Effects of Agribusiness Investments on Postharvest Losses and Food Security in Sub-Saharan Africa: Evidence from Maize and Beans Value Chains in Nyagatare District, Rwanda.

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Abstract

Agriculture is key to the economy of most Sub-Sahara African (SSA) states. A major characteristic of this agriculture is its low yield arising from many factors. The poor yield is further compounded by widespread losses occasioned by inadequate post-harvest handling practices. Post-Harvest Losses (PHL) in SSA underlie rural poverty and flow through a deadly cascade of food insecurity, hunger, malnutrition, and ecosystem dysfunction. In Rwanda, the local agricultural transformation program is built on an interplay of productionist and private investment promotion policies targeted at raising crop commodity output levels, reducing PHL, increasing product uptake and guaranteeing food security. As part of efforts to help the country in this direction and create a trajectory of definite impact, the United Nations International Fund for Agricultural Development implemented a five-year complementary intervention project focusing on climate resilient postharvest and agribusiness support program. This paper assessed the impact of the project in Nyagatare District of the country. It looked at the relationship between agribusiness investments and PHL and how these investments had impacted on food security. A total of 272 randomly selected smallholder farmers were surveyed using semi-structured questionnaires. Amongst others, study found high levels of drought-related crop losses, increased investments in rural postharvest infrastructures and a reciprocal drop in PHL secondary to deficiency in PHI. Based on the peculiar nature of crop losses in the season under review, the study recommends a stronger focus on climate-smart agriculture while sustaining current efforts at scaling up more investments in the post-harvest sector.

Key words: agribusiness, post-harvest losses, food security, Rwanda.

INTRODUCTION

Agricultural practice in Africa is mostly subsistence in nature built on local farmers using simple tools. Despite the fertile ecosystem, food production continues to lag behind food demand. Almost everywhere in SSA, yield trends for staple crops are showing signs of climate change impacts (Olayide, 2017). The falling yield rates are deeply compounded by loss of crop products occurring during and after harvest in the farm. These Post Harvest Losses (PHL) are recognized as a major cause of inefficiency in SSA agriculture and eliminating them is not just a way of increasing food availability but also a resource-efficient means of increasing food supply without additional cost or environmental burden. As the surge of urbanization unfolds in Africa and many other countries in the Global South, challenges of food security are emerging while the ability of agriculture to contribute to the absorptive capacity of national economies, enhance food sufficiency, generate employment and address the looming shift in poverty from rural to urban areas is increasingly becoming suspect (Ruel, et al, 2017).

With the likelihood that the proportion of the global population not producing food will continue to grow, ensuring efficiency in the agriculture sector to meet growing and changing demands for food products has become a matter of urgent imperative (Satterthwaite, 2010). Efforts to scale up productivity and increase the competitiveness of African agriculture have been approached at both regional and national levels. The Comprehensive Africa Agricultural Development Program (CAADP) is the regional blueprint for the development of agriculture in Africa and provides a “set of principles and broadly defined strategies to help countries critically review their own situations and identify investment opportunities with optimal impact and returns.” (UNOSAA, 2016). It stipulates an annual productivity target of 6% and recommends a sustained sectoral funding of a minimum of 10% of yearly national budget. Meeting CAADP targets requires multi-level actions that address circumstantial peculiarities. Two of these are particularly vital to postharvest losses and food security: grow yield and preserve output. In furtherance of this, the Government of Rwanda introduced the Crop Intensification Program (CIP). CIP is a productionist policy targeting higher volumes of crop products to boost domestic consumption, increase food sufficiency and grow household income (PASP, 2013). While CIP delivered on stated objectives, existing post-harvest infrastructures developed for the traditional cropping system soon became inadequate to cope with the demand of product surplus arising from the scheme. In addition, changes in the climate system produced a situation whereby harvest began to take place in the wetter months of the year thereby hurting the post-harvest process of drying of crop products.

The foregoing provides the context for IFAD multilateral engagement designed to provide crucial assistance in climate-resilient measures specifically tailored to close postharvest sectoral gaps and generate entrepreneurial mindset among smallholders. Programmatically, it operated through a set of two interrelated components focused at helping farmers adopt more efficient business models. The project’s empirical model in figure 1 below shows the main activities and deliverables.

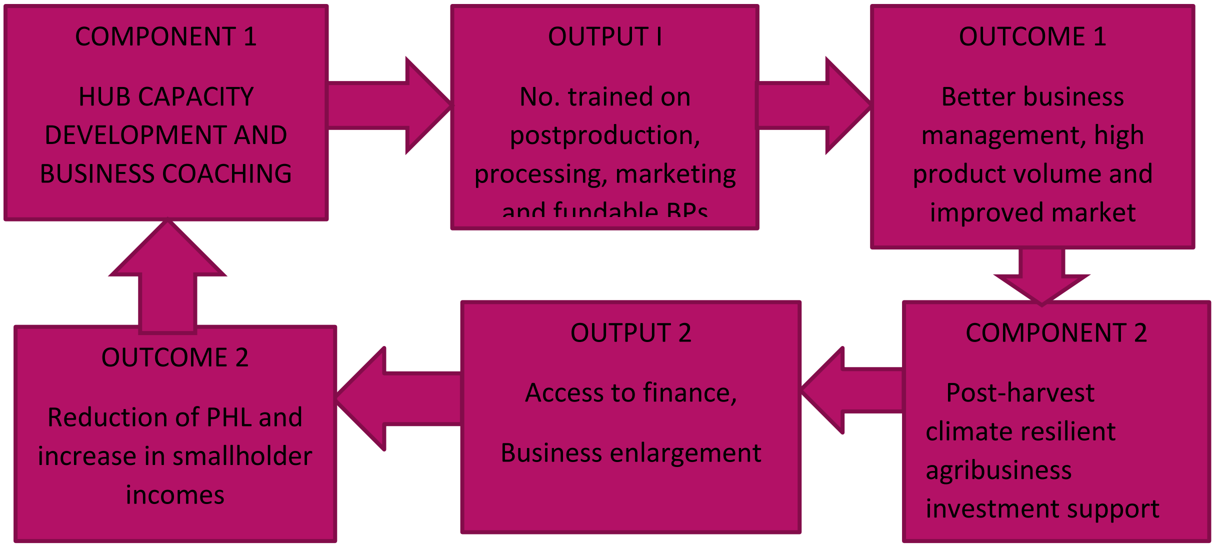

Figure 2: EMPIRICAL PROJECT MODEL
Source: Adapted by author from project document, 2018

OVERVIEW OF POST-HARVEST LOSSES (PHL)

A large body of literature has developed around the subjects of PHL, agribusiness investments, and food security. Each of the numerous studies has focused on different aspects of the concepts in varying dimensions of details. On PHL, contemporary studies have concentrated on five main areas namely: definition, magnitude, etiology, economic cost and impact as well as possible remedies applicable to each region. While past efforts to define the concept and set clear boundaries of understanding have been marred by controversies among contending scholars in the field, nevertheless, countries, governing bodies and aid agencies in the post-harvest sector still need to know what postharvest losses are, the size and scope as well as how the problem impacts people and economy. Tyler and Gilman, 1979, quoted in Food and Agricultural Organization publication "Post-harvest Losses" (FAO, 2011) defined PHL as "measurable quantitative and qualitative loss in a given product which can occur at any point in the postharvest system". Kader (2002) sees PHL as "the degradation in both quantity and quality of a food product from harvest to consumption." The recurring "farm-to-fork" definition of PHL underpins the work of most scholars in the field even though there are many other conflicting perspectives which call for distinctions between related terms such as food waste, food loss and product damage. For example, can product damage such as damage to a portion of yam tuber be interpreted as postharvest loss when healthy portion can still be recovered for use? Similarly, are food wastes synonymous with PHL since most cases of food wastes are either quantities prepared in excess of consumption or food products exceeding their expiry dates. All these clarifications are desirable in order to ascertain the true magnitude of PHL in both monetary and quantitative terms and also help inform evidence-based interventions. Furthermore, with the rising worldwide demand for bio-energy, PHL are becoming increasingly inevitable in some specific contexts. In what is now known as planned, non-use food losses, there is a deliberate diversion of crop commodities to bio-energy industries subsequently creating avoidable consumption scarcity (FAO, 2013). Therefore, as Africa gravitates towards diversification of its energy sources, intensification and preservation of crop production will become part of a broad sweep of integral measures to meet product needs on both sides.

The lack of global modelling data has not facilitated a meaningful consensus on what parameter should be universally applied when measuring PHL particularly in the area of policy response. In view of this, any of the parameters of magnitude, economic cost and economic impact may be adopted for assessing the severity of PHL and determining the appropriateness and urgency of intervention. In "Missing food: The case of postharvest grain losses in sub-Saharan Africa" published in 2011 by the World Bank, FAO and the UK Natural Resources Institute, the cost of PHL in SSA alone was estimated at USD 4bn. This represents a vast amount of food sufficient to meet the annual food need of around 48million people. Using self-reported estimates by smallholder farmers in household (HH) survey of PHL in SSA, Kaminski and Christianensen (2014) showed that on the average, between 1.4, 2.9-4.4, and 5.9 percent of the total national maize harvest is lost in Malawi, Tanzania and Uganda respectively. Data from the African Postharvest Loss Information System put the mean annual loss of cereal crops at 10%-20% for all countries in East Africa**.**

In SSA like many other low-and middle-income countries, PHL are set in the context of poor postharvest handling practices, low literacy, poverty, low level of private sector investment, and gender inequality. Most smallholder farmers rely on traditional methods of handling and preserving their crop products after harvest. These methods include head-load carrying practices, open drying of crop products either by the road side, on roof tops or concrete platforms while the use of rudimentary holding devices like sacs loaded with cow dung ash, roofed iron drums sealed with mud, wooden cribs and many more are used for storage purposes (Wambugu, 2009). Each and every of these rudimentary practices is fraught with varying degrees of product loss resulting either from wind, rain or avoidable attacks from pests and diseases. However, important as these are in the etiology of in-country PHL, unpredictable changes in the climate system are today imposing a scale of product loss well beyond the capacity of national governments to evolve and sustain appropriate prevention and control measures.

Addressing PHL requires a good understanding of product flow in the value chain. The analytical framework shown below reflects the dynamic sequence of product loss right from the point of harvest on the farm all through the different processing stages to the final consumers in a typical value chain. The framework identifies the possible causes of PHL at each stage of the post-harvest system and the producer-consumer dissociation in the final product mass. It provides helpful and instructive insights into policy options or intervention measures that could be adopted to fight PHL either in a stage-specific or system-wide approach.

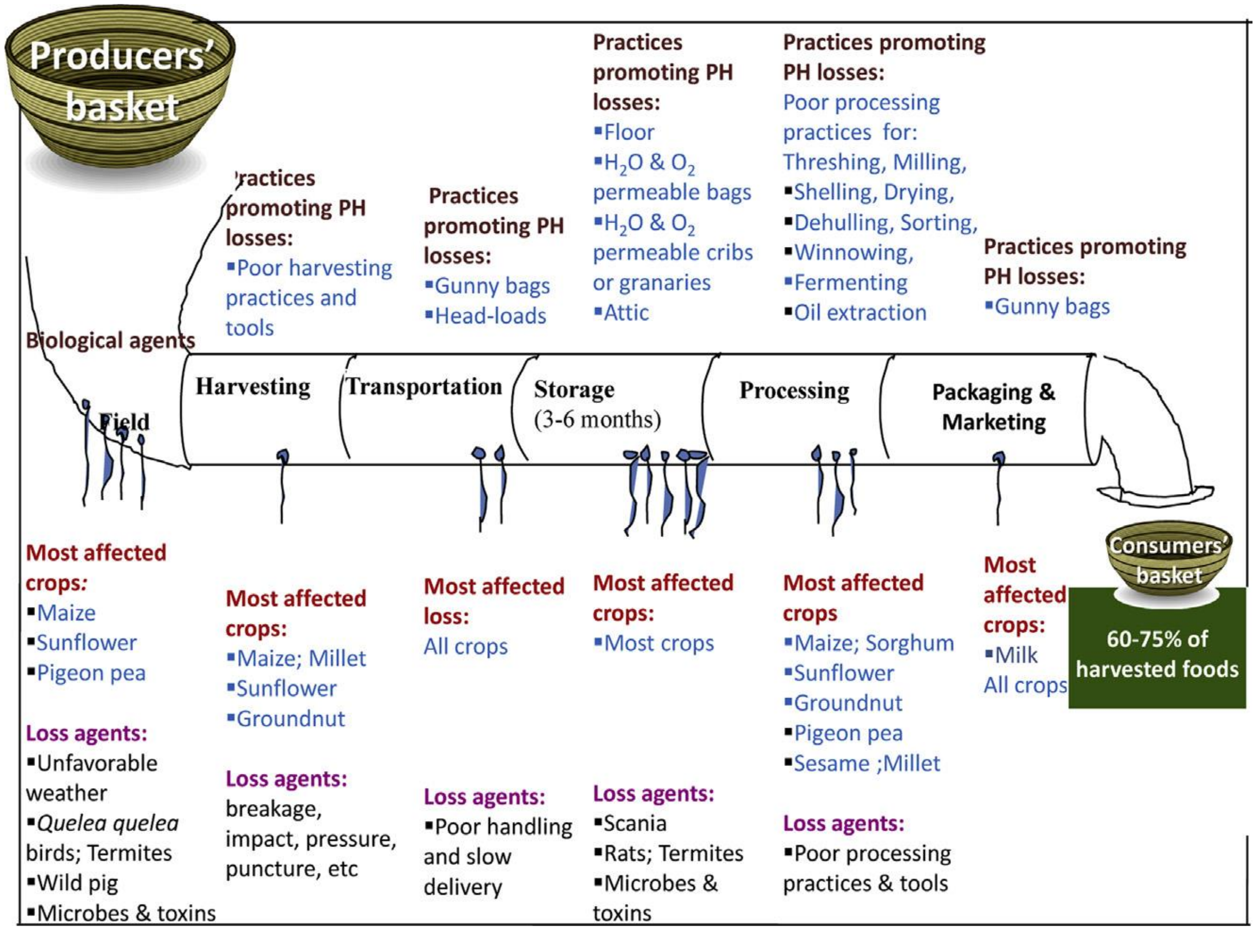

Figure 1: The Leaking Food Pipeline Model (Bourne, 1977; Obeng-Ofori, 2011)
Source: Journal of Stored Products (2014)

AGRIBUSINESS INVESTMENT

In Rwanda, despite a growing SME subsector, agribusiness investments geared towards preserving and promoting product uptake have been less pronounced. Apart from a handful of agro-input companies, private sector investment in the downstream sector is poor. Processing companies are few and far between while direct markets for products sale remain inadequate causing stock build-up and massive biodegradation of crop products.

Among the major steps required towards meeting the growing demand for high-value agribusiness products in SSA is incremental private investments in agriculture. Four principal investment domains have been identified: 1) input delivery 2) farming/primary production 3) post-harvest and processing (agro-industry) and 4) marketing and distribution. Regrettably, the present level of agro-investments has not been sufficiently impressive. Despite the notable political, policy and institutional reforms to ease the climate of investments, strong barriers in the form of rampant corruption and poor infrastructures still remain a disincentive. Agribusiness financing is pervasively low notwithstanding the average public expenditure of 7% in terms of annual budget. In a survey of 11 selected countries of Botswana, Gambia, Kenya, Ghana, Lesotho, Malawi, Mozambique, Nigeria, Sierra Leone, Uganda and Tanzania between 1995 and 2008, average lending to the sector as a percentage of total portfolio stood at a paltry 5.8% (Mhlanga, 2010).

Overall, the yearly funding gap in the sub-continent is estimated at a frightening $11bn. Countries in the Southern Africa sub-region had the largest share of agribusiness investments involving both local and foreign investors followed by West Africa. The main commodities involved are rice, palm oil, sugarcane, and timbre. Nwibo *et al*. (2013), working in the South-eastern part of Nigeria, found that 60% of agribusiness investments in the region was concentrated in the agro-input subsystem. The shares of others were given as: 55%-processing and 54%-distribution and marketing.

FOOD SECURITY

Food Security has been defined by the United Nations Committee on World Food Security to mean that "all people at all times, have physical, social and economic access to sufficient, safe, nutritious food that meets their food preferences and dietary needs for an active and healthy life. The Global Food Security Index measures food security based on three core pillars of availability, affordability and quality/safety and classifies countries into four categories which are: high food security, marginal food security, low food security and very low food security (IFPRI, 2016). Over the years, the proportion of the global population that is food secure has been diminishing. Close to 800 million people do not have access to adequate food, over 2 billion individuals are gripped by micro-nutrient deficiencies and 60% of people in low-income countries are food insecure (Escamilla, 2017). Of the 86 countries that are defined as low-income and food-insecure, 43 are in Africa. Worse still, by 2050, the demand for food will be 60% higher than current levels today (Keith, 2016). Within the SDGs framework, ending hunger, achieving food security and improved nutrition is a paramount goal. The path to meeting this goal begins by identifying the challenges and developing appropriate solutions. Among these challenges are physical factors such as climate change, soil quality and water scarcity, as well as human factors like change in taste, technology and population growth. Broadly, five ways have been suggested to improve global food security. These are closing of yield gap, increased use of inputs, scaling up of water productivity, targeting of food for direct consumption and reduction of postharvest losses.

MATERIALS AND METHODS

A total of 22 cooperatives made up of 2991 members were supported in the district. These were stratified into three groups using local administrative proximity. Eligible farmers in each group were prequalified on the basis of land ownership. Farmers, who co-owned plots either with their wives, husbands or friends, were excluded from enumeration. From each cluster, a subsample of 100 farmers was taken by simple random sampling. Of the total sample of 300 farmers, only 272 of them completed enumeration using semi-structured questionnaires adapted from the baseline study. Responses were collected on variables such as farmers' demographics, product loss, household characteristics and food consumption pattern, access to financial services, crop yield, quantity sold and many others. Performance of cooperatives as a function of transformative investments in Post-Harvest Infrastructure (PHI) was evaluated using their Annual Financial Statements. Project documents and external country project evaluation reports were also consulted for supportive secondary data. Both descriptive and inferential statistical tools were utilized in the final analysis of results. Total Factor Productivity Theory was applied to assess overall agricultural productivity in the study district.

Measured as the inverse of unit variable cost,

TFP= $\frac{Y}{\sum PiXi}$ where,

Y=quantity of product or output

P=unit price of i^{th} variable

X=quantity of ith variable

Then, $\sum pixi$=TVC

From cost theory,

Average Variable Cost (AVC) = $\frac{TVC}{Y}$ and

Y=$\frac{TVC}{AVC}$ showing that under efficient production practice, output (Y) is inversely proportional to Average Variable Cost.

The cost elements considered under the study were those of inputs i.e. seed and fertilizer, hired labour as well as credit facilities extended to farmers. Furthermore, economic cost of PHL was calculated by deducting total income received by farmers from the total production cost (TVC). This operation is given as:

EL=TVC-TI, where;

EL-Economic Loss

TI- Total Income from product sales

Major assumptions behind economic cost analysis
1. Mean selling price of both maize and beans was determined using price amplitude in each value chain within the sales period.
2. All farmers were assumed to have suffered product loss during the period given the preponderance of PHL among them

RESULTS AND DISCUSSION

In the various areas covered by this study, empirical findings show the series of changes that have taken place since project implementation. These changes are well noted in all areas though with varying degrees of impact.

Socio-demographic characteristics

Table 1: Participants by Gender

S/N	Gender	Frequency	Percentage
1	Male	107	39.3
2	Female	165	60.7

Source: Authors' Field Survey (2018)

From table 1, the study found a higher proportion of women (60.7%) than men (39.3%) in maize and beans value chains. This contrasts sharply with baseline findings of 64.1% for men and 35.9% for women but is essentially similar to what other studies have reported on the dominance of women in staple crop production in Africa (Yemisi, 2009).

Table 2: Gender and Age Distribution

		Age in years				Total
Gender		15-30	31-46	47-62	63-78	
	Male	9	61	28	9	107
	Female	29	56	66	14	165
Total		38	117	94	23	272

Source: Authors' Field Survey (2018)

Table 2 portrays the reality of farmers' age showing that most farmers (117/ 43.0%) were in the productive age group 31-46years as against 31-60years reported in baseline. This age-labour force distribution compares favourably with farmer age demographics around the world: US-58.3 years, Japan-60 years and Africa- >60 years (Gro-intelligence, 2016) and portends a healthy future for the development of agriculture in Rwanda. Notwithstanding the preponderance of women, a striking feature of the age-gender distribution is the larger number of men (61/ 52.1%) in the productive age cohort which tends to suggest that the district's agricultural practice was under the control of ageing women.

6.2 Magnitude and gender distribution of product losses

Table 3: Respondents by product loss

Product loss	Frequency	Percentage
Yes	235	86.7
No	36	13.3

Source: Authors' Field Survey (2018)

Table 3 shows the spread of PHL in the period under consideration. It revealed that virtually all farmers were affected with 86.7% of them admitting losses. This development was regarded exceptional in respondents' farming experience.

Table 4: Extent of Product Loss

Extent of losses in %	Frequency	Percentage	Mean
0-19	64	27.0	
20-39	24	10.1	
40-59	32	3.9	
60-79	35	15.2	
80-99	80	33.8	
			52.1%

Source: Authors' Field Survey (2018)

Self-reported estimated losses by farmers are contained in table 4 above. Clearly, majority of smallholders (33.8%) were worse off losing between 80% and 99% of their crop products. The mean proportional product loss stood at 52.1%. Loss pattern of this nature is strange in the literature and points to something much more fundamental.

Table 5: Gender and Product Loss

		Product Loss		Total	P-value
		Yes	No		
Gender	Male	98	8	(92.5%)106	
	Female	137	28	(83.0%)165	
					0.026

Source: Authors' Field Survey (2018)

Table 5 displays the relationship between gender and product losses. It delineates the pattern and shows the gross gender dimension of the problem. In absolute terms, more women (137), lost crop products than their male counterparts. However, further micro-analysis revealed the differential intensity of the losses with 92.5% of men compared to 83.0% of women suffering crop losses. The gender difference in PHL was statistically significant at $p<0.05$. Not much work has been done in the literature to profile gender differences in PHL and provide vital basis for comparative assessment.

Table 6: Stages of Product Loss by Respondents

Stage	Frequency	Percentage
On-farm	189	81.5
Harvest and handling	35	15.1
Processing	6	2.6
Transportation and marketing	1	0.4
Not applicable	1	0.4

Source: Authors' Field Survey (2018)

Table 6 is the visual narrative of the various stages at which product losses could occur. It shows that in the season under review, on-farm losses were predominant. The same pattern was observed in baseline study and represents the general trend in Less Developed Countries as reported by Hodges (2010) and Boxall (2001)

Figure 2 below is a summary of the major causes of PHL in the study district. Apparent is the leading role of drought accounting for 59.3% of all cases and precipitating massive production shortfalls across sectors. In other words, it could be said that the trend of PHL in the season was more of crop failure arising from drought rather than a true case of postharvest losses. This is not surprising given that Nyagatare is one of the notable drought-prone agricultural areas in Rwanda with frequent environmental surveillance.

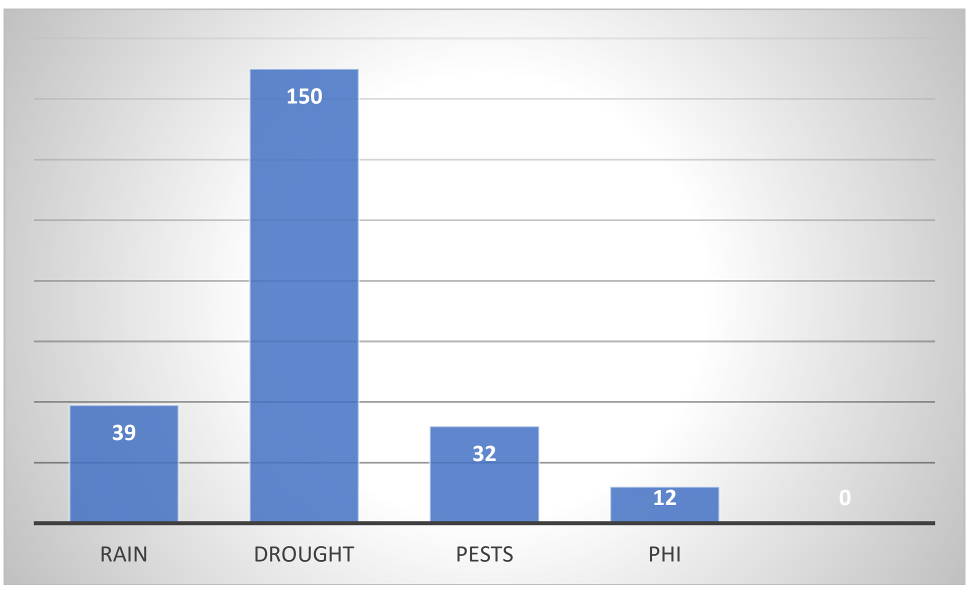

Figure2: Causal Distribution of PHL
Source: Authors' Field Survey (2018)

Economics of PHL

Table 7 provides the relevant indices for determining the economic impact of PHL on smallholders. The total variable costs are highlighted along with accruable revenue from product sales.

Table 7: Descriptive statistics of key economic variables

S/N	Variable	Frequency	Percentage	Total cost (Rwf)
1	Improved seed	241	88.6	2,253,800
2	Fertilizer	243	90	9,599,730
3	Hired labour	237	87.5	66,250,000
4	Farmers' labour cost	-	-	130,080,000
5	**Sub-total A (TVC)**			**208,183,530**
6	Sales income	-	-	136, 750, 000
	Sub-total B (TI)	**-**	**-**	**136, 750, 000**

Source: Authors' Field Survey (2018)

Substituting the various figures in the earlier equation,
EL =**71, 433,530Rwf.**
AL (average loss) =**262,623.27Rwf.**

Table 8: Product yield vs Quantity sold

Year	Crop yield	Quantity sold
2017	581	567

Source: Authors' Field Survey (2018)

District productivity summary

From tables 8

$$TFP=\frac{581}{208,183.53}x100=0.28\%$$

The foregoing reveals that farmers in the district lost an average of 262, 623.27Rwf largely approximating the cost of climate change. Similarly, labour efficiency was markedly low with a dismal TFP of 0.28%.

Agribusiness investments and PHL

Though, under the HUB intervention paradigm, many agribusiness support services were promoted by the project cutting across the pre-and post-production sectors. However, the project focus was on sustained improvement in post-harvest operations. In consequence, we looked at the effects of these investments on two levels namely: cooperatives, as primary project beneficiaries on the one hand, and individual farmers, as secondary beneficiaries on the other. Likewise, we equally made use of two distinct parameters for impact assessment: the magnitude of PHL attributable to deficiency of PHI as reported by SHF and then, cooperatives' inventory-revenue inflow secondary to the use of the facilities.

Table 9 Availability of modern PHI

S/N	PHI Type	Yes	%	No	%
1	Drying facility	160	59	108	41
2	Storage facility	191	71.3	97	28.7

Source: Authors' Field Survey (2018)

Table 9 reflects the character of rural agribusiness investments as they relate to the fundamental processes of drying and storing of crop products in an increasingly volatile climatic setting. For drying facility (DF), density increased from 46.6% pre-project to 59.0% at the time of the study while storage facility density, on the other hand, experienced a stunning leap from 46.8% to 71.3% within the same period. It is also apparent from the distribution that there were more investments in the SF arm than DF. This increase is a welcome development in view of the persistent clamour by researchers in the field to raise investments in basic PHI in order to tackle the challenges of postharvest care among smallholders in low-and middle-income countries which are predominantly environmental in nature. (Atanda et al, 2011)

Table 10 Utilization of modern PHI

S/N	PHI	Yes	%	No	%
1	Drying facility	116	42.6	156	57.4
2	Storage facility	152	55.9	120	44.1

Source: Authors' Field Survey (2018)

Table 10 shows the actual way each facility was put to use by respondents. Evidence indicates that lower number of respondents made use of DF compared to SF at 42.6% and 55.9% respectively with overall mean utilization rate of 49.3%. Though, this was less than the pre-project value of 55.3%%, nevertheless, the proportion of product losses attributed to deficiency of PHI declined from 25 % to 15.7%% (figure 3). Put differently, more farmers accessed better postharvest care than before.

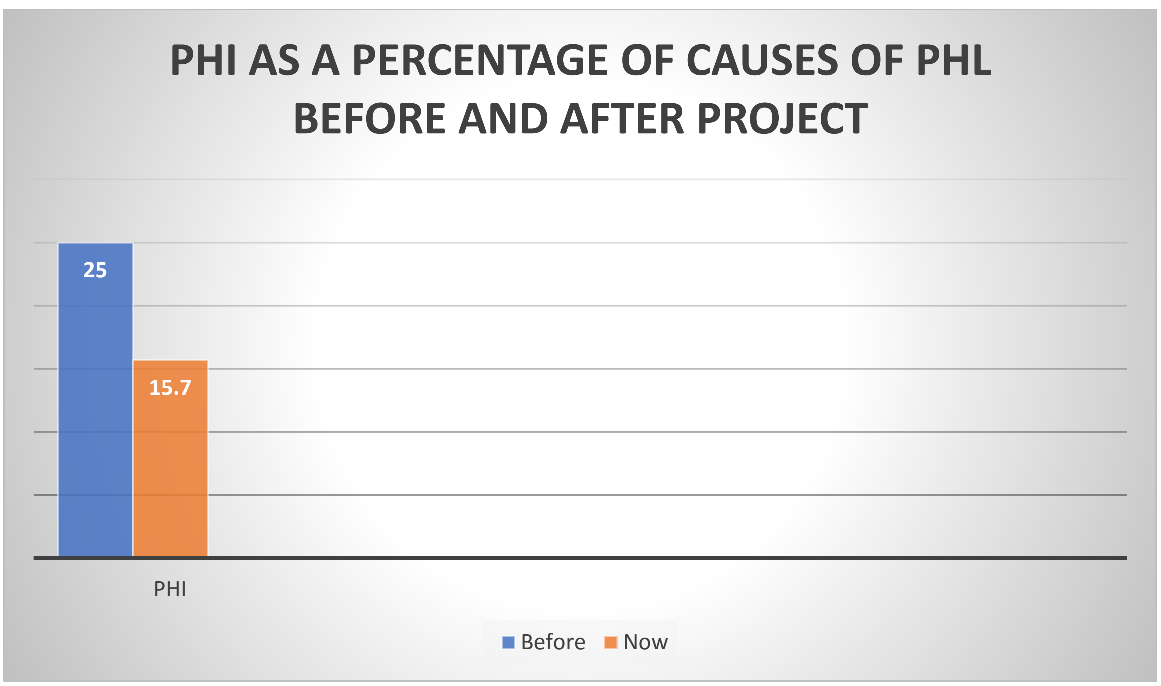

Figure 3: Percentage contribution of PHI to PHL
Source: Authors' Field Survey (2018)

Figure 3 shows the comparative benefit attribution of investments in PHI. Here, the share of PHI as a cause of PHL declined from 25.0% to 15.7%. This represents a laudable push towards realizing the government strategic objective of improved use of technology as captured in sub-program 1.5.2 of its PSTA

Table 11: Four-year cumulative inventory vs revenue inflow

S/N	Accounting year	Cumulative inventory (tons)	Accruable revenue (Rwf’000)	P-value (2-tail)
1	2014	171.59	27,956,500	
2	2015	336.11	63,047,230	
3	2016	187.72	36,892,220	
4	2017	297.02	77,629,105	
				0.01

Source: Computed by the author from AFS of selected cooperatives (2018)

Table 11 depicts the trend of product aggregation and sales over a four-year period. It shows fluctuating levels of product quantity against a generally upward trend in revenue. Of more importance is the 2016/2017 transitions in both harvest and product sales. Within this period, revenue more than doubled throwing up a critical, life-saving hedge around smallholders as the 2017 drought-driven production shock moved in. This development was made possible by higher product prices arising from a combination of contract farming, increased agro-processing investments and mainstreaming of smallholders’ produce in regional trade activities. We found the income-inventory relationship statistically significant at $p<0.01$ using Pearson Product Moment Coefficient.

6.6 Household characteristics and food consumption pattern.

Different parameters have been used for classifying HHs in Rwanda and determining the scope of social and economic support applicable to them. Some of these are contained in the tables below.

Table 12: Household Size

Household size	Frequency	Percentage
1-3 people	51	18.8
4-6 people	145	53.5
7-9 people	72	26.6
10-12 people	3	1.1

Source: Authors’ Field survey (2018)

Table 12 is an estimate of the number of person (s) making up a family unit. In the case shown above, HH size was moderate with 53.5% of respondents having a family size of 4-6 members. Overall average family size was 3.0 people against 4.5 nationally (EICV4). The observed modest family size may be a direct response to the bullish run of family campaign in the country.

Table 13: Household Head and Age Distribution

		Participant's age				Total
		15-30	31-46	47-62	62-77	
HH Head	Male	9	26	15	6	56
	Female	29	91	79	16	215
		0	0	0	1	1

Source: Authors’ Field survey (2018)

Table 13 on household headship and age distribution provides some instructive details. On the one hand, it indicates that family headship was defined mostly around women with 215(79.0%) of them heading their respective households. On the other hand, headship by young persons under 30 years was observed to be growing at 13.9%. Implication of youth headship of families in an atmosphere of rampant economic disadvantage is grave. For one thing, youth-based cooperatives supported by the project had a number of peculiar problems. They were essentially landless and operated on leasehold without certainty of tenure. As a result, they went and are still going through repeated cycles of engagement and joblessness with grim import for family welfare and stability.

Table 14: Access to food

S/N	No of meal(s) per day	Frequency	Percentage
1	3	237	87.1
2	2	35	22.9
3	1	-	0

Source: Authors' Field survey (2018)

Ability to feed is an important measure of poverty in all civilizations. In table 14, meal frequencies among respondents are displayed. It comes out explicitly that overwhelming percentage (87.1%) of HHs could afford three square meals daily (6% pre-project). Those who ate less than 3 times a day did not attribute the pattern to food shortage either in the physical or economic sense but rather to their farm schedule and customary eating habit. Disaggregation by gender and commodity value chains revealed nothing significant. This finding validates many other assessment reports on the changing food security profile in Rwanda. According to the 2018 Rwanda-Comprehensive Food Security and Vulnerability Analysis, 81.3% of Rwandans are food secure meaning they are able to provide their food and non-food needs without recourse to atypical coping strategies (WFP, 2018)

Table 15: Sources of food stuff

S/N	Source	Frequency	Percentage
1	Family farm	90	33.1
2	Trader	45	16.5
3	Open market	137	50.4
4	Food aid	Nil	0

Source: Authors' Field survey (2018)

Table 15 vividly reveals a pattern of self-sustenance among the study HHs. It shows that most respondents (50.4%) bought supplies from the open market followed by those who sourced their food needs from the family farm (33.1%). However, no respondent was ever involved in charity feeding. By implication, open-market access of food is a good indicator of purchasing power and when viewed against the background of table 8 showing that 97.6% of total harvest was sold in the season under review, we note with satisfaction that the two core dimensions of food security namely availability and affordability appeared significantly fulfilled.

CONCLUSIONS

This study has examined the nexus between agribusiness investments, PHL and food security. It has shown that building investment bridge between the government and the people especially in closing storage and drying gaps is pivotal to changing the narratives of PHL and promoting food security among rural populations. We are however, unable to prove a direct association between these investments and the response variables due to paucity of data. Future work may need to look more closely at intertemporal trend in more analytic manner to generate greater empirical evidence. Going further, climate change effects remain a strong catalyst of product loss with dire financial consequences in the reviewed season. When left unaddressed, it can worsen smallholders' poverty in many significant respects. In addition, we note appreciable improvement in the district's food security index even, if only in the crude sense of availability and affordability. While it is generally agreed that climate events are a shifting target much less amenable to accurate prediction and pinpoint actions, the authors believe that a lot can be achieved if the following measures, targeting both ecological and non-ecological events, are given adequate attention within the national policy space:

1. Promotion of climate-smart agricultural practices.
2. Human capital development
3. Adoption of crop insurance policy to indemnify farmers and also provide security for agro-dealers under the "buy now, pay latter" input supply system.
4. Deepening of private sector engagement in agriculture especially by encouraging more investments in low-carbon post-harvest management infrastructures like solar-powered drying tunnels through deliberate encouragement of multi-party investment platforms consisting of different value chain actors to address the cost constraint
5. The "co-sector" development plan is crucial to facilitating a system-wide approach to the reduction of PHL. Investments in co-sectors like power, ICT and roads have been identified as primal.

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