

From Value Creation to Value Capture: Dynamics of Value Transformation in an Agroecological Innovation Process in Benin

Falex Festa Sèmèvo Fossou^{1*}, Sonagnon Claude-Gervais Assogba¹, Gbèblonoudo Anicet Dassou²,
Ingrid Sonya Mawussi Adjovi¹, Ismail Moumouni-Moussa¹

¹Laboratory of Research on Innovation for Agricultural Development (LRIDA), Faculty of Agronomy, University of Parakou, Parakou, Benin

²National University of Sciences, Technologies, Engineering and Mathematics (UNSTIM), Abomey, Benin

Email: *falex.fossou@lrida-up.org, a_claude2003@yahoo.fr, samysonya@gmail.com, ismailmm@gmail.com, dassoua5@gmail.com

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Abstract

This article analyzes how the knowledge and capacities developed during an agroecological innovation process are gradually transformed into appropriate solutions, uses and benefits perceived by producers. To analyze this dynamic, the study mobilizes the theory of network value and is based on a survey conducted among 70 producers who participated in the DigiCLA project in five villages in northern of Benin. The results first show that the process has contributed to the strengthening of growers' knowledge of Fall armyworm, in particular the recognition of the first symptoms ($M = 4.26$; $p < 0.001$), the identification of caterpillars ($M = 4.10$; $p < 0.001$) and the understanding of their development cycle ($M = 4.07$; $p < 0.001$), thus constituting a first form of value created. This value extends into the assessment of the solutions developed, which are judged to be adapted to the needs of producers ($M = 4.07$; $p < 0.001$) and to the problems related to caterpillar control ($M = 4.06$; $p < 0.001$), which reflects a realized value. On the other hand, their effective use remains more limited, as indicated by the moderate level of continuity of use after the project ($M = 3.11$; $p < 0.001$). The benefits associated with this use mainly concern the reduction of caterpillar attacks ($M = 3.39$; $p < 0.001$). The mediation analysis confirms that the value created contributes to the value captured through the value realized, with a significant indirect effect ($\beta = 0.146$; $p = 0.004$). Thus, the results show that the value produced during the innovation process is built gradually, from the knowledge developed to its translation into solutions, uses, and benefits for producers. However, the transition from one form of value to another remains partial, particularly in terms of the actual use of solutions.

Keywords

Innovation Process, Value Creation, Agroecological Transition, Fall Armyworm, Benin

1. Introduction

Innovation can be considered as a value creation process in which ideas, knowledge and resources are transformed into new or improved products, services, processes or practices (Hartono, 2013; Shefiu, 2019; Jacobs & Pretorius, 2020). It is therefore not limited to the development of something new. It also includes its implementation to generate new or increased value for users, organizations or society (Lee, 2018; Koffi et al., 2021; Yang et al., 2025). From the identification of a problem to the implementation of a solution, different resources are thus mobilized, combined, and transformed throughout the process (Jacobs & Pretorius, 2020; Herbst & Barnard, 2016).

This transformation therefore no longer relies on the action of a single actor. It involves several participants who bring different knowledge, skills, information, and experiences (Orcik et al., 2013; Hamidi et al., 2019; Smorodinskaya et al., 2017). Their interactions make it possible to compare viewpoints, bring needs and ideas closer together, and connect capabilities that, taken separately, would not necessarily make it possible to address the problem at hand (Aquilani et al., 2020; Khan et al., 2021). In such a dynamic, value therefore depends not only on what each actor contributes individually, but also on what becomes possible when these resources are connected around a common objective.

Value creation thus takes shape through interactions and is progressively built throughout the process (Jaakkola et al., 2024). Actors mobilize their knowledge, skills and information, compare and recombine them to advance collective action (Shi et Wang, 2026; da Silva et Cardoso, 2024; Yang, 2024). The complementarity of contributions plays an important role here, as does the quality of exchanges. Indeed, interactions do not only serve to circulate resources; they also enable actors to learn from one another and to develop their own knowledge and capabilities (Shi et Wang, 2026; Häikiö & Koivumäki, 2016). Value can therefore emerge well before the final solution is used. It is built through exchanges, discussions, and activities carried out jointly, but also through the learning that results from them (Jantan et al., 2020). Participants may acquire new knowledge, develop skills or reach a shared understanding of the problem they seek to solve (Pokojski, 2020; Allataifeh & Moghavvemi, 2021; Takahashi et Takahashi, 2022). From this perspective, learning itself constitutes a component of the value produced through participation in the innovation process (Wenger-Trayner & Wenger-Trayner, 2020).

However, the fact that an outcome is collectively produced does not yet mean that it will be useful in practice. This distinction is important for understanding

how value evolves throughout the process. The first dimension, which we refer to here as created value, corresponds to what emerges from interactions among participants: knowledge, skills, capacities for action, new ideas, practices or solutions developed collectively (Pokojski, 2020; Allataifeh & Moghavvemi, 2021; Atkočiūnienė et al., 2025; Osorno-Hinojosa et al., 2022). This value therefore reflects what actors can produce together, without yet making it possible to know whether these outcomes will actually be useful later.

Implementation in practice makes it possible to address a second dimension: realized value. This corresponds to the utility actually obtained when the outcomes produced are mobilized in a concrete context. It depends in particular on their fit with the objectives, practices and conditions in which they are used (Royo-Vela & Velasquez Serrano, 2021; Tran et al., 2025). This use then makes it possible to confront the solution with field realities, assess its usefulness, and reveal its possible limitations. It may also lead users to adapt the solution to their needs or constraints, which can subsequently result in new adjustments and learning.

But the usefulness produced by an innovation does not necessarily mean that all participants derive the same benefits from it. This leads us to consider a third dimension, captured value. It refers to the benefit actually obtained by an actor from the outcomes produced and used in the network. The ability to capture this value may depend on the position occupied in the network, the relationships established with other actors, and the possibility of accessing and mobilizing the resources produced (Leone et al., 2021). These benefits may include new knowledge and skills, improved practices or operational gains (Ammann & Hess, 2025). The same value produced collectively can therefore translate into different benefits depending on the actors.

These three dimensions should not, however, be considered as three completely separate moments. They are connected within the same process. Interactions first make it possible to produce knowledge, solutions and other outcomes; their use then makes it possible to verify their usefulness in a given context; finally, this use can generate benefits for actors. In turn, these benefits and the experiences gained can stimulate new learning or lead to adaptations of existing solutions, thereby restarting the value creation process (Jaakkola et al., 2024; Linton, 2024).

This way of understanding value is particularly relevant in agriculture. Agricultural value creation is not reduced to an economic dimension; it can also be social and environmental and depends on how resources and relationships among actors are combined (Sadovska et al., 2020). A collectively developed solution must therefore be able to find its place in producers' practices, be appropriated and, when necessary, adapted to local conditions. It is therefore insufficient to evaluate only the solution produced. It is also necessary to consider the interactions, learning, appropriation and use that enable this solution to actually produce value.

This issue is particularly relevant in innovation processes, where several actors participate in defining problems, producing knowledge and developing solutions.

The diversity of knowledge and experiences may lead participants to question their initial representations, explore different possibilities and progressively adjust the solutions under consideration (Sjödin, 2019). Exchanges, collective problem solving and user involvement then play an important role in these adjustments, while organizational conditions can influence the quality and frequency of interactions (Häikiö & Koivumäki, 2016; Takahashi & Takahashi, 2022; Qin et al., 2024).

The DigiCLA project provides a relevant setting for observing this dynamic. Focusing on the management of *Spodoptera frugiperda*, it aims in particular to produce and implement agroecological practices for controlling this pest. The process studied brings together different actors in activities involving diagnosis, experimentation, learning, adaptation, and use of solutions. It therefore makes it possible to follow how knowledge and practices are collectively produced, then appropriated and mobilized by producers, up to the benefits that may result under their concrete production conditions.

From this perspective, we understand value creation as a process that develops through interactions among actors, the combination of their knowledge and resources, and the learning that emerges from their participation in the innovation process. Value is therefore not considered as something generated once and then simply transferred to producers. Rather, it evolves as the knowledge and solutions produced through interaction are mobilized, adapted, and used in practice. We distinguish three interdependent dimensions. Created value refers to the knowledge, capacities, and other outcomes collectively produced through the innovation process. Realized value refers to the usefulness of these outcomes when they are mobilized in producers' practices. Captured value refers to the concrete benefits that actors, particularly producers, are able to obtain from their use. This distinction allows us to follow value beyond the production of a solution and examine how it is put into practice and what benefits ultimately emerge from its use.

Accordingly, this study analyzes how value is created, realized, and captured within an innovation process situated in the context of agroecological transition. It pays particular attention to interactions among actors, the production and mobilization of knowledge, and how producers use and adapt collectively developed solutions. The objective is therefore not only to assess what is produced through the innovation process, but also to examine whether and how this value becomes useful in producers' practices and, ultimately, translates into benefits that they are able to capture.

Conceptually, this approach draws on the value-creation framework for communities and networks developed by Wenger et al., (2011) and further elaborated by Wenger-Trayner & Wenger-Trayner (2020). The framework describes value creation in social learning networks through five interrelated cycles: immediate value, referring to what participants experience and obtain through their interactions; potential value, referring to knowledge, capacities, relationships, and resources that may become useful later; applied value, referring to the mobilization

of what has been learned in practice; realized value, referring to the effects or performance improvements resulting from such application; and reframing value, referring to changes in how actors understand and assess what constitutes success.

For this study, these five cycles are condensed into three analytical dimensions: created value, realized value, and captured value. Created value brings together the immediate and potential value generated through participants' interactions, particularly the knowledge, capacities, and resources developed through the innovation process. Realized value corresponds to the applied-value cycle and captures the extent to which this knowledge and the solutions developed collectively are mobilized in producers' concrete practices. Captured value refers to the benefits resulting from this use, corresponding to what [Wenger et al. \(2011\)](#) describe as "realized value" in their original framework. This terminological adaptation is made explicit to avoid confusion with the original five-cycle model. It allows us to retain the theoretical logic of network-based value creation while adapting it to the sequence examined in the DigiCLA innovation process: what actors collectively produce, how producers use it, and what they ultimately gain from that use.

2. Research Methodology

2.1. Study Area

The study was based on activities implemented within the DigiCLA project, selected as the empirical setting for analyzing the value creation process in an innovation context. The project aimed to develop, together with the actors concerned, natural solutions for controlling the fall armyworm (*Spodoptera frugiperda*) in maize production systems. The project activities provided a framework for experimentation and learning in which actors participated in the development, experimentation and adaptation of the proposed solutions to address the problem of fall armyworm (FAW).

The choice of DigiCLA thus makes it possible to examine how value is constructed throughout the innovation process and the forms it takes for the different actors, particularly producers. The analysis focuses on the different stages of the process, from the mobilization of knowledge and resources to the use and adaptation of solutions on farms. This approach makes it possible to assess both the outcomes generated by the process and how these outcomes are concretely translated into producers' practices.

The study was conducted in the municipality of Natitingou, where the project deployed its activities. Data were collected in the five intervention villages: Pouya, Kotopounga, Bongou, Pampam and Tigninini. The producers surveyed were selected through purposive sampling, with the main criterion being their actual participation in DigiCLA project activities. The project team provided a list of producers who took part in activities in the five villages, which served as the sampling frame. In total, 96 producers were registered as eligible participants in DigiCLA project activities across the five villages (Pouya: 25; Kotopounga: 25; Bongou: 19; Pam Pam: 17; Tigninti: 10). The survey targeted the entire list, with no additional

selection criteria. During data collection, 26 of the listed producers could not be surveyed due to several reasons: death, emigration to Nigeria, artisanal gold-mining, no participation in project activities. This reduced the effective sample to 70 producers surveyed, distributed as follows: Bongou (19), Pouya (17), Kotopounga (15), Pam Pam (11) and Tigninti (8). No refusals were recorded among the producers who were reached and available.

2.2. Data Collection Methods and Tools

Data were collected using a structured questionnaire administered face-to-face to producers. The questionnaire aimed to document the different dimensions of the value creation process associated with their participation in the project. It covered, in particular, the knowledge and skills acquired, the practices used to control FAW, their frequency of use, maintenance over time and possible application to other crops.

Data collection took place approximately two years after the completion of DigiCLA project activities. This interval does not reflect a deliberate choice to measure delayed effects. It follows from the case-selection logic on the basis of criteria unrelated to assessment timing, in particular the existence of a co-construction process among actors. In addition, fall armyworm pressure, which typically peaks at the young-plant and grain-filling stages of maize, was also reported to be low during the year of data collection, owing to abundant rainfall unfavorable to the pest's development.

Particular attention was paid to adaptations made by producers. The information collected concerned, in particular, modifications to the preparation process, dosages and ingredients used. The questionnaire also collected information on the perceived effects of using the solutions, particularly in terms of changes in FAW attacks, maize production and expenditure on chemical products.

The questionnaire thus combined factual questions and items designed to collect producers' assessments of the usefulness, suitability and effects of the solutions used. These assessments were measured using a five-point Likert scale, ranging from 1 "Strongly disagree" to 5 "Strongly agree", with a central category "Neither agree nor disagree".

2.3. Data Analysis Methods and Tools

Data analysis was based mainly on descriptive and inferential statistics. The analysis was structured around the three forms of value defined in the theoretical framework, namely created value, realized value and captured value. The items grouped within these different dimensions were assessed for internal consistency using Cronbach's alpha coefficient. The internal reliability of the different dimensions was verified using Cronbach's alpha. A threshold of 0.70 was retained as an acceptable level of reliability, following the recommendations of [Ahmad et al. \(2024\)](#). However, interpretation of this indicator also took into account the number of items in each dimension and the correlations between items, two factors that may

influence the value of alpha (Cortina, 1993; Tavakol et Dennick, 2011). The 28 items were distributed across five dimensions corresponding to the constructs retained in the study. Once their internal consistency had been verified, a composite score was calculated for each of these dimensions.

Given the ordinal nature of the responses measured on the Likert scale, the non-parametric Wilcoxon test was then used to determine whether there was a significant difference between the scores obtained and the neutral value of the scale, set at 3. This test makes it possible to assess whether an observed distribution differs from a reference value when the conditions for using parametric tests are not met (Wilcoxon, 1945; Noether, 1992).

The relationships among the three forms of value were then examined. Spearman's correlation coefficient was used to assess the strength and direction of the associations among created value, realized value, and captured value. A bootstrap mediation analysis and a 95% confidence interval were conducted to examine the mediating role of realized value in the relationship between created value and captured value.

For all inferential analyses, the statistical significance threshold was set at 5%. These analyses were performed using Python software (pandas, scipy, and pingouin libraries).

The mediation model followed the standard three-equation specification proposed by Baron and Kenny (1986), with X = created value, M = realized value, and Y = captured value, all measured as composite scores:

$$M = i_1 + a \cdot X + e_1 \quad (1)$$

$$Y = i_2 + c' \cdot X + b \cdot M + e_2 \quad (2)$$

$$Y = i_3 + c \cdot X + e_3 \quad (3)$$

where a is the effect of created value on realized value; b is the effect of realized value on captured value, controlling for created value; c is the total effect of created value on captured value, estimated without controlling for realized value; and c' is the direct effect of created value on captured value, controlling for realized value.

i_1 , i_2 , and i_3 are the intercepts; and e_1 , e_2 , and e_3 are the residual error terms.

All three equations were estimated by ordinary least squares on the composite scores. The indirect effect ($a \times b$) and its 95% confidence interval were obtained through a bias-corrected, non-parametric bootstrap procedure.

2.4. Operationalization of Variables Used to Measure the Three Forms of Value

Table 1 presents the indicators selected to capture the three forms of value in the analytical framework using questionnaire data.

2.5. Scale Reliability Test

The internal consistency of the items selected to measure the different forms of value was assessed using Cronbach's alpha coefficient. This test makes it possible to determine the extent to which the items of a given scale consistently measure the dimension under consideration. The results are presented in **Table 2**.

Table 1. Operational variables of value.

Form of value	Variables used
Created value	Technical capability - knowledge of control methods; - ability to choose the appropriate method; - ability to adapt practices to the farm; - ability to apply doses/methods; ability to recognize maize caterpillars; - recognition of the first symptoms; ability to assess the level of infestation; - understanding of the FAW development cycle; - knowledge of natural enemies. Ability to transmit knowledge - ability to explain - help and train other producers. Relational capacity - ability to share knowledge, - regular exchange among producers, - ability to advise other producers, - ease of access to advice on FAW, - collaboration with researchers, technicians and development agents.
	Sustainable use - Practices actually used to control FAW; - frequency of use of these practices;
	Realized value - adaptations made by producers (modifications to the preparation process, dosage and ingredients used). - maintenance of practices over time; - application of practices to other crops;
Captured value	- Changes in FAW attacks; - changes in maize production; - avoided expenditures associated with the use of chemical products

Table 2. Reliability of the scales used (Cronbach's Alpha).

Scale	Form of value	Number of items	Cronbach's alpha	95% CI
Technical capability	Created value	9	0.885	[0.840; 0.921]
Ability to transmit knowledge	Created value	3	0.989	[0.983; 0.993]
Social value	Created value	7	0.876	[0.826; 0.916]
Use/suitability	Realized value	5	0.930	[0.900; 0.953]
Perceived effects	Captured value	4	0.741	[0.626; 0.828]

The reliability test shows good internal consistency of the five scales, with alpha coefficients ranging from 0.741 to 0.989. These coefficients are above the 0.70 threshold retained as the acceptance threshold for consistency. It therefore follows that the five scales are sufficiently consistent for the construction of the composite scores used in subsequent analyses.

3. Results

3.1. Forms of Added Value Generated by the Innovation Process

Analysis of the innovation process that led to the development of agroecological solutions highlights three forms of value: created value, realized value, and captured value.

3.1.1. Value Created during the Innovation Process

Created value throughout the innovation process is assessed through three dimensions: technical capabilities, knowledge transmission capabilities, and the social dimension of interactions among actors.

❖ Producers' Technical Capabilities

Table 3 presents, for each item characterizing producers' technical capabilities, the distribution of responses across the five Likert-scale categories, expressed as a percentage of respondents, together with the mean and standard deviation (σ). The significance of responses relative to the neutral value of the scale was assessed using the Wilcoxon test. Significance levels are indicated as follows: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; ns = not significant.

Table 3. Producers' technical capabilities.

Items	1	2	3	4	5	Mean (σ)	p
Knows the control methods better	15.7	4.3	0.0	17.1	62.9	4.07 (1.50)	<0.001***
Able to choose the appropriate method	24.3	11.4	0.0	2.9	61.4	3.66 (1.78)	0.001**
Can adapt practices to the farm	25.7	14.3	0.0	1.4	58.6	3.53 (1.82)	0.005**
Able to apply doses/methods	25.7	11.4	0.0	0.0	62.9	3.63 (1.82)	0.001**
Knows how to recognize maize caterpillars	0.0	0.0	0.0	90.0	10.0	4.10 (0.30)	<0.001***
Recognizes the first symptoms	0.0	1.4	0.0	70.0	28.6	4.26 (0.53)	<0.001***
Able to assess the level of infestation	12.9	52.9	5.7	1.4	27.1	2.77 (1.46)	0.559ns
Understands the FAW development cycle	10.0	7.1	5.7	20.0	57.1	4.07 (1.35)	<0.001***
Knows the natural enemies	10.0	24.3	0.0	17.1	48.6	3.70 (1.52)	<0.001***

1 = Strongly disagree; 2 = Disagree; 3 = Neither agree nor disagree; 4 = Agree; 5 = Strongly agree. Significance levels: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; ns = not significant.

The results show that technical capabilities related to the recognition and understanding of FAW are those that appear to be best mastered by producers. Recognition of the first symptoms is the most highly reported capability (Mean = 4.26; $\sigma = \pm 0.53$), followed by recognition of maize caterpillars (Mean = 4.10; $\sigma = \pm 0.30$). Knowledge of control methods and understanding of the FAW development cycle also show high levels (Mean = 4.07; $\sigma = \pm 1.50$ and Mean = 4.07; $\sigma = \pm 1.35$), while knowledge of natural enemies remains relatively high (Mean = 3.70; $\sigma = \pm 1.52$). These results may be explained by the fact that producers were already confronted with the caterpillar in their fields before the project, but did not nec-

essarily have the knowledge needed to understand its behavior and development. As one producer from Pouya explains, “*We knew the caterpillars, but we did not know how they attack and develop. It was the project actors who explained to us how these caterpillars develop and attack the field.*” Another producer states: “*I knew the caterpillars and the periods when they attack, but I did not know how to kill them. Thanks to the project, we made solutions that drive away and kill the caterpillars.*”

However, this good appropriation of knowledge appears to weaken when it has to be mobilized in concrete situations. Scores are indeed lower for the ability to choose an appropriate method (Mean = 3.66; $\sigma = \pm 1.78$), apply doses or control methods (Mean = 3.63; $\sigma = \pm 1.82$), and adapt practices to farm conditions (Mean = 3.53; $\sigma = \pm 1.82$). The ability to assess the level of infestation is the main weakness, with a mean score of 2.77 ($\sigma = \pm 1.46$), which does not differ significantly from the neutral value of the scale ($p = 0.559$). This difference may be related in particular to the concrete conditions under which the solutions developed within the project are implemented. Although these solutions were developed participatorily, their preparation and use may remain demanding for some producers. Some report not having enough time to make them, particularly because the preparation process is tedious. Others mention their advanced age, which makes certain operations more difficult, while some producers say they prefer to buy the solutions rather than prepare them themselves. These constraints may help explain why the acquisition of knowledge does not always translate into regular and autonomous mobilization of practices. Thus, the innovation process mainly strengthened producers’ ability to recognize and understand FAW and to know control methods, while the translation of this knowledge into abilities to choose, adapt and especially assess the level of infestation remains more limited.

❖ Producers’ Capacity to Transmit Knowledge

Table 4 presents the level of producers’ capacity to transmit the knowledge acquired, through their ability to explain, help, and train other producers.

Table 4. Knowledge transmission capacity.

Items	1	2	3	4	5	Mean (σ)	p
Ability to explain to other producers	24.3	7.1	0.0	5.7	62.9	3.76 (1.76)	<0.001***
Able to help other producers	24.3	7.1	0.0	5.7	62.9	3.76 (1.76)	<0.001***
Ability to train another producer	18.6	7.1	5.7	11.4	57.1	3.81 (1.61)	<0.001***

1 = Strongly disagree; 2 = Disagree; 3 = Neither agree nor disagree; 4 = Agree; 5 = Strongly agree. Significance levels: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; ns = not significant.

The results show that producers report a good ability to transmit the knowledge acquired during the innovation process. The ability to explain to and help other producers shows the same level (Mean = 3.76; $\sigma = \pm 1.76$; $p < 0.001$), while the ability to train another producer is slightly higher (Mean = 3.81; $\sigma = \pm 1.61$; $p <$

0.001). These results suggest that the knowledge acquired does not remain only at the individual level, but also circulates among producers. Statements collected from respondents support this finding. One producer explains: “*I share what I learned during the farmer field schools with my neighbors to enable them to solve the caterpillar problem.*” Other producers indicate that when they encounter difficulties, they turn to their peers to learn how to prepare and use the solutions in their own fields. Transmission is therefore not limited to simply sharing information; it takes the form of practical support, in which one producer shows another how to prepare and use the solutions. The value created during the innovation process therefore extends beyond producers directly involved in the project activities, as it can be taken up, shared, and mobilized by other producers within the community.

❖ Producers’ Social Relational Capacity

The results reveal differences in relationships maintained with the different actors involved in the innovation process (Table 5).

Table 5. Social relationships developed.

Items	1	2	3	4	5	Mean (σ)	p
Ability to share knowledge	0.0	24.3	10.0	14.3	51.4	3.93 (1.27)	<0.001***
Collaboration with researchers	42.9	55.7	1.4	0.0	0.0	1.59 (0.52)	<0.001***
Collaboration with technicians	11.4	24.3	0.0	60.0	4.3	3.21 (1.20)	0.178ns
Collaboration with development agents	12.9	51.4	4.3	30.0	1.4	2.56 (1.10)	0.002**
Regular exchange among producers	5.7	32.9	0.0	34.3	27.1	3.44 (1.35)	0.005**
Ease of access to advice on FAW	8.6	15.7	0.0	12.9	62.9	4.06 (1.43)	<0.001***
Ability to advise other producers	15.7	21.4	0.0	8.6	54.3	3.64 (1.65)	<0.001***

1 = Strongly disagree; 2 = Disagree; 3 = Neither agree nor disagree; 4 = Agree; 5 = Strongly agree. Significance levels: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; ns = not significant.

The ability to share knowledge is high (Mean = 3.93; $\sigma = \pm 1.27$; $p < 0.001$), as is ease of access to advice on FAW (Mean = 4.06; $\sigma = \pm 1.43$; $p < 0.001$). Regular exchanges among producers are also significant (Mean = 3.44; $\sigma = \pm 1.35$; $p = 0.005$), as is the ability to advise other producers (Mean = 3.64; $\sigma = \pm 1.65$; $p < 0.001$). In contrast, relationships with technical and institutional actors appear more mixed. Collaboration with technicians does not differ significantly from the neutral value of the scale (Mean = 3.21; $\sigma = \pm 1.20$; $p = 0.178$), whereas the scores for collaboration with development agents (Mean = 2.56; $\sigma = \pm 1.10$; $p = 0.002$) and researchers (Mean = 1.59; $\sigma = \pm 0.52$; $p < 0.001$) are significantly lower. These results therefore suggest that the relational dimension of created value is expressed more through exchanges among producers and access to advice than through maintaining regular collaboration with research and technical support actors.

3.1.2. Value Realized during the Innovation Process

Realized value is assessed through the suitability of solutions to producers' needs, their ease of use and understanding, their ability to address the problems encountered, and their maintenance in practices after the end of the project (Table 6).

Table 6. Suitability of the solution to the producer's needs.

Items	1	2	3	4	5	Mean (σ)	<i>p</i>
Solutions adapted to my needs	17.1	0.0	8.6	7.1	67.1	4.07 (1.53)	<0.001***
Practices address caterpillar control problems	11.4	0.0	14.3	20.0	54.3	4.06 (1.32)	<0.001***
Solutions easy to use under my production conditions	20.0	11.4	5.7	1.4	61.4	3.73 (1.70)	<0.001***
Continuity of use after the end of the project	28.6	24.3	0.0	1.4	45.7	3.11 (1.81)	<0.001***
Solutions easy to understand	20.0	0.0	0.0	15.7	64.3	4.04 (1.57)	<0.001***

1 = Strongly disagree; 2 = Disagree; 3 = Neither agree nor disagree; 4 = Agree; 5 = Strongly agree. Significance levels: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; ns = not significant.

The results relating to realized value show that the solutions developed within the innovation process are, overall, well adapted to producers' needs. The suitability of the solutions to producers' needs obtains a high score (Mean = 4.07; $\sigma = \pm 1.53$; $p < 0.001$), as does their ability to address problems related to maize caterpillars (Mean = 4.06; $\sigma = \pm 1.33$; $p < 0.001$). Producers also report that the solutions are easy to understand (Mean = 4.04; $\sigma = \pm 1.57$; $p < 0.001$) and relatively easy to use under their production conditions (Mean = 3.73; $\sigma = \pm 1.70$; $p < 0.001$). These results show that the solutions developed correspond fairly well to the problems producers face in their fields and can be integrated into their practices. This supports producers' statements, expressed as follows: "*The solutions provided by the project helped us a lot. The caterpillars are no longer present in our fields.*"

The situation is different, however, when considering their use after the end of the project. Continuity of use has a mean of 3.11 ($\sigma = \pm 1.81$; $p < 0.001$), with fairly divided responses: 47.1% of producers report continuing to use the solutions, while 52.9% do not. In other words, having participated in the process and having access to suitable solutions is not always sufficient to ensure their continued use over time. These results can be explained by various reasons. Some producers stated that they had not experienced attacks, so they participated in order to acquire knowledge for possible future use. Others who had used the solution in their fields observed a cessation of attacks in their fields, hence the abandonment of the practice. By contrast, some attributed the abandonment of these practices to the tedious manufacturing process and the reluctance to go and obtain the raw materials needed to make the solution. Some producers may therefore recognize the value of the solutions and their ease of use without maintaining them once project support has ended. Realized value thus appears more clearly in the suitability of solutions to needs and in their use than in their maintenance beyond the project

intervention period.

Table 7. Suitable use of the solutions.

Use of the solution	Category	%	Test	<i>p</i>
Practice continuation	Still using	82.1	Binomial	<0.001***
	Stopped	17.9		
Frequency of use	Every attack	56.3	χ^2	<0.001***
	Every season	40.6		
	Only if attack	3.1		
Application to other crops	Yes	42.1	Binomial	0.418ns
	No	57.9		
Adaptations made	At least one	13.2	Binomial	<0.001***
	None	86.8		

Note: Binomial tests are two-sided, against a 50% reference value; the frequency-of-use test is a chi-square goodness-of-fit test against an equal three-way split. Significance levels: *** $p < 0.001$; ns = not significant.

Beyond the suitability items presented above, **Table 7** provides a clearer picture of what happened to the practices after their introduction. Most producers kept using them. Indeed, 82.1% of those who had adopted at least one of the practices developed during the project were still using them at the time of the survey, compared with 17.9% who had discontinued their use.

Use was generally maintained when the need arose. Among continuing users, 56.3% applied the practices whenever caterpillars were observed, whereas 40.6% used them systematically during each growing season. Only 3.1% reported using them exclusively in response to an attack. The practices therefore remained embedded in routine crop management for many producers, although their use was still closely linked to pest pressure.

The practices also extended, to some extent, beyond maize. A total of 41.0% of producers reported applying them to other crops, while 56.4% did not. The difference was not statistically significant, suggesting that their use was not clearly expanding across cropping systems.

Adaptation was limited. Only 13.2% of producers reported modifying at least one aspect of the practices, whether the production process, dosage, or ingredients. Changes to ingredients were the most frequently reported form of adaptation.

The statistical tests reinforce these patterns. A binomial test against a 50% reference value shows that continuation of use was significantly more frequent than discontinuation (82.1%; $p < 0.001$). Adaptation, by contrast, was significantly less common than non-adaptation (13.2%; $p < 0.001$). Application to other crops did not significantly depart from an even split (42.1%; $p = 0.418$), providing no statistical evidence of a clear tendency toward either expansion or non-expansion of

use.

Frequency of use tells a similar story, but with greater differentiation across categories. The distribution differed significantly from an equal distribution across the three categories ($\chi^2 = 14.31$; $p < 0.001$). Regular use was therefore concentrated around situations in which the practices were most relevant, particularly the occurrence of caterpillar attacks and the growing season, rather than occasional use.

3.1.3. Value Captured during the Innovation Process

Captured value is assessed through the effects perceived by producers following the use of the solutions, particularly the reduction in caterpillar attacks, increased production, and reduced expenditure on chemical products (Table 8).

Table 8. Perceived effects of using the solutions.

Items	1	2	3	4	5	Mean (σ)	<i>p</i>
Perceived reduction in caterpillar attacks	27.1	17.1	0.0	1.4	54.3	3.39 (1.83)	<0.001***
Increase in production	45.7	30.0	18.6	0.0	5.7	1.90 (1.08)	<0.001***
Reduction in expenditure on chemical products	64.3	28.6	0.0	1.4	5.7	1.56 (1.02)	<0.001***
Higher maize production than before	64.3	28.6	2.9	4.3	0.0	1.47 (0.76)	<0.001***

1 = Strongly disagree; 2 = Disagree; 3 = Neither agree nor disagree; 4 = Agree; 5 = Strongly agree. Significance levels: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; ns = not significant.

The results relating to captured value show that the effects of the solutions are mainly visible through the control of caterpillar attacks. The perceived reduction in attacks has a mean of 3.39 ($\sigma = \pm 1.83$; $p < 0.001$), with 55.7% of producers stating that they agree or strongly agree. However, this perception remains fairly divided, since 44.3% of producers fall within the disagreement categories. The solutions developed therefore appear to have enabled a significant proportion of producers to better cope with FAW attacks, without this effect being perceived in the same way by everyone.

This positive perception is not found, however, when it comes to production and expenditure on chemical products. The increase in production obtains a mean of 1.90 ($\sigma = \pm 1.08$; $p < 0.001$), and 75.7% of producers do not report having observed an increase. The finding is even more pronounced for maize production compared with previous years: the mean is 1.47 ($\sigma = \pm 0.76$; $p < 0.001$), and 92.9% of producers do not report having produced more maize than before. Similarly, the reduction in expenditure on chemical products obtains a low score (Mean = 1.56; $\sigma = \pm 1.02$; $p < 0.001$), with 92.9% of producers reporting no decrease in these expenditures.

Captured value therefore appears to manifest itself mainly through better control of FAW attacks rather than through direct gains in production or expendi-

ture. In other words, the fact that the solutions make it possible to better control caterpillars does not necessarily mean that producers are already deriving economic benefits or increased production from them. These results are explained by the fact that some producers state that increased production does not depend on caterpillar attacks but rather on the producer's financial capacity and ability to cultivate a larger number of hectares. Others state that they do not produce for marketing purposes and therefore do not measure the quantity produced. The innovation process therefore made it possible to address, at least for some producers, the immediate problem of reducing FAW attacks.

3.2. Relationships among the Forms of Value in the Innovation Process

The relationships among the three forms of value were examined to assess the extent to which created value, realized value and captured value evolve jointly, in accordance with the relationships postulated in the analytical framework. Spearman's correlation coefficient was used to measure the direction and strength of these associations (Table 9).

Table 9. Correlation among the forms of value.

Variable pair	Spearman's ρ	p
Created value $\times$ realized value	0.797	<0.001***
Realized value $\times$ captured value	0.787	<0.001***
Created value $\times$ captured value	0.742	<0.001***

The results show strong and statistically significant relationships among the three forms of value. The strongest relationship concerns created value and realized value ($\rho = 0.797$; $p < 0.001$). Thus, the greater the value created during the innovation process, the higher realized value also tends to be. This result reflects a close relationship between the value collectively produced by actors and the benefits actually obtained during the process.

A relationship of the same nature appears between realized value and captured value ($\rho = 0.787$; $p < 0.001$). The greater the realized value, the more benefits the actors appear to derive from it. Finally, created value and captured value also show a strong positive correlation ($\rho = 0.742$; $p < 0.001$). Actors who report greater created value therefore also tend to report greater captured value.

Taken together, these results show that the three dimensions of value evolve in a closely related manner. Created value thus appears to be accompanied by greater realized value. This is itself associated with greater value capture. However, these correlations only indicate that the variables are associated with one another. They do not yet make it possible to determine whether realized value actually plays a role in the transition from created value to captured value. Mediation analysis makes it possible to examine this relationship more precisely.

For this purpose, Table 10 presents the results of the test of the relationships

among the three forms of value and of the mediation analysis.

Table 10. Test of hypotheses on the relationships among the forms of value.

Tested relationship	Coefficient	SE	95% CI	<i>p</i>	Conclusion
Value created → value realized (a)	0.980	±0.076	[0.831; 1.129]	<0.001	Confirmed
Realized value → captured value (b)	0.149	±0.067	[0.017; 0.281]	<0.05	Significant
Total effect (created value → captured value)	0.585	±0.060	[0.467; 0.703]	<0.001	Significant
Direct effect (created value → captured value)	0.439	±0.112	[0.220; 0.658]	<0.001	Significant
Indirect effect (mediation via realized value)	0.146	±0.065	[0.048; 0.303]	0.004	Confirmed

Analysis of the relationships among the different forms of value first shows a very strong link between created value and realized value. The coefficient associated with this relationship is 0.980 (95% CI = [0.831; 1.129]; $p < 0.001$). This result means that producers who report having acquired more knowledge and capabilities during the innovation process are also those who perceive the solutions as more adapted to their needs and production conditions.

Realized value is, in turn, positively related to captured value ($\beta = 0.149$; 95% CI = [0.017; 0.281]; $p < 0.05$). Thus, when solutions correspond to producers' needs and can actually be used under their production conditions. They are more likely to produce effects that they can perceive. Particularly in controlling FAW attacks.

The relationship between created value and captured value is also significant. The total effect is 0.585 (95% CI = [0.467; 0.703]; $p < 0.001$). Even after taking the realized value into account, the direct effect remains significant ($\beta = 0.439$; 95% CI = [0.220; 0.658]; $p < 0.001$). Created value can therefore translate into captured value in two ways: directly and through realized value.

The mediation analysis clarifies this mechanism. The indirect effect of created value on captured value through realized value is positive and significant ($\beta = 0.146$; 95% CI = [0.048; 0.303]; $p = 0.004$). Realized value therefore plays an intermediary role in the process. However, the direct effect remains significant. It does not by itself explain the transition from created value to captured value. The mediation is therefore partial. In other words, the knowledge and skills acquired during the process can directly contribute to the benefits perceived by producers. But their transformation into suitable solutions and their implementation in practice also constitute a pathway through which this value becomes concrete. The innovation process therefore produces value not only through the use of the solutions developed. But also through the knowledge, skills and capabilities that producers develop during the process.

4. Discussion

4.1. From Knowledge Creation to Its Implementation in Practice

The innovation process enabled producers to develop knowledge about the recognition and understanding of FAW, as well as capabilities enabling them to transmit this knowledge to other producers. The value created during the process is therefore not limited to the solution developed. It is also constructed through the knowledge and capabilities acquired by actors through their participation. For [Fu \(2022\)](#), knowledge is a central resource in the innovation process: it is produced, transformed and exploited in the search for new solutions and value. [Hajar et al. \(2021\)](#) also give an important place to the capabilities and skills required to implement innovation.

The capabilities developed are nevertheless not of the same nature and do not show the same level of mastery. Producers appear to have greater mastery of FAW identification than of assessing its level of infestation. This difference shows that acquiring knowledge does not necessarily lead to mastery of all the capabilities required for its use. [Molden et Clausen. \(2021\)](#) precisely distinguish available resources from the capabilities that make it possible to transform these resources into outcomes. In the process studied, created value thus emerges progressively, as acquired knowledge becomes capabilities that can be mobilized in action.

4.2. From Knowledge to the Use of Solutions

The knowledge and capabilities developed are then extended through the use of the solutions. Producers generally consider them adapted to their needs and production conditions. Value therefore lies not only in what is produced during the process, but also in the possibility of mobilizing the solution in a concrete situation. [Cropley et al. \(2011\)](#) distinguish the generation of ideas from their exploitation, the latter making it possible to transform ideas into innovations that can actually be used. [Sjödin et al. \(2020\)](#) also locate value realization in use, since the solution acquires its value under the concrete conditions of its use.

The continuity of practices after the end of the project is nevertheless less assured. A solution can be understood and considered appropriate without being durably integrated into practices. This situation shows that the transition from knowledge to use constitutes a stage that still requires a process of appropriation. Use may lead producers to adjust practices according to their conditions and the results observed. Value creation then takes an evolving form, in which testing, adjustments, and implementation participate in the process itself ([Lavikka et al., 2021](#)). [Linton \(2024\)](#) also describes co-creation as a dynamic that evolves with the conditions encountered and the contributions of the different actors.

4.3. From Use to the Benefits Actually Captured

The transition from realized value to captured value appears more uncertain. Producers perceive the suitability and usefulness of the solutions, but the benefits associated with their use are less clearly established. Particularly when it comes to

production or expenditure on chemical products. This difference makes it possible to distinguish what is created during the process from what producers are actually able to obtain from it. Ko et al. (2020) distinguish value creation from its appropriation in this regard. Olaleye et al. (2026) also emphasize that knowledge and resources do not directly produce benefits: they must be transformed through innovation processes and their implementation.

In the case studied, use is therefore an important point in the transformation of value. The knowledge and capabilities acquired during the process must be mobilized in practices before they can produce benefits for producers. Realized value consequently occupies an intermediate position between the outcomes of the process and the effects that may result from them. This conception helps explain why value creation and value capture are not two separate moments: the different phases of the process are connected through successive interactions, adjustments, and learning (Sjödín et al., 2020).

4.4. Realized Value as an Intermediary Mechanism

The mediation analysis provides further insight into this relationship. Created value has a positive relationship with realized value. Realized value is itself associated with captured value. Part of the relationship between created value and captured value therefore passes through realized value. The use of solutions thus constitutes a mechanism through which the knowledge and capabilities produced during the process can be transformed into benefits for producers.

Because the mediation is partial, created value nevertheless retains a direct relationship with captured value. Use therefore does not by itself explain the transition between these two forms of value. This observation is important for understanding how the process operates: certain resources or capabilities produced during the innovation process may be useful to producers without necessarily following the same pathway of use. Ko et al. (2020) precisely distinguish the mechanisms of value creation and appropriation. Sjödín et al. (2020) describe processes in which these dimensions are articulated through cycles of interaction and adjustment.

Overall, the process studied reveals a progressive transformation of value. The knowledge and capabilities developed constitute a first form of value; their mobilization in practices enables their realization; and their translation into benefits ultimately depends on how these solutions are used and maintained. Value therefore does not move mechanically from creation to capture. It is transformed throughout the process, with use as one of the main mechanisms enabling the outcomes of the innovation process to become benefits that are actually perceptible to producers. This interpretation is consistent with the conception of innovation as a dynamic, iterative process based on the continuous transformation of knowledge and resources (Takahashi & Takahashi, 2022; Sjödín et al., 2020).

5. Conclusion

This study shows that the innovation process makes it possible to construct several

forms of value as it unfolds. Producers' participation enabled them to acquire knowledge about the recognition and understanding of FAW. It also to develop technical and knowledge-transmission capabilities. These outcomes constitute a first form of created value. Their mobilization in practices then gives this value a more concrete dimension through the use, maintenance, and adaptation of solutions to farm conditions.

However, this dynamic does not automatically lead to benefits for producers. A solution may be considered appropriate and actually used without the expected effects on production or expenditure necessarily being perceptible. Created value and captured value therefore appear as two distinct dimensions. Between which realized value occupies an intermediate position. The mediation analysis shows that the use of solutions contributes to the transition from value created during the process to value actually captured by producers. The innovation process therefore produces not only a solution: it also generates knowledge, capabilities and possibilities for action whose scope depends on their mobilization in practices.

Ultimately, the study highlights a progressive construction of value. From the outcomes developed during the innovation process to their use and the benefits that may result from them. It thus emphasizes the importance of assessing the value of an innovation not only based on the solution produced, but also on the basis of what actors learn, what they can use, and what they can actually derive from it.

Author Contributions

Conceptualization, F.F.F.S. and A.S.C.G.; methodology, F.F.F.S. and A.S.C.G.; validation, F.F.F.S., A.S.C.G., D.G.A., A.I., and M.M.I.; formal analysis, F.F.F.S. and A.S.C.G.; investigation, F.F.F.S.; resources, F.F.F.S.; data curation, F.F.F.S.; writing original draft preparation. F.F.F.S. and A.S.C.G.; writing review and editing. F.F.F.S., A.S.C.G., D.G.A., A.I., and M.M.I.; visualization, F.F.F.S.; supervision. A.S.C.G.; project administration. A.S.C.G. All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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