Investing in on-farm and post-harvest resilience to climate change in smallholder value chains

Lessons from Rwanda

Working Paper No. 193

CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)

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Abstract

This study assessed intermediate results of an investment intended to support climate change adaptation and resilience-building among farmers' cooperatives in Rwanda. The assessment was based on a purposive sampling survey of farmers' perspectives conducted in sites in 10 programme intervention districts of the country's 30 districts. Assessed interventions included the enhancing of farmer-access, quality and utilization of climate information services; on-farm participatory trials of climate-smart crop and forage varieties; and climate-smart harvest and post-harvest support for infrastructural development at "HUBs" for shared post-harvest storage and marketing. Interventions included the capacity development among farmers' organizations to access funding from commercial lending for integrating climate-smart features in warehouse construction and in other post-harvest infrastructure. Demonstration infrastructures were also constructed by a funding arrangement between the programme, local government structures and farmers' organizations.

Farmers' perspectives indicated appreciation of the value of and need for the (yet to be available) weather information. Farmers understood weather information that includes seasonal advisories to be of higher quality than daily weather forecasts. Farmer-scientist participatory on-farm trials were successful in identifying potato and maize varieties that met both climate-resilience and other farmer-defined criteria. However, the applied method for forage trails did not indicate satisfactory yield levels, nor did it generate farmer confidence. The assessment revealed resounding farmers' approval for climate-smart infrastructure demonstrations. Misgivings were, however, indicated by farmers and their organizational leaders on the efficiency and effectiveness of the capacity development mechanism for commercial lending access to finance climate-smart requirements.

Keywords

Climate information services; weather information; seasonal advisories; post-harvest; infrastructure; participatory trials; climate-smart; farmers' cooperatives; capacity development; value chain; commercial lending

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Acronyms

ASAP	Adaptation in Smallholder Agriculture Programme
CCAFS	CGIAR Research Program on Climate Change, Agriculture and Food Security
ENACTS	Enhancing National Climate Services project
FGD	Focus Group Discussion
HUB	PASP hub for aggregation, storage, marketing and agribusiness support services
IFAD	International Fund for Agricultural Development
MoU	memorandum of understanding
PASP	Climate-Resilient Post-Harvest and Agribusiness Support Project
PHCRAB	Post-Harvest Climate-resilient Agribusiness
RAB	Rwanda Agricultural Board
SPIU	Single Project Implementation Unit

Contents

Introduction

Agricultural value chains that source from, and supply to, smallholder farmers in low-income countries are especially vulnerable to the impacts of climate change. These farmers are heavily reliant on low-input rainfed agriculture to make their livings, and have limited access to safety nets such as farm insurance or social security payments, so that their livelihoods and food security are especially highly exposed to climatic variability and climate change. Also, large losses are characteristic of harvesting and post-harvest handling of agricultural products by smallholder farmers in low-income countries. While many governments are making serious investments to reduce post-harvest losses, mainly through local-level infrastructure and technologies, there is a significant risk that losses will be exacerbated by climate change.

The Adaptation for Smallholder Agriculture Programme (ASAP) is a global programme that invests in climate resilience among small-scale farmers in countries eligible for finance from the International Fund for Agriculture (IFAD). IFAD launched ASAP in 2012 and Rwanda was an early recipient of an investment of USD 7 million, in 2014, to support the Climate-Resilient Post-Harvest and Agribusiness Support Project (PASP). PASP support is structured in three components. Component 1 aims at HUB capacity development and business coaching; Component 2 aims at post-harvest climate-resilient agri-business investment support while Component 3 aims at project management and coordination.

The intended outcome of Component 1 is that "cooperatives, farmers' organisations or small and medium enterprises associated with participating HUBs have the skills and knowledge, as well as access to specialized service providers, to create viable and competitive businesses capable of delivering larger volumes of improved produce to the market chain and provide low-carbon value-adding to an expanding number of clients", while the intention of Component 2 is that "HUB business investments in improved climate-resilient and low-carbon post-harvesting procedures, drying, processing and value addition, storage, logistics and distribution result in reductions in product losses and increased smallholder and rural labourer incomes."

PASP describes the key component of the HUB as its linkage to agribusiness support services, which the project facilitates and strengthens, either directly or through sub-contracted services by other relevant institutions and/or private sector providers.

The purpose of this study is to report on and assess the intermediate results of the ASAP investments within the PASP Components 1 and 2 in (a) weather information (services and local institutions), (b) participatory trials of climate-adapted maize and forage crops, and (c)

climate-resilient infrastructure. While it is too early to assess the ultimate impacts of the program at local or national levels, this working paper offers lessons for parallel programs in Rwanda and internationally.

The assessment was based on a purposive sampling survey of farmers' perspectives conducted in 10 programme intervention districts of the country's total of 30 districts. Assessed interventions included the enhancing of farmer-access, quality and utilization of climate information services; on-farm participatory trials of climate-smart crop and forage varieties and; climate-smart harvest and post-harvest support for infrastructural development as well as the promotion of climate-smart harvest and post-harvest materials.

Focus Group Discussions (FGDs) were carried out with 12 cooperative management committee members in 8 intervention districts and individual interviews conducted with 32 member farmers in 7 districts. A location map of the PASP-ASAP intervention districts and visited sites is featured in Appendix 1. The interview questionnaire was formulated according to the commodity-specific cooperatives, with different questions targeted respectively for maize, for potatoes and for milk cooperatives. The questionnaire was also separated with dedicated sections for FGDs and individual interviews.

Interview data were collected on farmer perspectives on each of: information quality, access, use and feedback in climate information services; participatory trials of new climate-resilient maize and forage varieties; climate-resilient infrastructures built or installed for their benefit; and demonstration and promotion of climate-resilient post-harvest materials distributed to them. Field observations on participatory variety trials, as well as on climate-resilient infrastructure and materials and their respective uses, were capture in photographs and testimonies in video recording clips and written quotes. Collected data and information were analyzed using SPSS statistical software.

Climate information services

Intermediate results for climate information services

During the PASP-ASAP project design, partners identified provision of climate information services to farmers as a key priority for reducing on-farm and post-harvest risks and losses. PASP collaborates with state national institutions to deliver the planned climate services intervention activities, under shared memoranda of understanding (MoU).

To assess intermediate results, this study obtained information on access, quality and use from farmer cooperative management committee members, via FGDs and from individual member farmers separately. Climate information in this case was taken to mean both the weather information of daily forecasts and the weather and climatic data that Rwanda Meteorological Agency (Meteo Rwanda) models, interprets and collates into seasonal climate advisories that are then distributed to farmers for application in the planning and execution of farming operations. Perspectives on quality of weather information were therefore assessed from responses to questions that addressed both *seasonal climate advisories* and *daily weather information*.

Interviews also included questions with respect to farmer perspectives on the participation in the production and provision of feedback of daily weather forecasts and seasonal climate advisories. Progress made in the implementation of the Rwanda Meteorological Agency (Meteo Rwanda) under the MoU was made available to the assessment team by relevant officials through office meetings and electronic communications.

PASP-ASAP efforts to expand access to weather and seasonal advisory information

Personal communication with relevant officials of Meteo Rwanda indicated that measures were taken to create and operate an agro-meteorology advisory service center in each HUB as stipulated in the MoU above. Meteo Rwanda conducted a survey in 5 PASP-ASAP intervention districts and obtained local micro-climate information to enable the preparation and dissemination of seasonal climate advisories tailored to local agro-climatic conditions and cropping patterns.

Meteo Rwanda also sent mobile phone texts containing daily weather information and early warning messages appropriate to the risks identified (droughts, floods, cessation of rains etc.) to 5,089 farmers in 12 PASP-ASAP intervention districts. All 10 FGDs said that cooperative committee members accessed weather information as members of the text message target groups of Meteo Rwanda. However, the majority of cooperative committees indicated that

they obtained daily weather information, mainly cloud-cover, rainfall and temperatures from radio programs, while only the minority who had received training on message interpretation accessed text messages on their phones.

All but one of the FGDs indicated that they access seasonal climate advisories from the Rwanda Agricultural Board, the state institution mandated to, working with Meteo Rwanda, to prepare and disseminate seasonal climate advisories for farmers.

Table 1 Farmer responses to mode of access to weather information

Responding farmer	Mode of weather info access				Total
	no access	SMS	radio&/or TV	other	
Female	0	1	12	1	**14**
Male	1	4	12	0	**17**
Total	**1**	**5**	**24**	**1**	**31**

A similar access trend was observed among individual respondents as shown in Table 1; all except one of the 31 respondents said they had access to daily weather information. Also, an even higher percentage of farmers (80%) accessed weather information from radio and/or TV with only 16% (1 female and 4 male farmers) from phone text messages and 3% (one female farmer) from other means. An equal number of women and men member farmers accessed weather information by radio and/or TV. However, more male farmers (13%) accessed weather information by phone than female (3%). Although the purposive sampling method and the small number of respondents have statistical significance limitations, it would seem that farmers currently rely more on radio and/or TV than text messaging for weather information.

Farmer perspectives on access to seasonal climate advisory information

Seasonal climate advisories were shared with farmers directly in workshops. In implementation of the intervention activity for preparation and dissemination of seasonal climate advisory information, as reported in the 2016 ASAP Rwanda working document, 695 people (522 men and 173 women) including district and sector agronomists, environmentalists, input suppliers, agriculture extension agents and farmer cooperatives in 12

PASP-ASAP intervention districts participated in one-day workshops (17 March to 24 April 2016) on the rainfall outlook for growing season 2016B.

Meteo Rwanda also reported having carried out training activities on how to interpret and use the seasonal forecasts in training workshops of HUB users including agronomists. The seasonal forecast for March-April-May 2016 was used a reference in the workshops. However, the summary report indicates that dissemination of the seasonal forecast for the last period of 2016 (September thru December) was not done due logistical constraints that resulted in the forecast being released in the middle of the season.

Indeed, FGDs indicated that all cooperative committees received seasonal climate advisory information. It was indicated that most committee members accessed advisories through meetings or workshops convened and facilitated by PASP in collaboration with Meteo Rwanda while fewer accessed them through radio and other sources. This was confirmed by the 32 member farmers interviewed that 45% (5 female and 9 male farmers) accessed seasonal climate advisory information through PASP meetings with fairly balanced access for women and men.

Cross-tabulation analysis in Table 2 shows that 25 farmers out of 32 interviewed (78%) obtain seasonal climate advisory information regarding growing seasons from officials of RAB, PASP, cooperative leaders, local agronomists and the radio. Table 2 indicates that female and male famers evenly get the climate information mostly from cooperative leaders and agronomists in meetings. Interviews indicated that of the 32 respondents, 7 farmers (22%) did not obtain seasonal climate advisory information.

Table 2 Farmer response on source of seasonal climate advisory information

Responding farmer	**Seasonal Climate Info Source**					**Total**
	RAB	**PASP**	**Coops**	**Agronomist**	**Radio**	
Female	0	3	8	7	3	**13**
Male	4	6	5	7	2	**12**
Total	**4**	**9**	**13**	**14**	**5**	**25**

Table 3 shows that 50% of respondents (7 female and 9 male farmers) obtained seasonal climate advisory information, 17% regularly (4 female and 1 male farmer) and 13% rarely (1 female and 3 male farmers). Frequency of access to seasonal climate advisory information seems to be gender-balanced among interviewed farmers. This indicates varied access of information that does not seem systematic, as indeed it seems to be delivered in different meetings by different institutional officials.

The assessment generally reveals that whereas ASAP support is aimed at raising farmers' personal access to climate information services through mobile phone applications, radio and/or TV seem to remain the main mode of weather information access, for the majority of farmers and for their organizational leaders (Table 1). Seasonal climate advisory information is accessible to farmers through physical meetings and through institutional officials as wells as radio, as in Table 2.

Table 3 Frequency of receiving seasonal climate information

Frequency of receiving seasonal climate information	Responses	
	N	Percent
Start of growing season	7	21.2%
At harvest	4	12.1%
Weekly	7	21.2%
Monthly	6	18.2%
Rarely	9	27.3%
Total	**33**	**100.0%**

Farmer perspectives on use of weather information and climate advisories

Table 4 Farmer use of weather information

Case		Use: weather info in harvest & post-harvest		Total
		No	yes	
Farmer response	Female	1	13	**14**
	Male	3	14	**17**
Total		**4**	**27**	**31**

FGDs indicated that the weather information and climate advisories were used in the planning of farming operations including post-harvest activities. Female and male farmers seem to be

balanced in the use of weather information in planning and execution of farming operations including harvest and post-harvest activities as shown in Table 4. A similar gender balance use of seasonal climate advisory information is observed in Table 5. However, it came out clearly from some of the committee members that they felt that daily weather information was not useful for their post-harvest purposes and preferred some kind of forecast over several days. Testimonies of farmers' opinions to the effect that daily weather is not helpful in planning and carrying out farming operations were captured.

Table 5 Farmer use of seasonal climate advisory information

Case		Use: climate advisory in harvest & post-harvest		Total
		no	yes	
Farmer response	Female	2	11	**13**
	Male	3	12	**15**
Total		5	23	**28**

FGDs indicated that although farmers were able to use weather information of the day for example to put out grain for drying, the information was not helpful in making planning decisions for harvesting. They recommended that a forecast over several days would be more helpful in decision-making in farming operations including harvest and post-harvest.

Farmer perspectives on roles in production of and feedback on climate information

During personal communication with Meteo Rwanda officials it was mentioned that a toll-free facility is available for anyone to call and give the feedback or request clarifications for verification of provided forecasts. The agency reported that an average of 10 persons per week call the toll-free number with more people tending to call during rainy season. The Agricultural Information Centre also operates a toll-free line for farmers to phone in for information. However, personal communication with the relevant official indicated that the planned call center to be established with the ASAP funding support has experience extended delays due to constraints related to the procurement of consultancy services to carry out the works and services.

Farmers' perspectives regarding their roles in the production of weather information and provision of feedback regarding climate services received were inferred from FGDs and

individual interviews. FGDs indicated that the majority of cooperative committees did not provide feedback on weather information. The few that did indicated that feedback was given regarding forecast errors in daily weather information provided. Table 6 shows from individual member interviews that almost half the farmers provided feedback on weather and advisory errors.

Table 6 Farmer feedback on climate information

Case		Feedback on weather information		Total
		No feedback	Feedback on forecast errors	
Farmer response	**Female**	8	6	**14**
	Male	7	10	**17**
Total		**15**	**16**	**31**

However, contrary to weather information, farmers provided feedback on seasonal climate advisory information during meetings with technical officials. Table 7 shows that 20 farmers out of 32 (62%) interviewed provided feedback during meetings whereas the remaining 12 (38%) did not give feedback. Reasons for not giving feedback included lack of a facility to give feedback (4 farmers, all of them women) and lack of adequate knowledge on weather information (4 farmers). Other reasons given by 4 farmers included being shy and not having a suitable forum in which to provide feedback.

Table 7 Farmer reason for not providing feedback on seasonal climate information

Responding farmer	Reason for no feedback				Total
	Feedback provided	No feedback facility	Not enough knowledge	Other	
Female	7	4	1	2	**14**
Male	13	0	3	2	**18**
Total	**20**	**4**	**4**	**4**	**32**

Meteo Rwanda implemented activities to increase network efficiency and effectiveness and to fill gaps in historical meteorological data in order to improve the quality of weather data and weather information products in collaboration with the CCAFS Rwanda Climate Services for Agriculture Project. The Meteo Rwanda maintained 77 weather stations in the second quarter of 2016.

However, despite the fact that almost 40% of interviewed farmers did not give feedback, almost all of them expressed willingness to do so in the future by indicating preference in the means to provide feedback as shown in Table 8. Out of 32 farmers interviewed, 24 indicated preferences of mode to give feedback. The most preferred mode of feedback would be through meetings and trainings. Second and third preferences are toll-free phone-in/

messaging facilities, and via cooperative leaders. It is interesting to note that only one female farmer preferred a toll-free facility in comparison to 7 men. This could be related to access to mobile devices as it is indicated in Table 1 that only one female farmer receives weather information by text message compared with 4 male famers.

Table 8 Farmer preference mode for providing feedback to weather and seasonal climate information

Responding farmer	Preferred feedback mode on climate info						Total
	Coop leader	Toll-free phone	Meetings/ trainings	Local leader visits	No preference	Other preferences	
Female	2	1	4	2	3	2	12
Male	3	7	6	0	1	2	12
Total	5	8	10	2	4	4	24

Farmers and their respective cooperative leaders generally indicated that weather and climate seasonal climate advisory services were very useful in minimizing losses in harvest and post-harvest handling. Farmers however made suggestions on how weather information services could be improved. A number of farmers suggested that more meetings and training with experts would improve the use of weather information and seasonal climate advisories, and enable effective farmer involvement through feedback mechanisms. Other suggestions included local-scale weather data acquisition and transformation into more accurate forecasting.

General perspectives on climate information services

Intermediate results of the ASAP investment were assessed mainly based on 10 FGDs composed of leaders of farmer cooperatives and interviews with 31 of their members as representative part of the target population. Farmer representatives and member farmers of cooperatives generally had gender-balanced access to weather and seasonal climate advisory information. The preferred mode of access of weather and seasonal advisories through mobile messaging systems has not been achieved at the desired level; heavy reliance on radio and TV continues. Although a smaller number of smallholder farmers access weather data on their mobile phones, it is reasonable to expect that the numbers will increase to desired levels by the full term of the project.

Seasonal climate advisories were considered high-quality weather information. Farmers' perspectives were that daily weather information was not as useful as advisory information in form of several-day forecasts or seasonal climate advisories. The study indicated that limited higher-quality information in the form of growing season advisory prepared by RAB is generally accessible to farmers of both genders. The assessment however revealed that

similarly to weather data, seasonal advisory information is obtained through modes other than mobile messaging, mainly through meetings, radio, cooperative leaders and extension staff.

The assessment revealed that recipients of weather and growing season advisory information generally used it in planning of farming operations, including harvest and post-harvest activities. However, farmers indicated that they were aware of accuracy limitations in weather and growing season information and that most farmers did not provide feedback on the information received and used although there was a willingness to do so. Preferred means of giving feedback suggested by farmers included toll-free messaging and/or phone-in facilities and meetings and trainings.

ASAP investments provided financial support through PASP to Meteo Rwanda, RAB, the Agricultural Information and Communication centre and through the Single Project Implementation Unit (SPIU) directly. These ASAP investments envisage the ultimate outcome of enhanced capacity of smallholder farmers to adapt to climate change. Weather information access, quality and user-knowhow in its production, use and feedback are central to adaptation capacity for climate risk management through farming operations that have as low a carbon footprint as possible.

Meteo Rwanda planned activities to strengthen its weather data acquisition capacity through enhanced maintenance support of its weather-measuring network. Maintenance of weather measuring stations has included stations in the PASP-ASAP intervention districts of the Northern and Southern Provinces of Rwanda. It was expected that the synergies would be established to collaborate on the development of weather information products that meet the needs of the different end-users in Rwanda. Synergetic partnerships were planned and established between PASP-ASPA activities under the MoU with those of the project "Strengthening Meteo Rwanda's Weather and Climate Services to Support Development" funded by the national Fund for Environment and Climate Change (FONERWA; French acronym) and those of the Enhancing National Climate Services (ENACTS) program and the USAID-funded "Rwanda Climate Services for Agriculture" project, which involves the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).

Meteo Rwanda carried out micro-climate studies in 5 PASP intervention districts that will enable localized agro-climatic advisories that include climate risks and vulnerabilities specific to each value chain such as quantity of rainfall, length of rainy season as well as dry season, wind directions, and sunrise and sunset times. At the same time, RAB is in the process of running a yield forecast simulation for 2 maize varieties and 2 potato varieties using the Agricultural Production System Simulator (APSIM). These inputs are prerequisite

information for the preparation and dissemination of early warning messages appropriate to the risks identified in each PASP intervention areas, including droughts, floods, cessation of rains for specific areas. The Rwanda Climate Services for Agriculture project is supporting Meteo Rwanda to build on web products already produced by ENACTS for Rwanda that include growing season advisories and weekly warning as necessary for farmers at a 5x5 km grid scale. The Rwanda Climate Services for Agriculture project is also developing crop development monitoring for early decision making for food security considerations. The latter also plans to facilitate the establishment of a government structure for sustainable coordination of climate services.

For the time being, Meteo Rwanda is only able to disseminate weather information until the necessary micro-climatic modeling and associated processes are completed. Currently, over 5,000 farmers receive weather information text messages in all the PASP intervention districts as originally targeted. However, PASP in collaboration with Meteo Rwanda disseminated seasonal climate advisory information in workshops and meetings at community level throughout the country-level seasonal forecast advisory for the 2016B growing season.

A parallel activity was planned to create and operate an agro-meteorology advisory service center in each HUB within the PASP intervention areas to enhance access and to train HUB users in weather information production and communication. At the same time, the Agricultural Information and Communication Centre also planned a call center. Both institutions have mandated obligations to establish efficient feedback or back-cast systems for agro-climatic advisory verification under the PASP-ASAP investments framework. Both institutions have existing public phone-in facilities that are operating at some level.

Although these weather information centers have not yet been established, training of HUB users on weather information packages produced and disseminated by Meteo Rwanda has been carried out in almost half of the PASP intervention districts in the Northern and Southern Provinces. Climate Risk Management training has been provided in parallel by the PASP SPIU through a service provider to over 720 farmers from 120 cooperatives; with 10 cooperative in each District to over 40 SPIU and service provider staff and to over 30 officers from financial institutions.

Maize, potato and forage variety trials

Intermediate results of maize variety trials

PASP is collaborating with the Rwanda Agricultural Board (RAB), a technical institution of the Ministry of Agriculture and Animal Resources, under a MoU for technology transfer and provision of incentives in the identification and promotion of crop and forage varieties that mature earlier and are more tolerant to floods and droughts, through appropriate field demonstrations.

RAB carried out research on drought tolerance and disease resistance of maize varieties. The 2016 ASAP Rwanda working document reported that 5 new and promising maize varieties were released in the 2016B growing season for seed multiplication following on-farm assessment and passing with farmer participation. Another 7 varieties were evaluated in a participatory process while field work for this study was underway in July 2016. Trial plots were planted in land owned by COOPAMA and KODPCUM both in Nyagatare district within the drought prone region of Rwanda.

Figure 1 COOPAMA cooperative members inspecting the matured maize crop variety trials on 14th July 2016

Suitability of varieties and participatory trial process

The assessment research team witnessed a farmer evaluation of 7 promising maize varieties that was facilitated by RAB on 14 Jul 2016. The team was able to observe the participatory approach used by RAB in variety trials. The evaluation took place at the trial plots of the COOPAMA maize farmers' cooperative in Mimuri Sector, Nyagatare District. The trial involved 5 white and 2 orange maize varieties that were grown by the COOPAMA cooperative members on plots they volunteered for the trials in the vicinity of the cooperative. All the varieties tried had drought tolerance, early maturity and disease resistance.

Participatory facilitators explained the method they wished the farmer members to use in selecting their preferred trial varieties, which had now matured and ready for harvest. All farmers present were invited to participate. Participants were facilitated into gender-based

groups and asked to develop criteria for selecting the preferred varieties. Participants were then asked to inspect the standing crop for the evaluation. Women and men were provided ample time separately to deliberate on the pros and cons or each variety, and to rank them according to preference, keeping in mind the differences in growing seasons. After respective gender-based rankings according to preference criteria, the two groups of women and men were brought back together to present their respective preferences. There seemed to be differences between the choices of women and those of men. A consensus-finding deliberation was facilitated (Figure 1) and final rankings of preferred varieties by growing season were agreed by all. Table 9 shows the outcome matrix of the participatory evaluation featuring the varieties preference ranking by growing season against positive and negative qualities.

Table 9 Participatory preference ranking of mature maize crop variety trials at COOPAMA Cooperative 14th July 2016 (translated from Kinyarwanda)

Variety code	RHM1407	RHM104	RHM111	RHM127	RHT132
Preference	First	Second	Third	Fourth	Fifth
Positive qualities	• Big ears • Early maturing • Drought resistant	• 2 ears per node • Well covered • Drought resistant	• Medium size ear • Off-white kernels	• 2 ears per node • Drought tolerant • Tolerant to poor soil	• None
Negative qualities	• Only 1 ear • Pest birds	• Late maturing	• Pest birds • Some stunted ears	• No vigour • Maize Smut • Vulnerability to pests	• Many dead ears • Maize Smut • Infested with bugs • Needs early planting • Empty ears
Choice season	• Season A&B	• Season B	• Season B	• Season A	• Not considered

Farmers seem to have preferred that variety that produced bigger ears, was early-maturing and was drought-resistant. The farmers rationalized that an early-maturing variety could be grown in both growing seasons of Rwanda, the so-called season A (Sep-Dec) and Season B (Mar – May).

All the 7 maize crop varieties tried at the COOPAM cooperative site were planted on 15th March 2016 and at the time of harvest exactly 122 days later clearly displayed water stress tolerance as the standing crops had not yet completely dried out in the pick of the dry season, in the lowest rainfall and drought prone region of the country. The varieties also displayed disease resistance as no plants were visibly disease-affected, though this could be due to lack of infection. Farmers said that some varieties had matured earlier but were not harvested so that they could be evaluated alongside other varieties. However, as pointed out by farmers, some varieties had been fed on by birds and others had been infested by weevils (Figure 2). However, other varieties seemed to be well intact and healthy and were ranked as most preferred as displayed in the Table 9 matrix. Varieties developed and successfully tried by COOPAMA members may therefore be confirmed as suitable or the agro-climatic zone.

The approach to the maize variety trials used by the Rwanda Agriculture Board enabled farmers to grow the trial varieties and to evaluate their performance in order to pick out the preferred varieties for multiplication. This participatory process built a sense of ownership of the process, building confidence that the change to climate-resilient maize varieties for the drought-prone region is likely to succeed.

During the evaluation Kabera (not real name) pointed out undesirable traits of variety RHT132 for its attraction of pest birds and weevils and instead commended the RHM1407 below, that had big ears, drought tolerant and early maturing.

Figure 2 Evidence of undesirable qualities pointed out by farmers during participatory trial evaluation of new maize varieties 14 Jul 2016.

Intermediate results of potato trials

Six new potatoes clones with moderate resistance to late blight disease and tolerance to water stress were developed by RAB and trialled in the districts of Musanze, Burera, Nyabihu and Rubavu. The assessment team witnessed harvesting of the in-station trial of potato varieties in the grounds of RAB research station at Musanze on 21st July 2016. The assessment team also visited trials that were carried out by a Farmer Field School Facilitator in Musanze district and by the KOAB cooperative at Kora, Nyabihu district. Both districts belong in the high altitude volcanic region with typical rich volcanic soil, cool temperatures and high rainfall of over 1,000 mm annually.

Suitability of varieties and participatory trial process

Clone varieties of potato CIP395112.6; CIP392617.54; CIP399075.22; CIP393251.64; CIP396081.241; CIP398190.615; and CIP393371.58 were trialled at the research plots of RAB in Musanze in on-farm plots. The assessment team was able to attend the harvesting of the trials (Figures 4 and 5). The research scientist responsible for the trials explained that all the varieties performed as expected displaying potato late blight resistance, drought tolerance and early maturity against the indigenous favourite, the Kinigi variety as the reference.

The assessment team visited parallel trials were facilitated on-firm by collaborating with a local farmer in Musanze but who also plays the role of Farmer Field School Facilitator and a cooperative in an adjacent district of Nyabihu.

The Farmer Field School Facilitator explained his role in the trial of new potato varieties growing in trials. Although he had not harvested yet, he expressed confidence that he would get good yields from the trials. He mentioned that although he applied normal plant protection

measures as he did the usual varieties, he noted that early maturity, water-stress tolerance qualities among the new varieties. He also confirmed that all the varieties tolerated late blight disease better than the ordinary varieties, as he had to spray fewer times. The farmer indicated that he had already made his choice of the best performing varieties that he would keep and recommend for multiplication. The same observations were made at the trial site of KOABI cooperative in Nyabihu, where farmers expressed satisfaction with the performance of the new varieties.

Figure 3 RAB scientist (left) explaining potato variety trial to assessment team Masters students at Musanze RAB research station, Musanze 21 July 2016.

Figure 4 Farmer Field Facilitator (middle) explains the qualities of new potato varieties to the assessment team and RAB scientist in the trial plots, Musanze; KOABI cooperative farmer (right) shows progress of trial, Nyabihu. 21st Jul 2016.

RAB used the same participatory approach for the on-farm trialling of new potato varieties with cooperative collaborators, but with a strategic variation of working with a Farmer Field School Facilitator. Both participants expressed enthusiasm in their participatory roles and it was clear that they were interested in next step of propagating the new information and practice of using new climate-resilient varieties. However, both participants had not benefited in any of the harvest and post-harvest assistance benefits provided by PASP. The participating farmers indicated the critical need of harvest handling and storage infrastructure in order to

reduce losses of the produce. They expressed the delicate nature of the potato crop that needs careful handling in harvest and storage.

Intermediate results of forage trials

Under an MoU with PASP, RAB carried out activities to transfer technology and to implement an incentives framework for the identification and promotion of early maturing and drought- and flood- tolerant forage varieties that mature earlier through appropriate field demonstrations.

Participatory on-farm evaluation of forage legumes that are adapted to low rainfall patterns were initiated. *Mucuna pruriens* and *Medicago sativa* were ranked as potential protein supplement sources based on their suitability, biomass yield, regrowth ability and drought tolerance. RAB undertook characterization of new forage species and forage preservation (hay-making, silage, crop residue treatment). *Brachialia species* and *Pennisetum kakamega I* were recommended for silage making; *Panicum cloratum* and *Chloris gayana* were evaluated and found to show potential for hay-making.

Forage preservation techniques were demonstrated to farmers during training; 360 farmers from 4 cooperatives operating in the districts of Nyagatare and Gatsibo participated in silage and hay preparation and storage as well as livestock feeding. Awareness raising and training on the benefits of climate-resilient forage varieties with regard to sustainable quantitative and qualitative livestock feeding were also provided to cooperative farmers.

Suitability of varieties and participatory trial process

The assessment team visited RAB research station in Nyagatare district to observe intermediate results regarding in-station trials of new forage species. The team also visited Milk Collection Centre cooperatives of COPEKA in Kamonyi district and KOTUA in Rugango district in the Southern Province; Rwimbogo in Gatsibo district, Rwabiharamba and Rwempasha in Nyagatare district in the Eastern Province.

However, it was observed that on-farm forage variety trials had not yet reached yields sufficient to be harvested and fed to diary stock since planting in November 2015. Forage variety trials had struggled to take root at best, or dried-out at worst (Figures 6-9). Farmer members and cooperative committee members of COPEKA and Rwabiharamba cooperatives mentioned in FGDs and individual interviews that trials of forage varieties were not successful and dried out immediately after planting. Figures 6 to 9 show photos of forage trials taken during fieldwork at different locations between 12th and 22nd July 2016.

Figure 5 Forage variety trials planted at Rwimbogo MCC, Gatsibo district above in Nov 2015. Photos taken on 18th Jul 2016.

Figure 6 Forage variety trials at COPEKA MCC in Kamonyi district above planted in Nov 2015. Photos taken on 12th July 2016.

Figure 7 Farmer (middle right) explaining forage variety trials at KOTUA MCC in Ruhango district above planted in Nov 2015. Photos taken on 20th July 2016.

In-station trials of 20 grass and forage varieties at the Nyagatare research station were planted on 5ha. The drought tolerant varieties generally performed slightly better than on-farm plots but had not gown to harvest stage after the 2 growing seasons a and b (2015/16) as can be seen in Figure 8 photos.

Figure 8 In-station climate-resilient forage variety trials at the RAB research station in Nyagatare district, 22 July 2016

Farmers generally are of the perception that the forage variety trials were planted too late, almost 2 months into the growing season 2015a (Sep-Dec). The responsible officials of RAB mentioned that funding for the trails arrived to them late, when the growing season had already started, which interfered with the success of the trials.

Although some farmers blamed the poor performance of the varieties on mistiming in planting and on unsuitable grass seeds, some of them could already see desirable drought tolerance qualities as displayed by the *Pennisetum* and *Brachialia* species at COPECA and KOTUA cooperatives trials in Figure 6 and Figure 7 respectively. It would indeed be expected that trials in the higher rainfall Southern Province districts of Kamonyi and Ruhango would perform better than those in the drier Eastern Province. The Kamonyi and Ruhango trials showed a noticeable tolerance, with a fresh greenness at the peak of the dry season in mid July.

Nevertheless farmers generally expressed that they are willing and ready to try the forage varieties again and hoped to see the trials take root and thrive in the coming rainy season. It would, however, seem that questions remain around the suitability of the identified forage varieties as well as the appropriateness of the farm-level trial approach.

Climate-smart infrastructure

Intermediate results for climate-smart infrastructure

Suitability of support and beneficiary participation

PASP planned and implemented a progressive investment support facility through the Post-Harvest Climate-resilient Agribusiness (PHCRAB) funding mechanism. Guidelines for administering the grant were designed and operationalized with the basic framework of defining characteristics of loan classes for existing or start-up cooperatives as "small" for loan sizes up to USD 40,000; "medium" up to USD 100,000 and "large" up to USD 200,000. A partial loan settlement of between 30% and 40% of the borrowed amount is settled by the PHCRAB grant depending on whether the business is existing or a start-up, and on whether the climate risk reduction classification is moderate or notable. The borrowing cooperative pays the balance to the lending financial institution.

At the time of this assessment study, a "small" grant had been disbursed to the KOPABOKI cooperative in Kamonyi district and a "large" grant to Pasta Rwanda, a pasta processing unit in Muhanga district. A "medium" and a "large" grant were approved for Nyagatare and Kayonza districts respectively. However, only KOPABOKI had fully utilized the grant for the construction of a warehouse. The assessment team visited KOPABOKI cooperative on 12th July 2016 to (Figure 10) obtain their perspectives on the effectiveness of the grant facility.

Figure 9 KOPABOKI cooperative, Kamonyi district: PHCRAB grant warehouse with rainwater harvesting and solar power, 12th July 2016

KOPABOKI cooperative grows maize on 7 ha. It has a membership of 81 women and 26 men. The female majority membership of the cooperative is also reflected in the management committee that made up of 6 women including the chairperson, and one man.

Having received PASP training and Business Plan development assistances from a service provider, KOPABOKI successfully received a bank loan. The cooperative obtained a loan amount from the collaborating bank of RWF 8,357,000 with the eligibility for a 40%

PHCRAB matching grant of RWF 3,343,000. However, the cooperative requested an amount above the matching grant of RWF 3,980,300. PASP approved an amount just below the matching grant of RWF 3,187,900. KOPABOKI committee members expressed misgivings due to the fact that the back charged them interest on the full amount of the loan, despite the grant amount having been paid against the loan. This concern was also raised by other cooperative committees during Focus Group Discussions.

KOPABOKI cooperative committee members expressed appreciation for the PHCRAB facility, mentioning among the significant benefits reduction of post-harvest losses in maize and beans, having offices and meeting rooms, lighting and power for electronic equipment from the solar installations and water from rainwater harvesting. The grant was used in the purchase of rainwater tanks, solar power system, dying tarpaulins and hermetic bags.

The second beneficiary that had received the PHCRAB grant by the time if this assessment study is Pasta Rwanda, which is a cooperative of 764 members located in Muhanga district that is building a processing unit for pasta with a capacity of 5 tons per day. A grant amount of RWF 50,126,100 was approved and disbursed as appropriate for the climate-smart aspects including biogas digesters, solar power and rainwater. The plant will use maize for 70% of the flour requirement. Construction of the processing plant only recently started with building structures up and roofed and underground biogas digesters pits as well as rainwater storage tanks preparation.

Out of 15 business plans submitted by cooperatives and individuals for PHCRAB, including 8 grants worth almost 170 million Rwandan Francs (USD 211,000), only 5 business plans worth just under12 million Rwandan Francs (USD 14,763) had been approved and entered into contract processing procedures. Appendix 2 provides an overview of the PHCRAB implementation status provided by PASP-ASAP staff. There is recognition in PASP-ASAP that the implementation of the PHCRAB facility is not optimal in terms of the rate of intended beneficiation. Cooperative committees also raised the concerns on the slow pace of accessing the grant during FGDs.

It came through during the discussions that the Business Planning process was slow because it was too technical and too bureaucratic in design and was resulting in “procedure fatigue” on the part of cooperative applicants. Perspectives also indicated that service providers that provided technical business development tended to work by themselves with minimum input from beneficiary representatives, only bringing a Business Plan and PHCRAB proposal for the committees to adopt and submit to the bank for loans. The issue has been investigated with a team from IFAD that has made remedial recommendations. Furthermore PASP-ASAP staff indicated that the PHCRAB financing mechanism was a new approach in Rwanda and that all players went through the necessary learning experience. They expressed optimism that

a lot had been learned by all players and that, going forward, the experience gained would help remove bottlenecks and reduce bureaucracy to provide faster access to PHCRAB grants.

Demonstration and promotion of climate-smart post-harvest infrastructure

According to Bendito and Twomlow (2015), IFAD estimated post-harvest losses in Rwanda at 30%. In their evaluation, almost all rural post-harvest and storage infrastructure in Rwanda did not comply with the basic guidelines for climate resilience, demonstrating high vulnerability in the face of imminent effects of climate change. One of the critical causes of post-harvest losses that PASP interventions address is lack of, or inappropriate, post-harvest handling infrastructure and storage. IFAD supported Rwanda's Ministry of Agriculture and Animal Resources (MINAGRI) to address this critical problem through PASP-ASAP.

Key interventions involve the development of climate-smart building standards for rural post-harvest warehouses and drying hangars (Appendix 3). Pilot demonstrations included climate-resilient warehouses and drying hangars in the drought prone Eastern Province, constructed according to standardized climate-resilient guidelines.

The PASP 2016 working document reports that 6 climate-resilient pilot demonstration drying hangars at the cost of 48.2 million Rwandan Francs each and 4 climate-resilient warehouses at 92 million Rwandan Francs each were built in partnership with cooperatives in a partnership arrangement under which ASAP provided 40% of the cost of each unit, government 40% and farmers' cooperatives 20%. Contributions of cooperatives were mainly in kind, such as building plots and labour during construction.

Table 10 Climate-resilient post-harvest facilities by type and district as observed during fieldwork, July 2016.

Cooperative	District	Climate resilient post-harvest facility	
COOPAMA	Nyagatare	Warehouse	
KOAMA	Gatsibo	Warehouse	Drying hangar
Twitezimbire	Kayonza		Drying hangar
KOREMU	Ngoma	Warehouse	Drying hangar
COPAMUJA	Ngoma	Warehouse	Drying hangar
COAIGA	Kirehe	Warehouse	Drying hangar

During field work in the Eastern Province, warehouses and hangars constructed according to PASP-ASAP developed climate-resilient guidelines as specified in Table 10 were observed and documented. Compliant warehouses and drying hangars were constructed in partnership arrangements with cooperatives selected according to a geographic representation strategy for piloting and demonstration in Cooperatives KOAMA (Gatsibo district), KOREMU and COPAMUJA (Ngoma district) and COAIGA (Kirehe district). COOPAMA (Nyagatare district) was beneficiary to a compliant warehouse only from the pilot demonstration activities, while Cooperative Twitezimbere (Kayonza district) was only beneficiary to a compliant drying hangar.

Features of the standardized climate-resilient infrastructures as captured during field visits are displayed in Figures 11 and 12.

Figure 10 Features of demo drying hangars and warehouses built in the Eastern Province according climate-resilient guidelines developed by PASP-ASAP. Photos were taken during field work between 12th and 22 July 2016.

Pilot warehouses displayed uniformity in compliance to the minimum requirements of design, construction and materials used according to the specified quantitative building measures and structural element dimensions for each facility. Warehouses and hangars featured standardised features designed to withstand climate-change-related extreme weather hazards. These features included structure height, width, slope and pitch of the roof, distance between each column and roofing truss, width of roof overhang, thickness of floor slab and rainwater management systems. The facilities included metal tube and mess sun-drying tables.

Use of metallic materials burnt bricks and concrete eliminated the wood-eating termite risk. Locations of the warehouses and hangars seemed well considered with respect to flood risk, contaminant seepage and industrial sources of pollution. All warehouses had adequate floor loading capacity and height as well as space for trucks to park and turn.

Functional considerations for storage included the roof cyclofan turbines and side wall so-called N-vents for convective internal humidity control. Operational considerations included photo-voltaic solar installations both in warehouses and drying hangers mainly for lighting and phone charging. All warehouses were fitted with rainwater harvesting system installations for drinking, basic crop processing and cleaning of the storage floor. All structures had

portable fire extinguishers. Photos in Figure 12 display some of the climate resilience functional features of the infrastructures.

Figure 11 Functional features installed in demonstration warehouses and drying hangars; Field photos taken 12-22 July 2016.

FGDs with cooperative leaders indicated that pilot climate resilience warehouses and drying hangars were completed fairly recently and had not yet been fully used in post-harvest operations. It was indicated that some of the infrastructures were awaiting official inauguration officiated by the Ministry of Agriculture. It was noted that although the warehouse constructed from the PHCRAB grant (KOPABOKI cooperative, Kamonyi district) had climate-smart features, it did not fully comply with the PASP-ASAP recommended guideline specifications in Appendix 3) as the guidelines had not yet available.

Cooperative leaders generally expressed enthusiasm towards the new infrastructure indeed expecting significantly reduced losses in post-harvest handling. However, they also expressed discontent regarding their role in the conceptualization and implementation of the pilot infrastructure during FGDs. Cooperative leaders indicated that they felt left out of the key processes of conceptualization, planning and implementation of infrastructure.

Demonstration and promotion of climate-smart post-harvest materials

Climate-smart post-harvest technologies and infrastructure appropriate for Rwanda's environmental, climate change and socio-economic circumstances were identified for demonstration and promotion, including hermetically sealed grain storage bags, multi-purpose tarpaulins, silage bags, perforated packaging crates, net bags, solar bubble dryers and rainwater harvesting.

The PASP-ASAP working document 2016 reported that 100,500 hermetic bags and 9,848 tarpaulins (plastic sheets) for distribution among cooperative members to promote proper drying and loss minimization from pests. 10,500 hermetic bags had been distributed within the 12 intervention districts whereas 1,140 tarpaulins given to farmers' cooperatives.

Figure 12 A young boy proudly demonstrates the use a manual shelling device onto a promotional PASP-ASAP tarpaulin provided to his household that is a member of the KOPABOKI cooperative in Nyarubaka, Kamonyi district 28 Jul 2016.

Farmers indicated a high level of appreciation and enthusiasm as in Figure 13 photos, for the climate-resilient materials in reducing post-harvest losses. However, they expressed need for adequate numbers of hermetic bags and multi-purpose tarpaulins to match harvest volumes and seemed to look up to PASP to "donate" more materials and to "supply" them in good time for harvest. Farmers seemed to have misunderstood or do not have an adequate understanding of the PASP-ASAP to "promote" the use of climate-resilient harvest and post-harvest material as an adaptation strategy. However, some cooperative leaders seemed to grasp the demonstration and promotion approach and were looking to PASP-ASAP to facilitate affordable and long-term suppliers of the materials.

Conclusion and recommendations

This assessment covered results with respect to accessibility, quality and use of weather and climate advisory information services among the target groups in intervention districts for PASP-ASAP investment. The assessment also covered the effectiveness of participatory trials for climate-resilient priority crops and forage and that of climate-smart infrastructure pilots as a result of PASP-ASAP investments. Observations of activities on the ground and implementation approaches were documented from which conclusions were developed and recommendations made regarding intermediate results of each intervention.

Climate information services

Under the collaborative MoU, Meteo Rwanda is enhancing its capacity to collect adequate and appropriate data through instrument calibration and maintenance activities. The agency has also carried out micro-climate analyses and is collaborating with the Rwanda Climate

Services for Agriculture project to address the local variability. The Rwanda Agricultural Board is undertaking modelling for agro-ecologic based crop performance estimates, all necessary to transform weather data into agro-climatic advisory information products for farmers' decision making.

However, although Meteo Rwanda in collaboration with the Rwanda Climate Services for Agriculture project is producing web-based agro-climatic information that may be used institutional and technical level decision-making, the information has not yet been re-packaged for rural farmer usability. PASP-ASAP will establish a notice board system at HUB level to improve accessibility of weather and climate advisory information. PASP-ASAP in collaboration with Meteo Rwanda already disseminates climate advisory information related to the start and outlook of growing seasons and obtains feedback from farmers. The planned central weather information call center to be based at the Agricultural Information Communication Centre will provide climate advisories that include both harvest and post-harvest information, as requested by farmers.

The lack of an established mechanism for the coordination of activities for the transformation of weather data into agro-climatic advisory information and in the dissemination and feedback management was noted with concern. There is an urgent need for a more formal platform for the coordination of the active institutions involved in the production, dissemination and feedback management of climate information services. Operational roles and responsibilities for the production, packaging, dissemination and feedback management need to be defined or clarified. Personal communication with the coordinator of the Rwanda Climate Services for Agriculture project indicated that the project intends to facilitate the establishment of a government structure for coordination of climate services. It is recommended that the establishment of such a coordination mechanism be expedited in order to avoid duplication of effort and ensure greater efficiency to achieve the intended impact.

Climate-smart crop and forage trials

A common participatory approach was taken by RAB in facilitating on-farm trials of new climate-resilient varieties of maize and potato crops as well as forage varieties. Different levels of success were achieved for crops and forage varieties. For crops, farmers carried out entire operation sequences from land preparation, planting, fertility management, through to weeding and crop protection, on their own plots. It was observed from field visits that trialled varieties were suitable for farmers' management practices and environmental conditions as there were good yields. A sense of ownership of results from the trials was inferred from interviews with the cooperative focus groups and with individual growers of new maize and potato varieties.

By contrast, climate-resilient forage variety trials did not thrive. Widespread failure or slow development was observed among trials. Focus groups and individual farmer interviews attributed the dismal performance of the forage variety trials to late planting, although there was mention of having received unsuitable variety seeds. The responsible RAB official confirmed supplying seed and seedlings late when the 2016a season was midway due to delays in obtaining funding resources from PASP-ASAP. Also, station trials seemed to be carried out in parallel with on-farm trials. Forage varieties had not yet passed in-station requirements. The lesson to be learnt is that the failures that may happen when there are administrative and procedural irregularities need not halt progress altogether. PASP-ASAP technical staff indicated that climate-resilient forage trials will continue with due consideration of the identified gaps.

PHCRAB grant financing mechanism

It was demonstrated that a relatively small grant can make a huge difference in post-harvest capability of a farmer's organization. Although quantitative improvements had not yet been realized with respect to reduction in post-harvest losses, as the construction of the climate-smart infrastructure had only recently been completed for the sole cooperative that received and utilized the grant, a fundamental capability shift was visibly apparent and farmer morale was high.

However, PHCRAB grant processes were not functioning optimally. Farmers indicated misgivings of the approach with respect to technical support provided by service providers in business plan preparation. Farmer misgivings were also expressed regarding bank interest charges on the grant. It is recommended that the approach be re-evaluated for fundamental changes. The lesson to be learned is to recognize that the PHCRAB concept is good, given the result obtained with the cooperative KOBOKI, but the access procedures are too bureaucratic to achieve the intended impact.

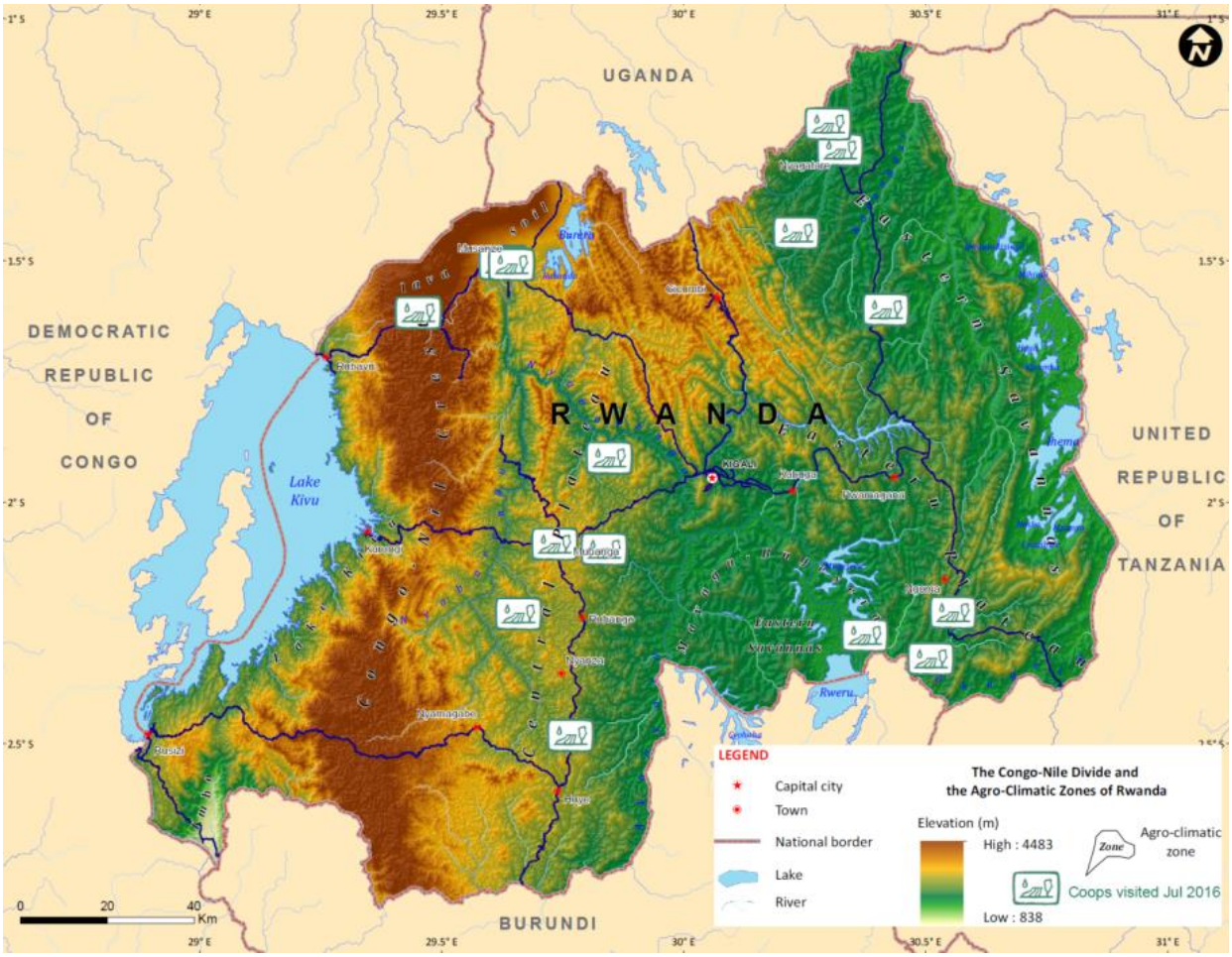
Climate-smart rural infrastructures and materials

The assessment noted the remarkably high quality and uniformity of the newly constructed climate-smart warehouses and drying hangars. High morale among cooperative leaders when showing the field team around the new facilities was palpable as they explained the anticipated benefits in post-harvest handling and profits. These successful pilots could be up-scaled to have at least one similar demonstration at the administrative sector level depending on the availability of funding support within the PASP-ASAP, Government and Cooperative arrangements. These would serve as standard reference for farmers' cooperatives, Savings and Credit Co-operatives and commercial lenders, plus improve efficiency in the PHCRAB and other future support arrangements.

However, issues were noted during FGDs that could have a bearing on the credibility on the part of PASP-ASAP due to misinterpretations of pilot demonstration and promotion intervention activities. Farmers perceive ownership of infrastructure pilots and expect to be in charge of all related activities including construction. It is possible that confusion may have arisen from that fact that construction was contracted to third-party contractors. Clearly, due to public and development partner procurement requirements, construction of the infrastructure would have to be done through a tender process in which the *de jure* owners, the cooperative members, feel lack of control.

Similarly, recipients of promotional climate-smart post-harvest materials tend to misunderstand the approach and develop an expectation or entitlement to assistance. PASP-ASAP has recruited technical service providers to assist and train cooperative farmers on different issues according to identified capacity gaps. The untested hypothesis is that the capacity development programmes eventually lead to a change in mindset among beneficiary farmers towards self-motivated adaption attitudes and practices.

Appendix 1: ASAP intermediate results assessment sites



Appendix 2: Implementation status of the PHCRAB finance mechanism

Promotor	District	Grant Purpose	No. of Members	Amount (RWF)	Grant Status
PASTA Rwanda	Muhanga	Processing Unit	764	50,126,100	Disbursed in 2015
F. Kadugara	Kayonza	Warehouse	-	47,765,305	Disbursed in 2015
CODPECUM	Nyagatare	Warehouse	79	18,593,000	Disbursed in 2015
KOPABOKI	Kamonyi	Warehouse	107	3,187,900	Disbursed in 2015
					Subtotal – Disbursed in 2015: RWF 119,672,305
COAPAI	Musanze	Potato storage	15	3,989,470	On hold
KOPABAMU	Kamonyi	Warehouse rehab	45	760,000	Disbursed in 2016
Impabaruta	Kamonyi	Warehouse rehab	784	1,788,000	Disbursed in 2016
J. Mahungiro	Kayonza	Maize milling equipment	-	1,347,400	Disbursed in 2016
J. Zigira	Nyabihu	Diary processing factory	-	45,530,000	Disbursed in 2016
					Subtotal – Disbursed in 2016: RWF 49,425,400
KOPABU	Kamonyi	Warehouse rehab	-	1,068,200	Approved pending signature
KOPASONYA	Kamonyi	Warehouse	-	1,068,200	Approved pending signature
Kwizera	-	-	-	3,257,250	Approved pending signature
Rwemera	-	-	-	6,097,470	Approved pending signature
					Subtotal – Approved pending signature: RWF 11,811,120
					Total: RWF 184,898,295

Appendix 3: ASAP guidelines for climate-smart warehouses and drying hangars

Warehouse space specifications:

- Storage area of 20 x 15 x 6 m
- Office room of 5x5x3m
- Chemical Store of 5x10x6m
- Modern toilets
- 5-truck parking space
- Green area as appropriate
- 2 Verandas for weighing, loading
- Galvanized wire security fence with gate

Climate-smart installations:

- Roof cyclofan ventilation turbines
- Two 5,000l with taps; overflow soakaway
- Solar PV installation with inverter

Construction materials:

- Good quality burnt brick
- Reinforced concrete for columns and beams
- Concrete for pavement
- Steel trusses, metallic tubes
- Birmingham Gauge 28 metallic roof sheets
- Metallic windows and sliding doors
- Weather guard painting
- BRC roof protective mesh

Drying Hanger space specifications:

- Drying ground area: 25x5m (or 12.5x10m);
- Shed: 20x10x4.5m;
- Drying mesh: $12m^2$ (with 60x40x2mm steel logs); 40x40x1.5mm cross members; coffee mesh;
- 4x10m equipment store/temporary grain store;
- Modern toilets (2 seat units & urinals);
- Retainer wall as appropriate;

Climate-smart installations:

- Two 5,000l rainwater tanks; overflow soakaway;
- Solar PV installation with inverter;

Construction materials:

- Birmingham Gauge 28 metal sheets for roof & sides ;
- 60x40x2mm metallic tube columns; 25x25x3mm T-metal crossing members hanging maize cobs;
- 10cm-thick concrete pavement on 15cm-thick hard core;
- 60x40x1.5mm steel trusses, metallic tubes for roofing

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