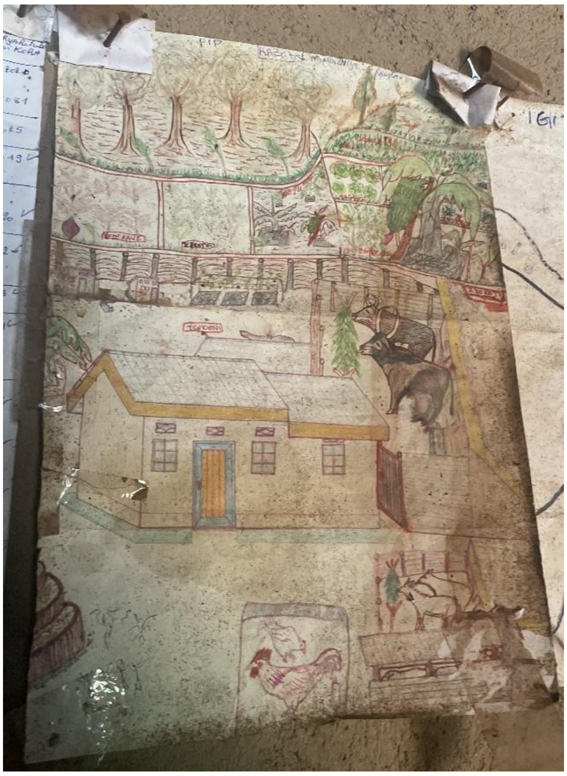
PIP & Resilience in Burundi

Assessing the Influence of the Participatory Integrated Planning (PIP) approach on the Resilience of Smallholder-farming Households in Burundi



MSc thesis by Dexter Frederik Mordechai Bazelet

September 2025

Soil Physics and Land Management Group

PIP & Resilience in Burundi
Assessing the Influence of the Participatory Integrated Planning (PIP) approach on the Resilience of Smallholder-farming Households in Burundi

Master thesis Soil Physics and Land Management Group submitted in partial fulfillment of the degree of Master of Science in International Land and Water Management at Wageningen University, the Netherlands

Study program:
MSc International Land and Water Management

Student registration number:
1044889

SLM 80336

Supervisors:
WU Supervisor: Aad Kessler

Host supervisor: Micael Beun
Mark van der Poel

Assessors:
First: Aad Kessler

Second: Eva Huet

Examinator
Dr. Ir. Aad Kessler

Date:
22/09/2025

Soil Physics and Land Management Group, Wageningen University

“We cannot hide from our lord the fact that since our money is gone and our livestock belongs to you, there is nothing left for our lord except our bodies and our land. Why should we perish before your eyes – we and our land as well?”

Genesis 47:13 - 27

DEDICATED TO ALL THE FARMERS THAT HAVE CONTRIBUTED TO THIS RESEARCH,

THE TWITEZIMBERE, IFDC & WUR STAFF THAT MADE THE RESEARCH POSSIBLE,

ERNEST HABONAYO WHO SHARED HIS IDEAS AND EXPERIENCE,

AND MY FRIENDS AND FAMILY WITH WHOM I EXCHANGED IDEAS

SPECIALLY DEDICATED TO BEPPE, WHO WILL STAY IN MY HEART AND MEMORY FOREVER

Abstract

Smallholder-farming households in Burundi face multiple challenges, including land degradation, climate change, population pressure, and poverty. The Participatory Integrated Planning (PIP) approach aims to strengthen household resilience to these challenges by promoting long-term planning and the integration of farming activities.

This study evaluates the impact of the PIP approach on household resilience. For this purpose, it applies Meuwissen et al. (2019)'s resilience framework. Over a two-month period, 65 farmers – both PIP participants and non-participants – were interviewed about the shocks and stresses they experienced and their reactions to these events. Their responses indicated which resilience attributes they applied in the recuperation process. Besides, the influence of PIP on their livelihood was assessed.

Findings indicate that PIP has enhanced several key resilience attributes, such as livestock keeping, agricultural productivity and agricultural income diversity. However, the increase in income diversity was limited to agriculture-related activities, whereas off-farm income sources emerged as a crucial resilience factor in the research context. As such, it is recommended that the project that is using the PIP approach in Burundi enhances support for off-farm income generation, for example through trainings and awareness. Additionally, PIP improved intra-household collaboration, planning, organization, motivation, and adoption of sustainable land management (SLM) practices, while reducing erosion, according to the testimonies of the farmers. Notably, some of these benefits were not fully captured by the resilience assessment framework, suggesting a need for more comprehensive evaluation tools.

Contents

Terminology

Colline	French for 'hill', referring to a group of houses that is comparable to a village in its societal structure
IFDC	International Fertilizer Development Centre – NGO aiming for enhanced soil protection and food security
Functions of a farming system	The key roles or services that a farming system is expected to deliver, even when facing shocks or stresses
General resilience	A farming system's capacity to deal with the unknown, uncertainty and surprise
Intangible resilience attributes	The non-material, non-physical qualities, capacities, or resources that contribute to a system's (or household's) ability to withstand, adapt to, and recover from shocks and stresses
Off-farm income source	An income source that is independent of the agricultural production system and would therefore not be influenced by a perturbation in that system
On-farm income source	An income source that is (partly) dependent on the agricultural production of the farming system and would be affected by a perturbation in that system
PAGRIS	Projet d'Appui pour une Gestion Responsable et Intégrée des Sols, a project using PIP that started in 2020
PAPAB	Projet d'Appui à la Productivité Agricole au Burundi, a project using PIP that started in 2016
PIP	Participatory Integrated Planning, or Plan Intégré Paysan in French

Resilience attributes	Resilience-enhancing competences of a farming system and its environment; they support its ability to persist, adapt, or transform in response to challenges
Resilience capacities	Robustness, adaptability & transformability – three types of responses a farming system can have to shocks and stresses
SCAD	Projet de Solidarité Communautaire pour l'Auto Développement; a project using PIP that started in 2013
Shocks	Sudden challenges
SLM	Sustainable Land Management
Specified resilience	A farming system's capacity to deal with a specific shock or stress
SSA	Sub-Saharan Africa
Stresses	Long-term challenges
Urwarwa	A traditional liquor made from banana's (pronounce: gwagwa)

1. Introduction

Smallholder-farming households in sub-Saharan Africa are affected by a complex interplay of environmental, socio-economic, and demographic stressors. In Burundi, these challenges are particularly acute. High population density, land fragmentation, soil degradation, climate variability, and persistent poverty severely constrain agricultural productivity and household well-being (Kessler et al., 2020; World Bank, n.d.). To deal with these challenges, smallholder-farming households are in need of increased resilience capabilities.

In response, development initiatives have emphasized the need for integrated and participatory approaches to build resilience at the household and community levels effectively (Wijeratne & De Silva, 2024). The Participatory Integrated Planning (PIP) approach was developed to empower farming households to take charge of their own development through vision-based, long-term planning and the integration of farming and livelihood activities. Central to PIP is a participatory methodology that fosters intrinsic motivation, stewardship, and collaboration within households and communities. By strengthening capacities, the approach aims to enable smallholder-farming households to cope with existing shocks and stresses and to adapt and transform their farming system as desired.

While the PIP approach has shown promising results in practice, empirical assessments of its impact on resilience remain limited. This study contributes to filling this research gap, by evaluating how the PIP approach influences the resilience of smallholder-farming households in Burundi. Therefore, it aims to answer the question:

"In what ways has the PIP approach influenced the resilience of smallholder-farming households in Burundi?"

It uses the resilience framework proposed by Meuwissen et al. (2019), which conceptualizes resilience as a system's capacity to absorb, adapt to, and transform in response to adverse events. The framework aims for the discovery of resilience-enhancing competences of the farming system - i.e. resilience attributes. These elements can be both tangible resilience attributes (e.g. money savings) and intangible resilience attributes (e.g. knowledge of irrigation techniques).

The research uses semi-structured interviews and group discussions to compare a group of households that have been applying PIP for the last 12 years (called SCAD) with a group of households that have been applying it for the past 9 years (called PAPAB) and a group without knowledge of PIP (called non-PIP). Three years after the initiation of the SCAD project, its implementation expanded to other areas. This gives an opportunity to assess a longer duration of the project on the resilience of households, thereby also answering the research question.

To answer the research question, the research is subdivided into three parts. Firstly, it compares five pre-determined resilience attributes between the groups. Secondly, it investigates what resilience attributes the farming households usually rely on when dealing with challenges and if they differ between the groups; and thirdly, it assesses the influence that the PIP approach has had on the households and their farming systems and connects the dots between PIP's influence and the resilience attributes that households rely on. Accordingly, it answers three sub-research questions (SRQ's):

1. How do the five pre-determined resilience attributes differ between SCAD, PAPAB and non-PIP households?
2. How do the resilience attributes of the SCAD, PAPAB and non-PIP households differ?
3. How has PIP influenced the SCAD and PAPAB households? And how does this influence relate to the resilience attributes of PIP households?

This research expects to discover 'intangible resilience attributes' among the PIP households, as PIP focuses on intangible aspects of resilience, such as improved collaboration, and enhanced self-determination. Since the PIP households are encouraged to plan and organize their work, their mentality is expected to be more pro-active, which links to the creation of possibilities and opportunities (Lecegui et al., 2022). This mindset, in turn, might enhance their resilience in the light of shocks & stresses.

Including the introduction, the study is built up by seven chapters. It starts with a contextual background, describing the agro-ecological context of Burundi and the influence of past and current development initiatives on the resilience of Burundian households, followed by an explanation of the PIP approach. The chapter ends with a scientific background of existing literature on resilience assessment, building towards an elaboration on the choice of framework applied by this research. After providing the contextual and scientific background of the research, the methodology will elaborate on the applied resilience assessment framework and how the research questions are answered, ending with the practical organization of the field work in Burundi. The results-section then provides all findings of the research that help answer the research questions. The interpretation of these findings is done in the discussion, where they are also compared to existing scientific literature. Finally, the conclusion answers the main research question, added by a chapter with a suggestion for the further development of Meuwissen et al. (2019)'s resilience framework and two practical recommendations.

2. Theoretical & Contextual Background

2.1. Agriculture in Burundi

Burundi has the potential to be self-sufficient in food production, counting on assets like abundant rainfall, a large farming population, an extensive network of lakes and rivers and the possible market expansion within the context of the East African Community (EAC; Stefanelli, 2015). However, compared to the pre-war period[1], average per capita agricultural production had more than halved in 2015, being among the lowest in the EAC region (Stefanelli, 2015). Land fragmentation, declining yields, falling soil fertility, and low levels of input utilization and technical knowledge are major issues contributing to this decline. Additionally, as of 2023, the country had an estimated population of 13 million people, making it one of the most densely populated countries in Africa[2] (CIA, 2023). Consequently, food security in Burundi is among the lowest in the world (Global Food Security Index, 2022; figure 1) and land degradation is approaching a scale of permanent loss of ecosystem services[3] (Blake et al., 2018). The population is expected to increase over the coming years with an annual growth rate of 2,7 percent (World Bank, n.d.), while cycles of extreme weather events, particularly droughts and floods, have had severe impacts on the region and are expected to continue (Ngesa et al., 2021; Gatore et al., 2024). Meanwhile, 90% of the population depends directly on smallholder agriculture (Nyairo, Machimura & Matsui, 2020). Taken together, there is an urgent need for increasing the resilience of smallholder-farming households in Burundi.

Overall food security environment: the top- and bottom-ranking countries in 2022

Best performers	2022 score	Weakest performers	2022 score
Finland	83.7	Syria	36.3
Ireland	81.7	Haiti	38.5
Norway	80.5	Yemen	40.1
France	80.2	Sierra Leone	40.5
Netherlands	80.1	Madagascar	40.6
Japan	79.5	Burundi	40.6
Canada	79.1	Nigeria	42
Sweden	79.1	Venezuela	42.6
United Kingdom	78.8	Sudan	42.8
Portugal	78.7	Congo (Dem. Rep.)	43

figure 1. Global Food Security Index (2022) showing the relative ranking of Burundi on food security

[1] Burundi's last civil war endured from 1993 to 2005
[2] Implying a population density of 450 km−2, resulting from high birth rates and the return of refugees (Jeníček & Grofová, 2015).
[3] Ecosystem services are the benefits that humans receive from healthy natural ecosystems

2.2. Development policy- and political background

Burundi received considerable international development aid in the past, but hardly any progress was made in alleviating poverty and food insecurity. The underlying reason, according to Uvin (2010)'s analysis, is that these interventions were often short-term, top-down (i.e. with little involvement of the targeted communities in their formation), and focused on conflict-resolution or emergency aid. Meanwhile, Onu & Ngubwe (2024) indicate the crucial role that international cooperation plays in the development of Burundi. They state that because of the country's persistent corruption, resulting from long political instability, international partnerships are needed for economic support and technical assistance. However, despite previous research showing that agriculture plays a pivotal role in the development of Sub-Saharan Africa (SSA) as the major source of income, food, employment and in its effectiveness in reducing poverty, on a wider scale too, Ssozi, Asongu and Amavilah (2019) indicate that governments, donors and foreign investors have underinvested in African agriculture compared to other sectors (e.g. finance and health), and the sector continues to have low productivity (figure 2).

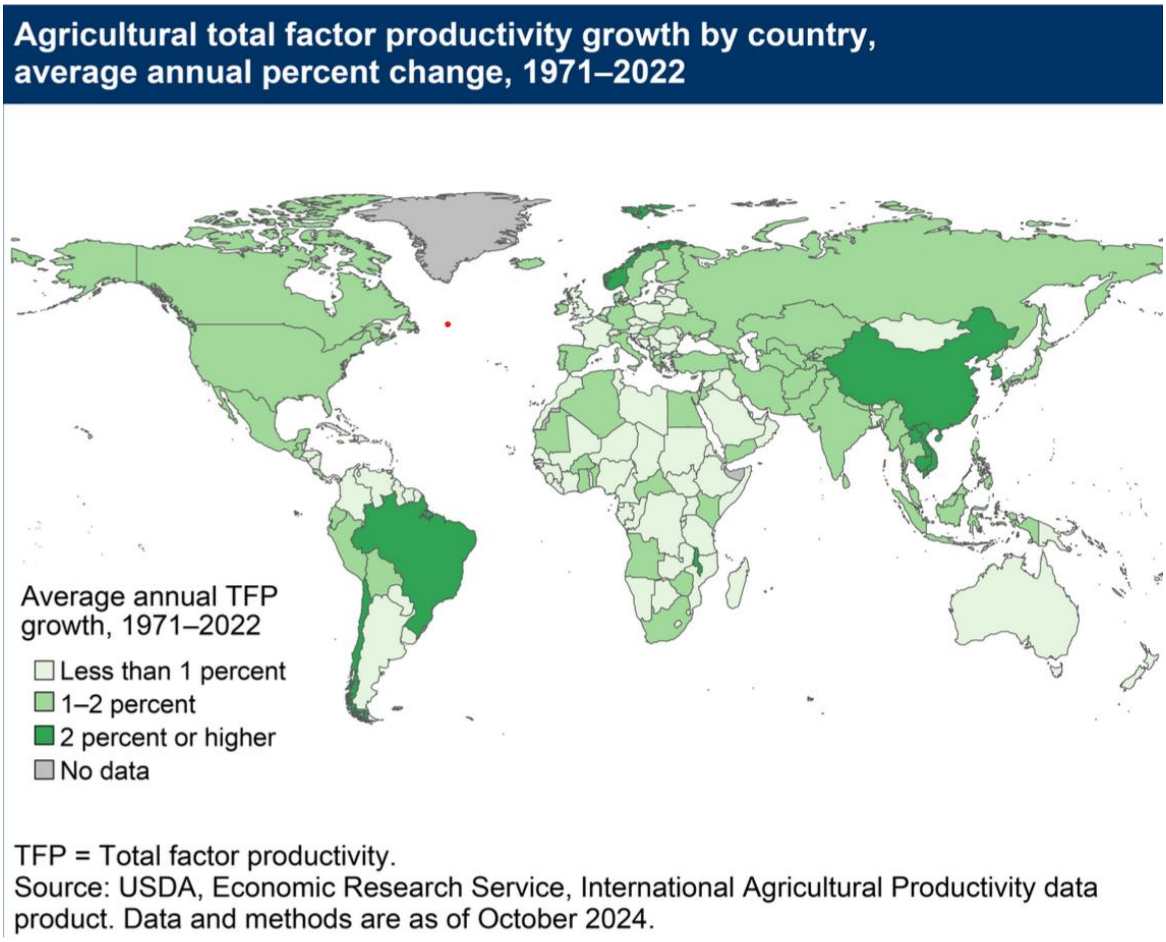


figure 2. SSA's low growth rate in agricultural productivity compared to the rest of the world

On the other hand, participatory learning approaches, which emphasize the involvement of the targeted communities in project formation, have been identified as highly important for effective agricultural research and in extension practices (de Graaf et al., 2013; Knook et al., 2024). Consequently, participatory extension is being increasingly applied as development approach (Wijeratne & De Silva, 2024).

In line with this, the Participatory Integrated Planning approach has been developed by Kessler et al. (2016) and is being used by development projects in various African countries. An increasing number of projects using the PIP approach is financed by the Dutch Government, which aims to tackle the root causes of socio-political instability and undocumented migration and invest in fairer opportunities[4] (Ministry of Foreign Affairs, n. d.).

The Participatory Integrated Planning (PIP) approach

The PIP can be described as a drawing or vision of a better future, which together with an action plan intrinsically motivates people to act and transform their reality (Kessler, Van Reemst & Nsabimana, 2018).

It starts with the members of a household sitting together and making a drawing of how they would like their farming system to look like in the future (figure 3). It is a requirement that all household members participate in the drawing process, as enhancing collaboration is a main aspect of PIP. Specific objectives are set, and a plan is made for the achievement of this envisioned future (e.g. in 2 years, have money saved to buy a goat; 3 years later, sell new-born goats to start a shop, and 5 years later, use additional revenues to buy a cow). The organization of tasks is clarified, and role divisions are made, as part of the plan. Participants can also ask for specific trainings in their plan. The topics of trainings vary from Sustainable Land Management (SLM) practices to a healthy household diet and from managing money to irrigation techniques.

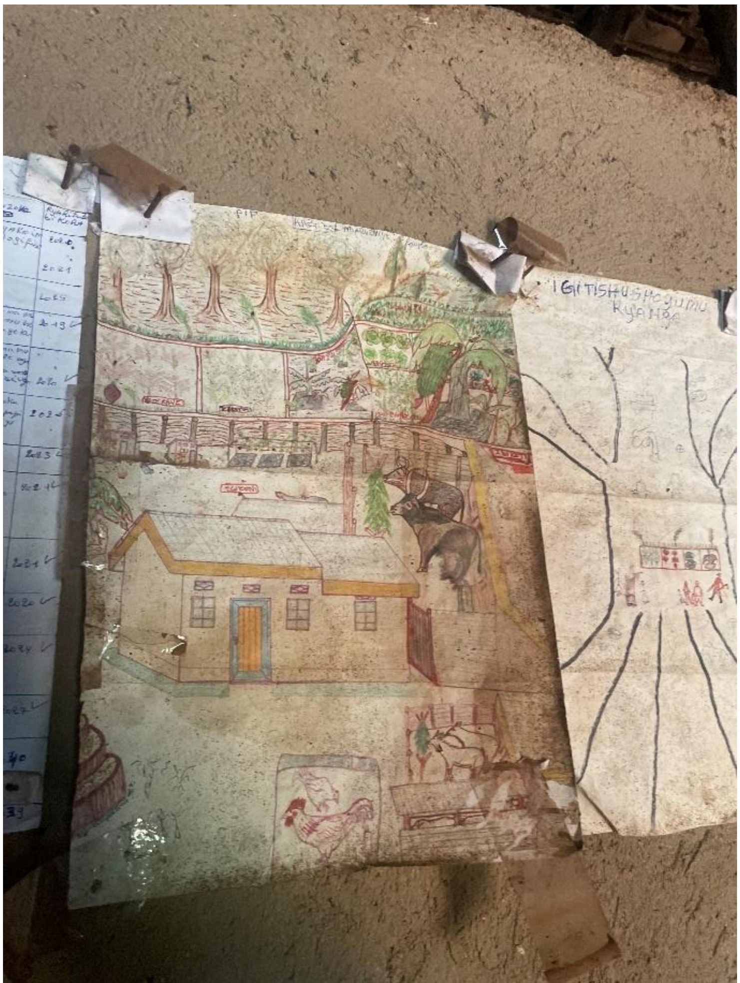


figure 3. PIP drawing by a Burundian smallholder-farming household. *Source*: author

[4] In Burundi, state capture by political elites and marginalization of the majority of the population created grievances that eventually led to revolts and civil war, and consequently refugees (Nkurunziza, 2022)

The SLM practices are an integral part of PIP. Various organizations make use of the PIP approach to educate and guide farmers on a variety of SLM practices. These practices foster SLM and counter soil erosion in a sustainable and accessible manner. Most practices are initially already applied by at least one of the farmers in the community. The farmers thus inspire each other during PIP related meetings and are taught on the use and application of the practices.

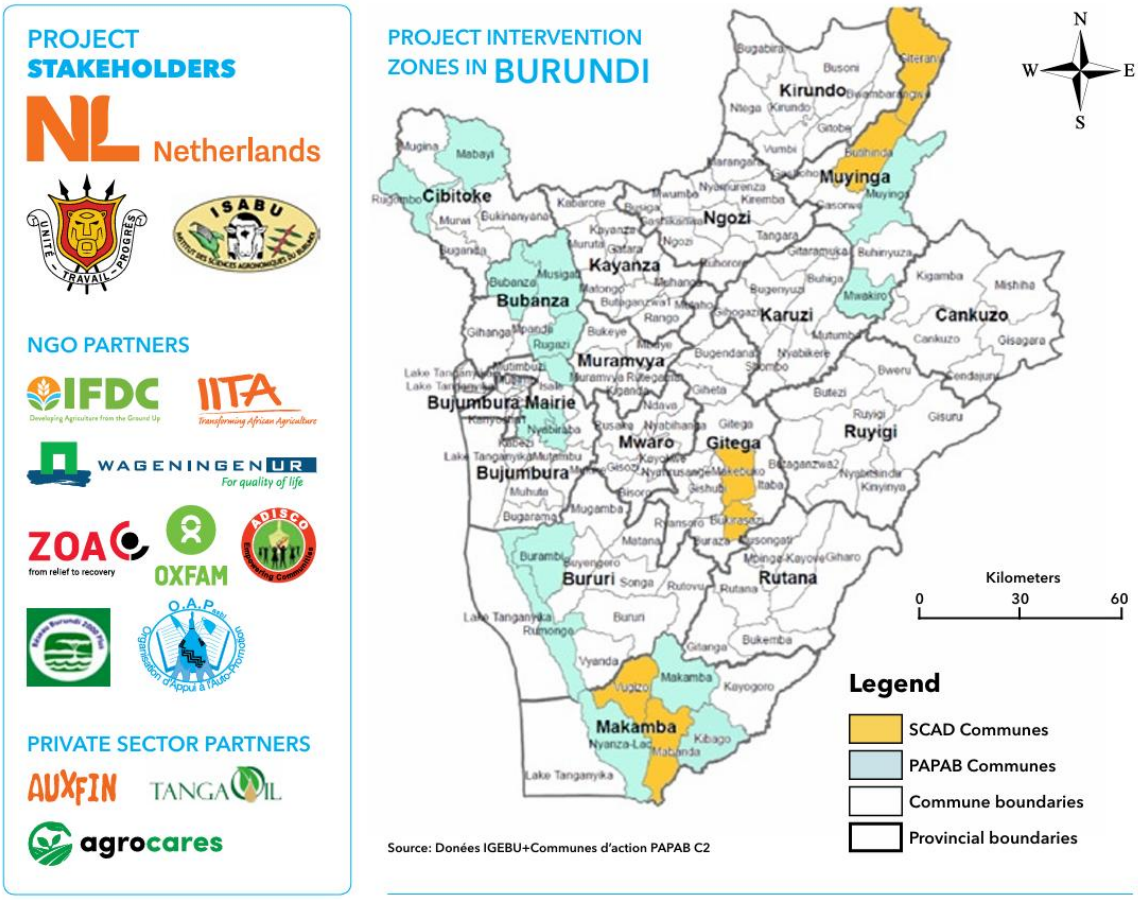


figure 4. Stakeholders and intervention zones of SCAD and PAPAB

The approach has been used in three projects which are extensions of one another:

- SCAD (Projet de Solidarité Communautaire pour l'Auto Développement), which started in 2013; followed up by
- PAPAB (Projet d'Appui à la Productivité Agricole au Burundi), which built further on SCAD from 2016 onwards, improving its approach based on lessons from SCAD and expanding its reach, and
- PAGRIS (Projet d'Appui pour une Gestion Responsable et Intégrée des Sols), scaling up the approach from household to community level, which has been in practice since 2020, and has recently been extended in time and in reach.

Figure 4 shows the provinces in which SCAD and PAPAB have operated and the partners that have contributed to the projects. The implementation of PAGRIS has mostly been conducted by the local organization Twitezimbere (Kirundi for 'self-development), supported by the International Fertilizer Development Centre (IFDC), a non-profit organization working on global food security. Since 2020, Twitezimbere is the organization leading trainings and guidance to all farming households that apply PIP in the research area and was thus an important organization to cooperate with in this research.

So far, PIP has succeeded in increasing food production, incomes and knowledge for Burundian farmers (IFDC, 2024) and an exploratory assessment by OXFAM (2020) has shown its probable contribution to resilience. However, several aspects of the PIP approach remain unresearched. Although PIP focuses on a change of mindset as pathway of enhancing resilience (Kessler et al., 2021), this effect has not yet been established. Furthermore, no study has yet been conducted on the effects of longer involvement in the PIP approach. Lastly, former studies on the PIP approach have researched pre-determined indicators, which are likely to contribute to resilience, but no research on the specific pathways through which resilience is enhanced in the research context has been conducted yet. This study aims to fill this research gap.

2.3. Scientific Background

Resilience is a concept in development and how to measure it more so, as can be seen from the ongoing scientific discussion on it (d'Errico, Romano, & Pietrelli, 2018; Shilomboleni, Epstein & Mansingh, 2024). Resilience thinking is widely applied in environmental and social studies and emphasizes the capacity of systems to adapt to change and uncertainty (Folke et al., 2010). In the agricultural sector there has been a focus on how to build resilience to climate events, which spans an economic, environmental and social area (Knook et al., 2024). Furthermore, studies have focused on the resilience to long-term stressors, such as degradation of ecosystems due to pollution, as well as to shocks, such as earthquakes or the Covid-19 pandemic (Knook et al., 2024).

Overall, work focusing on resilience in the agricultural domain provides the ability to understand farms and their systems facing complex challenges. However, there is no consensus on how to measure resilience, while an increasing number of organizations are applying the concept of resilience. This research aims to contribute to that development. Therefore, first, a variety of frameworks are explored in order to determine which one is most suitable for this research.

- The United Nations (UN) has developed a framework to measure resilience in 2015, called Resilience Index Measurement and Analysis (RIMA)-II, which has been deemed effective by Ngesa et al. (2021), who apply it to a multitude of case studies. RIMA-II focuses on a broad range of resilience indicators, which are measured and given a score, resulting in a final resilience score per household. Figure 5 shows one of the steps of RIMA-II and its accompanying indicators.

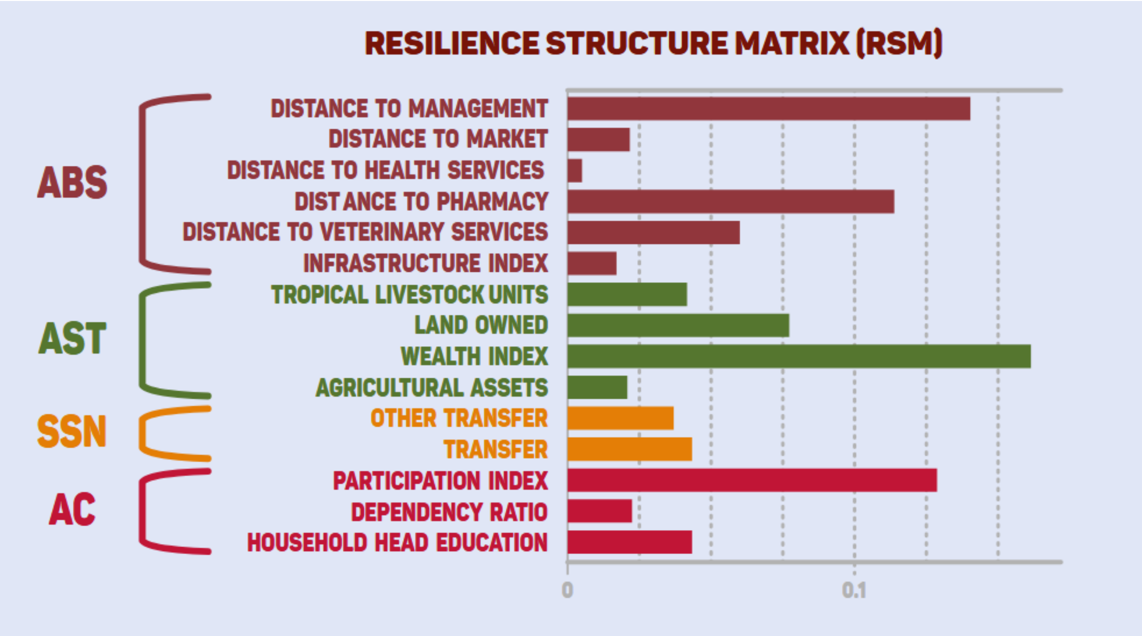


figure 5. The Resilience Structure Matrix, part of RIMA-II, applied to a case study in Uganda

- Meuwissen et al. (2019) take a more open approach to measuring resilience, by applying a framework that starts with a description of the researched farming system, including its structure, challenges and functions. Followingly, it looks for what resilience indicators the farming system is attributing to the specific situation (instead of measuring a given set of indicators as RIMA does). Knook et al. (2024) apply Meuwissen et al. (2019)'s framework to a case study that involves a participatory extension project. They deem the framework effective due to its open and flexible approach.
- Yet another approach is that of Béné (2020), which investigates and describes a system's response to a specific shock and categorizes it into positive and negative responses, based on measures taken by the farmer (e.g. borrowing money or selling assets).
- Finally, the UN's Food and Agriculture Organization (FAO) has developed the SHARP tool which uses a combination of subjective and objective components spanning across environmental, socio-economic, agronomic and governance dimensions (Choptiany et al., 2016).

As resilience is still a concept in development, there is a call for open research that avoids the predetermination of resilience indicators. Ansah, Gardebroek & Ihle (2019) state that "we still have a blurred understanding of which of the tangible (e.g., income, assets, savings, etc.) and intangible (e.g., self-efficacy, risk perception, etc.) elements are the basis of resilience capacities that are actually important, and under which conditions they become important." Intangible indicators, such as a resourceful mindset, could enhance resilience but are not represented in any framework (Meuwissen et al., 2019; Malekinezhad, Micha & Maye, 2024).

A project that uses the PIP approach seems appropriate to search for the role of intangible indicators, because PIP focuses on intangible resilience elements such as a mindset change, planning and collaboration, to enhance resilience. Accordingly, the framework by Meuwissen et al. (2019) seems most appropriate for the measurement, as it does not pre-determine the resilience indicators, thereby allowing for the inclusion of previously unidentified indicators. Moreover, the objective of the PIP approach is resilience-based stewardship: to foster resilient farming systems, i.e. farms that can withstand and recover from shocks (droughts, excessive rainfall, pest infestations, etc.), to continue producing food in a sustainable way, which will eventually lead to improved land management. This approach to resilience aligns well with Meuwissen et al. (2019)'s resilience assessment framework.

3. Methodology

As the research applies the resilience framework developed by Meuwissen et al. (2019), this section starts with an elaboration on its theory.

3.1. The Resilience Framework

Resilience theory generally focuses on change, uncertainty, and the ability of systems to adjust. As such, resilience is a concept used to assess to what extent households can cope with extreme events, adapt to changing conditions, and/or transform their situation toward greater food security. Meuwissen et al. (2019), focusing on farming systems, define resilience accordingly:

> *"**The resilience of a farming system** is its ability to ensure the provision of the system functions [e.g. food production] in the face of increasingly complex and accumulating economic, social, environmental and institutional shocks and stresses [e.g. climate change], through capacities of robustness, adaptability and transformability".*
>
> *– Meuwissen et al. (2019)*

Meuwissen et al. (2019)'s definition of resilience is also the one used in this research. In line with their definition, they have developed the framework shown in figure 6.

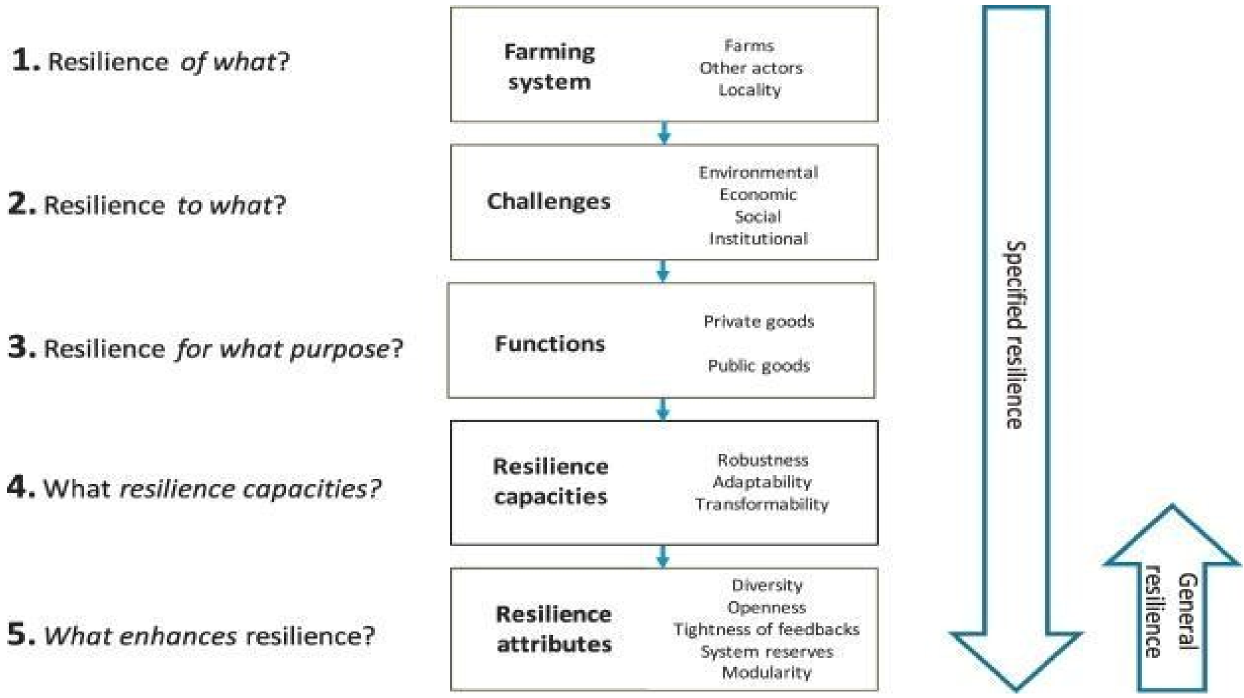


figure 6. Resilience assessment framework by Meuwissen et al. (2019)

The research refers to the framework either as ‘Meuwissen et al. (2019)’s framework’ or ‘the resilience (assessment) framework’.

Meuwissen et al. (2019)’s framework follows five steps to assess the resilience of a farming system. To begin with, steps 1 to 3 respectively investigate

1. the farming system at hand,
2. the shocks and stresses it faces (i.e. the challenges) and
3. the key roles or services that a farming system is expected to deliver, even when facing shocks or stresses (i.e. the functions).

Followingly, steps 4 and 5 serve to recognize the applied resilience strategies. Step 4 identifies three resilience capacities (figure 7). These can be described as follows:

- *Robustness* (figure 7.a.) is the capacity to withstand stresses and shocks, which implies maintaining the status quo of the farming system, without making changes to it.
- *Adaptability* (figure 7.b.) is the capacity to change the composition of inputs, production, marketing and risk management in response to shocks and stresses but without changing the structures and feedback mechanisms of the farming system.
- *Transformability* (figure 7.c.) is the capacity to significantly change the internal structure and feedback mechanisms of the farming system in response to either severe shocks or enduring stress that make business as usual impossible. Such transformations may also entail changes in the functions of the farming system.

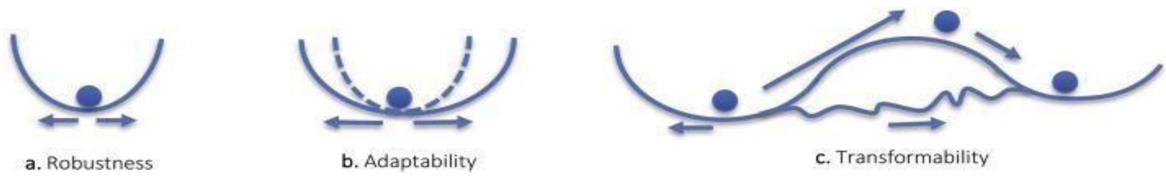


figure 7. Robustness, adaptability and transformability as resilience capacities (Meuwissen et al., 2019)

Lastly, step 5 responds to the question “what enhances resilience?” by identifying resilience attributes. These *resilience attributes* are “competences of a farming system and its environment that support its ability to persist, adapt, or transform in response to challenges” (Meuwissen et al., 2019), i.e. system elements that can be applied in the recuperation process and accordingly enhance resilience.

The attributes can contribute to two aspects of resilience: specified and general resilience, visible in the arrows in figure 6. The distinction between the two aspects of resilience is as follows:

Specified resilience is a farming system’s capacity to deal with a specific shock or stress. It is therefore enhanced by resilience attributes that can be applied to a specific shock or stress, e.g. pesticides in case of crop disease, or irrigation in case of a drought.

General resilience on the other hand is a farming system's capacity to deal with the unknown, uncertainty and surprise. This form of resilience is therefore enhanced by resilience attributes which are applicable to a multitude of shocks and stresses, such as having an extra income source or assets to rely on.

3.2. The Research Build-up

To begin with, I aimed to understand the context of the households and of the projects using PIP. Therefore I spoke to several IFDC and Twitezimbere staff members, who helped in the organization of the research, visited the field to see what practices have been applied due to PIP, and conducted test-interviews with farmers in order to see how certain questions could be interpreted and what format functioned well (e.g. using multiple choice or open questions). I tested what questions were best to pose to recognize common threads within their described responses to challenges i.e. their applied resilience strategies. The research uses semi-structured interviews and group discussions to assess the resilience of three research groups:

1. SCAD households
    - a group that has been trained in PIP relatively long ago (in 2013),
2. PAPAB households
    - a group that has been trained in PIP less long ago (in 2016), and
3. Non-PIP households
    - a control group that has not been trained in PIP

To answer the main research question, the sub-research questions are constructed according to three topics:

- Five pre-determined resilience attributes of the households,

  The first sub-question compares five pre-determined resilience attributes between the three groups. This provides a baseline understanding of how resilient these groups are and whether differences exist that could be linked to PIP.

- The resilience attributes that households apply,

  The second sub-question examines which specific resilience attributes are applied by the households and how they differ across the groups. This helps identify how resilience is expressed or lacking in each group, which is essential for understanding the mechanisms through which PIP may have an effect.

- The influence of PIP on the identified resilience attributes

  The third sub-question focuses directly on the role of the PIP approach within SCAD and PAPAB. It aims to uncover how PIP has shaped households and their farming systems, and links these influences back to the resilience attributes from sub-question 2. This allows for a more nuanced analysis of the PIP approach's contribution.

This sub-chapter elaborates on the meaning of and approach to these questions. The interview questions that are related to each step are provided here, while the authentic interview can be found in Annex I. The following sub-chapter, chapter 3.3., will explain the organization of the field work.

SRQ 1 – Five Pre-determined Resilience Attributes

General resilience is enhanced by resilience attributes that are multi-employable or multi-functional. These kinds of resilience attributes are important for smallholder-farming households to cope with unexpected events. A few resilience attributes that are likely to contribute to general resilience can be established prior to the fieldwork. This allows for some important resilience attributes to be quantifiably compared. Therefore, the first sub-research question investigates

"How do the five pre-determined resilience attributes differ between SCAD, PAPAB and non-PIP households?"

In the research context, five resilience attributes are presumed to convey general resilience. These are based on scientific literature, interviews with IFDC and Twitezimbere staff members, and test interviews. While general resilience may be constituted by additional attributes, these five attributes are assumed to contribute to the general resilience of smallholder-farming households in the province of Gitega:

- Crop diversity
- Livestock
- Income source diversity
- Land ownership
- SLM practices

During the test-interviews, farmers indicated to have their land ownership, crop production and livestock as most important assets which they use to fall back on in times of difficulty, because all can be sold and are important for the continuation of their practices. However, measuring the amount of crop production was not possible in the scope of this research. PIP participants also stated to experience enhanced resilience as a result of crop diversification, especially to challenges related to the weather. While some crop types survived severe droughts others survived excessive rainfall, which made it beneficial to have both. This is in line with research by Baffour-Ata et al. (2023), who investigated the resilience of smallholder farmers in Ghana. They found crop diversity to be one of the farmers' most important practices to cope with climate change, while also enhancing marketing opportunities and soil and water conservation.

Income source diversity is a main focus of the PIP approach. It enhances general resilience of smallholder-farming households because it gives redundancy to the farming system. When a drought or excessive rainfall results in a failed harvest, the household has an income source to fall back on. A differentiation is made between on-farm and off-farm income sources: on-farm income sources are related to the farming system to an extent that if a shock or stress would affect the farming system, this income source would be affected as well (e.g. coffee production). An off-farm income source is unrelated to the farming system of the household and would thus not be affected (e.g. masonry).

Lastly, SLM practices constitute a main focus of the PIP approach, because it increases yields and protects the soil. This way erosion should be reduced, and fertility of the soil is protected for the long-term. The SLM practices were asked for during the interviews. Farmers could choose from and add to 14 SLM practices. The choices that were given in the interview were derived from conversations with IFDC and Twitezimbere staff members and on recurring practices named during the test interviews. The following format was used to assess the five pre-determined resilience attributes:

Type and quantity of the land:

0 Inherited   0 acquired   0 rented

Main crops grown (& for each crop whether it is for selling, for consumption or both):

Livestock (type and quantity):

All income sources:

SLM practices applied:

- Mulch
- Cover crops
- Intercropping
- Agroforestry
- Ploughing less
- Tranches
- Earth dikes
- Living hedges
- Continuous ridges
- Manure
- Compost
- Sowing in lines
- Ploughing perpendicular to the slope
- Ploughing along contour lines with fixating herbs
- Additional:

SRQ 2 – What Enhances Resilience?

Resilience attributes reflect strategies that households can use and choose to apply in response to a shock or stress. Besides contributing to the aim of this research (i.e. assessing the influence of PIP on household resilience), they also show the resources and knowledge that farming households in the research area rely on. Such an overview can be beneficial to each organization that wants to contribute to the resilience of the farming households in the area, whether it is the government or another NGO, as it makes targeted interventions possible.

"How do the resilience attributes of the SCAD, PAPAB and non-PIP households differ?"

Following the five steps of the resilience framework results in the identification of resilience attributes. Therefore, to answer this question, all five steps of the framework are answered, as indicated by figure 6, and reminded by table 1. The operationalization of these steps is described followingly.

Table 1. Reminding overview of the resilience framework's steps

Step 1. Resilience of What?	The Farming System
Step 2. Resilience to What?	The Challenges
Step 3. Resilience for What Purpose?	The Functions
Step 4. What Resilience Capacities?	Robustness, Adaptability, Transformability
Step 5. What enhances Resilience?	The Attributes

Step 1. The Farming System

The subject of this research is the smallholder-farming household. Step 1 can therefore be answered by describing the farming system of the households in question. According to Meuwissen et al. (2019), the farming system can be characterized by

- The regional context e.g. a rainfed cropping system.
  A description of the regional context was based on a tour given by a farmer. The tour crossed multiple hills in the region and demonstrated farmers' practices and explained the local climate.
- The main products of interest e.g. which crops are produced.
  The main products of interest have been deducted during the test interviews; they constitute crops and livestock.
- The external effects and public goods related to the household members' activities e.g. through job and income creation, network effects, resource use, landscape impacts.
  These were based on group discussions and the interview questions on income source diversity and SLM practices.

- Actors that mutually influence each other within the farming system e.g. extension services and the farming households.
  These were based on group discussions and deducted from the interview responses

Step 2. The Challenges

Step 2 is answered by asking the farmers about the shocks and stresses they have experienced. The year that the shock or stress occurred is also asked to be sure of the relevance and comparability of the answers. As stated by Meuwissen et al. (2019), shocks and stresses can be environmental, economic, social and institutional (e.g. drought or the absence of a working household member, for instance due to sickness). The questions asked to answer step 2 were the following:

> Have you known any shocks or stresses in the past years that have strongly influenced the well-being of your household? Which ones? When did they occur?

Additionally, based on the initial explorative conversations with IFDC and Twitezimbere staff and the test interviews, inflation was recognized to be a widely felt stress. Since 2023 prices had gone up relatively quickly, thereby obliging many households to adapt their daily habits. As inflation was a stress that was experienced by all research participants, this allowed for the comparison of resilience strategies to the same stress. Therefore, all farmers were asked specifically for the effects of inflation during the interviews (see step 3 for the question on effects).

Step 3. The Functions

The functions are the key roles or services that a farming system is expected to deliver, even when facing shocks or stresses. One function was chosen for the assessment of this research, which is:

- Alimentation

Purchasing power and *agricultural production* were also assessed as functions, but alimentation proved to be the most indicative for resilience. Alimentation provided stronger links to household well-being and their coping strategies. Therefore, only the effects on alimentation are considered.

Options were given whether these functions had decreased, changed otherwise or were not affected by the named shocks and stresses. The questions asked to answer step 3 were the following:

How has this [shock/stress] influenced your..

Agricultural production: increased/ no influence/ decreased

Purchasing power: increased/ no influence/ decreased

Alimentation in the household: increased/ no influence/ decreased

Step 4. The Resilience Capacities

The fourth step regards the resilience capacities. The capacities are studied by looking at how households are affected by shocks and stresses, and how they recover. Looking at how households recover is also how the resilience attributes are identified. Therefore, the same interview questions regard step 4 and 5 together.

If none of the functions (agricultural production, purchasing power or alimentation) had been affected, the resilience capacity was deemed *robust*.

The farmers were asked how their household had recuperated from the shock or stress. If the farmer indicated that the household had adapted to the effects of the shock or stress but did not make any changes in the operation of the farm, the household was deemed to be *adaptable*. For example, a household that loses its crops to a drought but uses another income source to complement for the lost income and alimentation and eventually invests in new seeds and fertilizers to continue farming as before.

Finally, if the household had changed the farming system's structure in response to a shock or stress, it was deemed to be *transformable*. For example, if a household would change its income generation from crop cultivation to livestock rearing in response to climate change. The questions asked to answer steps 4 and 5 were the following:

How is it now? Have you been able to recuperate/ find solutions/alternatives? How?

What has helped you to recuperate? What has limited you?

Step 5. The Resilience Attributes

The fifth and final step investigates the resilience attributes that enhance the household's resilience. These are based on the descriptions of the recuperation process and additionally asking if anything else had helped or limited the household in this process (questions of step 4). Follow-up questions were asked with the aim of grasping the whole recuperation process; If a farmer would indicate that they had borrowed money, it was asked what helped them to repay the debt. If the household would resow and eat less until the next yield, it would be asked how they got the seeds and fertilizers for the new yield. Altogether, this allowed for the identification of resilience capacities and attributes. This method was tested successfully during the test interviews, as clear resilience components could be identified.

During data analysis, some resilience attributes were grouped under overarching terms to enable comparison between the research groups (e.g., using 'off-farm income source' as a general category rather than specifying each income source).

SRQ 3 – PIP's Influence

The resilience attributes assessed under SRQ 2 do not necessarily imply an influence of PIP. Therefore, the research also investigates how, according to the interviewed farmers, PIP has influenced their households and farming systems, and how this influence relates to the identified resilience attributes. Taken together, this SRQ thus investigated the following:

"How has PIP influenced the SCAD and PAPAB households? And how does this influence relate to the resilience attributes of PIP households?"

To establish the effect of PIP on farmer households' resilience, farmers were asked about PIP and the effects it has had on the household and the farming system through open questions. The questions focused on two main aspects of PIP: the plan and the collaboration within the household. The influence of PIP was also discussed in the group discussions. Followingly, it was possible to connect the dots between the resilience attributes and PIP's influence. The following questions were posed to assess the influence of PIP:

How has PIP influenced you household?

How has PIP influenced your agricultural production?

Has the fact of having a plan and objectives changed the well-being of the household? How?

Has PIP changed the way in which you collaborate within the household? Has PIP changed how you get along within the family?

What would change if the project would stop in your view?

3.3. Field Work Strategy

Societal structure

First, it should be understood what a colline is, being part of the societal structure in rural Burundi. Burundi, like its neighbouring Rwanda, is often referred to as 'the land of a thousand hills'. The country is largely characterized by a central plateau with elevations ranging between 1,400 and 2,600 meters, thereby forming hills as far as the eye can see. The hills also constitute its societal structure. A colline (French for hill), sometimes consisting of 2 or 3 sous-collines (French for sub-hill) is the first societal layer. In most cases it covers approximately one hill and the valleys and it has a leading representative i.e. chef de colline. A commune is the next societal layer, encompassing several collines and often constituting a central point where the municipality is located.

Participant Selection

The research made a distinction between collines where the PIP approach was implemented relatively long ago (SCAD), less long ago (PAPAB) and where no PIP had been applied. This could show whether the PIP approach has different effects on a longer term and whether there are noticeable differences between PIP and non-PIP households. Sometimes the study refers to SCAD and PAPAB together as the PIP groups, because both have knowledge of PIP, contrary to non-PIP collines. For a valid database, 3 collines per group were selected in the Gitega province. The Twitezimbere staff helped select the collines, based on their relation to PIP and distance from the city of Gitega, where most people related to the research were based. Eventually, 8 collines, of which 3 SCAD, 2 PAPAB and 3 non-PIP collines, participated in the research. The visit to one PAPAB colline was cancelled due to a force majeure earlier leave. The 8 collines were spread over two communes. The communes of this research, Bukirasazi and Makebuko, are respectively a ~37 and a ~27 km drive from the city of Gitega.

- Three of the collines (Kibere, Rwesero and Rwezamenyo) had participated in the SCAD and PAPAB project;
- Two collines (Makebuko and Mwaro Mavuvu) had participated in the PAPAB project;
- and another three collines (Gasongati, Nyamagandika and Murago) formed the control group i.e. they had not participated in any project related to the PIP approach (awareness of PIP's existence was additionally asked for).

In total, 66 interviews were held. During the data analysis, 4 of these were deducted, resulting in a total of 62 interviews used for the research (Table 2). The results of two of the interviewees were deducted because they had a plot of 20 ha, which was not representative of their research groups; another farmer's results were not included because his answers were incomplete; and one farmer had only participated in PAGRIS and not in the former projects, because he had moved to the colline in 2020. Additionally, in total, 8 group discussions were held.

Table 2. Data collection of the three research groups

Research group	SCAD	PAPAB	non-PIP
Relation to PIP	PIP since 2013	PIP since 2016	Control Group
Representing collines	Kibere, Rwesero and Rwezamenyo	Makebuko and Mwaro Mavuvu	Gasongati, Nyamagandika and Murago
# of participants	23	14	25
# of shocks & stresses	75	44	75

Group discussions

Group discussions were held in each colline, with other participants than those of the individual interviews. The group discussions asked farmers about the shocks and stresses they had experienced, their recuperation process, what helped and limited them in the recuperation process and PIP farmers were asked for the influence of PIP. The group discussions were expected to produce slightly different answers than the interviews, because of the different approach and setting, thereby adding to the results and comprehension of the context. Moreover, the group discussions served for clarification and elaboration on given answers (e.g. explaining the mechanisms of the credit associations or the awareness of agricultural insurance).

The participants

In each colline 7 to 10 farmers were interviewed personally and 1 or 2 group discussion were held, except for the last 3 visited collines, where no group discussions were held due to the force majeur earlier leave. Each colline was visited for 3 subsequent days. The farmers were mostly available at the beginning of the day, although those were their labor hours. Later in the day farmers were often occupied with meetings and communal gatherings or could be less reliable to attend the interview. Cooperation with the translator in the set-up of the semi-structured interview was important in order to have the same understanding of the aim of the research and to choose the correct translation for key words of the research, such as the understanding of resilience and shocks and stresses. Ernest Habonayo, the translator, had much field-work experience in Burundi, which helped in the arrangements of the interviews.

Data analysis

To begin with, the translator translated mostly the part of the farmer's response that answered the questions, sometimes with some additional information that gave insights on the local context (e.g. how revenues are used or why a farmer was cultivating less coffee than before), but intending to filter out miscomprehensions or small talk. All the translated information was noted down on paper. After gathering all the data, the translations of the interviews were analyzed and trans possessed into Excel. The gathered data were entered into Excel without the additional information and with some generalisations. For instance, only 'hospitalisation' was noted, excluding the reason why the person was hospitalised. Data cleaning was done in Excel.

Regarding livestock keeping, the livestock owned were given a comparable value score according to the tropical livestock units (TLU). A cow of 175 kg represents 0.70 TLU. The rest of the scores are given in the table, while an elaboration can be found in Annex III.

Table 3. Livestock animal and their related weight approximation and TLU values

Animal type	Weight approximately (in kg)	TLU value
Cow	175	0.7
Foal	50	0.2
Pig	50	0.2
Sheep	25	0.1
Goat	25	0.1
Poultry	2.5	0.01
Rabbit	2.5	0.01
Rat	0.5	0.002

Testing for significant differences

To answer SRQ 2, the study assessed which resilience attributes are applied by the farming households. It was expected that there would be differences in which attributes households apply between SCAD, PAPAB and non-PIP households. To have a comparable score, the percentage of shocks & stresses that a resilience attribute was applied to was calculated for each group. Namely, each group had produced a different number of shocks & stresses (table 2). To assess whether these differences were significant, the MANOVA test was conducted. A MANOVA-test (Multivariate Analysis of Variance) is a statistical test used to determine if there are significant differences between two or more groups when there are multiple continuous dependent variables.

Lastly, the differences in the five pre-determined resilience attributes were assessed with ANOVA tests on significance. An ANOVA-test is the same as a MANOVA-test, except that it tests for differences between groups using one dependent variable.

4. Results

The findings are presented in three parts:

- First, according to the five pre-determined resilience attributes, thereby answering the first research question
- Second, according to the five steps of the resilience assessment framework (figure 8), thus addressing the second research question.
- Third, according to PIP's influence and its connection with the resilience attributes, which answers the third research question

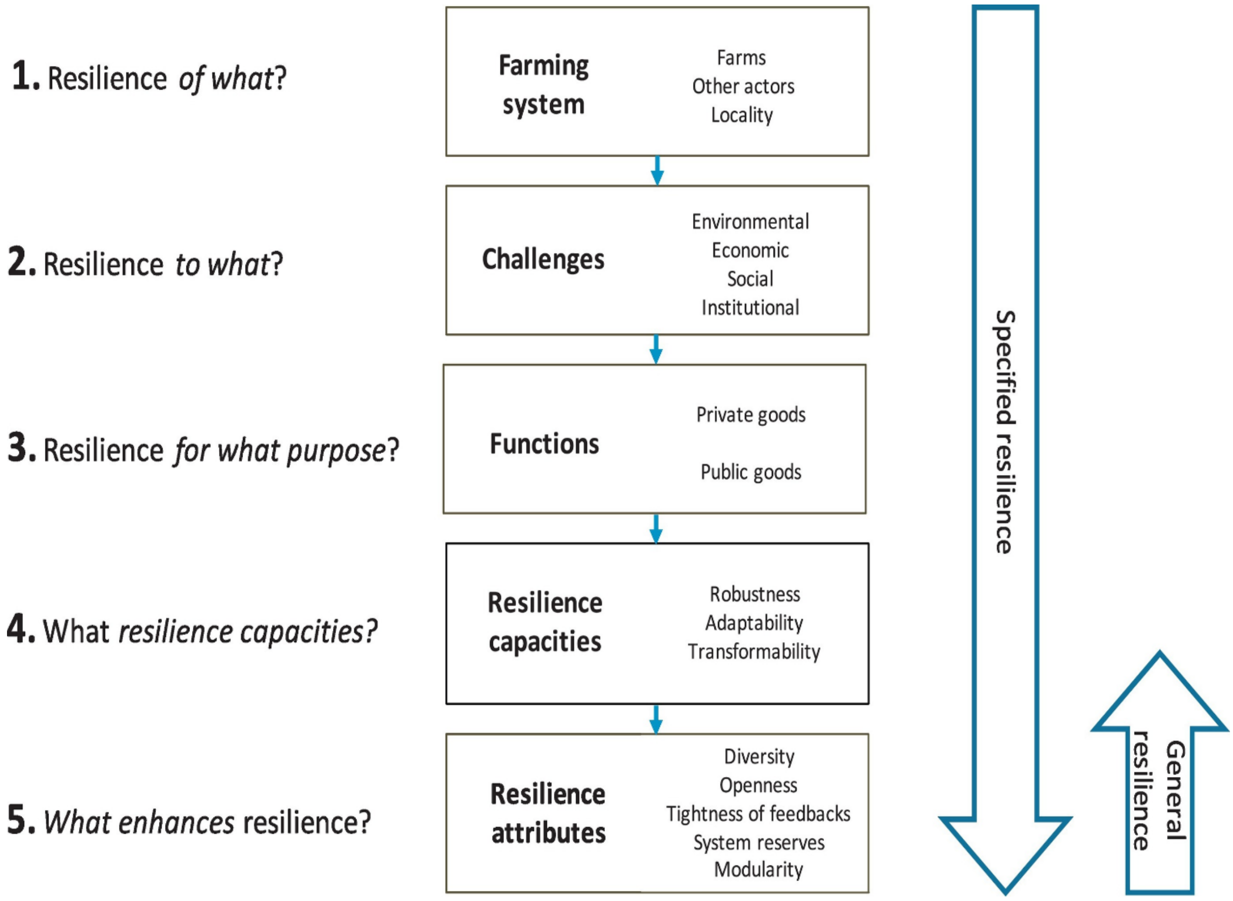


figure 8. Resilience assessment framework by Meuwissen et al. (2019)

4.1. The Five Pre-determined Resilience Attributes

- Crop Diversity

The following figure shows some of the main crops grown in the region, indicating the percentage of participants of each research group that cultivates that crop over the year.

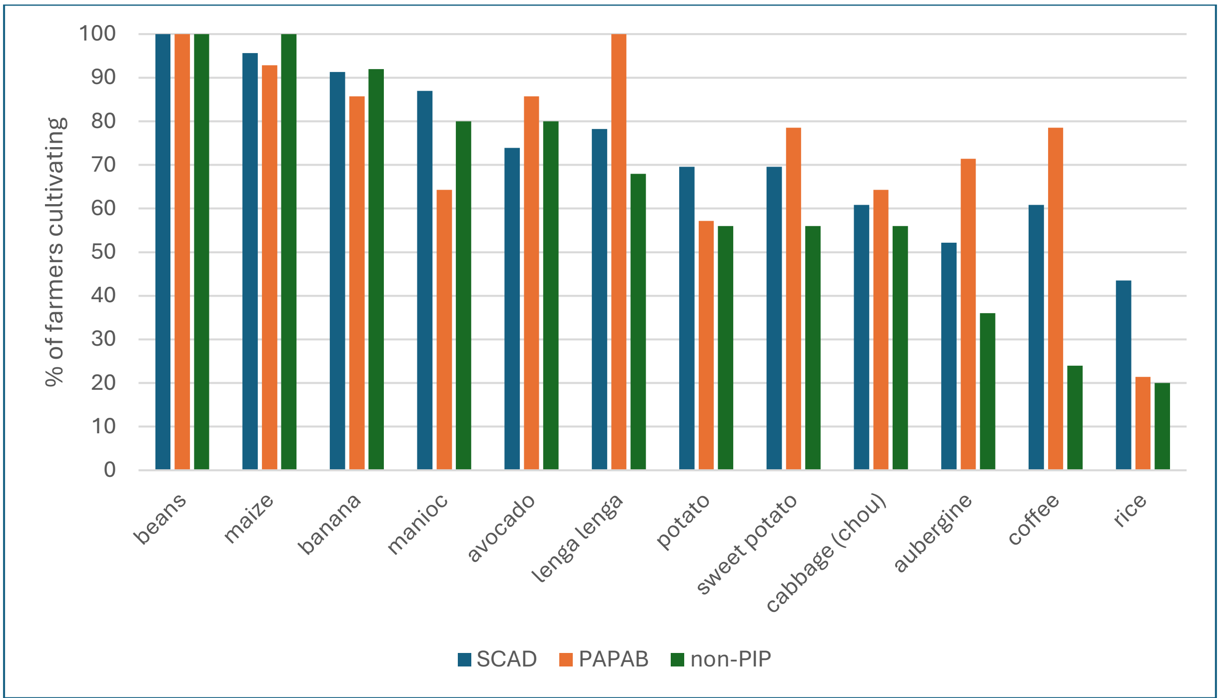


figure 9. The percentage of households of each group that cultivates the indicated crop; ordered from left to right in descending order of the control group (i.e. non-PIP)'s percentages

Altogether, the SCAD and PAPAB households have a higher crop diversity than the non-PIP households. The figure shows that 100% of the households of each group cultivates beans and more than 90% of each group cultivates maize. Standing out is the relatively high percentage of PAPAB households cultivating lenga lenga, which is a type of Amaranth. For this, an explanation is missing, but it could be biased by the relatively small PAPAB sample. Furthermore, all crops to the right of lenga lenga in the figure show a lower percentage of cultivation by non-PIP households than by the two PIP groups. This indicates a lower crop diversity for non-PIP households than SCAD and PAPAB households, which is confirmed by the following data: table 4 shows the average numbers of cultivated crop types as stated by the farmers. Data on which crops are used for selling was collected as well. The differences between SCAD and PAPAB households are not significant, neither in crop types, nor in crop types for selling. The differences between SCAD and non-PIP ($p = 0,002$) and between PAPAB and non-PIP households ($p < 0,001$) are significant on both aspects.

Table 4. Average numbers of crop types for consumption and selling per research group

	SCAD	PAPAB	NON-PIP
# CROP TYPES	11,7	13	8,9
# CROP TYPES FOR SELLING	6,5	6,6	3,6

Other crops that farmers stated to cultivate include courgette, tomato, lettuce, leek, Japanese plum, taro, pigeon peas, finger millet, sorghum, guava, passion fruit, ananas, and some crops grown by sole farming households including sugarcane and soja.

- ### Livestock

A large majority (98%) of households own livestock, consisting of pigs, chicken, cows, goats, rabbits and rats, which are used for manure, consumption and as assets. The following figure shows the average number of each animal that households keep, per group.

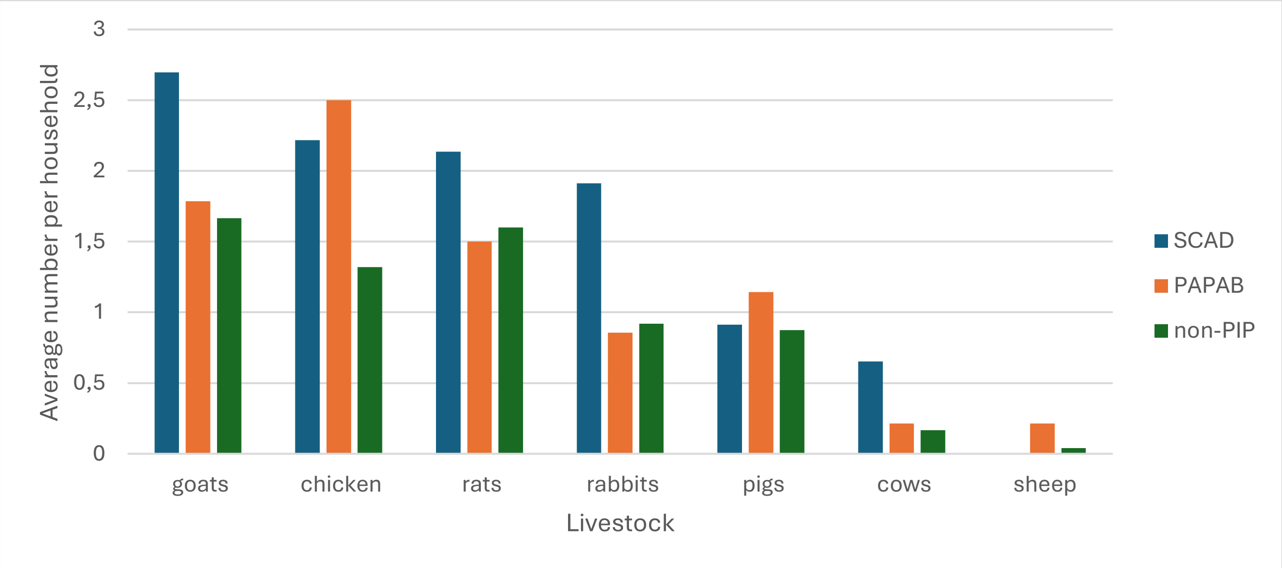


figure 10. The average numbers of livestock owned by households per group

Based on the results, SCAD and PAPAB households generally own more livestock than non-PIP households. In Burundi, especially cows are valuable. They are expensive and have the extra characteristic of providing manure. Rabbits and rats are kept for meat consumption and for selling. The average total TLU is highest for SCAD households, followed by PAPAB households and finally non-PIP households (Table 5). The difference in TLU is only significant between SCAD and non-PIP households ($p = 0{,}003$).

Table 5. Tropical Livestock Units (TLU) per group

	SCAD	PAPAB	NON-PIP
TLU	0,96	0,58	0,42

- ## Income source diversity

PAPAB households have significantly more income sources than non-PIP households (p < 0,001). Other than that, no differences are significant in income source diversity, although both PIP groups have a higher income source diversity than the non-PIP households. Zoomed in on off-farm income source diversity, no significant differences are present, and the differences are negligible. Therefore, the higher income diversity results from on-farm income sources.

Table 6. Income source diversity per group

	SCAD	PAPAB	NON-PIP
# INCOME SOURCES	4,3	5,2	3,6
# OFF-FARM INCOME SOURCES	1,8	1,9	1,8

Looking at what income sources households have, the SCAD and PAPAB households (take account for the smaller sample of the latter) relatively more often engage in additional agricultural income generating activities such as coffee production and commerce, while non-PIP households more often engage in paid ploughing (see figure 11). Paid ploughing is the most accessible job in the region, according to farmer testimonies, while starting a commerce often involves a plan and organization.

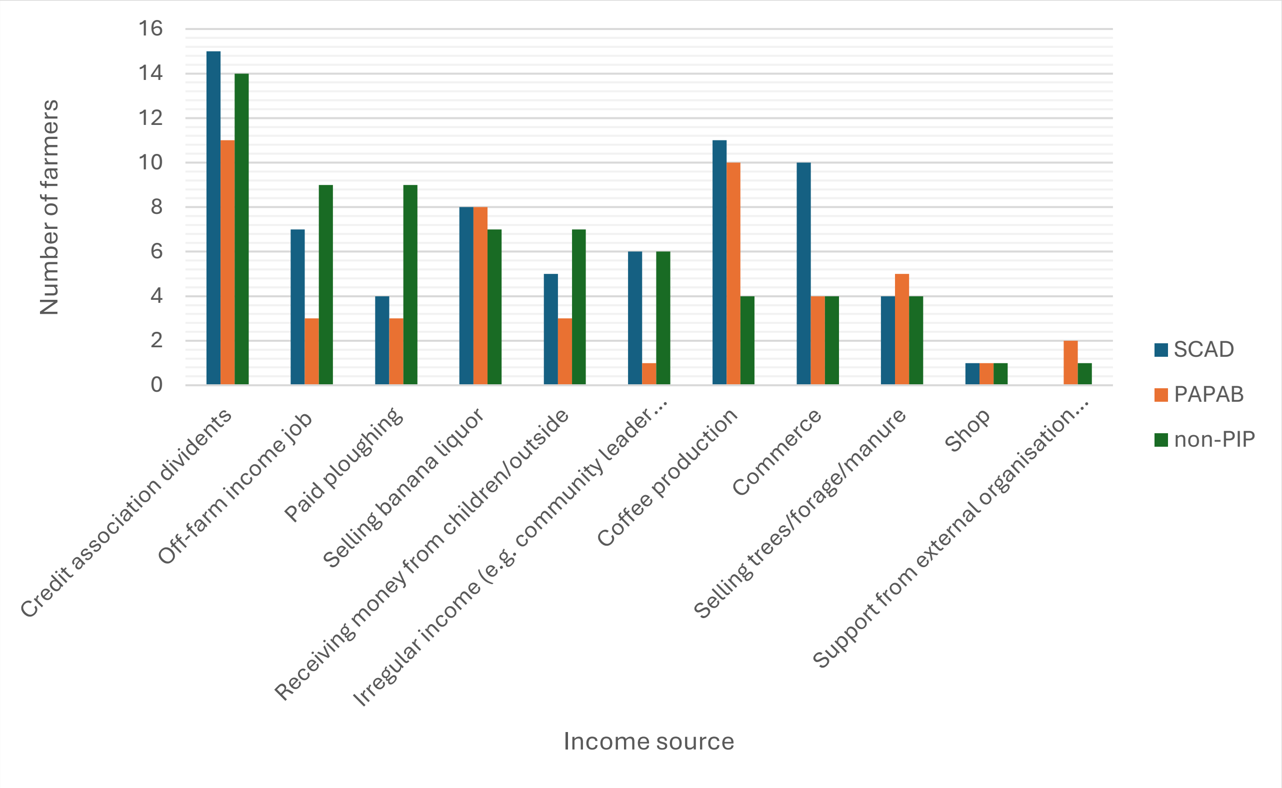


figure 11. Income sources per group; SCAD (n = 23); PAPAB (n = 14); non-PIP (n = 25).

Overall, all households have a similar main method of income generation. At each harvest the farmer households put aside food reserves to last until the next harvest and sell their estimated surplus to provide for other basic requirements – school, clothes, palm oil, seeds, fertilizers, etc. The products are sold on the local markets. In rare cases, farmers also go to the larger city of Gitega to sell their produce. Others also engage in off-farm jobs (e.g. mason or carpenter).

- Land ownership

Regarding land ownership, SCAD households have bought, received and rented more land than the others (table 7).

Table 7. Averages of land owned, family owned and rented for the three group

	SCAD	PAPAB	NON-PIP
ACQUIRED LAND (IN HA)	0,9	0,3	0,7
INHERITED LAND (IN HA)	1,7	1,4	1,1
RENTED LAND (IN HA)	0,3	0,1	0,1
TOTAL	2,9	1,8	1,9

Although there are differences between the groups, based on statistics none are significant. Nevertheless, the SCAD households have on average a hectare more land than the two other groups. Several farmers explained that acquisition of land was part of their PIP. This study has no explanation for a difference in *inherited land*.

- SLM practices

The graph shows that the application of the PIP approach has been effective in the education on and application of SLM practices by the participants, as both SCAD and PAPAB households apply significantly more SLM practices than non-PIP households (both with $p < 0,001$). Farming households apply a variety of SLM practices, which they learn from their parents, the local agronomist, each other or through external projects. Additional SLM practices referred to by farmers include *connecting their fields to other farmers' fields* and *interchanging crops consciously*. Other named practices are not confirmed to be SLM practices (e.g. applying fertilizers).

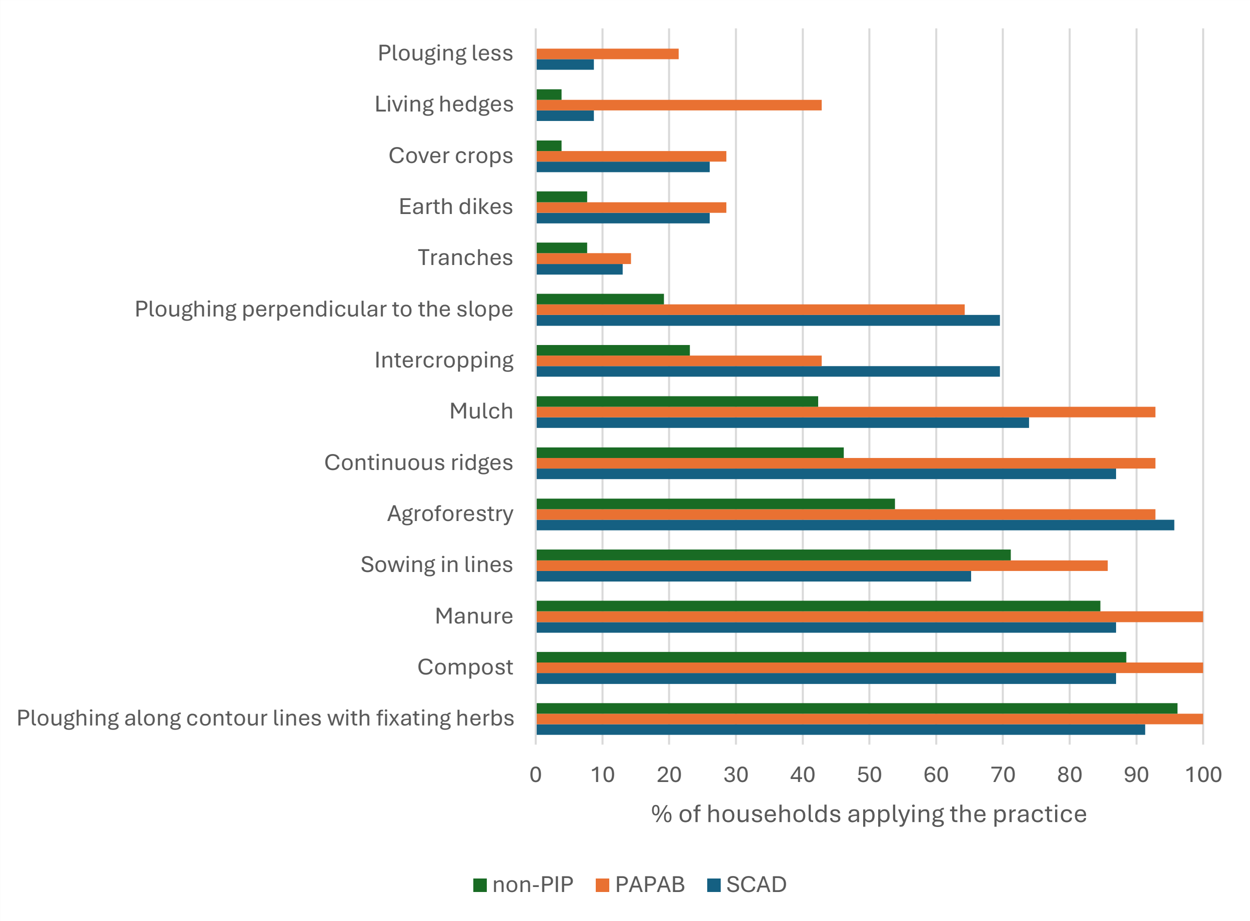


figure 12. Percentages of households applying SLM practices for the three groups

Table 8 summarizes the results for the five pre-determined resilience attributes. The p-values of the significant differences can be found in Annex IV.

Table 8. Summary of results for general resilience per group; SCAD (n = 23); PAPAB (n = 14); non-PIP (n = 25). Means that share the same letter are <u>not</u> significantly different.

	SCAD	PAPAB	NON-PIP
# CROP TYPES	$11,7^{a}$	13^{a}	8,9
# CROP TYPES FOR SELLING	$6,5^{a}$	$6,6^{a}$	3,6
# INCOME SOURCES	$4,3^{ab}$	$5,2^{a}$	$3,6^{b}$
# OFF-FARM INCOME SOURCES	$1,8^{a}$	$1,9^{a}$	$1,8^{a}$
TOTAL LAND ACCESS (IN HA)	$2,9^{a}$	$1,8^{a}$	$1,9^{a}$
# SLM PRACTICES	10^{a}	$11,4^{a}$	7
TLU	$0,96^{a}$	$0,58^{ab}$	$0,42^{b}$

4.2. The Resilience Attributes

Step 1. The Farming System (Resilience of what?)

- *The regional context*

The regional context can be described as a rainfed farming system in steep and highland areas, consisting of a mixed crop- and livestock system. Farming households in the area cultivate crops on steep hills and in the valleys in between (figure 13). The valleys are wet and thus often sustain rice, vegetables and sweet potato. On average, the participants have 4 children and have finished 6th grade.

figure 13. Cultivated valley and hills in commune Makebuko

figure 14. Farmer Faustine in her field

Food is grown over roughly three seasons in a year (figure 15);

- season A, from September to Januari;
- season B, from February to June; and
- season C, the dry season, in July and August, during which only the valleys are cultivated.

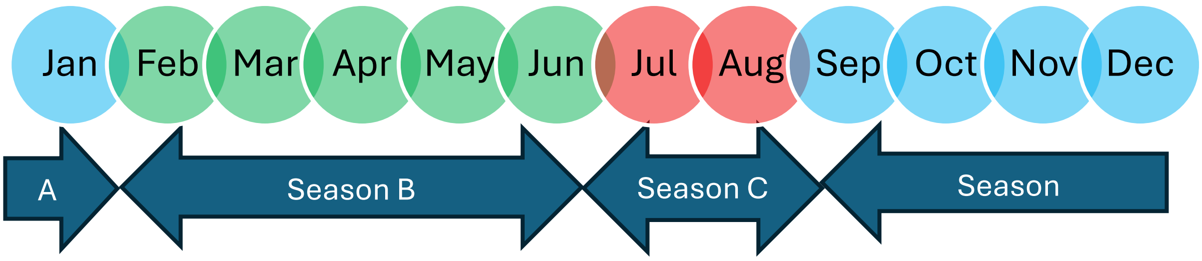


figure 15. The three general cultivation seasons of Burundi (the colours represent different seasons)

- *Main products of interest*

The main crops that farmers grow are maize, beans and bananas (figure 9). Other produce includes herbs for cattle, eucalyptus for construction and chicken eggs. Most households rear livestock (e.g. goats, chicken, cows; figure 10) and engage in additional income-generating activities, primarily the selling of a traditional banana liquor called 'urwarwa' (pronounce gwagwa), a remaining tradition from the former Kingdom of Burundi. Some households trade agricultural products (e.g. avocado), run small shops, or produce coffee, which is purchased by the state (figure 11).

- *Land use*

The households' fields are fragmented and dispersed over the region, totalling on average 2,5 ha per household. The dispersion is a result of the partition of land over several siblings, added by households buying or renting plots of land when they get the chance.

Furthermore, farmers apply a variety of SLM practices, ranging from agroforestry to mulch and from manure application to ploughing along the contour lines (Annex II).

- *Actors*

The actors involved in the farming systems include mainly the smallholder-farming households themselves. They produce food for themselves and sell and buy supplementary products from each other on the markets.

Seeds and fertilizers are either bought from the state every season or are used from the former production, added by manure and compost.

Every colline has a local agronomist, paid by the state, who guides farmers in their agricultural practices. The agronomist also serves as a contact person for external actors such as ISABU, the national agricultural research institute, or development organisations that support smallholder-farming households. Some veterinaries are also present in the collines.

Step 2. The Challenges (Resilience to what?)

Each interviewee referred to 2 to 4 shocks and stresses that he or she had experienced in the past years. Figure 16 shows the 8 most experienced shocks and stresses, while other challenges include:

- the destruction of crops by moles,
- state seeds inavailability or delay,
- violent winds that can destroy houses,
- the loss of material needed to work,
- a land dispute,
- the loss of an income source (e.g. a household had their bar closed down), and
- banana not giving liquor after it has already been bought.

All shocks & stresses and their occurrences are also shown in a graph in Annex V.

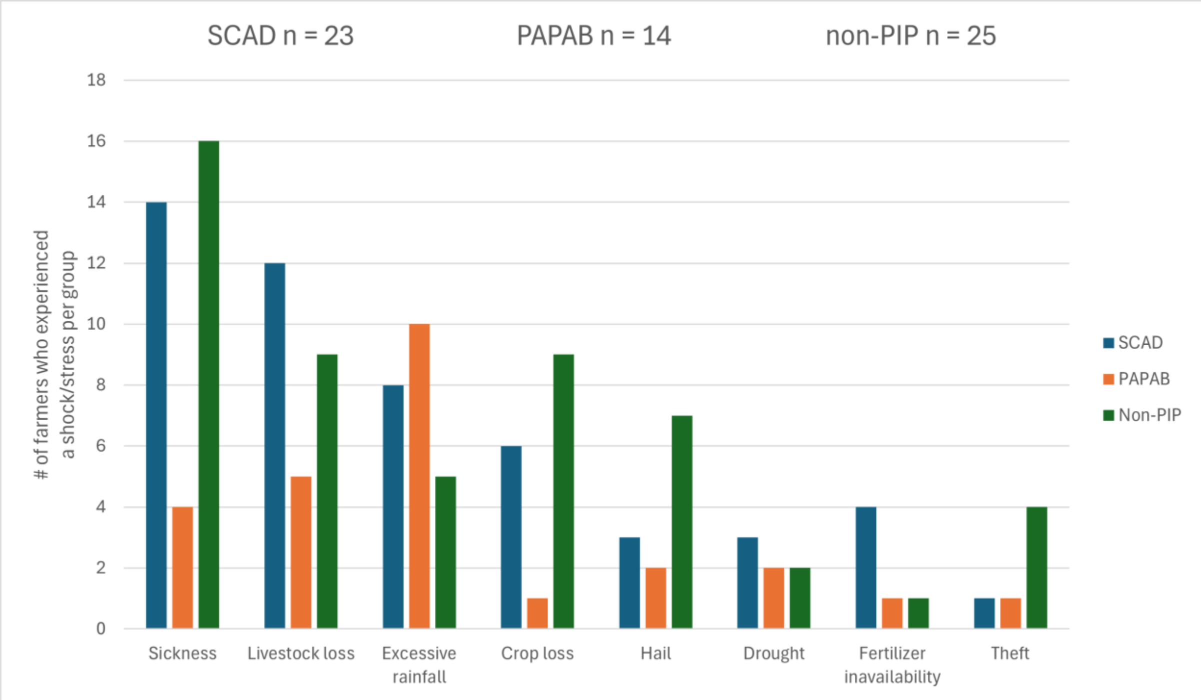


figure 16. Shocks and stresses experienced by the three groups

Sickness

The graph shows that many households (n = 34) have experienced the sickness of a household member. In the group discussions farmers repeatedly referred to malaria as a common disease in the region, requiring pills that are costly, while also the mosquito nets to prevent the disease are costly. Whether the affected household member contributed to the income of the household or whether it was a child, both cases were experienced as a shock, because both included hospital bills, and because the inability of a household member to work could also occur when a parent had to accompany the child to the hospital.

Hail, Excessive Rainfall & Drought

Excessive rainfall could flood the valleys and lead to erosion and crop destruction. Also hail could destroy the crops. Besides, drought affects the households regularly, and in time of the research (january to march, 2025) was the shock that farmers foresaw most, because the rain had not yet come while the new growing season had started, which normally begins with a rainy period (figure 15).

Livestock & Crop loss

Livestock could be lost to diseases or to theft. The same holds for crops, with especially crop disease affecting a variety of crops regularly.

Theft

Additionally, livestock theft (included under *livestock loss*), of items in the house (included under *theft*) and of crops (included under *crop loss*) is common in the collines. During the genocide, many people had weapons. When in 2005 it was over, some people were left with weapons and started to use them for theft. In reaction, some communities established a self-organized security force around the time of harvest, sometimes took their animals inside and from time to time hired a detective to trace back the animals.

Fertilizer inavailability

Lastly, the state provides fertilizers and seeds but these often come with delay or do not come at all, which is problematic for the timely sowing of crops. This stress was indicated both in individual interviews and group discussions.

Step 3. The Functions (Resilience for what Purpose?)

The function assessed in this research is *alimentation*. The following graph (figure 17) shows how many of the reactions to the shocks & stresses resulted in a 'quantity decrease', 'quality decrease' or 'no significant effect' in alimentation, for each group.

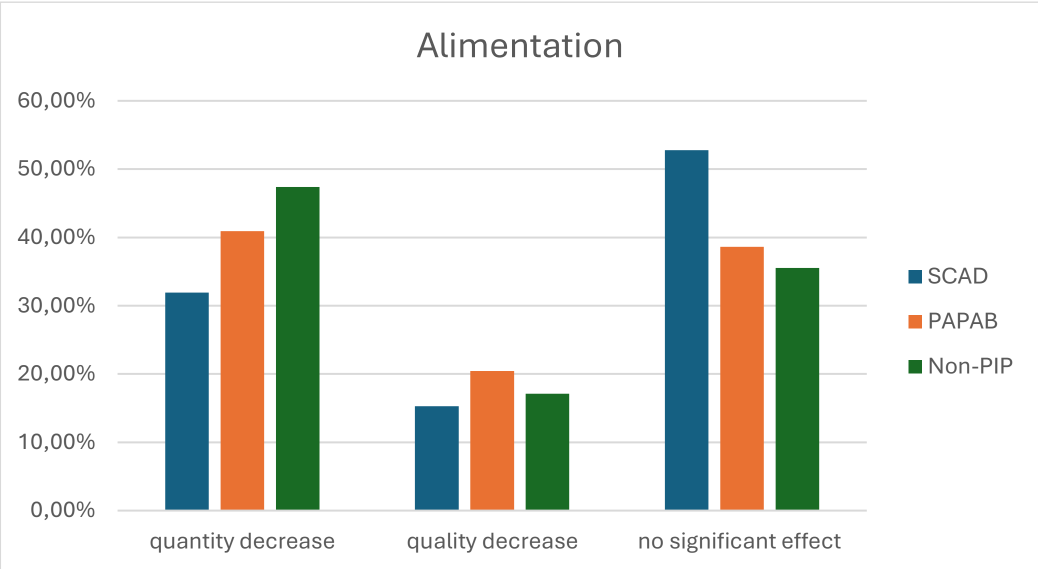


figure 17. The effects of shocks & stresses on alimentation, expressed in percentages per group; Quality decrease refers to a decrease in nutritional value (e.g. through elimination of meat) while quantity decrease refers to reduced daily portions of food (e.g. from 3 to 2 or 2 to 1 meal per day)

The graph shows that the non-PIP households most often experience a decrease in alimentation quantity in reaction to a shock or stress, while SCAD households do not experience any significant effect in more than 50% of the cases. Meanwhile, it shows that also a high percentage of both PAPAB and SCAD households are still obliged to reduce the quantity and quality of their daily alimentation. Unfortunately, many households experience prolonged reductions in food quantity and quality, ranging from a month to a full year. Therefore, it can be stated that also the PIP households remain vulnerable to a point that is undesirable.

Effects of inflation

A majority of all households is affected negatively by inflation (figure 18). Inflation is mostly felt in the prices of palm oil, salt and soap (based on group discussions in Makebuko and Rwesero and individual interviews). While some households reduced the consumption of certain goods such as salt and oil (i.e. quality decrease) since inflation had increased rapidly, other households were obliged to reduce their meal portions (i.e. quantity decrease).

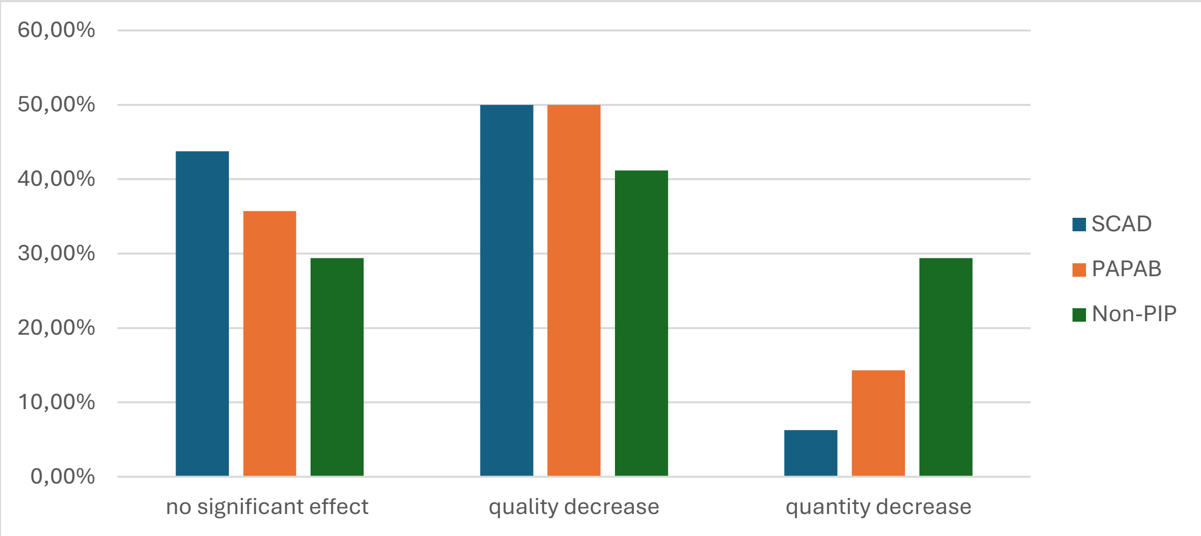


figure 18. The effects of inflation on alimentation for SCAD, PAPAB and non-PIP households

Non-PIP households most often reduce their alimentation quantities in response to inflation, while SCAD households most often continue with their former alimentation habits, although this percentage is still less than 50%.

Step 4. The Resilience Capacities (Robustness, Adaptability & Transformability)

The capacity that was identified most often was *adaptability*, as households would temporarily adapt to the new circumstances; A recuperation process would often consist of borrowing money from the credit association to buy new seeds and fertilizers, repay the debt by selling agricultural produce or livestock or temporarily working elsewhere, and then eating less until the next harvest. This process is regarded to fall under *adaptability* because active measures are taken but no changes to the structure of the system are made. Transformability was found in the least cases. Regarding transformability, one non-PIP household started a trade in avocados and installed a kitchen garden[5] in reaction to drought. Another PAPAB household that was running a bar next to their agricultural practices shifted its focus to agriculture when the bar was closed[6]. Table 9 shows the capacities identified per group, in percentages. Robustness

[5] In the research area kitchen gardens are small, home-based gardens placed near the kitchen so that residual water from the kitchen can be used for irrigation. Mostly vegetables are grown in it.
[6] The reason for the closure of the bar is not clear but had to do with a fine

is identified most among PAPAB households, followed by SCAD households and least among non-PIP households (~9%).

Table 9. The percentages of resilience capacities; SCAD (n = 75); PAPAB (n = 44); non-PIP (n = 75)

	SCAD	PAPAB	NON-PIP
TRANSFORMABILITY	0%	2%	1%
ROBUSTNESS	16%	20%	9%
ADAPTABILITY	84%	75%	89%

Step 5. The Resilience Attributes (What Enhances Resilience?)

As the final step of the framework, in total 32 resilience attributes were found. These are indicated in table 10, ordered from most applied to least applied, as percentages of the challenges they were applied to. The 10 attributes that are most recurring (all applied in ~10% or more of the recuperation processes) are highlighted in blue and followingly referred to as 'key resilience attributes'. These key resilience attributes are briefly explained, after which the differences between the groups deemed to be significant are discussed.

Table 10. The resilience attributes. The recurrence total includes the attributes of two households that do not belong to SCAD, PAPAB or non-PIP because they were formed in PAGRIS. Yet their resilience attributes are deemed relevant for the recurrence total and do not influence the comparison between the groups.

RESILIENCE ATTRIBUTE	RECURRENCE TOTAL (%)	SCAD (%)	PAPAB (%)	NON-PIP (%)
SELLING AGRICULTURAL PRODUCE	46,7	49	59	31
USING FOOD RESERVES	23,1	25	16	20
BORROWING CREDIT ASSOCIATION	22,6	21	27	19
USING OFF-FARM INCOME SOURCE	20,5	17	16	24
LEAVING A PURCHASE (OR BUYING LESSER QUALITY OR LESS)	19,0	17	14	20
SELLING LIVESTOCK	16,9	24	18	8
USING ON-FARM INCOME SOURCE	14,4	21	16	5
COMMUNITY MATERIAL/LABOUR SUPPORT	12,8	12	5	16
USING MANURE	10,8	9	9	9
PAID PLOUGHING	9,7	1	11	16
INVESTING (E.G. IN COMMERCE)	7,2	5	11	7
USING SEED RESERVES	7,2	11	7	3
SELLING OR RENTING OUT LAND	6,7	5	2	9
CULTIVATING SHORT-CYCLE CROPS	6,2	4	9	5
SELLING URWARWA	5,6	5	14	1

RESILIENCE ATTRIBUTE	RECURRENCE TOTAL (%)	SCAD (%)	PAPAB (%)	NON-PIP (%)
GETTING SEEDS THROUGH ALTERNATIVE SOURCE (TUBURA)	5,1	3	5	7
BORROWING FROM FRIENDS OR WORK (MONEY OR SEEDS)	4,6	5	5	4
USING KNOWLEDGE	4,1	5	0	5
CULTIVATING LESS LAND	4,1	5	0	5
USING MONEY RESERVES	4,1	7	2	3
STRENGTHENED BY CROP DIVERSITY	4,1	7	5	1
CULTIVATION IN VALLEYS	3,6	7	5	0
EXTERNAL FINANCIAL SUPPORT (E.G. CHILDREN, AID PROJECT)	3,1	3	0	5
TEMPORARY OFF-FARM INCOME (OTHER THAN PAID PLOUGHING)	3,1	1	5	4
CONSULTING VETERINARY	3,1	7	2	0
USING HOSPITAL CARD	3,1	3	2	3
INTENSIFYING COMPOSTING	2,6	3	5	1
MENTAL SUPPORT	1,5	0	0	4
PRAYING	1,5	1	0	3
APPLYING LESS SEEDS/FERTILIZERS	1,0	1	2	0
LEAVING RENTED LAND	0,5	1	0	0
AGRICULTURAL INSURANCE	0,5	0	2	0

Selling agricultural produce & using food reserves

As farmers, most households naturally rely firstly upon their agricultural production in times of difficulty. They consume their food reserves and sell their estimated surplus.

Borrowing credit association

Credit associations are widely used to borrow money, which is often an integral part of the recuperation process. With the borrowed money farmers can buy food and make investments needed for the recuperation process, e.g. buying seeds and fertilizers to sow anew. Besides, the credit associations can provide an income through dividends.

Credit associations are made up of members who voluntarily come together to save their money in the form of shares. These savings are pooled into a loan fund that allows them to borrow money, which they repay within an agreed period, along with agreed-upon interest.

Off-farm income sources & Paid ploughing

Households that have off-farm income sources always use these in support of their recuperation process. Off-farm income sources include mason, carpenter, guard, working abroad or in the city, welder, cook, agricultural instructor/agronomist, sewer, police officer and teacher. These occupations provide a stable income and a safety net for when agricultural production is affected. The recuperation process also often includes a period of paid ploughing on another, often larger farmer's land, to pay for short-term requirements or to repay the debt at the credit association. Also other temporary jobs, often requiring physical labour, are used for this purpose.

Leaving a purchase

As resilience measure, household members are often obliged to leave or reduce the quantity of a purchase, such as of clothes, soap, olive oil, etc., either for a while, or as a consequence of inflation for an undetermined period of time.

Selling livestock & using manure

Livestock is important for households because they can sell it, use the manure, and eat their meat.

On-farm income sources

Household members also have a variety of income sources that are related to agriculture but are different than the agricultural production, such as owning a shop where they can sell bought-in products, complemented by their own produce, or the selling of urwarwa, a traditional banana liquor, as discussed under income source diversity in chapter 4.1.

Community material/labour support

Other than that, households also rely upon the support of their community. This support can come in the form of helping each other with required labour, giving or lending each other equipment or money, and mental support needed to process the shock. An example of mental support is shown by a woman whose husband left her and who felt strengthened by her friends and family.

The background to other resilience attributes is explained in Annex VII. All these attributes have been applied in different proportions by the three groups. Statistics show that 6 of these differences are significant, shown in table 11, and discussed followingly. The related p-values can be found in Annex VIII.

Significant differences

Table 11. The differences in attributes between the groups which are established to be significant; values with the same letter (a or b) within the same column do not differ significantly

	Selling agricultural produce	*Selling Livestock*	*Using on-farm income source*	*Paid ploughing*	*Selling urwarwa*	*Consulting veterinary*
Total times counted	91	33	28	19	11	6
SCAD (%)	**49,33^{a}** **p = 0,068**	**24,00^{a}** **p = 0,017**	**21,33^{a}** **p = 0,012**	**1,33^{b}**	5,33^{ab}	**6,67^{a}** **p = 0,047**
PAPAB (%)	**59,09^{a}** **p = 0,009**	18,18^{ab}	15,91^{ab}	**11,36^{a}** **p = 0,154**	**13,64^{a}** **p = 0,13**	2,27^{ab}
non-PIP (%)	**31,08^{b}**	**8,11^{b}**	**5,41^{b}**	**16,22^{a}** **p = 0,006**	**1,35^{b}**	**0,00^{b}**

Selling agricultural produce

First, PAPAB households sell their agricultural produce to cope with challenges most often, in 59% of the cases. Second are SCAD households, with 49%, and finally the non-PIP households, who sell their produce in 31% of the cases. Only the difference between SCAD and PAPAB households is not deemed to be significant, while the other differences between the three groups are significant.

Selling Livestock

Second, SCAD households sell their livestock in 24% of the cases, while non-PIP households do this only in 8% of the cases. PAPAB households sell their livestock in 18% of the cases, which is in between the two, but its difference with the other groups is established to not be significant.

Using on-farm income source

Third, SCAD households most often use an on-farm income source to enhance their resilience, in 21% of the cases, while non-PIP households apply it only in 5% of the cases. The PAPAB households have a number of appliances in between the two, 16%, but their differences with the others are not significant.

Paid ploughing

Fourth, temporarily ploughing a field for money, is a resilience measure most often applied by the non-PIP households, in 16% of the cases. PAPAB households apply the measure in 11% of the cases and SCAD households only in 1%. The difference between PAPAB and non-PIP households is not proven to be significant but the other two differences are significant.

Selling urwarwa

Fifth, PAPAB households most often, in 14% of the cases, sell urwarwa to help them recuperate from a shock or stress, while non-PIP households do this in only 1% of the cases. SCAD households apply the measure in 5% of the cases but their difference with the others is not significant.

Consulting a veterinary

Lastly, the possibility of consulting a veterinary is limited to all because of the lack of veterinaries around. However, the appliance of this resilience attribute is also related to the awareness of when it is needed. Not all farmers consult a veterinarian in time to save the animal.

Specified & General Resilience

Regarding specified resilience, *consulting a veterinary* is specific to the disease of an animal as shock; *cultivation in the valleys* is specific to shocks that affect crop production on the hills; and the *usage of a hospital card* is specific to the hospitalization of a household member. Other than that, almost all of these resilience attributes contribute to general resilience because their employability is not shock- or stress-specific, as can be seen from the fact that they are employed to multiple shocks.

4.3. PIP's Influence

This section describes the influence of PIP as referred to by the farming households, unrelated to resilience. After the assessment, connections are made between this influence and the resilience attributes identified so far.

From all SCAD and PAPAB interviewees (n = 37), 27 farmers stated to experience improved collaboration within the household. This is generally explained as being a result of the following process: firstly, while constructing the plan, all household members are required to sit together and analyse the current task division within the household. For some men this is a point that they realize how little they do compared to the woman of the household. Followingly, while constructing the plan to achieve the set objectives, the men also realize that without their contribution, the household will not reach the objectives. Consequently, 11 farmers stated to have enhanced motivation to work towards their objectives. Lastly, with the drawing – often hanging in the living room of the household – the household members, including the children, have a common reference, enhancing their communication[7]. Several farmers, both in the individual interviews and in the group discussions, stated that with the drawing and clear objectives, now, when they have some money, they think about how to use it considering the objectives and discuss it within the household, while before they would often waste the money, for example on beer or presents for friends and family, and not communicate on how to use that money.

"Each time we have some money, instead of wasting it, now we invest it in our objectives" – Ferdinand Bunyoni, male farmer aged 37

In line with this, 20 farmers stated to have better planning and organisation of the farming system due to PIP. For example, in a group discussion in Kibere, farmers stated that they used to work without a plan, partly working on a task one day and the next day randomly starting another task, while now they work according to a plan. In another group discussion in Makebuko, farmers stated that in reaction to inflation, now they put their heads together in the household to decide where they will reduce expenses, as an organised way of working. Moreover, several farmers stated to give increased importance to the time of sowing the field. Two farmers stated that as a consequence of their improved organisation and planning, they receive increased trust from external organisations that aim to support the farmers. Furthermore, 16 farmers referred to increased agricultural production and increased revenue of their activities, while 19 referred to 'better agricultural practices', implying the SLM practices that better protect

[7] It should be noted that several farmers had lost their drawing, due to winds or deterioration, and that they would generally not make a new one, reportedly due to a lack of resources.

the soil and produce more food, in line with the 9 farmers that specifically referred to decreased erosion. Additionally, 7 farmers indicated to have more livestock and better know how to take care of it because of PIP. In Kibere, SCAD farmers indicated to use better seeds since PIP, but with inflation these are harder to get, so they organize themselves to buy larger quantities together, but could buy less than desired/before. Several PIP participants in the group discussions stated to be better dressed, have better hygiene and improved/healthier alimentation due to their increased revenues and enhanced knowledge resulting from the related trainings. Various farmers stated in the group discussions that they could not have achieved their objectives without the trainings they had received.

Table 12. The influence of PIP that interviewees stated to have experienced

PIP's influence	# of interviewees
Improved collaboration	27
Increased motivation to work	11
Better planning and organisation of the farming system	20
Increased trust from external organisations	2
Increased agricultural production	16
Increased revenues	16
Better agricultural practices (SLM practices)	19
Decreased erosion	9
Increased livestock	9

Table 12 summarises the results. The influences that are directly linked to the identified resilience attributes of SRQ 2 are:

- Increased agricultural production
- Increased revenue and
- Increased livestock

The other influences have no apparent direct correlation with the identified resilience attributes.

5. Discussion

Based on the semi-structured interviews held with over 62 farmers in the province of Gitega and the comparison of their answers, findings suggest that PIP has enhanced the resilience of smallholder-farming households in several ways.

5.1. The SRQ's

The Five Pre-determined Resilience Attributes

Regarding the five pre-determined resilience attributes – crop diversity, livestock, income source diversity, land ownership and SLM practices – PIP households generally score higher than non-PIP households.

SCAD households, who are using the PIP approach for 12 years, have the highest *crop diversity, TLU* and *land ownership*. Non-PIP households have a significantly lower crop diversity and TLU than SCAD households. The difference in land ownership with the other two groups is not deemed significant.

PAPAB households, who are using the PIP approach for 9 years, have the highest *income source diversity* and apply the most *SLM practices*. Non-PIP households have a significantly lower income source diversity than PAPAB households and apply significantly less SLM practices than both PAPAB and SCAD households.

The Key Resilience Attributes

Both SCAD and PAPAB households apply several resilience attributes significantly more often than non-PIP households – selling agricultural produce, selling livestock, using an on-farm income source, selling urwarwa and consulting a veterinary – while non-PIP households significantly more often resort to paid ploughing. Of these, four attributes are part of the key resilience attributes and are discussed followingly:

Selling agricultural produce

This attribute is most applied by PAPAB households and least applied by non-PIP households. Based on the results, it is probable that this attribute can be applied more often by PIP households because they have a higher agricultural production. The assessment of PIP's influence showed that PIP increases agricultural production for households. This is in line with earlier research by IFDC (2024) and Oxfam (2020).

Selling livestock

This attribute is most applied by SCAD households and least applied by non-PIP households. The same logic holds for selling livestock as for selling agricultural produce: the PIP households may sell livestock in reaction to a shock or stress more often than non-PIP households because they have more livestock. From the five pre-determined resilience attributes it appeared that SCAD households have the highest

TLU, followed by PAPAB households, and with non-PIP households having the lowest TLU. The importance of this attribute to the resilience of smallholder-farming households in SSA is confirmed by scientific literature (Le Goff et al., 2022; Maguire-Rajpaul et al., 2025).

Using an on-farm income source

This attribute is most applied by SCAD households and least applied by non-PIP households. Again, this attribute is probably applied more often by PIP households because they have a higher on-farm income source diversity than non-PIP households. Income diversification is a verified measure to enhance resilience within a household (Brück, d'Errico & Pietrelli, 2019; Nzeyimana et al., 2025).

Notably, the increase in income diversity is limited to on-farm income sources for PIP households. Off-farm income source diversity does not differ between the three groups, although it does emerge as a key resilience attribute (being the fourth most applied resilience attribute).

Paid ploughing

This attribute is most applied by non-PIP households and least applied by SCAD households. Paid ploughing is an accessible temporary income source in the research area. PIP households have more income sources to resort to, which might explain their lower appliance of *paid ploughing* as a resilience attribute.

PIP's Influence

Based on the testimonies of farmers, PIP improved intra-household collaboration, planning, organization and motivation. However, the stated influences only correlated with 3 identified resilience attributes: increased agricultural production, increased revenue and increased livestock.

5.2. Overall Reflection on the Results

Overall, the households that have been involved in one of the two PIP projects, are thus more resilient than the control group. Nevertheless, also the PIP households remain vulnerable to shocks and stresses, being regularly obliged to reduce their alimentation for multiple months, although they are affected less than non-PIP households overall and demonstrate robustness more often than non-PIP households.

The difference between SCAD and PAPAB households is mostly insignificant. No consistent remarks can be made about the role of the length of the project that uses the PIP approach, as in some cases PAPAB households score highest on resilience attributes and in others the SCAD households.

An important finding of this research regards the households' income diversity. The increase in income diversity for PIP households is limited to on-farm income sources.

Off-farm income source diversity does not differ between the three groups, although it did emerge as a key resilience attribute in this research.

The Intangible Resilience Attributes

While the tangible resilience attributes potentially were enhanced by PIP, notably, however, some of the intangible benefits were not fully captured by the resilience assessment framework. Only a limited number of intangible resilience attributes was identified. Three respondents cited receiving mental support, another three mentioned praying, and nine indicated relying on their knowledge, which is mostly knowledge of agricultural techniques (e.g. seed breeding). While such small numbers suggest that intangible aspects were less frequently captured, they also demonstrate that the applied methodology is capable of revealing some of them.

The limited appearance of these attributes may be due to the fact that, as recognised by resilience theory, capacities like collaboration, planning, and motivation often serve as *enabling mechanisms* rather than immediate *coping mechanisms* (Béné et al., 2016). Coping mechanisms are direct actions or resources farmers use in response to shocks (e.g. selling livestock, agricultural insurance), while enabling mechanisms create the conditions that allow these responses—such as having knowledge about insurance options. In essence, enabling mechanisms support or activate coping strategies. These mechanisms create the conditions for effective adaptation or transformation, but respondents may not be explicitly aware of this as the reason they recovered (Béné et al., 2016; Folke et al., 2010). In high-stress situations, where households face acute needs, such as food shortages, people may focus on short-term, tangible actions (borrowing money, taking on labour, selling assets) and not be aware of the enabling role of internal or social capacities that helped facilitate those responses.

Alternatively, the lack of intangible resilience attributes could point to a limitation in the methodology, where such attributes, though critical, are less likely to be articulated by respondents without a psychological or behaviour-focused inquiry. Although multiple interview formats were tested, none succeeded in bringing forward a robust set of intangible resilience attributes. A more psychological approach, focusing explicitly on mental and behavioural traits, might better capture this dimension in future studies. For this purpose, the Foundation Essentials of PIP can be used, which measure various targeted influences of PIP (Common Ground, 2023). Comparative research into the psychological impact of PIP versus non-PIP interventions could yield further insights, as many PIP participants reported mental and motivational benefits, even if these did not directly manifest as resilience attributes in this study. As the PIP households in this research are assessed to be more resilient, while they have stated to be enhanced in several intangible aspects, there are good implications for a link to be present.

5.3. The Resilience Assessment Framework

Use for future research

Overall, the framework demonstrated strong flexibility and adaptability to personal contexts, enabling a nuanced understanding of each household's unique resilience pathway. While common strategies emerged in the research, such as reliance on agricultural production, the study also highlighted unique, context-specific responses, such as one farmer establishing a kitchen garden during drought and another cultivating in the valleys at an unconventional time. The resilience framework shows potential as an exploratory tool prior to implementing development initiatives, enhancing the possibility of targeted resilience measures. It is important to note, however, that the semi-structured interviews used here are not the only way to apply this framework. Open-ended interviews or other qualitative tools could apply the same steps of the resilience framework (see Knook et al., 2024).

Adding to the framework

The resilience capacities proved useful for analysing strategies, but they were found to lack descriptive depth. In reflection, the term adaptability currently does not indicate a difference between households who adapt to a situation because of necessity (e.g. borrow money to sow anew and reduce consumptions until the next harvest) and households who innovatively change and adapt their farming practices to the new circumstances e.g. installing a kitchen garden or cultivating with different methods. The latter of the two seems to involve a more proactive mindset, as a proactive mindset involves searching for new possibilities and opportunities (Lecegui et al., 2022). In turn, these measures have potential to produce better results for a household. Therefore, based on the identified resilience strategies, it is recommended to split up *adaptability* of Meuwissen et al. (2019)'s framework (step 4; figure 2) in yet another capacity. The extra capacity can be called 'resourcefulness', because the adaptations come forward from a resourceful mindset, while *adaptability* would refer to the necessary adaptations.

6. Conclusion

“In what ways has the PIP approach influenced household resilience of smallholder-farming households in Burundi?

Based on the farmers’ testimonies, the PIP approach has shown to enhance various resilience attributes that are consistently used by smallholder-farming households when facing shocks and stresses, including livestock keeping, a higher diversity of income sources and possibly increased agricultural production to use as reserves and to sell. Additionally, PIP has reportedly enhanced collaboration, organisation and motivation within households. However, no clear link could be established between these intangible PIP influences and resilience in the face of shocks and stresses.

Meanwhile, many farmers reported to have used off-farm income sources as important resilience attribute. However, the PIP approach does not seem to enhance their use. Therefore, this research recommends enhancing the focus on off-farm income formations in the PIP approach.

All in all, while generally all farming households remain vulnerable to shocks and stresses affecting their agricultural practices, PIP does enhance various resilience attributes that strengthen their ability to recover from these shocks and stresses. Although some effects of PIP have not been directly linked to improved resilience, they likely serve as important enabling factors that support resilience indirectly.

7. Recommendations

Optionally Downscaling the Project

Most PIP farmers indicated the need for continued support of the project through trainings and check-ups of their progress. Therefore, if possible, it is recommended to support the continuation of the project but, taking in mind the possibility of a future end to the PAGRIS project in the region, it is recommended to make use of extension services for the continued support of households in their PIP development. Antwi-Agyei and Stringer (2021) emphasize the crucial role that extension services play in household food security of smallholder farmers. Each colline currently has a local agronomist; they could be trained in the PIP formations.

A collaboration with the national agricultural research institute 'ISABU' may strengthen the effectiveness of such a collaboration. In Rwanda, farmers stated the need for innovative institutions that can facilitate access to markets and enable collaboration between different agricultural sectors (Nzeyimana et al., 2025). Although IFDC already has a focus on the enhancement of these institutional relations, it is recommended for the IFDC to support an increased cooperation with research institutes (such as ISABU), extension services and governmental institutions, as also recommended by Maguire-Rajpaul et al. (2025).

Expanding the PIP Approach

Based on the assessed importance of this resilience attribute, it is recommended to increase the attention to off-farm income formations in the PIP approach or at least enhancing awareness of its benefits (figure 19). This research recommends projects using the PIP approach to incorporate an explanation to participating farmers that specifically off-farm incomes can contribute to resilience. When agricultural income sources suffer from shocks and stresses this allows for a back-up that would mostly not suffer from the same shocks and stresses, as other agricultural income sources often would. The research participants with an off-farm income source often had learned their occupation from an acquaintance. This possibility exists for other farmers as well. Moreover, the government or other projects can facilitate and provide formations in e.g. carpentry, construction, and more.

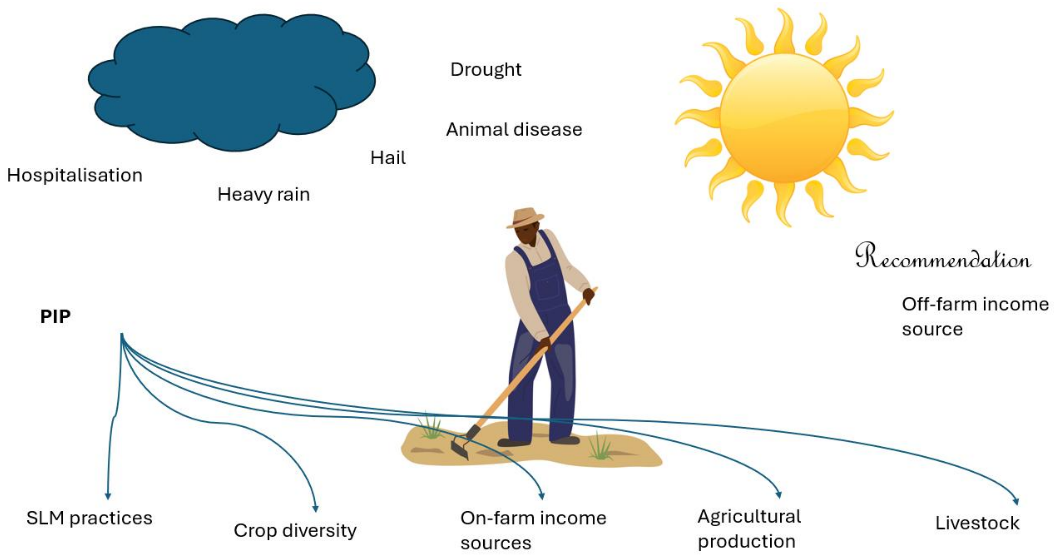


figure 19. An overview of shocks & stresses and resilience attributes influenced by PIP among farmers, added by a recommendation to incorporate the support for off-farm income sources

Adding to the Resilience Framework

Finally, based on the identified resilience strategies, it is recommended to split up *adaptability* of Meuwissen et al. (2019)'s framework in yet another capacity, as it currently does not indicate a difference between households who adapt to a situation because they have no other choice and households who proactively seek for improvements of their situation in reaction to a shock or stress. The extra capacity can be called 'resourcefulness', because the adaptations come forward from a resourceful mindset, and can be added to the framework (figure 20; step 4).

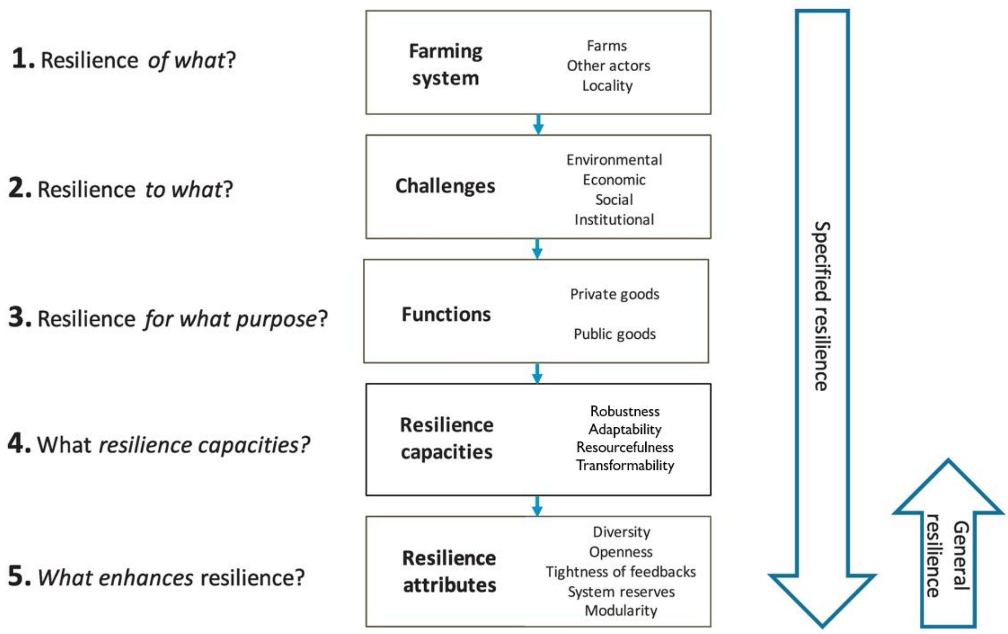


figure 20. The suggested resilience framework, with an added capacity. Author's modification of Meuwissen et al. (2019) framework

8. Acknowledgements

I am grateful to everyone who made this research and experience possible. Thank you Aad Kessler for the offer to go on the unforgettable trip to Burundi. I appreciate your constructive feedback, patience with the research and guidance, based on clearly visible experience. Thank you, Eva Huet and Mark van der Poel for your kind and inspirational feedback. Thank you all for the pleasant meetings and supportive work approach. Thanks to the whole IFDC staff in Burundi who welcomed me, took me along in their work environment and supported me on the ground. Thanks to the Twitezimbere staff who continuously supported the arrangement of the field work and provided a base where I always felt welcome. Thank you, Ernest Habonayo, for not only supporting my research but also showing me around in the beautiful and special Burundi. Thanks to all the farmers and 'les animateurs relais' for giving their valuable time to this research. I am grateful to all people in Burundi who shared with me their hospitality and genuine warmth and for the friendships we've developed. Hopefully this research can give you all something back in a way. Thanks to my family and friends who listened to my explanations of the research, helped me in my train of thought and inspired and supported me. Finally, thanks to Wageningen University, who practically made it possible to go on this journey.

9. References

Antwi-Agyei, P., & Stringer, L. C. (2021). Improving the effectiveness of agricultural extension services in supporting farmers to adapt to climate change: Insights from northeastern Ghana. Climate Risk Management, 32, 100304.

Ansah, I. G. K., Gardebroek, C., & Ihle, R. (2019). Resilience and household food security: a review of concepts, methodological approaches and empirical evidence. Food Security, 11(6), 1187-1203.

Baffour-Ata, F., Atta-Aidoo, J., Said, R. O., Nkrumah, V., Atuyigi, S., & Analima, S. M. (2023). Building the resilience of smallholder farmers to climate variability: Using climate-smart agriculture in Bono East Region, Ghana. *Heliyon*, *9*(11).

Béné, C. (2020). Resilience of local food systems and links to food security–A review of some important concepts in the context of COVID-19 and other shocks. Food security, 12(4), 805-822.

Blake, W. H., Rabinovich, A., Wynants, M., Kelly, C., Nasseri, M., Ngondya, I., ... & Ndakidemi, P. (2018). Soil erosion in East Africa: an interdisciplinary approach to realising pastoral land management change. Environmental Research Letters, 13(12), 124014.

Brück, T., d'Errico, M., & Pietrelli, R. (2019). The effects of violent conflict on household resilience and food security: Evidence from the 2014 Gaza conflict. World Development, 119, 203-223.

Central Intelligence Agency (CIA) (2023). Burundi. The World Factbook. Retrieved from https://www.cia.gov/the-world-factbook/countries/burundi/

Choptiany, J., Lagana, M. H., Colozza, D., & Graub, B. (2016). Building resilience to climate change through the sharp tool: lessons learned through best practices in climate adaptation in sub-Saharan Africa.

Common Ground (2023) 2023-09-01_CommongGround_Inception_report-revision-final-clean.pdf

d'Errico, M., Romano, D., & Pietrelli, R. (2018). Household resilience to food insecurity: Evidence from Tanzania and Uganda. Food Security, 10(4), 1033-1054.

Folke, C., Carpenter, S. R., Walker, B., Scheffer, M., Chapin, T., & Rockström, J. (2010). Resilience thinking: integrating resilience, adaptability and transformability. Ecology and society, 15(4).

Gatore, A. C. I., Kim, S. H., Parisouj, P., & Bae, D. H. (2024). The analysis of the long-term trend of extreme precipitation and discharge in Burundi. Earth Science Informatics, 1-20.

Global Food Security Index (2022) 'Burundi'. The Economist Impact. Accessed 2 November 2023: https://impact.economist.com/sustainability/project/food-security-index/explore-count ries/burundi.

de Graaff, J., Aklilu, A., Ouessar, M., Asins-Velis, S., & Kessler, A. (2013). The development of soil and water conservation policies and practices in five selected countries from 1960 to 2010. Land Use Policy, 32, 165-174.

IFDC (2024) Evaluation finale du projet PAGRIS Hesterman, Mpeteye & S. Bigirimana

Jeníček, V., & Grofová, Š. (2015). Least developed countries--the case of Burundi. Agricultural Economics/Zemědělská Ekonomika, 61(5).

Kessler, C. A., van Duivenbooden, N., Nsabimana, F., & van Beek, C. L. (2016). Bringing ISFM to scale through an integrated farm planning approach: a case study from Burundi. Nutrient Cycling in Agroecosystems, 105, 249-261.

Kessler, A., Van Reemst, L., Nsabimana, F. (2018) PIP manual A step-by-step explanation of the PIP approach The creation and implementation of Integrated Farm Plans, with examples from Burundi https://ifdc.org/wp-content/uploads/2020/09/PIP-manual-4.5.pdf

Kessler, A., Van Reemst, L., Beun, M., Slingerland, E., Pol, L., & De Winne, R. (2021). Mobilizing farmers to stop land degradation: A different discourse from Burundi. Land Degradation & Development, 32(12), 3403-3414.

Knook, J., Eastwood, C., Beehre, L., Mitchelmore, K., & Barker, A. (2024). Resilience building in agricultural extension programmes: application of a resilience framework and development of a farmer-focused assessment tool. The Journal of Agricultural Education and Extension, 30(5), 753-773.

Le Goff, U., Sander, A., Lagana, M. H., Barjolle, D., Phillips, S., & Six, J. (2022). Raising up to the climate challenge-Understanding and assessing farmers' strategies to build their resilience. A comparative analysis between Ugandan and Swiss farmers. *Journal of Rural Studies*, *89*, 1-12.

Lecegui, A., Olaizola, A. M., López-i-Gelats, F., & Varela, E. (2022). Implementing the livelihood resilience framework: An indicator-based model for assessing mountain pastoral farming systems. *Agricultural Systems*, *199*, 103405.

Maguire-Rajpaul, V. A., Hirons, M., Rajpaul, V. M., Asare, R. A., Boyd, E., Malhi, Y., ... & McDermott, C. (2025). What resilience theory and praxis can learn from multi-dimensional approaches to understanding poverty: A study of Ghanaian cocoa forest landscapes. *World Development*, *185*, 106785.

Malekinezhad, F., Micha, E., & Maye, D. (2024). Examining the connection between resourcefulness and resilience: Analysis of UK rural SME firm-level enterprise characteristics. Journal of Rural Studies, 112, 103450.

Meuwissen, M. P., Feindt, P. H., Spiegel, A., Termeer, C. J., Mathijs, E., De Mey, Y., ... & Reidsma, P. (2019). A framework to assess the resilience of farming systems. Agricultural Systems, 176, 102656.

Ministry of Foreign Affairs (n.d.) Dutch Development Policy | Government of the Netherlands [https://www.government.nl/topics/development/the-development-policy-of-the-netherl ands](https://www.government.nl/topics/development/the-development-policy-of-the-netherlands)

Ngesa, O., Grey, S., Duveskog, D., & Atieno, I. (2021). Characteristics and determinants of the resilience of smallholder farmers: Lessons from application of the RIMA II methodology in eastern Africa. In Handbook of Climate Change Management: Research, Leadership, Transformation (pp. 1547-1569). Cham: Springer International Publishing.

Nkurunziza, J. D. (2022). The origin and persistence of state fragility in Burundi. In State fragility (pp. 101-140). Routledge.

Nyairo, R., Machimura, T., & Matsui, T. (2020). A combined analysis of sociological and farm management factors affecting household livelihood vulnerability to climate change in rural Burundi. Sustainability, 12(10), 4296.

Nzeyimana, L., Danielsson, Å., Brodén-Gyberg, V., & Andersson, L. (2025). Constructing Ubudehe? Farmers' perceptions of drought impacts and resilience capacities in Bugesera, Rwanda. *International Journal of Climate Change Strategies and Management*, *17*(1), 89-108.

Onu, G., & Ngwube, A. (2024). Political Leadership, Corruption and Development in Burundi. *African Renaissance*, *2024*(si2), 127.

OXFAM (2020) From Drawing to Reality: The Impact-of the PIP-approach on farmers' motivation, resilience and stewardship in rural Burundi

Shilomboleni, H., Epstein, G., & Mansingh, A. (2024). Building resilience in Africa's smallholder farming systems: contributions from agricultural development interventions—a scoping review. Ecology and Society, 29(3).

Ssozi, J., Asongu, S., & Amavilah, V. H. (2019). The effectiveness of development aid for agriculture in Sub-Saharan Africa. Journal of Economic Studies, 46(2), 284-305.

Stefanelli, E. (2015). Country fact sheet on food and agriculture policy trends-Burundi.

USDA (2024) International Agricultural Productivity - Summary Findings. Economic Research Service. U.S. Department of Agriculture https://www.ers.usda.gov/data-products/international-agricultural-productivity/summary-findings

Uvin, P. (2010). Structural causes, development co-operation and conflict prevention in Burundi and Rwanda. Conflict, Security & Development, 10(1), 161-179.

Wijeratne, M., & De Silva, W. N. (2024). The Paradigm Shift of Agricultural Extension from Technology Transfer Towards Participatory Approaches. Journal of Agricultural Sciences (Sri Lanka), 19(1).

World bank (n.d.). Data on Burundi. Retrieved April 4th 2024, from: https://data.worldbank.org/country/burundi

Annex I; The Semi-structured Interview

The interview questions were translated by the translator to Kirundi and the answers were written down in French. This annex provides the original interview format in French.

Informations générales

Colline : Âge :

Nom : Sexe : M / F

Niveau d'éducation :

Nombre de membres du ménage ; Adultes : Enfants :

Type(s), quantité et location (marrais ou colline) de propriété foncière :

O Communautaire O Familiale

O Localisation O Propre

Formé au PIP ? Oui / Non Par qui ? Projet : SCAD / PAPAB

Principales cultures ; (v)end, (c)onsume :

Élevage (type et quantité) :

Toutes les sources de revenus :

Pratiques de gestion durable des terres :

O Paillis avec : O

O Cultures de couverture ; Laquelle ? O

O Cultures intercalaires (mixte) O

O Agroforesterie

O Labour en courbes de niveau

O Moins de labour ; Combien ?

O Tranchées

O Digues des terres

O Haies vives avec :

O Billons continues

O Utilisation de matière organique ; O fumier O compost O déchets ménagères

O Semis en lignes

O Perpendiculaire à la pente

Quelles techniques avant le PIP et apprises où :

Avez-vous connu des chocs ou des stress à long terme ces dernières années qui ont fortement influencé le bien-être de votre ménage ? Lesquels ? C'était quand ?

1.

2.

3.

4. Augmentation des prix au marché

Comment cela a-t-il influencé votre...

Production agricole : 1. augmenté / aucune influence / diminué 2. Aug. / auc. influence / dim.

3. augmenté / aucune influence / diminué 4. Aug. / aucune influence / dim.

Pouvoir d'achat : 1. augmenté / aucune influence / diminué 2. Aug. / aucune influence / diminué

3. augmenté / aucune influence / diminué 4. Aug. / aucune influence / diminué

Nourriture à la maison :

1. Aug. / aucune influence / diminué / changé ;
2. Aug. / aucune influence / diminué / changé ;
3. augmenté / aucune influence / diminué / changé ;
4. Aug. / aucune influence / diminué / changé ;

<u>Description (quantité, période)</u>

Description (quantité, période)
1.
2.
3.
4.

Comment ça se passe maintenant ? Avez-vous pu vous rétablir (trouver des solutions/alternatives) ? Comment ?

1.

2.

3.

4.

Qu'est-ce qui vous a aidé à vous rétablir ?

1.

2.

3.

4.

Qu'est-ce qui vous a limité ?

1.

2.

3.

4.

Avez-vous des objectifs qui étaient atteint les dernières années ? Lesquelles ?

Avez-vous des objectifs pour les prochaines années ? Lesquelles ?

Comment planifiez-vous pour les activités de l‘exploitation? Quand est-ce que vous planifiez (dans quel délai)? Qui fait partie de la planification?

Quelle est la distribution de travail dans le ménage entre l’homme et la femme ?

Est-ce qu’il y a des chocs ou stresses prévisibles ? Est-ce que vous se sentez prêt pour agir ? Comment ? Votre préparation pour des chocs et stresses prévisibles était-elle différente avant le PIP ?

Pour les ménages avec PIP

Comment le PIP a-t-il influencé votre ménage ?

Comment le PIP a-t-il influencé votre exploitation agricole ?

Est-ce que le fait d'avoir un plan et des objectives a changé le bien-être du ménage ? Comment ?

Est-ce que le PIP a changé la manière dans laquelle vous collaborez dans le ménage ? Et est-ce que le PIP a changé comment vous vous entendez dans la famille ?

Qu'est-ce qui changerait si le projet s'arrêtait à votre avis ?

Annex II; SLM practices

Sustainable Land Management (SLM) practices

The SLM practices were asked for during the interviews. Farmers could choose from and add to 14 SLM practices. The asking for these practices was based both on the work of PIP and IFDC and on the recurring practices named by farmers during the test interviews. The IFDC, with the help of the PIP approach, has trained and guided farmers on a variety of SLM practices:

- Mulch
- Cover crops
- Intercropping
- Agroforestry
- Ploughing less
- Tranches
- Earth dikes
- Living hedges
- Continuous ridges
- Manure
- Compost
- Sowing in lines
- Ploughing perpendicular to the slope
- Ploughing along contour lines with fixating herbs

figure 7. Example of applied mulch in commune Makebuko

These practices counter soil erosion in a sustainable and accessible manner. Most practices are initially already applied by at least one of the farmers in the community. The farmers thus inspire each other and are taught on the use and application of the practices.

Additionally, the IFDC has focused on the re-application of dolomite, an agricultural practice that has been used traditionally in Burundi, but in the past decades had been applied relatively very little. Dolomite is affordable and locally available, improves nutrient availability, and enhances soil structure. However, risks of dolomite include nutrient lockout and soil compaction. The use of dolomite was not analyzed in the research because its development was handled by a branch of IFDC that did not make use of the PIP approach.

Annex III; TLU Value Score

Regarding livestock keeping, the livestock owned were given a comparable value score according to the tropical livestock units (TLU). In the tropics, a TLU is defined on the basis of an animal weighing 250 kg regardless of its type, age or sex; this definition coexists with that of a TCU represented by a bovine weighing 175 kg (1 TCU =0.70 TLU). A flat live weight, and therefore a TLU coefficient, is assigned to small ruminants (25 kg or 0.10 TLU), mules (175 kg or 0.70 TLU), pigs (50 kg or 0.20 TLU) or poultry (2.5 kg or 0.01 TLU) (Jahnke, 1982; Assouma et al., 2018; MIX-ENABLE, 2020)[8]. I added three values that weren't given in the MIX-ENABLE (2020) document: rabbits on average weigh the same as poultry and were thus given the same value, 0,01; rats on average weigh approximately half a kilo and are thus given a score that is one-fifth of that of a rabbit, resulting in a TLU value of 0.002; finally, foals are small horses and weigh approximately 50 kg on average, which is the same as a pig.

Table 3. Livestock animal and their related weight approximation and TLU values

Animal type	Weight approximately (in kg)	TLU value
Cow	175	0.7
Foal	50	0.2
Pig	50	0.2
Sheep	25	0.1
Goat	25	0.1
Poultry	2.5	0.01
Rabbit	2.5	0.01
Rat	0.5	0.002

[8] productions-animales.org/article/download/4855/17718?inline=1

Annex IV; Significance for Pre-determined Attributes

p-values for significance of general resilience characteristics

Crop types:

SCAD & non-PIP	0,002
PAPAB & non-PIP	< 0,001

Crop types for selling:

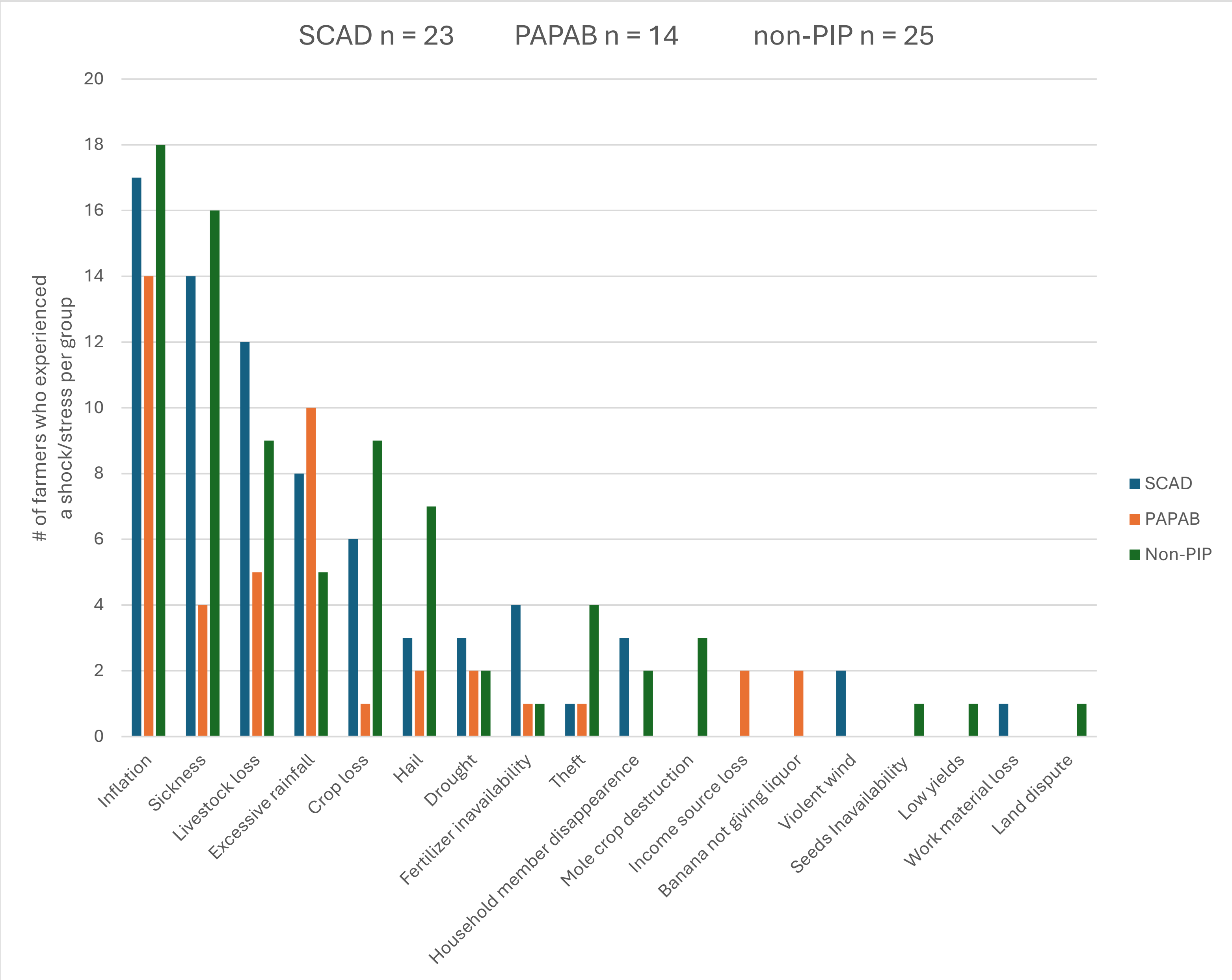
SCAD & non-PIP	< 0,001
PAPAB & non-PIP	< 0,001

SLM practices :

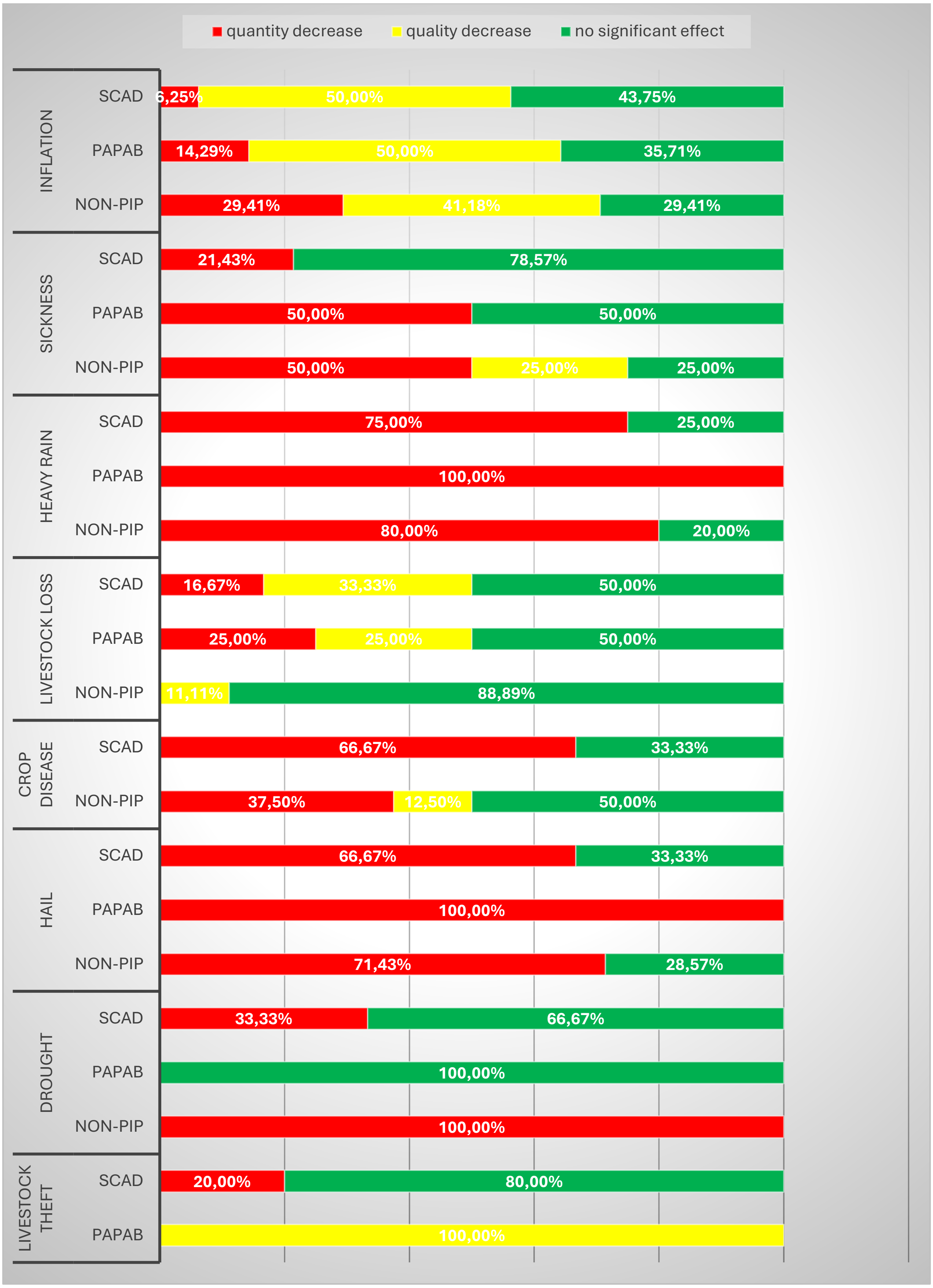
SCAD & non-PIP	< 0,001
PAPAB & non-PIP	< 0,001

Annex V; Shocks & Stresses

All shocks and stresses



Annex VI ; Effects on alimentation per shock & stress



Annex VII; Resilience attributes

Other resilience measures include renting out or selling land, cultivating short-cycle crops (mostly lenga lenga) in the valleys, getting seeds and other support through external organisations – especially Tubura is present in the region for farmer support – consulting a veterinary –in cases of livestock disease – using money reserves and cultivating and ploughing less land due to a reduced seeds quantity.

Additionally, some farmers stated to have made use of their knowledge in the recuperation process. The knowledge that farmers referred to is that of certain agricultural techniques that helped them adapt to the new circumstances. One farmer also stated that before participation in PAPAB, she did not know she could start cultivating certain crops in the middle of the season. This knowledge now helped her recuperate. Also praying is mentioned to have helped to recover from a shock or stress.

Agricultural insurance was used only once, although several farmers named it as a resilience attribute they planned to use in the future. Meanwhile, in a group discussion in Makebuko (PAPAB colline) participants stated that some farmers in the colline had used agricultural insurance before. However, they had not received full compensation after excessive rainfall had destroyed a large part of their bean crops. Therefore, some farmers distrust it, although the farmers with insurance were still better off than those without. Most farmers stated to not have an insurance simply due to lack of awareness of its existence or of how to get it.

Crop diversity was also stated to have helped farmers because as a consequence some crops remain when others are destroyed by drought or hail for example. Therefore, when one of these shocks occurred, the crop diversity of their farming system helped them recuperate.

Lastly, a hospital card helps to reduce hospital costs, but the availability of these cards is limited, therefore not all households are able to acquire one. They can be bought occasionally, and their possession reduces hospital costs for the owners during the following year.

Annex VIII; Tukey significant test

Multiple Comparisons

Tukey HSD

Dependent Variable	(I) Project	(J) Project	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Cultivating less land	non-PIP	PAPAB	,05	,038	,344	-,04	,14
		SCAD	,00	,032	1,000	-,08	,08
	PAPAB	non-PIP	-,05	,038	,344	-,14	,04
		SCAD	-,05	,038	,336	-,14	,04
	SCAD	non-PIP	,00	,032	1,000	-,08	,08
		PAPAB	,05	,038	,336	-,04	,14
Borrowing credit association	non-PIP	PAPAB	-,09	,078	,496	-,27	,10
		SCAD	-,03	,067	,902	-,19	,13
	PAPAB	non-PIP	,09	,078	,496	-,10	,27
		SCAD	,06	,078	,729	-,13	,24
	SCAD	non-PIP	,03	,067	,902	-,13	,19
		PAPAB	-,06	,078	,729	-,24	,13
Borrowing from friends or work (money or seeds)	non-PIP	PAPAB	-,01	,040	,988	-,10	,09
		SCAD	-,01	,034	,914	-,10	,07
	PAPAB	non-PIP	,01	,040	,988	-,09	,10
		SCAD	-,01	,040	,979	-,10	,09
	SCAD	non-PIP	,01	,034	,914	-,07	,10
		PAPAB	,01	,040	,979	-,09	,10
Selling Livestock	non-PIP	PAPAB	-,09	,085	,541	-,29	,11
		SCAD	-,20*	,073	,017	-,37	-,03
	PAPAB	non-PIP	,09	,085	,541	-,11	,29
		SCAD	-,11	,085	,390	-,31	,09
	SCAD	non-PIP	,20*	,073	,017	,03	,37
		PAPAB	,11	,085	,390	-,09	,31
	non-PIP	PAPAB	-,11	,065	,227	-,26	,05

Using on-farm income source		SCAD	-,16*	,055	,012	-,29	-,03
	PAPAB	non-PIP	,11	,065	,227	-,05	,26
		SCAD	-,05	,065	,679	-,21	,10
	SCAD	non-PIP	,16*	,055	,012	,03	,29
		PAPAB	,05	,065	,679	-,10	,21
Intensifying composting	non-PIP	PAPAB	-,03	,030	,532	-,10	,04
		SCAD	-,01	,026	,860	-,07	,05
	PAPAB	non-PIP	,03	,030	,532	-,04	,10
		SCAD	,02	,030	,808	-,05	,09
	SCAD	non-PIP	,01	,026	,860	-,05	,07
		PAPAB	-,02	,030	,808	-,09	,05
Investing	non-PIP	PAPAB	-,03	,054	,799	-,16	,09
		SCAD	,03	,047	,847	-,08	,14
	PAPAB	non-PIP	,03	,054	,799	-,09	,16
		SCAD	,06	,054	,510	-,07	,19
	SCAD	non-PIP	-,03	,047	,847	-,14	,08
		PAPAB	-,06	,054	,510	-,19	,07
Ploughing less	non-PIP	PAPAB	-,02	,019	,463	-,07	,02
		SCAD	-,01	,016	,697	-,05	,03
	PAPAB	non-PIP	,02	,019	,463	-,02	,07
		SCAD	,01	,019	,877	-,04	,05
	SCAD	non-PIP	,01	,016	,697	-,03	,05
		PAPAB	-,01	,019	,877	-,05	,04
Payed ploughing	non-PIP	PAPAB	,04	,054	,690	-,08	,17
		SCAD	,14*	,046	,006	,04	,25
	PAPAB	non-PIP	-,04	,054	,690	-,17	,08

		SCAD	,10	,054	,154	-,03	,23
	SCAD	non-PIP	-,14*	,046	,006	-,25	-,04
		PAPAB	-,10	,054	,154	-,23	,03
external financial support (e.g. children or aid project)	non-PIP	PAPAB	,05	,033	,245	-,02	,13
		SCAD	,03	,028	,626	-,04	,09
	PAPAB	non-PIP	-,05	,033	,245	-,13	,02
		SCAD	-,03	,033	,696	-,10	,05
	SCAD	non-PIP	-,03	,028	,626	-,09	,04
		PAPAB	,03	,033	,696	-,05	,10
Selling banana drink	non-PIP	PAPAB	-,12*	,043	,013	-,23	-,02
		SCAD	-,04	,037	,525	-,13	,05
	PAPAB	non-PIP	,12*	,043	,013	,02	,23
		SCAD	,08	,043	,136	-,02	,19
	SCAD	non-PIP	,04	,037	,525	-,05	,13
		PAPAB	-,08	,043	,136	-,19	,02
Using off-farm income source	non-PIP	PAPAB	,11	,092	,470	-,11	,32
		SCAD	,12	,079	,305	-,07	,30
	PAPAB	non-PIP	-,11	,092	,470	-,32	,11
		SCAD	,01	,092	,995	-,21	,23
	SCAD	non-PIP	-,12	,079	,305	-,30	,07
		PAPAB	-,01	,092	,995	-,23	,21
Temporary off-farm income (other than payed ploughing)	non-PIP	PAPAB	-,01	,033	,982	-,08	,07
		SCAD	,03	,028	,625	-,04	,09
	PAPAB	non-PIP	,01	,033	,982	-,07	,08
		SCAD	,03	,033	,593	-,05	,11
	SCAD	non-PIP	-,03	,028	,625	-,09	,04

		PAPAB	-,03	,033	,593	-,11	,05
Using food reserves	non-PIP	PAPAB	,04	,077	,874	-,14	,22
		SCAD	-,06	,067	,678	-,21	,10
	PAPAB	non-PIP	-,04	,077	,874	-,22	,14
		SCAD	-,09	,078	,447	-,28	,09
	SCAD	non-PIP	,06	,067	,678	-,10	,21
		PAPAB	,09	,078	,447	-,09	,28
Using seed reserves	non-PIP	PAPAB	-,04	,047	,648	-,15	,07
		SCAD	-,08	,041	,119	-,18	,02
	PAPAB	non-PIP	,04	,047	,648	-,07	,15
		SCAD	-,04	,047	,695	-,15	,07
	SCAD	non-PIP	,08	,041	,119	-,02	,18
		PAPAB	,04	,047	,695	-,07	,15
Selling or renting out Land	non-PIP	PAPAB	,07	,046	,283	-,04	,18
		SCAD	,04	,039	,584	-,05	,13
	PAPAB	non-PIP	-,07	,046	,283	-,18	,04
		SCAD	-,03	,046	,781	-,14	,08
	SCAD	non-PIP	-,04	,039	,584	-,13	,05
		PAPAB	,03	,046	,781	-,08	,14
Selling agricultural produce	non-PIP	PAPAB	-,28*	,093	,009	-,49	-,06
		SCAD	-,18	,079	,068	-,37	,01
	PAPAB	non-PIP	,28*	,093	,009	,06	,49
		SCAD	,10	,093	,545	-,12	,32
	SCAD	non-PIP	,18	,079	,068	-,01	,37
		PAPAB	-,10	,093	,545	-,32	,12
Using money reserves	non-PIP	PAPAB	,00	,038	,995	-,09	,09

		SCAD	-,04	,032	,427	-,12	,04
	PAPAB	non-PIP	,00	,038	,995	-,09	,09
		SCAD	-,04	,038	,476	-,13	,05
	SCAD	non-PIP	,04	,032	,427	-,04	,12
		PAPAB	,04	,038	,476	-,05	,13
Community material/labour support	non-PIP	PAPAB	,14	,071	,129	-,03	,31
		SCAD	,06	,061	,548	-,08	,21
	PAPAB	non-PIP	-,14	,071	,129	-,31	,03
		SCAD	-,07	,072	,551	-,24	,09
	SCAD	non-PIP	-,06	,061	,548	-,21	,08
		PAPAB	,07	,072	,551	-,09	,24
Using manure	non-PIP	PAPAB	,00	,055	1,000	-,13	,13
		SCAD	,00	,047	1,000	-,11	,11
	PAPAB	non-PIP	,00	,055	1,000	-,13	,13
		SCAD	,00	,055	,999	-,13	,13
	SCAD	non-PIP	,00	,047	1,000	-,11	,11
		PAPAB	,00	,055	,999	-,13	,13
Cultivating quick crops	non-PIP	PAPAB	-,04	,044	,658	-,14	,07
		SCAD	,01	,038	,940	-,08	,10
	PAPAB	non-PIP	,04	,044	,658	-,07	,14
		SCAD	,05	,044	,480	-,05	,15
	SCAD	non-PIP	-,01	,038	,940	-,10	,08
		PAPAB	-,05	,044	,480	-,15	,05
Cultivation in marshes	non-PIP	PAPAB	-,05	,035	,399	-,13	,04
		SCAD	-,07	,030	,071	-,14	,00
	PAPAB	non-PIP	,05	,035	,399	-,04	,13

		SCAD	-,02	,035	,818	-,10	,06
	SCAD	non-PIP	,07	,030	,071	,00	,14
		PAPAB	,02	,035	,818	-,06	,10
Mental support	non-PIP	PAPAB	,04	,023	,207	-,02	,09
		SCAD	,04	,020	,120	-,01	,09
	PAPAB	non-PIP	-,04	,023	,207	-,09	,02
		SCAD	,00	,023	1,000	-,05	,05
	SCAD	non-PIP	-,04	,020	,120	-,09	,01
		PAPAB	,00	,023	1,000	-,05	,05
Using hospital card	non-PIP	PAPAB	,00	,030	,992	-,07	,07
		SCAD	,00	,026	1,000	-,06	,06
	PAPAB	non-PIP	,00	,030	,992	-,07	,07
		SCAD	,00	,030	,991	-,08	,07
	SCAD	non-PIP	,00	,026	1,000	-,06	,06
		PAPAB	,00	,030	,991	-,07	,08
Agricultural insurance	non-PIP	PAPAB	-,02	,014	,215	-,05	,01
		SCAD	,00	,012	1,000	-,03	,03
	PAPAB	non-PIP	,02	,014	,215	-,01	,05
		SCAD	,02	,014	,216	-,01	,05
	SCAD	non-PIP	,00	,012	1,000	-,03	,03
		PAPAB	-,02	,014	,216	-,05	,01
Getting seeds through alternative source (Tubura)	non-PIP	PAPAB	,02	,040	,867	-,07	,11
		SCAD	,04	,034	,490	-,04	,12
	PAPAB	non-PIP	-,02	,040	,867	-,11	,07
		SCAD	,02	,040	,886	-,08	,11
	SCAD	non-PIP	-,04	,034	,490	-,12	,04

		PAPAB	-,02	,040	,886	-,11	,08
consulting veterinary	non-PIP	PAPAB	-,02	,032	,764	-,10	,05
		SCAD	-,07*	,028	,047	-,13	,00
	PAPAB	non-PIP	,02	,032	,764	-,05	,10
		SCAD	-,04	,033	,370	-,12	,03
	SCAD	non-PIP	,07*	,028	,047	,00	,13
		PAPAB	,04	,033	,370	-,03	,12
Leaving rented land	non-PIP	PAPAB	,00	,014	1,000	-,03	,03
		SCAD	-,01	,012	,489	-,04	,01
	PAPAB	non-PIP	,00	,014	1,000	-,03	,03
		SCAD	-,01	,014	,591	-,05	,02
	SCAD	non-PIP	,01	,012	,489	-,01	,04
		PAPAB	,01	,014	,591	-,02	,05
Leaving a purchase (or buying lesser quality or less)	non-PIP	PAPAB	,06	,072	,676	-,11	,23
		SCAD	,02	,062	,921	-,12	,17
	PAPAB	non-PIP	-,06	,072	,676	-,23	,11
		SCAD	-,04	,072	,867	-,21	,13
	SCAD	non-PIP	-,02	,062	,921	-,17	,12
		PAPAB	,04	,072	,867	-,13	,21
Strengthened by crop diversity	non-PIP	PAPAB	-,03	,038	,667	-,12	,06
		SCAD	-,05	,032	,225	-,13	,02
	PAPAB	non-PIP	,03	,038	,667	-,06	,12
		SCAD	-,02	,038	,840	-,11	,07
	SCAD	non-PIP	,05	,032	,225	-,02	,13
		PAPAB	,02	,038	,840	-,07	,11
Using knowledge	non-PIP	PAPAB	,02	,038	,898	-,07	,11

		SCAD	-,01	,032	,905	-,09	,06
	PAPAB	non-PIP	-,02	,038	,898	-,11	,07
		SCAD	-,03	,038	,699	-,12	,06
	SCAD	non-PIP	,01	,032	,905	-,06	,09
		PAPAB	,03	,038	,699	-,06	,12
Praying	non-PIP	PAPAB	,03	,023	,501	-,03	,08
		SCAD	,01	,020	,795	-,03	,06
	PAPAB	non-PIP	-,03	,023	,501	-,08	,03
		SCAD	-,01	,023	,837	-,07	,04
	SCAD	non-PIP	-,01	,020	,795	-,06	,03
		PAPAB	,01	,023	,837	-,04	,07

Based on observed means.

The error term is Mean Square(Error) = ,015.

*. The mean difference is significant at the ,05 level.