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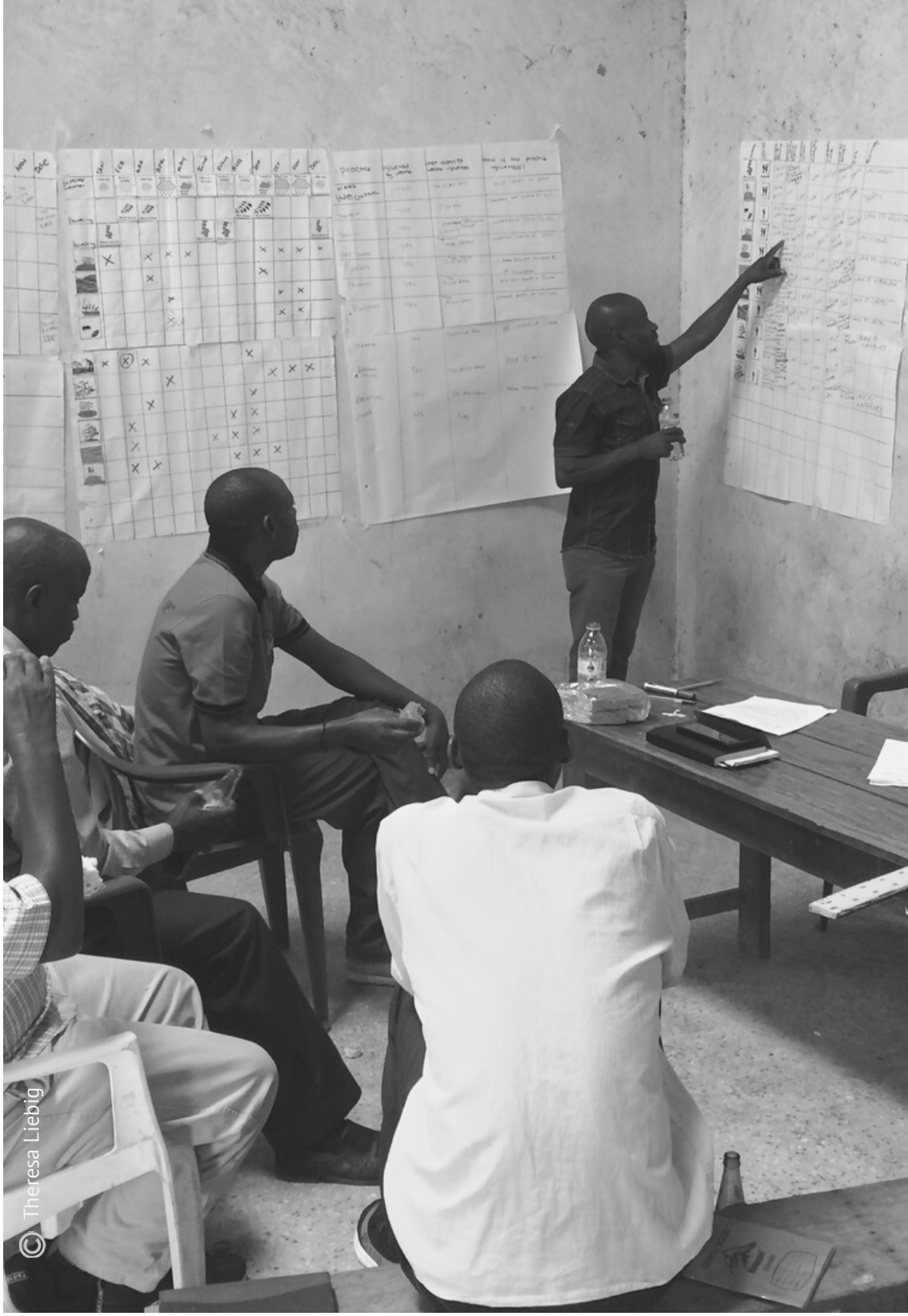
PREPARED BY THERESA
LIEBIG & CHRISTIAN BUNN



WORKSHOP REPORT

EVALUATING NEEDS FOR APPLYING CLIMATE SMART PRACTICES AND CLIMATE SERVICES FOR ORGANIC ROBUSTA COFFEE SYSTEMS IN BUSHENYI, UGANDA

NOV 2019

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PRODUCERS DIRECT

Producers Direct is an organisation that is owned and led by smallholder farmers. Since 2009, they have been working to pioneer a new model – one centred on smallholders taking leadership and developing innovative solutions to the challenges they face and provide an opportunity for smallholders to transform their farms into sustainable businesses. Key aspects of this model are farmer leadership and expertise to design and delivery of all activities, peer-to-peer services delivered in a mix of in-person and digital support to increase the rates of adoption and maximise impact, development of a global network of self-sustaining, revenue generating businesses led by cooperative partner organisations, and leveraging of investment in farmer-led programming through co-financing and payments from smallholder farmers.

CIAT

The International Center for Tropical Agriculture (CIAT) – a CGIAR Research Center – develops technologies, innovative methods, and new knowledge that better enable farmers, especially smallholders, to make agriculture eco-efficient – that is, competitive and profitable as well as sustainable and resilient. Eco-efficient agriculture reduces hunger and poverty, improves human nutrition, and offers solutions to environmental degradation and climate change in the tropics. Headquartered near Cali, Colombia, CIAT conducts research for development in tropical regions of Latin America, Africa, and Asia.

ACPCU

We Value Excellence

Ankole Coffee Producers' Co-operative Union (ACPCU), a fair trade organic specialty coffee cooperative union, was the implementing partner for this project. Established in 2006 and with 8,200 members from diverse, multi-ethnic communities, they aim at working together as progressive, forward-thinking farmers to market their coffee and to improve livelihoods across the mountains of South-Western Uganda.

ABBREVIATIONS

ACPCU - Ankole Coffee Producers' Co-operative Union
BCTB - Black Coffee Twig Borer
CWD - Coffee Wilt Disease
CIAT - Centro Internacional de Agricultura Tropical
IITA - International Institute for Tropical Agriculture
GAP - Good Agricultural Practices
PICSA - Participatory Integrated Climate Services for Agriculture
AF - Average Farmer
PF - Resource poor Farmer
CF - Commercial Farmer
PaD - Pests and Diseases

WHAT THIS REPORT IS ABOUT

This report presents results of a follow-up activity within the project entitled "Household resource- and site-specific adaptation options for Robusta coffee in Bushenyi, Uganda". During the first project phase, CIAT intended to develop portfolios to address specific climate related on-farm challenges that are resource-specific and impact specific adaptation options. A modification of the PICSA method (Participatory Integrated Climate Services for Agriculture) was used. PICSA is a structured workshop process for evaluating current farming and livelihood opportunities in light of historic climate risk, for identifying promising alternatives, and for adjusting management when seasonal forecasts shift relevant risks sufficiently. Through the PICSA approach, agricultural extension staff, development NGOs and other intermediaries can be trained to integrate climate services into their ongoing work. The following is an adapted approach for coffee farmers.

This first iteration of the practices prioritisation was conducted with lead farmers of ACPCU under leadership of IITA. The workshop format elicited typical cropping activities during the year, discussed potential additional activities and linked them to perceived climate risks throughout the year. Additionally, basic costs of implementation and barriers to uptake were reported.

The overall objective of the follow-up activity described in the current report was to validate workshop results and portfolios of adaptation options developed in phase 1 by repeating the PICSA workshop with local farmers from different districts where ACPCU is operating. Specific objectives are to:

- Establish a cropping calendar for a typical coffee growing cycle to evaluate which GAPs are implemented by farmers in the region and when
- Explore farmers' perception and knowledge on how GAPs are related to the state of the season
- Understand how farmers perceive changes in climate and its impact on weather and phenological seasons
- Evaluate farmers' perception and knowledge on GAP benefits under normal and extreme climatic conditions, as well as risks and constraints for implementing them.

Ultimately, the purpose is to identify which practices require interventions and incentives, and if/how climate services could be beneficial.

INFO AROUND THE WORKSHOPS

WHEN, WHERE, WHO

Three workshops were conducted on the 8th and 9th of October 2019 in Mitooma (Nyahkahita PC), Sheema (Kyangundu PC) and Bushenyi (Nyibingo PC) district. Each workshop was attended by 10-15 farmers representing resource poor (RF), average (AF) and commercial farmers (CF). Invited farmers were invited based on selection criteria (land under coffee, number of coffee bushes, production volume of the past season) relevant for the above mentioned typologies. These data were provided by the respective primary cooperative where the workshops took place, and verified by participants when signing attendance. Trained ACPCU extension officers and a research consultant facilitated the exercises of the workshop.

HOW

Three steps of the PICSA protocol were adapted and applied to the purposes of this study. Within each workshop, the following exercises were done separately for each of the three farmer groups (RF, AF, CF).

Step A - What does the farmer currently do?
Objective: Understand the coffee cropping calendar, i.e. identify main activities and their timing currently undertaken by farmers, and how climate and weather affects those activities.
Procedure: Prepared worksheet for a seasonal calendar and item cards for seasons and management practices were presented to farmers. Cards for expected rainy/dry seasons, phenological stages of coffee, i.e. flowering and harvesting periods, as well as for applied management practices were placed on respective months according to group discussions. Farmers then indicated on a second worksheet whether and how (timing and success) GAPs are affected by different weather aspects.

Step B – Is the climate changing? Farmers' perceptions and historical records
Objective: Get an understanding of farmers' perceptions on how the climate is changing and how it varies.
Procedure: Referring back to the expected seasonal distribution of climate from step A, farmers indicated perceived changes for expected weather seasons (compared to 20/30 years back) and for expected phenological seasons. Furthermore, extreme events were discussed, and the year, season and severity of the event recorded.

Step C - What are the options for the farmer?
Objective: Farmers should be aware of which management options are open to them.
Procedure: For each GAP discussed in previous steps, as well as those who were not applied by farmers, benefits (under normal and extreme weather events), investments (time, labor, money), risks and constraints were discussed and recorded.

WORKSHOP RESULTS

The following sections give a brief description of the purpose of each workshop step and a summary of the results. The detailed and adapted PICSA protocol as well as all relevant documentation, meta, raw and processed data of the workshop can be accessed via the shared google drive folder "CIAT_PICSA"). All exercises focused on field management and post-harvest practices for established robusta coffee farms.

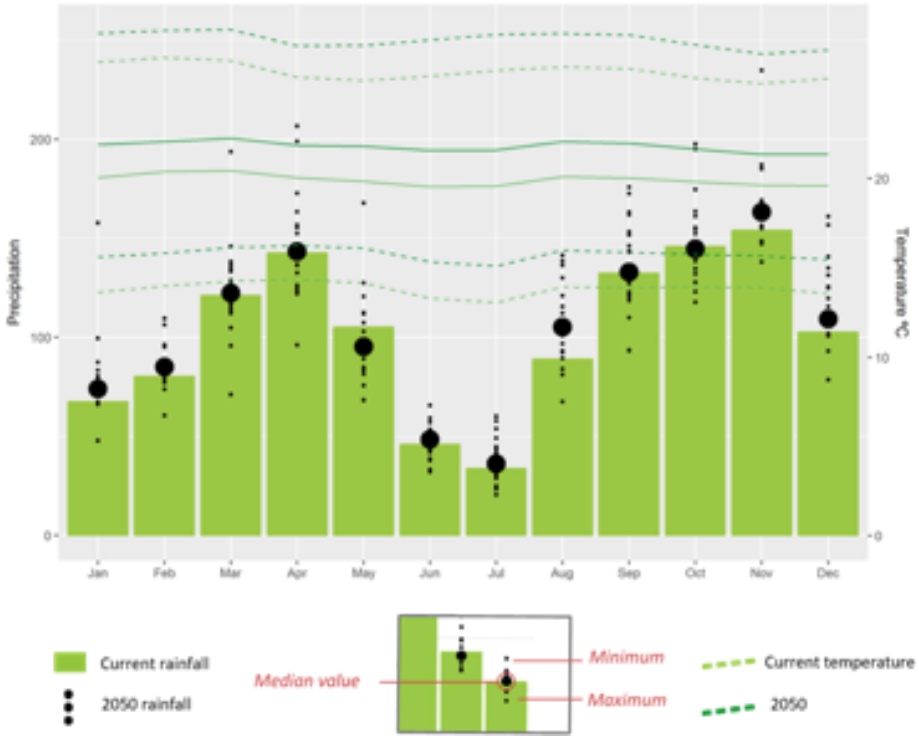
STEP A - WHAT DOES THE FARMER CURRENTLY DO?

Objective: Understand the coffee cropping calendar, i.e. identify main activities and their timing currently undertaken by farmers, and how climate and weather affects those activities.

Weather seasons

According to farmers, the main dry season in the districts Bushenyi, Sheema and Mitooma is between June/July - August, and the main rainy season between September and November. The months from December - February receive little rainfall and moderate sunshine, and hence refers to the minor dry season, while the minor rainy season was assigned to March - May. Information obtained by farmers correspond well to current climate patterns described for the region (Fig. 1).

Fig. 1 Climate diagram of Bushenyi region



Phenological seasons

In accordance with the weather seasons (one pronounced and one less pronounced dry and rainy season), farmers report each two flowering and harvesting periods. The main flowering period (June/July - September) usually happens at the end of the main dry season (around July/August), when the first rains break the dry spell. Minor and irregular flowering is observed in most of the districts between December and March. Most groups reported the main harvest season to occur between April and August, and a minor, less pronounced harvest season between November and January. Farmers' responses on flowering and harvesting periods agree with these of reports for this region (2,3).

GAPs

Farmers apply most of the pre- and post-harvest GAPs recommended for Robusta coffee in Uganda, and there was no evident difference between respondents from different farmer typologies nor districts. The timing and frequency of implementing the GAPs slightly varied from group to group. A lower frequency of applied practices was observed between districts (lower frequencies in Bushenyi), and within the district of Mitooma (lower frequency in the PF group) (Tab. 1 and Annex 1).

Farmer reported that most of the practices (8 out of 12) are influenced by weather. Only for pruning, stumping, storing and mulching, between 50-63 % of the responses were negative (i.e. the practice is not influenced by weather). Table 2 shows GAP influencing weather aspects according to farmer responses and literature.

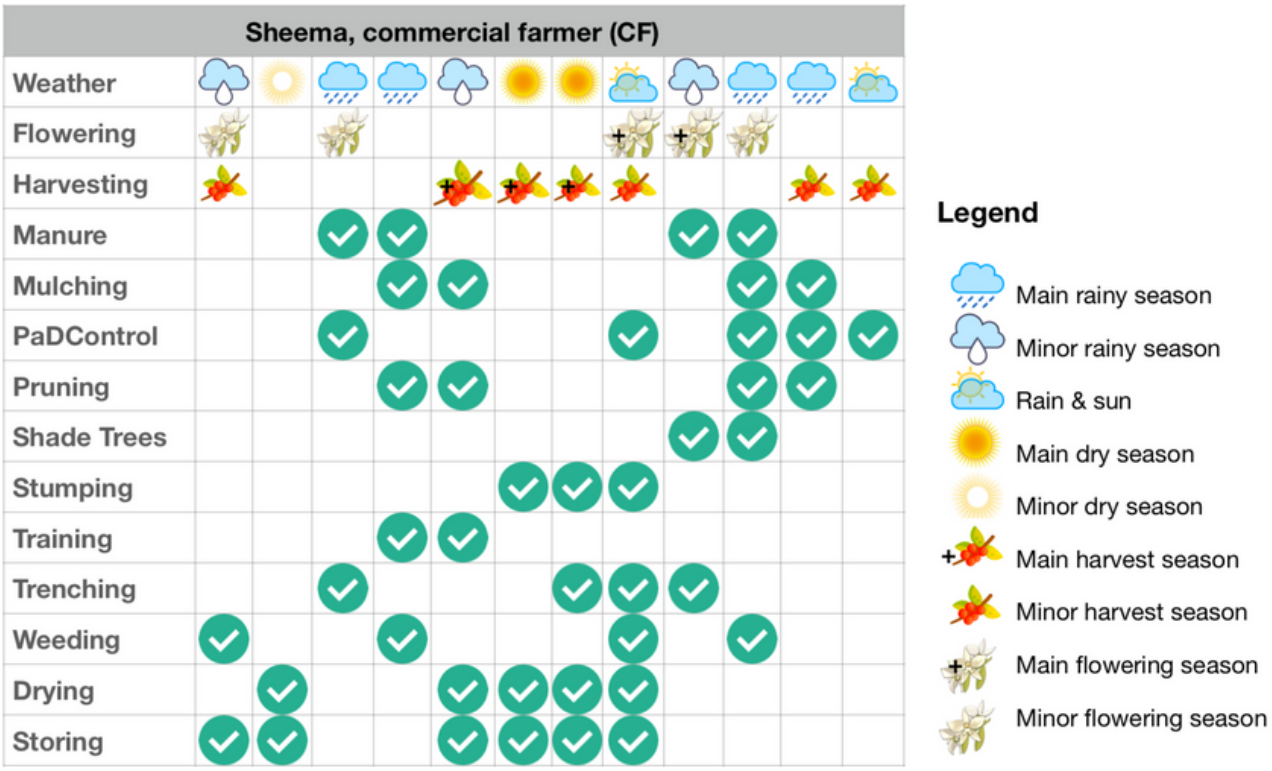


Fig. 2 Example for cropping calenadar

Table 1 Reported and recommended frequency and timing of GAPs

GAP	Frequency and timing of GAP reported by farmers	Recommended frequency and timing of GAP
Manure	Twice a year with the beginning or during the rainy seasons.	Once a year at the beginning of the rains. [5]
Mulching	Once or twice a year with the beginning or during the rainy seasons.	Once a year at the beginning of the rains. [5]
PaD control[1]	Varying throughout the year depending on emergence.	No recommendation on frequency and timing of cultural control measures available. General recommendations for both, BCTB and CWD: Regular inspection throughout the season and immediate removal when BCTB/CWD detected [7]
Pruning[2]	Either twice a year with the beginning or during the rainy seasons (i.e. after harvest seasons), or throughout the year whenever needed.	At the end of the main harvest season. [7] Suckers to be removed throughout the year [8]
Shade trees[3]	Mainly once or twice a year with the beginning or during the rainy seasons.	Shade tree pruning at the beginning of the rainy season. [7]
Stumping	Once a year, mostly around July/August, i.e. end of main dry season	One month before the rainy season. [8]
Training[4]	No clearly reported frequency and timing.	September/ October or April/May, depending on planting time. Young coffee bushes are trained 5-6 months after planting. Planting is done at the beginning of the rainy seasons, i.e. March and September. [7]
Trenching or terracing	Once or twice a year with varying timing, sometimes during the main or minor rainy season, other times during the main or minor dry season.	Beginning of rainy season or minor rainy season for establishment of new trenches/ terraces. Dry season for trench/terrace management (removal of sediment soil)[5]
Drying	During dry and minor rainy seasons (during / after the harvest seasons)	After each picking during each harvesting period, i.e. November - January for the fly crop, and April - July for the main crop) [7]
Storing	During the dry and minor rainy seasons (after drying)	15-30 days after drying. Storing, selling or processing dried coffee ("Kiboko") requires a moisture content of 13-14% or less. [7]

1 PaD control refers to the main PaD reported, i.e. BCTB and CWD.
2 Pruning included both, removal of unproductive branches and de-suckering
3 Shade trees referred to planting and management of shade trees
4 Training / bending is typically part of the practices for coffee field establishment, however since farmers replace old trees with young plants, training is also a relevant practice for established coffee fields.
5 Personal communication with field extension officers from ACPCU.
6 Uganda Training Materials for Coffee Production
7 Robusta coffee handbook
8 Wintgens, Jean Nicolas. Coffee: growing, processing, sustainable production. A guidebook for growers, processors, traders, and . esearchers. WILEY-VCH Verlag GmbH & Co. KGaA, 2004.

Table 2 Weather aspects influencing GAPs according to farmer responses and literature.

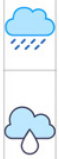
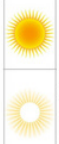
GAP	Influencing weather aspect	Influence of weather on GAPs according to farmers and literature
Drying		Heavy rainfalls is perceived as the most influencing weather aspect for drying. Insufficient drying leads to poor coffee quality. *Properly drying coffee to the required moisture content of 13-14% is indeed very much dependent on the weather. Wet conditions prolong the process and increase the risk of moulds, including aflatoxin-producing fungi. (7)*
Harvesting		Heavy as well as sporadic rainfalls, delaying and interrupting the harvesting process are mentioned as the most influencing weather aspect. *Sporadic rainfalls have an indirect effect on harvest via its effect on irregular flowering. It makes harvesting uneven, more costly to farmers and difficult for obtaining good coffee quality (7)*
Shade Trees		Both, rainfall and drought are influencing shade tree planting. Rainfall favours planting and increases growth, while extreme drought delays planting. *Rainfall does favour the growth of shade trees, however this also means that proper pruning is necessary to allow for sufficient ventilation and sunlight in the field. (7)*
Weeding		Mainly heavy and prolonged rains promote weed growth (e.g. *Oxalis app*), but drought was also mentioned to favour specific weed species (e.g. *Bidens pilosa*). Both result in an increased workload for weeding. *Weeds are generally promoted by rainfall. Since they compete with coffee for water and nutrients, weeding should also be carried out at the end of rainy seasons to decrease the competition for the diminishing moisture. (7)*
Manure		Heavy rainfall, but also insufficient rainfall and extreme drought influence manure application. Heavy rainfalls wash away nutrients, and drought prevents nutrients to dissolve in the soil, hence both reduce the manuring effect. Insufficient rainfall delays the timing of manure application. *Manure has to be applied at the beginning of the rainy season (8) so that the humidity dependent decomposition process has enough time to make nutrients available. Insufficient rainfall or a delayed start of the rainy season indeed delays the timing of manure application.*
PaD control		Both, rainfall and drought are promoting PaDs, more specifically, BCTB and CWD. Both weather aspects increase the emergence and intensity of PaD, hence resulting in more work load for control measures. *Drought has been observed to increase CWD severity (8), however its transmission is suggested to be dependent on rain (9). BCTB is present throughout the year (10). Information of seasonal BCTB fluctuations related to weather is not available for Uganda.*
Trenching		Both, heavy rainfall and drought influence the trenches/terraces. Rain might ease the construction of trenches, but heavy rains can destroy them and hence increase the workload for reconstruction. Drought makes the soil hard and therefore hampers the construction of trenches.
Training		Extreme and prolonged drought increases the risk of breaking and failure of shooting *Drought would hamper the purpose of training since vegetative growth is always water dependant. Bending the coffee bushes during a dry spell would indeed increase the risk for physical damage.*
Mulching		Both, heavy rainfall and extreme drought influence mulching. Heavy rains might wash away mulching materials and makes its transport more difficult. Extreme drought delays the application *Mulch should be applied at the beginning of the main rainy season to suppress weed growth and conserve soil water, hence drought indeed delays its application.*
Storing		Rain and humidity can disturb storing due to the risk of moulds.
Stumping		Both, heavy rainfall and drought might negatively affect the success of shooting.
Pruning		Heavy rains promote vegetative growth, resulting in an increased workload for removal of excessive branches and suckers.

STEP B – IS THE CLIMATE CHANGING? FARMERS' PERCEPTIONS AND HISTORICAL RECORDS

Objective: Get an understanding of farmers' perceptions on how the climate is changing and how it varies.

Farmers' perception on how climatic and phenological seasons have changed over the past 20-40 years are summarised in Table 3. Again here, there was no difference between responses of RP, AF and CF. Farmers perceive less rain during the rainy seasons, and more rain during the dry seasons. This perception does not agree with projected climate trends of the region. According to projections, Southwestern Uganda has indeed experienced statistically significant changes in precipitation, however in an opposite trend of what farmers perceived:

Table 3 Perceived climatic and phenological changes over the past years

Season		Change in season perceived by farmers
Main and minor rainy season		In all three districts, less rain at the beginning of the rainy seasons (March and September) is reported. Furthermore, farmers in Mitooma perceived rains to extent to December, while in Sheema a delay of the start of rains from August to September was noticed.
Main and minor dry season		More rainfall and humidity during both dry seasons was reported in all districts. In Sheema, the dry season was perceived to start earlier than usual (mid May instead of June).
Main and minor flowering season		Farmers perceive both, earlier and delayed flowering. Generally, farmers report scattered flowering across the season, compared to usual specific periods of the year.
Main and minor harvest season		Most of the farmers don't perceive a change in harvesting seasons. Some groups in Bushenyi and Sheema reported an earlier start of the harvest season.

It is shown that the wettest three months of the year (referring to the main rainy season from September - November) have become even wetter (Fig.3), while during the driest quarter of the year (referring to the main dry season in June/July - August), there is an uncertain trend in precipitation (Fig.4). However farmers reported that overall there are more rainfalls across the year, which agrees with the projected trend of precipitation following a more extreme distribution during the year (Fig 5).

Fig 3. Projected precipitation of the wettest quarter showing an increasing trend between 1980 and 2015

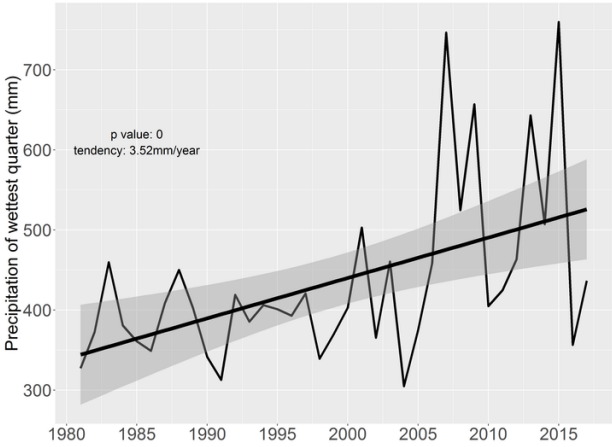


Fig 4. Projected precipitation of the driest quarter not showing an increasing trend as perceived by farmers

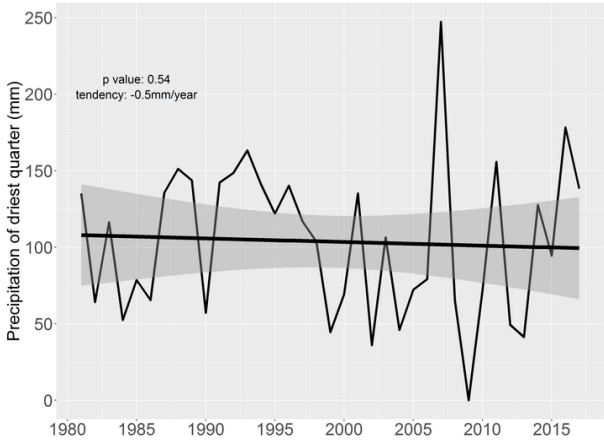


Table 4 Extreme weather events reported by farmers

Year	ExtremeEvent	District - Farmer typology	Season	Concern
1977	Hailstorm	Bushenyi - CF		
1985	Extreme drought	Sheema - AF	Entire Year	
1989	Prolonged drought	Sheema - PF		
1997	Hailstorm	Bushenyi -AF		
1997	Hailstorm	Sheema - AF		
1999	Extreme drought	Mitooma - CF	Entire Year	
2004	Strong winds	Sheema - AF		
2013	Prolonged drought	Bushenyi - CF		
2014	Hailstorm	Mitooma - CF		
2016	Extreme drought	Mitooma - PF		
2016	Prolonged drought	Sheema - CF		
2017	Extreme drought	Mitooma - AF		
2017	Strong winds	Mitooma - CF		
2018	Hailstorm	Bushenyi - AF		
2018	Hailstorm	Sheema - CF		
2018	Hailstorm	Sheema - PF		

Legend

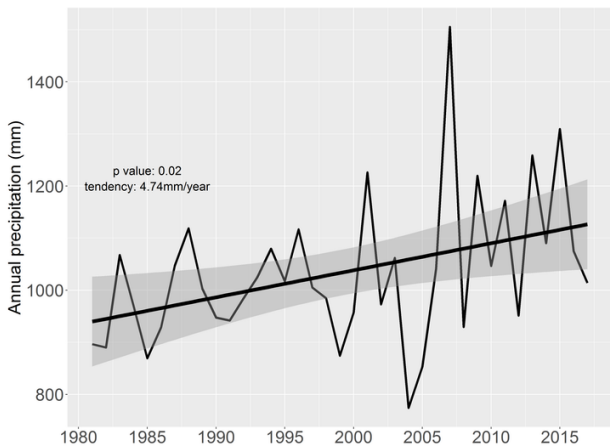
- Main rainy season
- Minor rainy season
- Main dry season
- Minor dry season
- Main harvest season
- Minor harvest season
- Main flowering season
- Minor flowering season
- High concern
- Intermediate concern
- Low concern

Over the last thirty years the annual increase in precipitation (+4mm/y) has outpaced the increase in potential evapotranspiration (+1.1mm/year). Thus, the region has become wetter overall, while other parts of Uganda have become drier. Future climate projections show that by 2050, precipitation might be increased throughout the year. The least change is projected for the June/July dry season, but with a possible reduction in rainfall in May. The August to November rainy season was projected to become wetter, while the March/April wet season may remain unchanged.

Farmer did not perceive temperature changes, which is another disagreement to what climate trend analysis suggests: There it is shown that annual average temperature in Bushenyi has increased by about 1.4°C throughout the year. Following the annual trend, also the maximum temperatures and the average temperatures during the driest quarter increased.

Table 4 shows extreme weather events farmers could remember in the last years. Hailstorms were mentioned most frequently, followed by extreme or prolonged drought and strong winds.

Fig 5. Projected annual precipitation showing a more extrem distribution during the year



STEP C - WHAT ARE THE OPTIONS FOR THE FARMERS?

Objective: Understand how farmers perceive benefits, risks & constraints of GAPs under normal & extreme weather conditions

Benefits of GAPs under normal and extreme weather conditions

Farmers seem to have a good understanding of the purpose and general benefits of GAPs (Table 5). Their perceptions are summarized in the following: Harvesting and drying contribute directly, and storage (bulking for further processing and marketing) indirectly to income generation. All pre-harvest GAPs directly or indirectly aim at increasing yield quality or quality, in essence and simplified via:

- Stimulation of new (and ideally productive) stems and branches (pruning, stumping, training)
- Reduction of nutrient competition (weeding, pruning, stumping)
- Nutrient provision (manure, mulching)
- Protection from biotic and abiotic stressors (mulching, shade trees, trenches for drought, shade trees for heavy rains and storms, PaD control)
- Prevention of nutrients leaching and soil erosion (mulching, trenching, manure)
- Increasing plant vigour (various)

Additional benefits under extreme climate conditions were less obvious to farmers (Table 5). For Some GAPs, no additional benefits other than generally increasing plant vigour and hence resilience to extreme weather events (pruning, stumping, PaD control, manure) were reported.

For other practices, i.e. mulching and trenches, farmers perceived an added value when extreme weather occurs. According to them, mulching and trenches contribute to soil water retention during extreme drought. Trenches were also reported to prevent soil water run-off and soil erosion during heavy rains. Other known benefits under extreme weather events for mulching (reduction of soil temperature variation, protection of young plants from frost damage) and especially shade trees (protection from heavy rain/hailstorms, solar radiation and strong winds, limitation of evapotranspiration, reduction of soil erosion and leakage of nutrients during heavy rains) were not mentioned during the discussions.

Risks and constraints of implementing GAPs

Risks referred to events that may or may not result in unwanted consequences when applying a specific GAP. Constraints referred to limitations on the possibility to apply a specific GAP.

The most frequently mentioned risk for harvest and post-harvest GAPs was theft. For harvest, weather (i.e. heavy rains) delaying and interrupting the harvesting periods were also mentioned. Humidity and consequently moulds were reported for drying and storage. Risks concerning to PaD were related to various GAPs: Transmission of diseases / spread of pests was mentioned for pruning, mulching, manure and PaD control itself (e.g. transmission of CWD with tools). Trenches and shade trees are believed to harbour pests or act as alternative hosts for PaD, respectively.

Table 5 Benefits, risks & constraints of GAPs under normal & extreme weather conditions

GAP	Who does it?	General benefit of GAP reported by farmers *and by literature*	Additional benefit in extreme weather event reported by farmers *and by literature*	Investment requirements reported by farmers			Time to benefit	Risks	Constraints
Harvest	♀♂	Income generation	None	RF report low, while AF and CF report high investment in labour	No trend in perceptions: Low, mid and high monetary investment is reported by all farmer typologies	PF report low and high, and AF and CF high time investment	1-3 months	Theft, weather, price fluctuations	Lack of labour and lack of funds
Drying	♀♂	Higher income (better quality = higher price)	None	Most groups report high investment in labour	No trend in perceptions: Low to high monetary investment in is reported by all groups	No trend in perceptions: Low to high time investment in is reported by all groups	1 - 4 months	Theft, humidity	Lack of materials and knowledge, rain,
Storing	♀♂	Better prices due to bulking	None	No trend in perceptions: Low to high investment in labour is reported by all groups	Most groups report low monetary investment	Most groups report low time investment	1 week - 3 months	Theft, price fluctuations	Lack of materials, theft, price fluctuations
Manure	♀♂	Increased productivity	Due to nutrients, resilience of coffee despite extreme weather.	Almost all groups report high investment in labour	Almost all groups report high monetary investment	Some PF and AF groups report low, but most high time investment	1 Year	Transmission of diseases, burning of coffee	Lack of materials and funds
Mulching	♀♂	Soil water and nutrient retention, yield increase, weed suppression	Water retention during extreme drought	Almost all groups report high investment in labour	Almost all groups report high monetary investment	Some groups report low, but most high time investment	3 months - 1 year	Fires, spread of pests, snake bites	Lack of materials and funds
Pruning	♀♂	Increases yield via reducing nutrient competition, increasing plant vigour and contributing to pest control.	During heavy rains, pruning of new shoots and suckers reduces nutrient competition.	PF report low, and AF and CF report low or intermediate investment in labour	All groups report low monetary investment	PF report low, and AV and CF mid or high time investment	3 months - 1 year	Transmission of diseases, accidents	Lack of materials and knowledge
Stumping	♂	Yield increase due to new generation of productive stems	Yield increase due to decreased competitions, also during heavy rain when more growth	No trend in perceptions: Low or high investment in labour is reported by all groups	No trend in perceptions: Low or high monetary investment in is reported by all groups	All groups report low time investment	1 - 3 years	Lack of income (since no production); failure to regenerate	Lack of materials and knowledge

Not all GAPs are shown in this table. A complete description of results for all GAPs in given in the text.

There is a risk of damaging or breaking coffee bushes while slashing weeds, removing branches, suckers and stems (pruning, stumping, PaD control) and training. Accidents resulting in injuries (to humans) were also reported frequently when handling tools for pruning and stumping. GAPs aiming at the stimulation of new growth might fail (i.e. shoots fail to grow), resulting in productivity losses. This is especially true for stumping, which entails significant income losses if rejuvenation of the entire bush fails.

Many of the constraints for applying GAPs related to limitations in either funds, materials/equipment or knowledge. Most frequently mentioned constraints were lack of labour and funds for harvesting, lack of material and humidity for drying, lack of facilities for storage, lack of funds for manure, lack of material and funds for mulching and lack of materials and knowledge for pruning and stumping. For PaD control, a lack of control alternatives for BCTB and CWD were also mentioned. Weeding was most constrained by lack of labour, and trenching by lack of labour and knowledge. Lack of knowledge was mentioned by all groups for training. Overall, lack of material and equipment was mentioned most often by all three farmer types. Interestingly, lack of funds was reported by AF and CF second most often, but least often by PF.

HOUSEHOLD-SPECIFIC GAP PACKAGES

Validation of adaptation packages developed in the first project phase

In the first project phase, adaptation packages specific to different household profiles were developed based on ACPCU extension officers' perceptions. One of the objectives of this second phase was to validate these packages (among others with workshop results of farmers). In the following, the suggested adapation packages of phase one will be restated, and subsequently validated.

For PF, current management was suggested to be limited to weeding, pruning, and harvesting. Suggested GAPs that are neither labor nor cost-intensive were shading and drying. Labor intensive GAPs such as stumping and trenching were also suggested.
Validation: There are more basic GAPs that are not cost-intensive and hence feasible for resource poor farmers, especially shade tree planting, cultural PaD control and training. Furthermore, drying harvested coffee is neither uncommon for ACPCU farmers (usually, all farmers deliver Kiboko to their primary cooperatives, and only selected speciality varieties might be sold as red cherries and processed at ACPCU stations) nor can it be seen as a climate smart adaptation (drying is a standard primary processing step which most Robusta farmers in Uganda do). The suggested package of phase one for PF can therefore not be confirmed.

For AF, weeding, pruning, harvesting, manure application, trenching, training, de-suckering, and stumping was suggested as current GAP portfolio, while drying, the use of cover crops, shading, spraying, cultural pest and disease management, sorting, and fertilizer application were reported to be less common. Practices found to be beneficial to adapt to climate change were drying, shading, and cultural pest and disease management because of their low resource requirements and clear adaptation benefits. Cover crops, record keeping and mulching is furthermore suggested.
Validation: Again, drying, shading and cultural PaD control should be (and according to data of the second phase) are part of the basic GAP package, especially for farmers with average land sizes. Spraying, sorting and fertilizers are irrelevant for ACPCU farmers. They are organic certified, hence do not use pesticides nor non-organic fertilizers. Sorting is part of the secondary processing, which ACPCU farmers definitely are not involved in (most of them do not even hull). The suggested package of phase one for AF can also not be confirmed.

For CF, all recommended GAPs were reported to be implemented, including cover crops. It was recommend to focus on the improved timing of seasonal sensitive practice application, specifically training, spraying, and fertilizer application. Additionally it is recommended to seek access to improved varieties, and explore options for contour planting, riparian buffers, windbreaks, solar driers, as well as shade management and natural land sparing.
Validation: The suggested package of phase one for CF can be confirmed, however improved timing of GAP application is crucial for any farmer type. Often it requires mainly knowledge, which is not cost-intensive and therefore accessible for resource poor and average farmers. Therefore it should not be recommended to only CF, but all farmers.

Suggested adaptation packages based on phase two

In the following, new adaptation packages are suggested. These were (as in phase one) not established during the workshop, but are based on farmer reported GAPs and expert knowledge (extension officers and consultant on smallholder coffee systems in Uganda). Table 6 shows estimated labor and material costs for GAPs according to ACPCU extension officers, as well as household-specific GAP packages. These costs all refer to seasonal activities, while the availability of less frequent investments in tools (pruning equipment, shovels etc.) is assumed for all farmers. On a seasonal basis, most of the GAPs mainly require labor. Therefore, these basic GAPs (pruning/de-suckering, weeding, PaD control, training, trenches, stumping, harvesting and drying) are part of the management packages for all farmer types. Depending on land and family size, resource poor farmers can theoretically manage most of these GAPs (i.e. the ones that do not require cash investment) with family labor only. Farmers with more resources can (again, depending on land and family size) use both, family and hired-in labor. Average farmers can also invest in regular manure application, while commercial farmers can additionally invest in mulching and tarpaulins for drying. These GAPs imply both, labor and monetary investments.

Most of the practices are general, i.e. not specifically climate-smart GAPs. Out of the four climate-smart practices (shade trees, soil erosion control, mulching and drying with tarpaulins), all farmer types could afford at least shade tree planting and trenching. Shade tree planting requires a low investment (20000 UGX / acre for 100 seedlings and labor), therefore monetary resources should not be a limiting factor. However, the availability of seedlings has been reported as a constraint. Average farmers could adapt by investing in tarpaulins and mulching, if resources are available.

Table 6 Household-specific adaptation practices

	ACPCU estimated GAPs costs per acre and season		FarmType		
GAP	**Material and labour costs (UGX)**	**Total (UGX)**	**PF**	**AF**	**CF**
Pruning&de-suckering	200 UGX x 450 trees	90000	x	x	x
Stumping	300 UGX x 200 trees (max. to be stumped / season)	60000	x	x	x
Weeding	4000 UGX x 7 man-days	28000	x	x	x
Drying	500 UGX x 18 bags x 7 man-days	63000	x	x	x
Trenches	30000 UGX x 3 trenches	90000	x	x	x
Harvesting	250 UGX x 1800 kg/18 bags of red cherries (labour) + 1500 UGX x 18 bags	450000	x	x	x
Training	100 UGX x 450 trees	45000	x	x	x
PaD control	10000 UGX x 7 man-days	70000	x	x	x
Shade tree management	Depending on the number of shade trees	na	x	x	x
Manure	150000 UGX x 1 trip + 20000 x 1 man-days	170000		x	x
Tarpaulins	35000 UGX x 6 tarpaulins	210000			x
Mulching	150000 UGX x 5 trips + 100000	850000			x

DISCUSSION OF WORKSHOP OUTCOMES

In the following, workshop results are discussed with reference to the specific objectives stated in the introduction.

- **Establish a cropping calendar for a typical coffee growing cycle to evaluate which GAPs are implemented by farmers in the region and when**

Workshop results suggest that most of the known GAPs recommended for Robusta coffee growing in Uganda are applied by farmers of the region. Practices which seem to be uncommon in the region are planting cover crops, as well as the use of synthetic pesticides and fertilisers. The latter is irrelevant for ACPCU farmers as they are organic coffee growers. Surprisingly, results also suggest that GAPs adaption is not household resource- and site-specific, i.e. all farmer groups (RF, AF and CF) in all districts reported to implement most of the GAPs. The group exercises also showed that farmers seem to be well informed about the timing of GAPs application. Comparing their responses to official technical guidance showed that there are only discrepancies for two GAPs, the timing for training and trenching. Also the timing of weather and phenology seasons reported by farmers match well with historical weather observations.

Overall, these results are positive, however there is a significant "but" to be considered: The questions posed in this exercise answers the "what's" and "when's" (i.e. what GAP is applied and when), but not the "how's". There is a lot technical nuance to the implementation of many GAPs, e.g. how much manure is applied? How exactly are the coffee bushes trained? How is diseased plant material handled after pruning?

The surprising fact that even resource poor farmers seem to apply most of the GAPs might also be related to this. It is possible that they do X practice, but to what extent, i.e. how frequent, which quantities, etc.? It is positive that farmers apply GAPs and that they have knowledge on the right timing, but identifying household and site-specific training needs to improve the success of GAPs has to take into consideration more technical details.

- **Explore farmers' perception and knowledge on how GAPs are related to the state of the season**

Farmers have a good understanding on why GAPs have to be applied when and how they are influenced by (extreme) weather. This is a good basis for using climate and other information to make decisions that depend on the state of the season and weather. An additional post-workshop exercise was conducted with ACPCU extension officers to get an idea if and at which relevant timescale such climate services (CS) would be relevant for farmers in the region. Table 7 lists current GAPs, the relevance of CSs for a specific GAP (a CS is not necessarily relevant for all GAPs), along with relevant timescales needed for CSs to be useful for farmers, and a priority rank. For coffee planting for instance it is important that it takes place at the beginning of the rainy season, hence a climate service helping farmers to decide on when to plant would be of high relevance. CSs are less relevant for practices such as harvesting and training, since they are not implemented depending on a weather, but on a phenological event (ripening of cherries, flowering).

Table 7 Relevance and timescales of climate services for GAPs

Practice	CS relevant?	Explanation	Required time intervals for CS	Priority Rank
Harvesting	No	Berries have to be picked independent of weather	na	na
Weeding	No	Done continuous anyways	na	na
Pruning / de-suckering	No	Done continuous anyways	na	na
Manure / fertiliser	Yes	Has to happen when the rains start. Manure has to be prepared. Getting the manure when rain has already started makes it heavy (more transport cost), so it should be purchased and transported before the rain start.	One month before	2
Mulching	Yes	Mulch is collected during dry season and applied towards the rainy season. When material wet, work gets heavier. Also, mulch is used to soil erosion, so has to be applied in time. Mulch can also be purchased and stored at farm.	One month before	5
Stumping	No	Stumping can be done any time during the dry season, timing is not so crucial.	na	na
PaD control	Yes	Depends on PaD	Depends on PaD and control measure	3
Trenches/terasses	Yes	Should be done when it is about to start to rain	One month	4
Training	No	Should be done after flowering - so end of flowering will indicate the right time for training	na	na
Shade tree planting	No	Can be planted any time during the rainy season	na	na
Coffee planting	Yes	Should be planted at the beginning of the main rainy season (September). Also depends on region (in some regions recommended at minor rainy season, too much rain can reduce emergence rate).	Two month (1 month for preparing the land, 1 month for digging the holes)	1
Drying	No	There is no choice, if coffee is harvested it needs to be dried	na	na
Storing	No	There is no choice, if coffee is dried it needs to be stored	na	na

- **Understand how farmers perceive changes in climate and its impact on weather and phenological seasons**

Given the natural variations in climate from season to season and the fact that memories fade over time, it is difficult for farmers to see a clear trend in how climate changed. Nevertheless there are trends that farmers and climate observations as well as projections seem to agree upon, i.e. an overall increased precipitation. Rainfalls throughout the year, including during dry seasons was mentioned repeatedly during the discussions with farmers. Sporadic rainfalls and as a consequence, irregular flowering and ripening of cherries extending over several months is an apparent climate change effect that makes coffee growing in Bushenyi region more difficult. GAPs relevant to adapt to these changes (higher rainfall and temperatures) are shading (interception of rainfall and buffering of temperatures), mulching and trenching (soil erosion control during heavy rainfalls). Higher precipitation and temperatures might increase pests such as BCTB, hence cultural control would need to be more intensive and would entail higher labour costs. The same is true for weeds, which might emerge in higher rates and frequently across the year. Here, suppressing cover crops should be tested and implemented. Cover crops would then mitigate two potential effects of increased rainfall, soil erosion and weed growth.

- **Evaluate farmers' perception and knowledge on GAP benefits under normal and extreme climatic conditions, as well as risks and constraints for implementing them.**

Again here, farmers were well aware of the purpose and benefits of most GAPs. However they seem to underestimate the benefits for mulching and shade trees, which are two key climate-smart GAPs. The benefit of shade trees under extreme weather conditions is much more than what is perceived by farmers. Protection from heavy rain/hailstorms, solar radiation and strong winds, limitation of evapotranspiration, reduction of soil erosion and leakage of nutrients during heavy rains are just some of these benefits. Hailstorms, strong winds, erratic rainfalls and as a consequence, irregular flowering seems to be an issue in the area. During such events, shade trees might help to prevent flowers and young cherries to drop. Farmers should therefore be aware of the various benefits of shade threes and also be trained in shade tree management as well as the choice of shade tree species.

Concerning risks and constraints, discussions with farmers gave clear insights into what is needed to successfully apply GAPs and assure high coffee productivity and income. Unfortunately, several risks and constraints are related to either security issues (theft) or lacking resources for paying materials and labour. Unfortunately, these are poverty related challenges that countless smallholder farmers around the world face, and for which to date no systemic solution has been found. However other identified risks and constraints can be addressed. For instance, lack of knowledge on how to apply GAPs, most notably for training, but also for drying, pruning, stumping, PaD control, shade trees and trenching was often specified as constraint. Mentioned risks to damage coffee bushes while training or pruning and the consequent fear to implement the practice can be solved by tailored trainings giving clear and detailed instructions on how to do a practice. Some practices do require advanced technical knowledge. For instance, for training coffee bushes, farmers have to know which height the bushes need to be, to which direction and how many degrees the stems have to be bend, how many and which suckers to select, etc. For manure, care has to be taken that the compost does not lose its fertility during storage, that it should be covered in the rain or in the sun because of the risk of washing out nutrients and of burning the coffee.

Household specific adaptation packages
The development of household and resource-specific packages takes into account the resources of a farmers on the one hand and the costs of implementing GAPs on the other. Data required to develop such packages are mainly of quantitative nature. The packages developed in this project however are based on qualitative information, and hence would still need to be validated with a more quantitative approach. The PICSA protocol serves as basis to develop climate services for farmers, and less for developing household specific adaptation packages. Therefore there are certain limitations to using this protocol to define these packages.

The main limitation was the estimation of detailed costs for each GAP / ha. The questions on labor and monetary investment posed in this workshop were qualitative , i.e. "low" or "high" investment, which of course is highly relative: a farmer might perceive the investment in labour for pruning as "low" because he/she has a very small plot and can manage the work with family members, while a farmer with large fields perceives labour for the same GAP as high, because he/she has to pay for labour. It is therefore very difficult to identify consistent trends in what is perceived as low or high investment.

Another limitation are the farmer typologies. Although in the second phase, it was intended to work with farmer typologies, data availability for establishing these were very limited / not available.

There are more criteria that need to be taken into account. For instance, the relative importance of coffee (i.e. % of income contributed with coffee to the total income) and other cash crops which might influence to what extent a farmer wants to invest in coffee management. Since the used typology in this project is not based on a robust data set, it is questionable if the farmers present at the workshop are actually representative for the population of resource poor, average and commercial farmers in the region. This might explain why according to workshop data, farmers in all groups and in all districts report to apply most of the GAP). It seems unlikely that resource poor farmers have sufficient funds to invest in expensive GAPs such as mulching and manure application

There are limitations in establishing these packages from purely qualitative data and very low sample sizes. Nevertheless, the here suggested packages serve as basis and are complementary to packages based on quantitative information, which can be obtained via surveys and regional expert interviews.

The financial viability technical working group of the Ugandan national coffee platform investigated the financial returns from Robusta and Arabica coffee farming, by undertaking gross margin analyses for different categories of farmers in different regions of the country. Though their results are based on conventional (i.e. non-organic / fair-trade) farmers, they might give guidance for establishing packages for ACPCU farmers.

CONCLUSIONS

The ultimate purpose of this workshop was to identify which practices require interventions and incentives, and if/how climate services could be beneficial. The workshops provided a good starting point to explore these questions. Following conclusions and recommendations can be made:

GAPs requiring interventions:

- *Training/bending:* Technical workshops/trainings on how and when to train/bend coffee bushes
- Climate-smart GAPs: Climate projections show that precipitation might increase throughout the year. Climate-smart GAPs, specifically shade tree planing and management, trenching, mulching and cover crops play a crucial role in mitigating these effects. For most of these practices, gaps in theoretical and technical knowledge were identified in the workshops. Future service deliveries, e.g. workshops, trainings or provision of materials should therefore focus on these practices.
    - *Shade trees:* Training on benefits of shade trees for general and extreme climatic conditions and technical guidance on the choice of shade tree species and shade tree management for optimising canopy cover
    - Soil erosion control:
        - Trenches: Information on when to best establish and manage trenches
        - Cover crops: Workshops for knowledge transfer on benefits of cover crops

Way forward for climate services:

- Validate extension officers' perception on the relevance of CSs with expert knowledge as well as farmers' perception
- Evaluate if required seasonal forecast models and skills exist
- Explore appropriate and feasible means for CS delivery.

Household specific adaptation practices:

- Need to conduct surveys to obtain representative samples for establishing farmer typologies and costs/ha for coffee growing in ACPCU districts
- These surveys could also give a more representative picture of what farmers in the region know, do and need.

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Annex 1 Crooping calendars for Bushenyi, Sheema and Mitooma for PF, AF & CF