

The awareness level among smallholder farmers in Zambia regarding the regulatory and market standards was relatively higher than in Rwanda. This could be explained by the fact that formal education among the farmers was higher, with 53% having attained a tertiary level of formal education compared to 27% in Rwanda, making it easier for farmers in Zambia to understand the regulatory and market standards and to seek information about the standards. The geographical proximity of Zambia to South Africa, where there is greater enforcement of standards, could also have a positive impact on the mindset of Zambian FFV farmers, whose produce must compete with imports from South Africa in

better-paying formal market outlets. The land used for FFVs in Zambia is also larger per capita, making the commercial orientation of production easier.

In addition to the low level of technical skills and knowledge of market standards, smallholder farmers did not feel formally compelled to comply with any of the standards, given that enforcement of the standards by the regulatory authorities and the industry itself was deemed to be weak. There was also a noted lack of harmonised industry standards, and limited public–private collaboration in co-designing and enforcing standards, which further undermined the enforcement of and compliance with standards. Public–private partnerships can play a vital role in linking small farmers and market actors, in addition to fostering industry self-regulation for enhanced compliance with standards [42].

Ensuring the availability of information on the standards in target markets and using these standards to develop or adapt standard operational procedures (SOPs) for farmers at each stage of the production process for selected FFVs is crucial. For example, the lack of a harmonised Horticulture Industry Code of Practice in Zambia poses a significant compliance challenge. Developing and adopting such codes, along with quality management systems and SOPs, can facilitate self-regulation and enhance compliance. Conversely, Rwanda’s horticultural industry is making progress in developing Rwanda GAPs, which will require capacity building and benchmarking against existing local GAPs, such as those in Kenya and other countries in Africa. However, these standards also need to be benchmarked against the most stringent standard in the desired destination market. For example, findings on pesticide residue levels in locally produced fruits and vegetables in Zambia revealed that meeting local regulations does not guarantee compliance with more rigorous standards like the Codex Alimentarius maximum residue limit, thereby hindering market access for local producers [20].

### 3.5. Institutional Arrangements to Enhance Smallholder Compliance with Standards

As much as the fresh fruit and vegetable sector is growing in the two studied countries, the opportunity to reach its full potential is hampered by the largely small scale of production, often with low productivity due to the suboptimal use of inputs. Smallholder farmers also largely sell their produce through unregulated and uncompetitive, informal open-air markets, since they pose minimum barriers to entry, with few safety and quality requirements. While smallholder farmers would switch to crops with fewer safety requirements and markets with lower entry barriers, the key concern is how sustainable such strategies are for smallholders. How best can smallholder farmers be aligned with better markets that require higher quality products and offer premium prices?

Theoretically, several institutional mechanisms for integrating smallholder farmers into high-value chains and enabling compliance, do exist. First, smallholder farmers organised into legally registered business entities, such as farmers’ associations or cooperatives, can access more organised markets, such as those involving supermarkets and exporters, for which consistency in terms of supply and compliance to standards is mandatory [43]. Second, smallholders can, through collective action, invest jointly in infrastructure, such as bulking and storage facilities, which help farmers reduce transaction costs, thus supporting certification [44,45]. Third, through public–private partnership (PPP) arrangements, smallholders can be supported to overcome the challenges of market requirements by investing in infrastructure, training, and extensions in terms of export requirements, and in alternative approaches, such as IPM, and the supply of essential services, such as safe water [40,46]. Fourth, farmers can negotiate contracts with exporters that can enable them to access certification services paid for by the exporters, in addition to capacity building. A successful example has been noted among mango producers in Peru [47].

Achieving this level of smallholder integration into value chains would require all existing farmers’ associations or cooperatives to be strengthened concerning the governance of such cooperatives and financial literacy. The same would apply in situations where farmers’ groups do not exist. In this case, the first step would be to organise farmers into viable groups, followed by capacity-building actions. This approach has been used

in Zambia, where the registered business entities were used as platforms to establish partnerships, in which the farmer organisation was modelled as a company limited by guarantee and co-owned by downstream value chain players, such as exporters [38]. This approach is a key consideration with great potential [48,49], provided the farmers' organisations are empowered enough to broker partnerships that are beneficial to the association and its members.

Self-regulation is another parameter for which small business units organised through cooperatives could be a critical enabler. The groups could, for example, be facilitated through technical assistance (TA) support to put in place a set of best practices, which mirror market standards, to be followed by group members. Monitoring of compliance with the agreed best practices could then be undertaken communally, through supervisory committees set up by the group. With appropriate assistance, such production and handling best practices could be benchmarked to the more stringent GlobalGAPs and/or any other private standards operating in the destination market, thereby promoting better access to markets and the possibility of better returns for farmers [50].

## 4. Conclusions and Recommendations

### 4.1. Conclusions

This study aimed to assess factors influencing compliance among smallholder fresh fruit and vegetable (FFV) producers in Zambia and Rwanda and identify practices essential for achieving widespread compliance to enhance the sector's competitiveness. Despite differences in value chain structures, farmer's socio-demographic characteristics, the scale of production, and upgrading strategies within FFV value chains across these two countries, there are opportunities to support smallholder compliance. For instance, the relatively young age of farmers and the good level of education, particularly in Zambia, present opportunities to accelerate the adoption of modern-farming and product-handling technologies, improving adherence to standards.

While farmers indicated an awareness of production standards, their knowledge was generally limited in terms of understanding international standards, such as GlobalGAPs, particularly regarding food safety, health, and environmental sustainability indicators. Additionally, the cost of certification was mentioned as a key barrier to compliance, though to a lesser extent compared to knowledge barriers. Addressing knowledge gaps, explaining the benefits of compliance, and developing institutional arrangements to reduce transaction costs are critical steps for ensuring widespread adherence to standards.

The value chain structure for FFVs in the two countries is nascent, with most produce traded in local markets. The potential for access to regional and global markets was mentioned for some crops, such as French beans and fine beans, necessitating further support to smallholders to tap into these lucrative markets. This will require the development of industry codes of practice and quality management systems, especially for Zambia, where there was a notable gap, and popularising them amongst producers for adoption. Showcasing the financial benefits of compliance and improving market access through traceability can also motivate farmers to comply with standards.

The findings from Rwanda and Zambia are relevant for other countries in sub-Saharan Africa, particularly those with emerging horticultural sectors. Developing industry codes of practice and quality management systems can serve as a model for other regions facing similar challenges, which can replicate these strategies to boost their agricultural sectors and enhance food safety and quality on a global scale.

### 4.2. Recommendations

The study results emphasise the need for a multi-faceted approach to enhancing compliance among smallholder FFV producers in Rwanda and Zambia. This approach should incorporate targeted training to address the most prevalent factors limiting compliance, and improved access to relevant and up-to-date information. Complementary interventions

could involve developing and rolling out monetary and technical incentive systems for compliance, such as linking farmers to niche markets that offer premium pricing.

In Rwanda, where land constraints necessitate intensification, it is critical to catalyse better access to financial resources and provide capacity building in terms of GAPs and soil health management. Conversely, in Zambia, where there is lower population pressure on land, the focus can be on both expanding cultivated areas and increasing the productivity per unit area through GAP training and promoting access to productivity-enhancing inputs.

Organising farmers into legal business entities, such as cooperatives, and mainstreaming traceability in the production system is vital for accessing structured markets and ensuring compliance with standards. Farmer groups are also vessels for enhanced access to information, infrastructure, contracts, and financial and advisory services, to enhance productivity and returns.

For smallholders to widely embrace FFV farming systems that improve compliance with regulatory and market standards, it is necessary to demonstrate the business case for compliance in terms of the financial returns associated with the extra investment required. Therefore, analysing and compiling evidence regarding the positive impact of compliance with regulatory and market standards on smallholder income in terms of market margins, price stability, and guaranteed markets is essential. This analysis should be contrasted with the returns gained when smallholders target informal markets with little or no attention to compliance.

#### 4.3. Limitations of the Study

Some of the questions posed to the smallholder farmers related to compliance with SPS standards, which are mandatory. This could have been misinterpreted to imply follow-up by the SPS enforcement authorities, with potential reprimands for non-compliance. Some farmers could, therefore, have been inclined to provide technically correct responses rather than truthful ones. There is the potential bias in the selection of farmers, with more progressive farmers showing more willingness to participate in the interviews and, hence, being more highly represented. In the absence of full information on the number of farmers involved in the production of the target study crops in each region and the fact that many farmers grow more than one of the crops in the study, the representativeness of the farmers might have been compromised. However, the smallholder farmers involved in any given FFV tended to be monolithic concerning their sources of information, production practices, access to services, such as finance, and socioeconomic demography, except for age.

**Author Contributions:** Conceptualization, M.A., C.A., N.E.G. and R.M.; Methodology, M.A., F.M., C.A., N.E.G., R.M. and D.K.; Software, F.M.; Formal analysis, F.M., R.M. and C.A.; Investigation, C.A., N.A.P., R.M., J.P.K. and B.U.; Data curation, J.P.K., B.U. and M.K.K.; Writing—original draft, F.M., R.N., C.A., N.A.P., J.P.K. and M.K.K.; Writing—review & editing, M.A., C.A., N.E.G., R.M., B.U., M.K.K. and D.K.; Supervision, D.K.; Project administration, R.N. and D.K.; Funding acquisition, D.K. and M.K.K. All authors have read and agreed to the published version of the manuscript.

**Funding:** This study received funding from CABI Development Fund (CDF) CABI-led PlantwisePlus programme, funded by the UK Foreign, Commonwealth and Development Office (FCDO) and the Netherlands Directorate-General for International Cooperation (DGIS), Swiss Agency for Development and Cooperation (SDC); the European Commission Directorate General for International Partnerships (INTPA, EU); the Australian Centre for International Agricultural Research (ACIAR); and the Ministry of Agriculture of the People's Republic of China (MARAs). CABI as an international intergovernmental not-for-profit organization, gratefully acknowledges the generous support received from our many donors, sponsors and partners. In particular, we thank our Member Countries for their vital financial and strategic contributions.

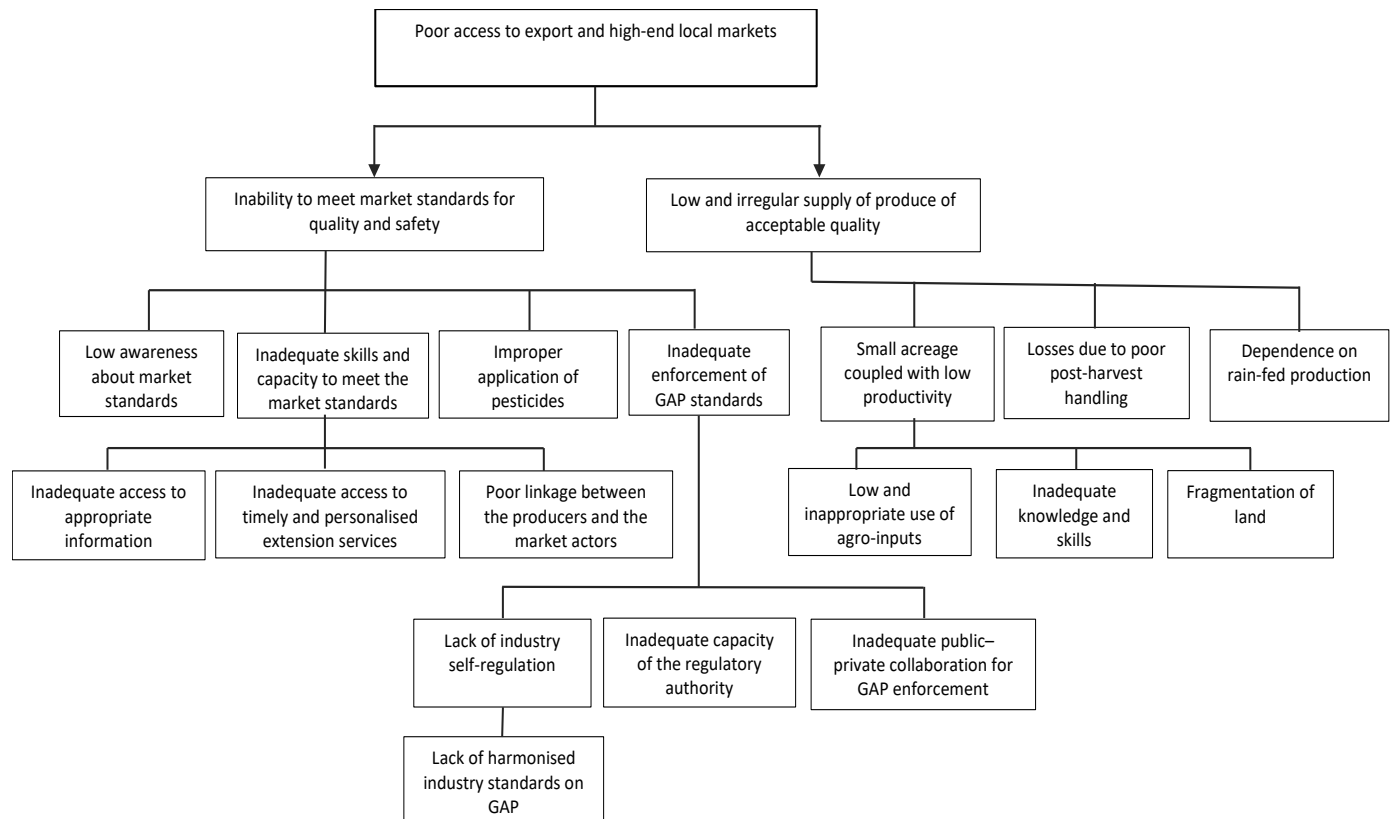
**Institutional Review Board Statement:** Not applicable.

**Informed Consent Statement:** Informed consent was obtained from all subjects involved in the study.

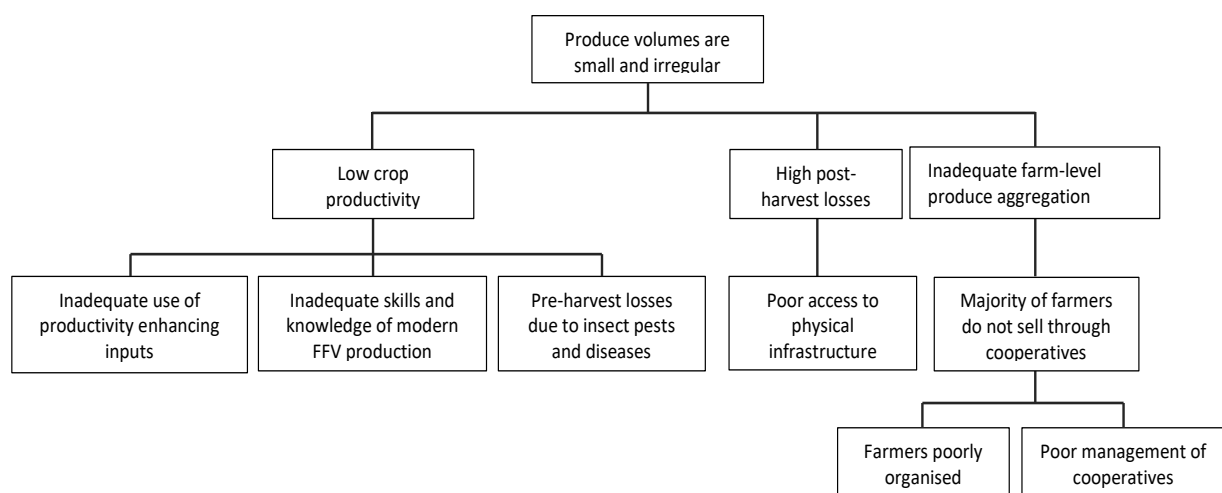
**Data Availability Statement:** The data presented in this study are available on request from the corresponding author.

**Conflicts of Interest:** Author Richard Musebe was employed by the company JUVILE Options and Solutions Ltd. The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

## Appendix A

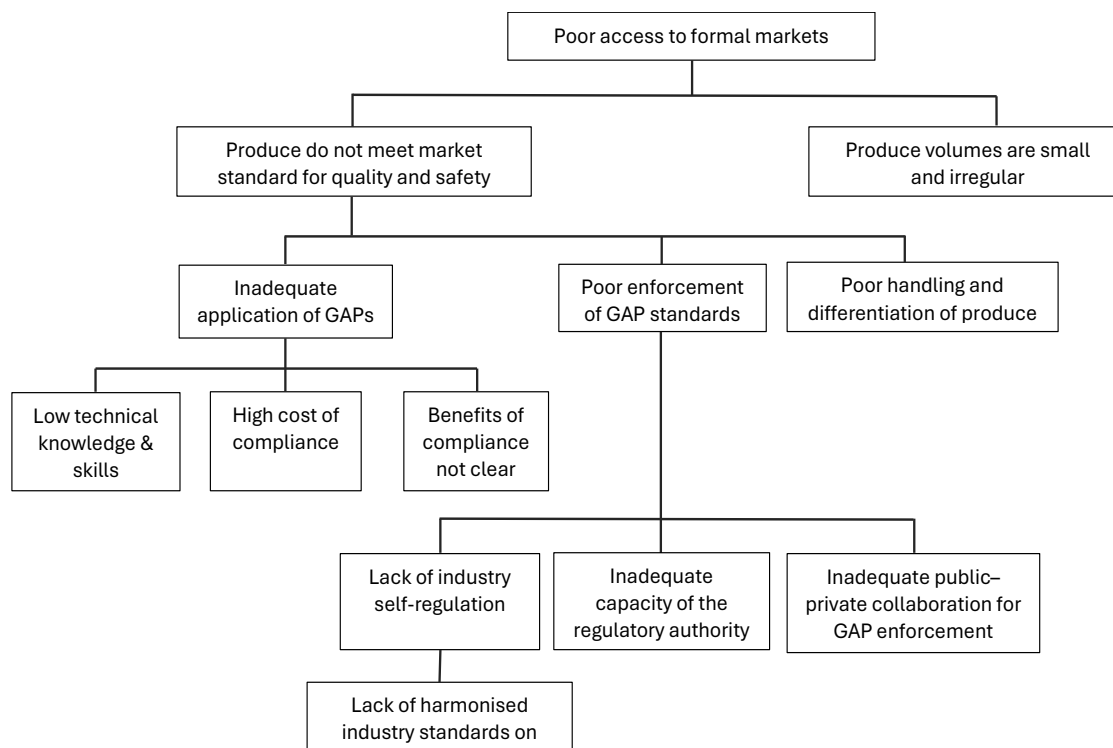


**Figure A1.** Constraints to market compliance of fresh fruits and vegetables (FFVs) in Rwanda.



**Figure A2.** Factors negating quantity and reliability of supply of smallholder FFV farmers in Zambia.





**Figure A3.** Factors negating smallholder compliance with market standards on quality and safety in Zambia.

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