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HOW INNOVATION PLATFORMS GOVERN THE EXPERIENTIAL LEARNING PROCESS OF COFFEE FARMERS IN UGANDA

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ABSTRACT

While researchers, development actors, and policymakers recognize that Innovation Platforms govern farmers' development knowledge when attempting to address challenges, the question of how IPs' governance mechanisms affect their learning process remains unaddressed. Using data from a cross-sectional survey of 214 coffee IP farmers, this study employs Partial Least Squares-Structural Equation Modeling (PLS-SEM) to analyze the relationships between IP governance and farmers' experiential learning. The relationship between challenges, reflection, experiential knowledge, active experimentation, and IP governance mechanisms (that is, IP members' commitment and trust, IP members' involvement, and Member access to IP resources) was specifically examined. Results show that when farmers try to address their challenges, IP governance mechanisms positively and negatively affect their acquisition of experiential knowledge through reflection and active experimentation using existing knowledge. Specifically, Innovation Platform members' commitment, trust, and involvement significantly and positively moderate the link between farmers' challenges and their reflection, while the influence of members' access to IP resources is insignificant. Similarly, while access to IP resources has an insignificant and negative moderation effect on the link between farmers' reflection and experiential knowledge, IP members' commitment, trust, and involvement have positive but insignificant effects on them. Farmers' commitment, trust, involvement, and access to IP resources did not affect the relationship between their experimentation and experiential knowledge. Finally, the IP members' commitment, trust, involvement, and access to IP resources have insignificant effects on the relationship between farmers' active experimentation and their challenges. Coffee farmers should use their networks to encourage commitment and involvement in intellectual property to reflect and gain knowledge. Similarly, IP facilitators should build trust among their members. Agriculture extension policymakers can use IPs as units to identify practical interventions to local challenges and improve targeted rural agriculture value chains by connecting different stakeholders to farmers at the community level because reflection as a learning activity must be consciously elicited through learning actions.

Key words: Agricultural extension systems, agricultural innovation systems, value chain development, governance

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INTRODUCTION

Innovation platforms (IPs) are the most prevalent operationalization of coffee value chains in Uganda. Innovation Platforms are described as a multi-stakeholder forum where farmers learn how to address their farming challenges for increased agricultural productivity, and socioeconomic well-being by tapping into the capacities of diverse actors. Existing literature attributes farmer-learning to address their challenges in part to the governance mechanisms established by IPs. In line with this literature, IP governance is defined as a set of mechanisms, such as set guidelines, that determine or regulate the activities of actors in the value chain. Innovation Platforms indirectly influence farmers' learning to overcome challenges by managing their learning activities and resulting knowledge. Indeed, Sako *et al.* [1] reported that farmer commitment and involvement in IP activities aided them in reflecting on their prior knowledge. Besides that, Akpo *et al.* and Audouin *et al.* [2, 3] found that trust fostered by IPs among farmers and other value chain actors encourages reflection on the farming information shared. Trust in the information shared encouraged involvement in IP-level activities, which resulted in increased knowledge. IPs promote commitment and trust among actors, allowing the sharing of farming information and getting involved in IP-level learning activities including reflecting on their challenges [2, 4]. Finally, IPs support farmer experimentation by mobilizing resources such as information, money, stakeholders, seeds, and research tools [1].

However, the existing literature attempting to link IP governance mechanisms to farmer learning to address their challenges is qualitative, descriptive, and fragmented [5]. These studies are fragmented in that they emphasize challenges and resulting solutions or challenges and resulting knowledge. Individual aspects of learning, such as challenges, and resultant outcomes, such as solutions or knowledge, cannot provide a whole picture (explain) of farmer learning to address their challenges. Furthermore, through synthesis one can capture IP governance mechanisms such as IP members' commitment and trust, participation, and access to IP resources. No link between the governance mechanisms and the farmer learning process is established. Moreover, these studies show the proportions of farmers' knowledge about ways to address their challenges. This is attributed to good IP governance. However, as stated earlier, there is no clear link with the IP governance mechanisms. Therefore, the current paper seeks to determine the effect of IP governance mechanisms on farmer learning to address their challenges.

Literature review and hypothesis development

Experiential learning (EL) is an approach to learning that entails addressing challenges [6]. Kolb's EL theory is widely used by scholars in contemporary research to better understand the EL process [7]. According to Kolb's theory, EL is a cyclical

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and context-dependent process in which experiences are transformed into experiential knowledge [8]. It portrays and idealizes a learning cycle in which learners engage in experiencing, reflective observation, abstract conceptualization, and active experimentation. When applying Kolb's theory to determine the effect of IP governance mechanisms on farmer learning to address their challenges, five sub-concepts are discussed, namely, (1) experiences, (2) reflection, (3) experiential knowledge, (4) active experimentation, and (5) context, which is IP governance systems in this case.

First, experiences are the result of active experimentation. According to Kolb, the EL process starts with actual experiences or experiential learning activities. Existing research on EL describes experiences as challenges. This study emphasizes the value chain challenges that smallholder coffee farmers' face. Ochago *et al.* [4] found that challenges such as pests and diseases, poor quality and quantity of coffee, and low and unpredictable coffee prices kick-start farmers' EL. This study, like Ochago *et al.* [4], combines four interconnected elements to identify farmers' challenges, in line with coffee value chains, including, challenges during production, harvesting, postharvest handling, and marketing.

The second step is reflection, which involves reviewing and analyzing expected and unexpected experiences. Farmers reflect on their learning experiences from challenges they encounter along their value chain. In the field of psychology and education, reflection involves seeing, hearing, and discussing the experience—what happened, how it happened, and why it happened [9]. Innovation Platforms place a greater emphasis on systematic and iterative learning through reflection[10, 11]. Innovation Platforms are known to provide space for farmers to reflect while engaging in IP-supported training, exchange visits, look and learn (observation), and experiments, as well as after such activities [2]. Recent evidence from qualitative studies suggests that when faced with coffee value chain challenges, the process by which farmers reflect on their current knowledge and interactions with other value chain actors is moderated by IP members' commitment, trust, involvement, and access to IP resources. As indicated by Ochago *et al.* [4], Mt. Elgon region coffee IP farmers' commitment and trust, involvement, and access to IP resources aided them in reflecting on their current knowledge, and interactions with other value chain actors when confronted with coffee value chain challenges. Similar findings have been reported in other IP and learning studies, for example, [1] reported that farmer commitment and involvement in Kolokani Groundnut Innovation Platform activities assisted them in reflecting on their existing knowledge. Besides that Akpo *et al.* [2] and Audouin *et al.* [3] found that trust fostered by IPs among farmers and other value chain actors encourages reflection on the farming information shared. Simultaneously, other studies such as Sah *et al.* [12] found that IP members rely

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heavily on IP-mobilized resources such as funds, stakeholders, land, meeting venues, seeds, transportation, and research technologies to support their learning activities, which may include reflection. Following the preceding, members' access to IP resources may influence their ability to reflect on their challenges. Therefore, this research was based on the following four hypotheses.

Hypothesis 2a: IP members' commitment, trust, involvement, and access to IP resources positively moderate the relationship between their coffee value chain challenges and reflection.

Abstract conceptualization is the third stage. Learners extract lessons and generate conclusions based on their reflective analysis at this stage. Abstract conceptualization is referred to as experiential knowledge in this article. Experiential knowledge is the result of reflection on farming challenges. Experiential knowledge is information learned solely from personal experience. Farmers in IPs, for example, learn about new farming methods including optimum plant spacing, line planting, composting, fertilizer application, and value chain actors through IP-regulated interactions [2, 13, 14]. According to Ochago *et al.* [4], farmers' level of experiential knowledge increased when they reflected on their current knowledge during and after participating in activities such as field demonstrations, and interacting with other value chain actors. Trust in the information shared encouraged commitment and involvement in IP-level activities, resulting in increased knowledge. Even though the moderating effect of IP governance mechanisms on farmers' knowledge acquisition through reflection was not statistically assessed in their study, it is implied. Therefore, Ochago's study, as well as others such as Audouin *et al.* [3] are used to evaluate the following hypothesis.

Hypothesis 2b: IP members' commitment, trust, involvement, and access to IP resources positively moderate the relationship between their reflection, and the level of experiential knowledge.

Active experimentation is the fourth step. At this stage, solutions, alternative methods of action, or remedial action plans produced from 'abstract conceptualization' are implemented. Farmers experiment to see if they can address their challenges with what they already know [15]. They experiment with new seed varieties, and alternative production processes, and look for new ways to promote their products through their social networks [16]. Farmers are, in fact, part of a larger social context, emphasizing the importance of networks. Skaalsveen *et al.* [17] found that farmers experimented by utilizing existing ideas and approaches and transmitting their knowledge through informal learning networks. Farmers' level of experimentation increased when they used their current knowledge of how to address challenges and interact with other value chain actors [16]. Therefore, active

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experimentation occurs when farmers use their existing coffee value chain challenges to solving-knowledge and interact with other value chain actors to increase their level of experiential knowledge. In terms of IP governance and farmer experimentation, IPs help farmers experiment in a variety of ways. For instance, the Burkina Faso Groundnut Innovation Platform built trust through brokering the relationship between farmers and extension service staff, leading to the establishment of field demonstrations on groundnut production and improved varieties as a solution to the low productivity caused by limited access to improved legume varieties [16]. Similarly, with the assistance of R&D partners, IPs encouraged farmer commitment and trust by establishing farmers' seed producer groups. Concurrently, the platform used extension agents' existing knowledge to spark the distribution of improved technology to a large number of farmers through field demonstrations [18]. Innovation Platforms, according to other researchers [1] facilitate farmer experimentation by mobilizing resources such as information, funding, stakeholders, land, meeting venues, seeds, transportation, and research tools. The following hypotheses were assessed because of this:

Hypothesis 2c: IP members' commitment, trust, involvement, and access to IP resources positively moderate the relationship between their experiential knowledge and active experimentation.

Again, IP farmers engage in a variety of experimentation activities to improve their challenges-solving abilities using existing farming challenges-solving knowledge [1, 19]. Ochago *et al.* [4], for example, found that IPs assisted farmers in experimenting with alternative pest and disease control measures as a solution to high disease and pest infestation. When farmers realized that the root cause of the pest and disease problem was fake agrochemicals, they collectively (via their IP) purchased certified agrochemicals in bulk from reputable dealers in their farming communities. In this arrangement, the IP acts as a facilitator to build interpersonal trust among IP members through the open sharing of information and evidence-based data [20]. Innovation Platforms improve farmer commitment, involvement (participation), and access to resources such as seeds and research technologies in other arrangements [1, 19]. According to the literature reviewed, IP governance moderates the relationship between experimentation and farmers' challenges solving ability, which leads to the final hypothesis of this study.

Hypothesis 2d: IP members' commitment, trust, involvement, and access to IP resources positively moderate the relationship between active experimentation, and their challenges solving abilities.

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MATERIALS AND METHODS

Description of study context

This research was conducted in the sub-regions of Sebei and Bugisu in the Eastern region of Uganda. Agriculture is the principal economic activity of the study area, which is divided into the following three zones as a highland, midland, and lowland. These topographical zones determine the types of farming activities farmers engage in, and the crops they produce. The highlands and midlands are dominated by coffee and bananas, while the plains, or lowlands are dominated by maize and bananas. Coffee is grown by smallholder farmers on plots of less than one acre (0.40 ha), which are frequently intercropped with bananas. The average coffee yields in Kapchorwa ranges from 1556 $kgha^{-1}$ to 1776 $kgha^{-1}$ (1388. 23 lb. ac^{-1} to 1584.51 lb. ac^{-1}) in Manafwa/Namisindwa. The high prevalence of insect pests and diseases is principally responsible for the low output potential [21]. Furthermore, insect pests and diseases are responsible for low coffee quality, resulting in low and volatile coffee market prices. This is an example of a complex coffee-growing challenge that needs several solutions. Complex farming challenges have several dimensions rooted in interactions across diverse social settings and involve a variety of actors. As a result, Uganda's extension strategy has focused more on coffee value chain development or upgrading. In this arrangement, a variety of actors come together to find solutions to farmers' challenges. The most prevalent operationalization of coffee value chains is through innovation platforms (IPs). Accordingly, coffee IP farmers in the districts of Kapchorwa, Manafwa, and Namisindwa were researched to contribute to ongoing discussions about IP governance and farmer learning.

Survey design

A structured survey questionnaire was used for data collection. A sample of 214 respondents were interviewed for an average of 1 hour and 15 minutes each, using a standardized survey questionnaire that was content validated. A systematic selection procedure was used to pick survey participants. The structured interview instrument's applicability was tested with a comparable group that did not participate in the study. The survey tool for actual data collecting was refined as a result of the pre-test. Following Kolb's definition of experiential learning, this study focused on five interrelated concepts (Table 6), which include (1) the challenges, (2) reflection, (3) the experiential knowledge, (4) active experimentation, and (5) the context, in this study specified as IP governance mechanisms.

Data analysis

The SPSS version 23 was used for data analysis. The survey data was edited using the SPSS version 23 for completeness and data omission before data analysis. Data editing involved checking missing values and revising incorrectly worded items and codes. After editing the data, the factorability of the data was tested using Kaiser-

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Meyer-Olkin (KMO) and the Bartlett test of sphericity (BTS). Ideally, a KMO value of 0.6 and a significant p-value of 0.05 for the BTS are required for the data to be considered factorable [22, 23]. The data for this study satisfied the criteria (Table 2), and an Exploratory Factor Analysis (EFA) was performed with principal component analysis (PCA) and varimax rotation. Based on the result from EFA, the partial least squares structural equation modeling (PLS-SEM) method [24] with the support of statistical software SmartPLS 3 was used to obtain the results [25]. Partial least squares structural equation modeling is a popular method for studying complex inter-relationships between observable and latent variables in a range of domains, including agricultural science and psychology.

RESULTS AND DISCUSSION

Descriptive statistics and correlations

The zero-order correlations among all dependent, independent, and moderator variables are shown in Table 1. Farmers' value chain challenges were found to have a significant correlation with reflective analysis, active experimentation (that is, $r = 0.195$, $p < 0.01$ and $r = 0.284$, $p < 0.01$), and experiential knowledge (that is, $r = 0.138$, $p < 0.05$). In this study, the moderator found no significant connections between IP-member involvement and member access to IP resources as IP governance mechanisms. Finally, Reflection, Active experimentation, Experiential knowledge, IP members' commitment and trust, IP members' involvement, and Member access to IP resources are correlated.

Assessment of the measurement models

Based on the zero-order correlations among all dependent, independent, and moderator variables (Table 1), the initial step before testing the hypothesis was to run algorithms to validate measurement reliability and validity before examining structural model linkages. At this stage, the outer loadings, Cronbach alpha value, composite reliability, and average variance extracted were obtained. For the generation of 95 percent confidence intervals for significance testing, a bootstrap using a 5,000 resampling technique was utilized. The standard error and covariance matrix estimator with heteroscedasticity was utilized. All factors that define the product, such as IP governance procedures, challenges, reflection, and active experimentation, were mean-centered. Hair *et al.* [24] have well-documented procedures for evaluating loadings, Cronbach's alpha, composite reliability, rho_A, the average variance extracted, and discriminant analysis for reflective components (Table 3 and 4).

As previously mentioned, the first stage in evaluating the reflective measurement model is to investigate the factor loading of the various variables grouped. Previous research has recommended using 0.70 as the cut-off for an acceptable factor

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because it explains more than 50% of the variance in the indicator [24]. The initial run of the PLS algorithm revealed that some items had low outer loadings (Table 6). After removing and rerunning the PLS algorithm, the results were satisfactory. The bulk of loadings in Table 6 was satisfactory and extremely significant ($p<0.01$). While some indicator loadings were less than 0.7, they were preserved since the constructs' composite reliabilities exceeded the acceptable requirement of 0.7 [26].

Cronbach's alpha, rho_A, and composite reliability with a cut-off of 0.7 were also used to examine the internal consistency of the groupings of impeding factors, as proposed in previous studies [24, 27, 28]. Table 3 shows that all Cronbach's coefficients, rho_A, and Composite Reliability values were greater than 0.7, demonstrating internal consistency and reliability. This outcome demonstrated satisfactory indicator reliability [27]. The convergent validity of these variables was also assessed using average variance extracted (AVE). The AVE test is intended to ensure that measurement variables are free of systematic measurement error, and the recommended cut-off for this test is 0.5 [24]. All AVE values were above 0.5, showing high convergent validity.

For discriminant validity, the bootstrapping procedure with 5,000 samples, the no sign changes option, the bias-corrected and accelerated (BCa) bootstrap confidence interval, and two-tailed testing at the 0.05 level were used [29]. The heterotrait-monotrait (HTMT) values were lower than the 0.85 conservative thresholds, as shown in Table 4 [25]. Discriminant validity was proven by these findings [27].

Assessment of the structural models

A moderated mediation model is shown in Table 5. As expected, Table 5 shows that IP members' commitment and trust had a positive and significant moderating effect on the association between challenges and reflection ($\beta=0.031$). Further analysis showed that IP members' involvement has a positive and significant effect on the link between challenges and reflection ($\beta=0.042$). These findings quantify what was previously reported in qualitative research. As per Ochago *et al.* [4], when confronted with coffee value chain challenges, coffee IP farmers' commitment and trust, involvement, and access to IP resources aided them in reflecting on their current knowledge and interactions with other value chain actors. Similar findings have been reported in other IP and learning studies; for example, Sako *et al.* [1] reported that farmer commitment and involvement in Innovation Platform activities aided them in reflecting on their existing knowledge. Besides, Akpo *et al.* [2] and Audouin *et al.* [3] found that trust fostered by IPs among farmers and other value chain actors encourages reflection on the farming information shared. Second, this is the first study to examine the moderating effects of specific governance mechanisms on reflection when faced with challenges and the acquisition of experiential knowledge through reflection. Surprisingly, member access to IP resources had no effect on the

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association between challenges and reflection (β=-.007). With resources [30] like money, stakeholders, land, meeting places, seeds, transportation, and research technologies, one would hope that farmers would have adequate time to reflect on their challenges. The explanation for the results is the type of provider (who and why), the shared resources (are this demand or supply driven), and the time and context (which domain of the value chain). For example, in the study area, the closest and key coffee-buying companies, which train farmers on organic coffee production, buy poor-quality coffee (every coffee in the market-whether organic or not) at a low and uniform price. Some extension arms of the government frequently provide seedlings outside of the planting season and do not follow up.

Table 5, indicates that IP members' commitment and trust yielded positive but insignificant results (β=0.002) on the relationship between reflection and experiential knowledge, the opposite to the positive and significant effects with IP members' involvement as a moderator (β=0.008). Even at that, IP members' involvement had a weak effect on the relationship between reflection and experiential knowledge. This finding implies that the involvement of IP members influences knowledge, but there are other important determinants as well. The most plausible explanation is the nature of IPs, which emphasize supporting learning activities aimed at addressing diverse and dynamic farmer challenges, of which knowledge of specific farming aspects is a component but not the sole source [31, 32]. More specifically, the composition (or even the governance mechanisms) of the IP change after a specific challenge is addressed or as members take on a new challenge [33] when new stakeholders are added to address the new or emerging challenge and others exit [34]. Because most IPs are challenge-solution oriented [31, 32], it supports activities as an indirect way to increase IP members' commitment and build trust [2, 3, 20], but also solve challenges rather than quantifying knowledge gained from such activities as reflection. Finally, like the relationship between challenges and reflection, member access to IP resources had no effect on the association between challenges and reflection (β=-.007).

Hypothesis 2c, which states IP members' commitment, trust, involvement, and access to IP resources positively moderate the relationship between their experiential knowledge and active experimentation, yielded positive but insignificant results as indicated in Table 5 (0.008, 0.033, and 0.017). So according to previous research [15], farmers experiment to see if they can overcome their challenges using what they already know. They experiment with new seed varieties, alternative production processes, and new ways to promote their coffee products through social networks [2, 14, 16]. The relationship between farmers' level of experimentation and experiential knowledge is, however, low (r=0.255***) and farmers' commitment, trust, involvement, and access to IP resources did not affect this relationship either.

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Because coffee farmers are old (mean=46 years and 17 years of growing coffee) and have interacted with the same networks for almost as long, there may not be anything new they can use (experiment).

Finally, Table 5 (hypothesis 2d), indicates that IP members' commitment and trust yielded negative and insignificant results on the relationship between active experimentation, and their challenges, the opposite of the positive and insignificant effects of IP members' involvement and members' access to IP resources as a moderator. This is unusual, since previous qualitative studies [1, 19] found that IP farmer commitment, involvement, and access to resources such as seeds, and research technologies enhanced farmers' solutions to their challenges through active experimentation.

CONCLUSION AND RECOMMENDATIONS FOR DEVELEPMENT

In terms of practice, the findings of this study suggest that coffee farmers who are engaged in reflection should rely on their networks to stimulate commitment and involvement in IPs to strengthen their reflection and knowledge acquisition through reflection. Second, IP facilitators should foster trust among their members. For instance, some IPs in the study area incorporate other developing actions centered on issues that are not central to IP objectives to foster trust within their platforms. Across the study area, farmers had negative experiences with seed dealers and coffee produce buyers. Seed dealers in particular supplied immature, poor-quality seedlings in insufficient quantities, resulting in very poor growth and resultant yield. Experiential learning through training and demonstrations by extension workers was a very effective tool in convincing farmers to produce quality seedlings. As a result, IP farmers established UCDA-certified coffee nurseries from improved or indigenous coffee plants, either individually or collectively. With the knowledge obtained from the IP facilitators, model farmers, and extension workers, and finances from NGOs to construct warehouses, farmers collectively bulked parchment and sold as an IP in response to the challenge of a few, unreliable, and untrustworthy coffee buyers. Moreover, farmers sought alternative buyers who would readily purchase coffee at a fair price, promptly, and if possible, offer bonuses. Coffee farmers collaborated with IP-connected networks to develop new markets such as wash stations, IPs for cherries, and local companies. IPs should continue to broker relationships by building trust. The Burkina Faso Groundnut Innovation Platform built trust through brokering the relationship between farmers and extension service staff, leading to the establishment of field demonstrations on groundnut production, and improved varieties as a solution to the low productivity caused by limited access to improved legume varieties [16]. Similarly, with the assistance of R&D partners, IPs encouraged farmer commitment, and trust through establishing farmers' seed producer groups. Concurrently, the platform used extension agents' existing

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knowledge to spark the distribution of improved technology to a large number of farmers through field demonstrations [14].

Again, since IPs in the study area depend on donor support [36], agricultural extension policymakers should encourage farmers' adoption of more IP sustainability measures rather than fostering resource dependence. To start, many IPs act as cooperatives, wash stations, coffee processors, and collection centers in addition to supporting their learning activities. These IPs' internal income pooling practices include joint projects, assets, and village savings and loan programs. To increase other IPs' capacity for demand-driven learning, policymakers may use this lesson to help them obtain legal statuses. Finally, most of the services, like advisors, are offered by other farmers in the study IPs. Farmers sharing knowledge inside and through IPs can be useful resources.

Policymakers can use the IP as a unit to identify practical interventions to local challenges and improve targeted rural agriculture value chains by connecting different stakeholders to farmers at the community level because reflection as a learning activity must be elicited consciously by learning actions [37]. The IP encompasses a wide range of actors through which new ideas, processes, seeds, and other resources move. A valuable endeavor is the continuous facilitation of interactions among actors resulting in the identification of practical solutions to farmer challenges throughout the learning process. Visualizing a farmer's challenges, for example, can help with concrete experiences, whereas reflective analysis can help during and after facilitated dialogues. Policymakers will then be able to plan rural agriculture research and development strategies that are relevant to the challenges faced by farming households, recognizing them as critical actors in agricultural knowledge production and dissemination [38]. This includes a better understanding of local, indigenous, technical, and informal knowledge, as well as individual farmers' innovative capacity.

Future research should expand the study's scope to include other coffee-growing locations and look beyond specific project-initiated/supported IPs. While this study examined IP governance from the standpoint of farmers, future research may examine it from alternative (or numerous) perspectives. Finally, other research would conduct the PLS analysis separately for the IPs with the highest number of respondents to check whether there were any changes.

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Table 1: Descriptive statistics and correlations

Constructs	Descriptive statistics		Correlations						
	Mean	Std. Deviation	CE	RA	AE	EK	IP members' commitment and trust	IP-members' involvement	member access to IP resources
Challenges (CE)	19	4	1						
Reflection (RA)	17	4	0.195***	1					
Active experimentation (AE)	19	4	0.284***	0.285***	1				
Experiential knowledge (EK)	12	3	0.138**	0.299***	0.255***	1			
IP members' commitment and trust	35	5	0.171**	0.277***	0.469***	0.395***	1		
IP-members' involvement	26	5	0.080	0.223***	0.508***	0.351***	0.515***	1	
Member access to IP resources	3	1	0.125	0.266***	0.269***	0.301***	0.398***	0.311***	1

Note. Significance level (2-tailed): p-value < 0.01 (***); < 0.05 (**); < 0.10 (*)

Table 2: Kaiser–Meyer–Olkin (KMO) measure and Bartlett's test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.807
Bartlett's Test of Sphericity	Approx. Chi-Square	4473.129
	Df	1035
	Sig.	0.000

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Table 3: Construct Reliability and Validity

Constructs	Cronbach' Alpha (α)	rho_A	Composite Reliability (CR)	Average Variance Extracted (AVE)
Challenges	0.758	0.773	0.835	0.504
Experiential Knowledge	0.710	0.723	0.821	0.535
Reflection	0.723	0.724	0.818	0.474
Active experimentation	0.810	0.816	0.868	0.569
IP members' commitment and trust	0.867	0.872	0.894	0.485
IP-members' involvement	0.838	0.852	0.878	0.508
member access to IP resources	0.820	0.839	0.866	0.481

Table 4: Discriminant validity (heterotrait-monotrait)

Constructs	Active experimentation	Challenges	Experiential knowledge	Reflection
Challenges	0.331[0.205;0.444]			
Experiential knowledge	0.344[0.204;0 .464]	0.192[0.103;0.289]		
Reflection	0.38[0.248; 0.502]	0.259[0.132;0.383]	0.423[0.263;0.571]	
IP members' commitment and trust	0.558[0.427;0.670]	0.204[0.118;0.279]	0.504[0.371;0.625]	0.37[0.234;0.493]
IP-members' involvement	0.616[0.476;0.728]	0.143[0.095;0.156]	0.456[0.315;0.586]	0.299[0.188;0.396]
member access to IP resources	0.326[0.192;0.460]	0.197[0.121;0.228]	0.380[0.253;0.492]	0.342[0.226;0.490]

Note. 95% Confidence Intervals Bias Corrected (BCa CI)

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Table 5: Moderation analysis

Hypothesis No.	Relationships	β	BCa CI	R^2
Hypothesis 2a (Challenges are related to Reflection and moderated by IP member trust, commitment, and involvement)	Challenges x IP members' commitment and trust -> Reflection	0.031***	0.006;.055	0.358***
	Challenges x IP members' involvement -> Reflection	0.042***	0.013;.072	0.334***
	Challenges x member access to IP resources -> Reflection	-0.007	-0.037;.023	0.326***
Hypothesis 2b (reflection is related to Experiential Knowledge and moderated by IP member trust, commitment, and involvement)	Reflection x IP members' commitment and trust -> Experiential Knowledge	0.002	0-.013;.017	0.443***
	Reflection x IP members' involvement -> Experiential Knowledge	0.008*	0.008;.245	0.427***
	Reflection x member access to IP resources -> Experiential Knowledge	0.007	-0.011;.025	0.378***
Hypothesis 2c (Experiential Knowledge is related to Active experimentation and moderated by IP member trust, commitment, involvement, and member access to IP resources)	Experiential Knowledge x IP members' commitment and trust ->Active experimentation	0.008	-0.024;.040	0.476***
	Experiential Knowledge x IP members' involvement -> Active experimentation	0.033	-0.017;.084	0.530***
	Experiential Knowledge x member access to IP resources -> Active experimentation	0.017	-0.029;.062	0.328***
Hypothesis 2d (Active experimentation is related to Challenges and moderated by IP member trust, commitment, involvement, and member access to IP resources)	Active experimentation x IP members' commitment and trust -> Challenges	-0.001	-0.028;.026	0.267***
	Active experimentation x IP members' involvement -> Challenges	0.019	-0.004;.043	0.294***
	Active experimentation x member access to IP resources -> Challenges	0.007	-0.016;.031	0.267***

Note. Significance level (2-tailed): p value < 0.01 (***); < 0.05 (**); < 0.10 (*); β= Coefficients; 95% Confidence Intervals Bias Corrected (BCa CI)

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Table 6: Variable measurement and item loading

Variable	Question asked	Questionnaire item	Outer loading at first PLS Algorithm rum	Outer loading at PLS Algorithm re-run
Challenges	Please indicate by ticking the appropriate box how often you faced challenges in the last 5 years (2015-now) in Challenges at production, harvest, postharvest handling, processing and storage, and marketing (on a 5-point scale as never (1) and always (5)	Pest and disease infestation	0.297	Low loading
		Production inputs (that is, pesticides, fertilizers, pruning saws, labor, etc.	0.261	Low loading
		Extreme weather changes (that is, sometimes too hot or too much rain	0.271	Low loading
		Knowledge about coffee agronomic practices (that is, weeding, spraying against pests and diseases, fertilizer application, etc.)	0.369	Low loading
		Harvesting skilled coffee-picking labor	0.393	Low loading
		Thieves	0.481	Low loading
		Knowledge about coffee picking (CE1)	0.584	0.536***
		post-harvest handling and processing knowledge about coffee sorting, washing, fermenting, drying, storage, etc.	0.444	Low loading
		post-harvest handling and processing coffee pulping labor	0.424	Low loading
		post-harvest handling and processing equipment (that is, pulping machines, drying materials, etc.)	0.492	Low loading
		post-harvest handling and processing too much rain slow down the coffee drying process	-0.189	Low loading
		Post-harvest handling and processing storage (that is, space, materials-bags) (CE2)	0.630	0.649***
		post-harvest handling and processing knowledge of proper coffee storage	0.479	Low loading
		Market coffee buyers (that is, few, unreliable, untrustworthy)	0.326	Low loading
		Market coffee prices (CE3)	0.504	0.716***
		Market fluctuating coffee prices (CE4)	0.600	0.767***
		Market transport challenges (CE5)	0.486	0.576***
		Market finances to run the coffee business	0.449	Low loading
		Market coffee prices information (CE6)	0.678	0.695***

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Experiential knowledge	Please indicate how much knowledge you have - compared to other IP members - in the following domains: Know about new value chain networks, and farming methods on 5 points scale as strongly disagree (1) to strongly agree (5)	Beneficial network relationships for coffee production (EK1)	0.705	0.747***
		Beneficial network relationships for coffee harvesting (EK2)	0.707	0.707***
		Beneficial network relationships for coffee post-harvest handling and processing (EK3)	0.691	0.671***
		Beneficial network relationships for coffee marketing	0.419	Low loading
		Knowledge about methods to increase my coffee production (yield) (EK4)	0.740	0.784***
		Knowledge about methods to improve my coffee harvesting (EK5)	0.713	0.680***
		Knowledge about methods to improve post-harvest handling and processing methods	0.468	Low loading
		Knowledge about methods to market coffee	0.293	Low loading
Reflection	How often- in the last 5 years - have you reflected on your interactions with existing relationships to tackle post-harvest and marketing challenges, compared to other IP members? I reflect on interactions with..., a) Operation Wealth Creation (OWC)/NAADS, b) National Agriculture Research Organization-Buginyanya c) Uganda Coffee Development Authority (UCDA) d) NUCAFE e) Makerere University f) etc. on a 5-point scale as never (1) and always (5)	National Agricultural Research Organization (NARO)	0.206	Low loading
		Uganda Coffee Development Authority (UCDA)	0.176	Low loading
		Makerere University	0.407	Low loading
		Kyagalanyi Coffee Limited (RA1)	0.646	0.683***
		Kawacom Uganda Limited (RA2)	0.549	0.599***
		Great lakes Ltd	0.339	Low loading
		Coffee A Cup	0.273	Low loading
		Gumutindo	0.297	Low loading
		Farmer groups	-0.162	Low loading
		Innovation Platforms	-0.059	Low loading
		National Union of Coffee Agribusinesses and Farm Enterprises Ltd (NUCAFE)	0.202	Low loading
		Cooperative union (that is, Kabeywa, Bukusu, Arokwo, etc.)	-0.072	Low loading
		Contact/model/influential farmers	-0.213	Low loading
		Politicians, gatekeepers	0.052	Low loading
	Compared to other IP members, I .... (i) question the way other coffee farmers' production methods and try to think of a better way on a 5-point scale	question the way other coffee farmers production methods and try to think of a better way (RA3)	0.640	0.685***

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	a 5-point scale as never (1) and always (5)			
	(ii) like to think over my coffee harvesting methods and consider alternative ways of doing it.	like to think over my coffee harvesting methods and consider alternative ways of doing it (RA4)	0.633	0.679***
	(iii) re-appraise my coffee post-harvest handling and processing so I can learn from it and improve for my next performance	re-appraise my coffee post-harvest handling and processing so I can learn from it and improve for my next performance (RA5)	0.686	0.724***
	(iv) reflect on my coffee marketing sales to see whether I could have improved on what I did.	reflect on my coffee marketing sales to see whether I could have improved on what I did (RA6)	0.612	0.607***
Active experimentation	How often- in the last 5 years - have you used the knowledge obtained through relationships to tackle production and harvesting challenges compared to other IP members? I used knowledge from..., a) Operation Wealth Creation (OWC)/NAADS, b) National Agriculture Research Organization-Buginyanya c) Uganda Coffee Development Authority (UCDA) d) NUCAFE e) Makerere University f) etc. on a 5-point scale as never (1) and always (5)	Operation Wealth Creation (OWC)/NAADS	-0.035	Low loading
		National Agricultural Research Organization (NARO) (AE1)	0.716	0.782***
		Uganda Coffee Development Authority (UCDA) (AE2)	0.570	0.621***
		Makerere University	0.126	Low loading
		Kyagalanyi Coffee Limited	0.225	Low loading
		Kawacom Uganda Limited (AE3)	0.610	0.706***
		Great lakes Ltd	0.080	Low loading
		Coffee A Cup	0.300	Low loading
		Gumutindo	0.262	Low loading
		Farmer groups	0.339	Low loading
		Innovation Platforms	0.061	Low loading
		National Union of Coffee Agribusinesses and Farm Enterprises Ltd (NUCAFE)	0.189	Low loading
		Cooperative union (that is, Kabeywa, Bukusu, Arokwo, etc.)	-0.005	Low loading
		Contact/model/influential farmers	0.018	Low loading
		Politicians, gatekeepers	0.003	Low loading

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	Compared to other IP members, I use my knowledge about coffee: on a 5-point scale as never (1) and always (5) (i) Production	use my knowledge about coffee production (AE4)	0.722	0.727***
	(ii) harvesting	use my knowledge about harvesting (AE5)	0.722	0.748***
	(iii) post-harvest handling and processing	use my knowledge about post-harvest handling and processing use my (AE6)	0.717	0.703***
	(iv) Marketing	use my knowledge about marketing (AE7)	0.703	0.729***
IP governance mechanisms	Please indicate by ticking the most appropriate box the contribution of IP governance mechanisms to your farming activities. [on 5 points scale where (1) "strongly disagree" to (5) "strongly agree"] (i) In my IP relevant stakeholders are represented (ii) Members in my IP are selected in a transparent manner (iii) My IP is inclusive of a diversity of actors (iv) Every participating member is sufficiently heard during IP discussions	IP members' commitment and trust include a trust for other actors, commitment, IP leadership, and facilitation (IPGM1)		
		As an IP member, I feel comfortable sharing information with fellow IP members (Trust1)	0.663	0.699***
		My IP members feel encouraged to contribute to the betterment of the IP (Trust2)	0.665	0.704***
		My IP creates trust among a diversity of actors (Trust3)	0.649	0.660***
		I trust my IP's leadership (Leadership1)	0.633	Low loading
		The selection process of my IP's leadership is in a transparent manner (Leadership2)	0.734	0.734***
		The rules in my IP are flexible allowing me to stay a member or cease being at will (Leadership3)	0.546	Low loading
		The IP is effective in organizing meetings (Facilitation1)	0.637	Low loading
		Coffee value chain information is widely shared among my IP members (Facilitation2)	0.691	0.689***
		The IP is effective in mobilizing members for agreed actions (Facilitation3)	0.680	0.708***
		My IP members are committed to sharing knowledge freely (Commitment1)	0.650	0.677***
		My IP members are willing to let go of their comfort for the sake of others (Commitment2)	0.646	0.636***
		My IP members freely take part in coffee IP activities (Commitment3)	0.702	0.755***
		My IP members offer me advice on coffee value chain activities (Capacities1)	0.602	Low loading
		My IP organizes learning activities for me (Capacities2)	0.531	Low loading

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		My IP facilitates the sharing of information between me and other members outside my IP (Capacities3)	0.561	Low loading
		IP members' involvement includes accountability, equitable participation, and the recruitment process. (IPGM2)		
		In my IP, members hold each other accountable for their actions (Accountability1)	0.625	0.663***
		In my IP, members have access to diverse sources of coffee value chain information (Accountability2)	0.740	0.773***
		In my IP, decision-making is in a transparent manner (Accountability3)	0.735	0.780***
		Every participating member is sufficiently heard during IP discussions (Participation_Equity1)	0.682	0.679***
		Within my IP any member can influence decision-making (Participation_Equity2)	0.630	0.662***
		My IP creates a feeling of ownership for members (Participation_Equity3)	0.569	0.617***
		In my IP relevant stakeholders are represented (Representation1)	0.508	low loading
		Members in my IP are selected in a transparent manner (Representation2)	0.804	0.793***
		My IP is inclusive of a diversity of actors (Representation3)	0.603	Low loading
		member access to IP resources (IPGM3)		
		finance (Resources1)	0.758	0.759***
		production inputs (that is, pesticides) (Resources2)	0.739	0.722***
		coffee processing equipment (that is, pulping machines) (Resources3)	0.691	0.703***
		transport services for coffee to the selling point (Resources4)	0.745	0.752***
		coffee markets (Resources5)	0.587	0.573***
		coffee storage space (Resources6)	0.712	0.721***
		As an IP, we have group projects as a strategy to raise money for the IP activities (Resources7)	0.600	0.606***

Note: Items to include in the model are chosen using outer loadings, reliability, and validity measures. The initial run of the PLS algorithm revealed that some items had low outer loadings. After removing and rerunning the PLS algorithm, the results were satisfactory

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