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CCAFS 'FARMS OF THE FUTURE', TANZANIA: NRI REPORT

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Contents

1. Introduction

The Climate Change, Agriculture and Food Security (CCAFS) CGIAR research programme has commissioned the Natural Resources Institute (NRI), University of Greenwich to undertake a project to test and develop its Farms of the Future (FoF) approach. The project falls within the CCAFS Adaptation to Progressive Climate Change Theme. The FoF approach comprises the use of the CCAFS climate analogue tool and farmer exchanges for learning about adaptation.

The overall goals of the Farms of the Future Project are to:

- devise, test and validate the "Farms of the Future" approach built on farmer-to-farmer exchanges to analogue sites as a valuable option to improve adaptive capacity and support knowledge transfer.
- improve understanding of local practices and available tools for enabling change, as well as cultural, economic, or institutional obstacles to such adaptive change.

The specific objective of this project was *'to develop and validate a methodology to assess the 'Farms of the Future' approach as a means of strengthening the adaptive capacity of farmers and other Agriculture Innovation System (AIS) stakeholders'.* This specific project was implemented in Tanzania and Ghana from August 2011 until December 2012.

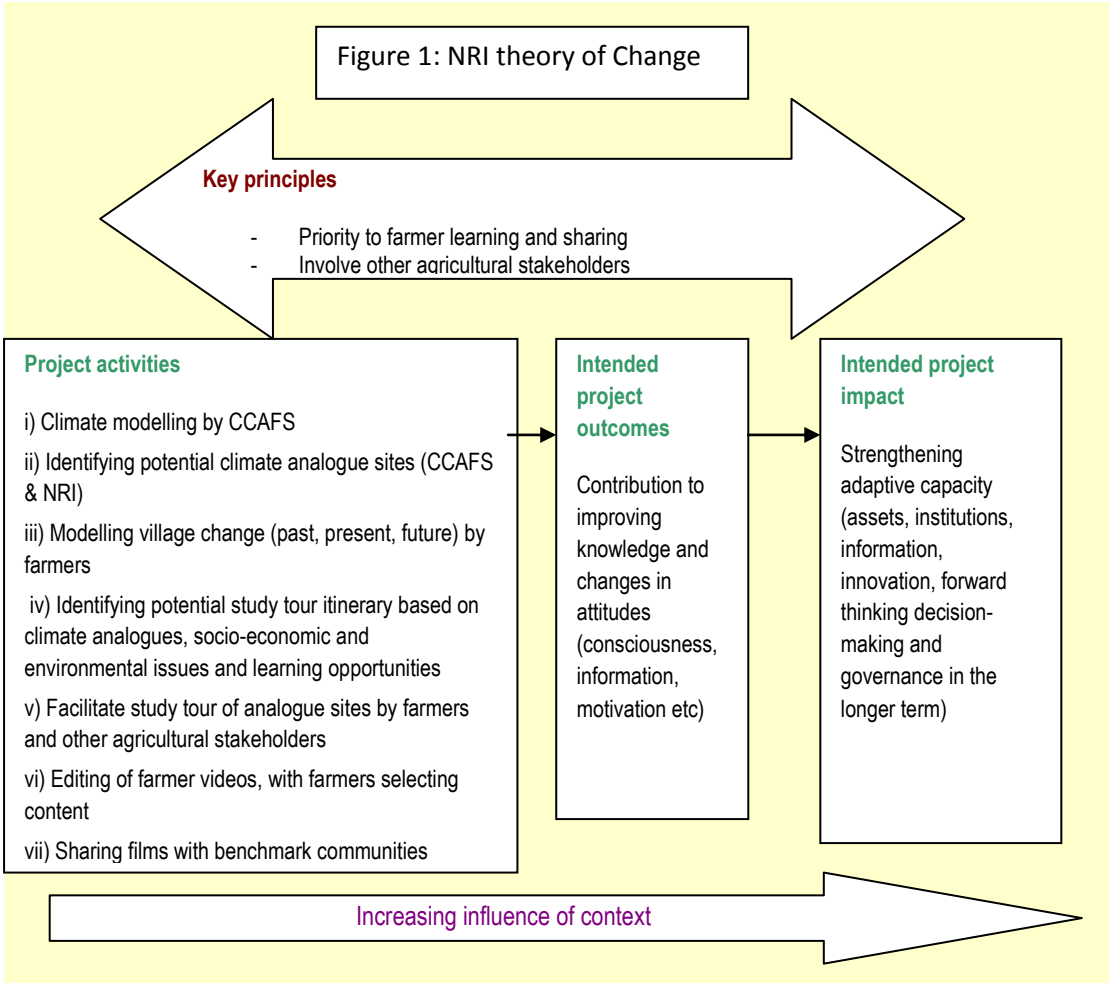
The project has four phases: Phase 1: Preparatory phase of the visits; Phase 2: Preparatory Planning Visit; Phase 3: Farmer-to-farmer learning visit in the field and reflection (visits to farmers and projects); Phase 4: Post Visit Analyses.

This technical report sets out the method used, learning outcomes for the participants and an assessment of the methodology employed, including the development and use of the analogue tool prior to and in the planning process of the study tour. The study tour involved a journey from the CCAFS benchmark site Lushoto Northern Tanzania to Mbinga in the Southern Highlands of Tanzania from 19th May – 2nd June 2012.

2. Overall approach: Theory of Change

This section explains the overall approach developed by NRI to test the 'Farms of the Future' approach.

Figure 1: NRI theory of Change



The key principles guiding the study emerged during the initial planning phases and are outlined in box 1 below.

Box 1: Key NRI 'Farms of the Future' Principles

- Give priority to farmers' voices and their learning from other farmers at the host communities
- Support other agricultural stakeholders from the benchmark site to participate. Farmers cannot adapt to climate change alone. Encourage these other stakeholders to learn from farmers and stakeholders in the visit locations – to help them reflect upon what they and their own organisations could do differently in the future.
- Support the farmers to share their findings from their study tour with their own communities
- Learn how to strengthen the ability of farmers, other stakeholders and organisations to respond to climate change and other pressure.
- Ensure that women farmers and agricultural stakeholders are supported to participate in the process (e.g. being trained in using the video cameras, encouraged to share their thoughts, supported to participate in the study tour etc). An analysis of social and gender differentiation is also important throughout. This is because existing gender and social inequalities mean that women and certain social groups are more likely to be negatively affected by climate change, having fewer resources to adapt.

The research team have developed a model of adaptive capacity strengthening – see Figure 5 in section 5. This conceptualisation has been refined after the fieldwork process and is used to assess how the study tour has contributed to building adaptive capacity by analysing the reflections before, during and after the tour as facilitated by the team of NRI and partners.

3. Method

3.1 A sequence of tasks

The sequence of activities for the Farms of the Future project is illustrated in figure 2 below. The key activities of the project are: i) using CCAFS climate modelling to identify climate analogue sites, potential social/economic/environmental similarities/lessons and learning opportunities; ii) facilitating learning between farmers and other agricultural innovation system (AIS) actors; iii) documentation of their own learning by farmers and other AIS stakeholders using low cost video cameras; iv) Sharing of the learning by farmers and the other AIS stakeholders; v) Participatory assessment of learning by benchmark farmers; vi) Capturing the process and learning outcomes.

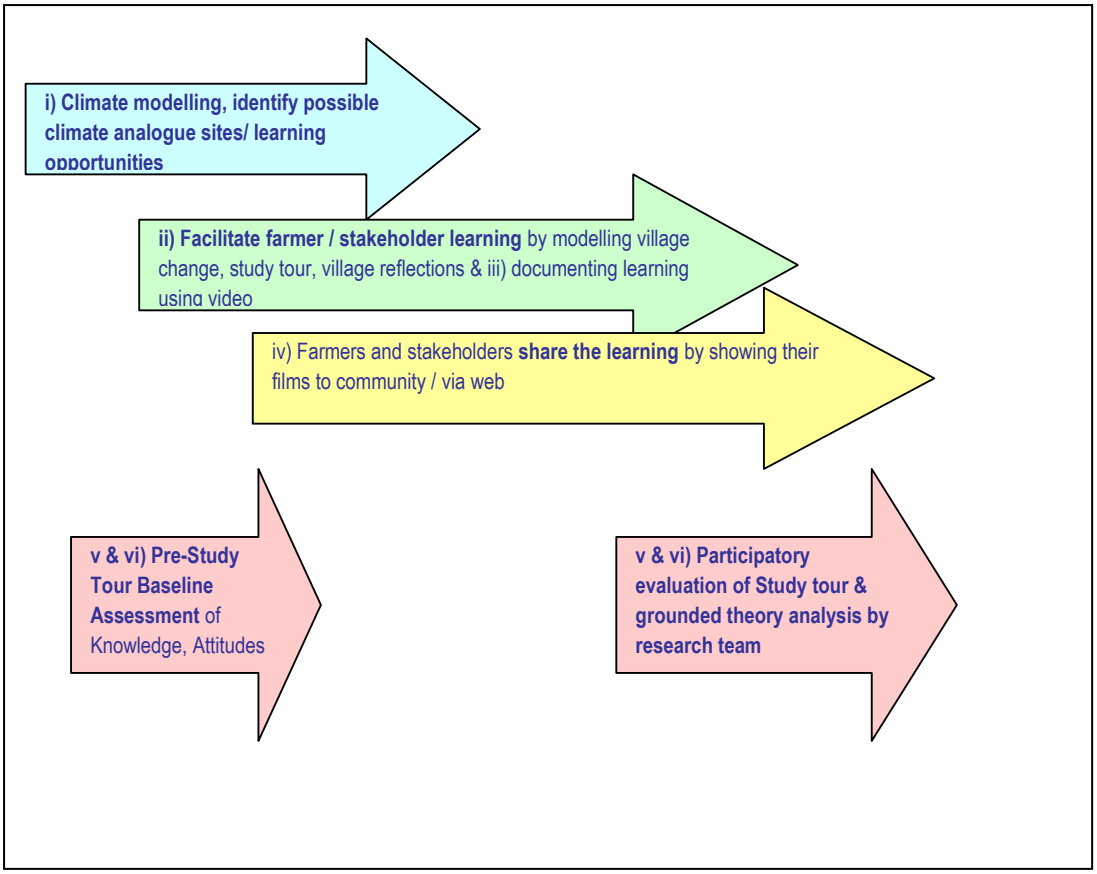


Figure 2: Farms of the Future Process

3.2 Supporting the development and use of the climate analogue tool

CCAFS developed an analogue tool prior to this commissioned research, which seeks to enable farmers in location A to identify another location (B) with an existing climate similar to that projected for location A. CCAFS have hypothesized that this creates a potential opportunity for farmers in location A to envisage how their climate and associated agricultural systems might look in the future, to learn from the adaptive practices of those

living in location B and to later enable follow-on targeted on-the-ground testing of cropping systems/technologies. Two CCAFS regions were suggested to undertake the project and test this approach in practice: East and West Africa, working with the CCAFS own benchmark sites as starting points and working with the CCAFS modellers to identify analogue sites.

The NRI team used the outputs from the climate analogue tool modelling provided by the CCAFS team in an interactive, iterative process stretching across several months (August 2011 to January 2012). The process of selecting appropriate exchange sites in both East and West Africa was lengthy as the protocol for using the team was still being developed and insights were to be garnered from this process. Each time that modelling information was provided (maps and graphs) questions arose. Clarifications were sometimes needed and on a couple of occasions serious anomalies were spotted in the projections[1]. These iterations revealed bugs in the tool, but also show the risks of such outputs being used without detailed good understanding and critical analysis.

The maps are based on mean temperature and precipitation data. CCAFS suggested that the analogue analysis could be run based on the selection of specific growing periods (tailoring it thus to particular crops) and should somehow also incorporate sociological variables for its interpretation.

The NRI team also requested climate analogue analysis from CCAFS for several sites where NRI has already been working with local communities in agricultural adaptation (as part of the CCAA programme and henceforth referred to as the 'CCAA sites'). However, CCAFS said this was not feasible – incorporating current climate data from these other sites was not possible at this stage. The NRI team also considered the project partners that were already linked to the CCAFS sites as part of identifying potential sites for the study tours, mindful of the fact that follow-on support, as well as good facilitation skills during the study tour itself, are needed to strengthen adaptive capacity and to avoid raising expectations without support to implement new ideas.

CCAFS then produced a finer grained analysis for Tanzania of the climate dissimilarity for the country and including the CCAFS Lushoto sites and the CCAA sites. One of the best fits existed between the Lushoto 2030 climate and the current climate of some of the Southern Highlands CCAA sites – according to the CCAFS models and climate information.

The graphs of the confidence levels (standard deviation) in the GCMs on a monthly basis for each of the CCAFS East and West Africa sites were provided by CCAFS. For East Africa this pointed the NRI team potentially to Rakai (Uganda) and Lushoto (Tanzania) - if the precipitation variable only was to be used - because there is some consensus amongst the models for a number of months of the year in terms of precipitation patterns. However, the temperature variable graphs showed a high level of variation/ large standard deviations within the year for all sites (when comparing the same months across the models). For West Africa none of the sites stood out based on the precipitation or temperature variable, with little consensus amongst the models in key months.

[1] For example, initially, the NRI team were given a weblink for climate analogue maps and CCAFS sent the team climate dissimilarity maps for the benchmark sites. The maps indicated that an exchange between Lushoto in northern Tanzania and Laikala village (Central Tanzania) of the CCAA (Climate Change Adaptation in Africa) sites was the closest match. This surprised the NRI team given that Laikala is semiarid and Lushoto is in the bi-modal rainfall area of the country where increased rainfall is expected in the future (*unfccc.int/resource/docs/**napa**/tza01.pdf).* The climate analogue maps represent a mean projection of 24 Global Circulation Models (GCMs) only.

There was some exploration of the level of certainty/consensus on the projections (initially for the Lushoto benchmark site, but later for all the CCAFS benchmark sites in East and West Africa), as potentially the level of agreement between the models could be used as a criterion for selecting research sites – i.e. on the basis of least uncertainty.

The focus then moved to the possible use of the level of 'precipitation agreement' in the models for part of the year. Precipitation projections seem to have more agreement in certain part of the year in East Africa, so the research team considered using this criterion for selecting sites. However, discussions with agriculturalists identified that for some crops *temperature* is more critical than precipitation, i.e. the relative importance of temperature or precipitation in determining crop growth varies from crop to crop. So it is not possible to assume that precipitation is the more important climate element in determining suitability for a particular crop and selecting sites.

Most of the climate change literature suggests that there is more agreement on temperature projections than rainfall. CCAFS suggested using the climate analogue model '*through the eyes of the crop'*, i.e. reviewing the growing season for several of the major crops for the key benchmark sites that were being considered by NRI as possible analogue sites. At this point, the NRI team requested the household survey baseline reports in order to look at the levels of diversity in production systems in the possible analogue sites in East Africa. CCAFS shared the draft reports, including a summary. NRI reviewed the data and concluded that it would be difficult to adopt this approach for two reasons: i) given the diversity of crops grown in these areas, and ii) because of the post-harvest dimensions (e.g. drying, processing) which are important in considering how climate might affect household's livelihoods as well as the growing season.

Climate data for the climate analogue sites – starting with Lushoto – was then shared by CCAFS. Around this time there was growing realization about altitude as a variable which affects the viability of using the climate analogue tool. Lushoto is characterized by a highly dissected landscape, meaning that there can be changes in the climate over short distances. The question arose: *'Is it appropriate to take farmers from Northern Tanzania to the south, where the climate may be colder, when the projection for Lushoto is for the temperature to rise?* This type of comparison may send a confusing message to the visitors if they had been told to expect a warmer climate. Much would depend upon the exact location of the communities at the Lushoto benchmark site (see Table 1) and the host communities in the Southern Highlands.

Information was extracted from the CCAFS baseline survey reports on the local perceptions of the climate. The changes reported by local people mainly relate to rainfall, but also the picture is mixed. It became clear that it would be useful to have the disaggregated data, because the benchmark site in East Africa is fairly varied, due to elevation differences and includes humid-warm and humid-cold locations.

Table 1: Lushoto: Features of the selected block

Agro – ecological zone	**Altitude (m) above sea level)**	**Rainfall (mm)**	**Average air temperature (^{0}C)**	**Soil type**	**Crops types**
Humid warm	800 -1500	800 - 1700	22	- Chromic Luvisol - Rhodic ferrasol	Tea, coffee, vegetables, sugar cane, maize, beans, sunflower paprika, Vanilla
Humid cold	900 - 1700	600 - 1200	18	- Luvic phaezem	Coffee, vegetables, banana, irish potato,

				- Chromic Luvisol	temperate fruits, beans, maize, paprika, vanilla

Source: CCAFS Lushoto baseline survey draft report

Table 2 Reasons for changing cropping practices, by category

Reasons given for changing cropping practices.	**% of households citing**
Markets	20
Weather/climate	18
Land	17
Labor	15
Pests/diseases	17
Projects	13

Source: Table 4.2 Reasons for changing cropping practices, by category, CCAFS Lushoto baseline report.

Table 3 Weather/Climate-related reasons for changes in cropping practices

Weather/Climate related Reasons..	**% of the households that cited at least one weather-related reason**
Earlier start of rains	18
Less overall rainfall	20
More frequent droughts	17
Later start of rains	15
More frequent floods	1
More overall rainfall	9
Higher temperatures	2
Strong winds	0.2
Lower groundwater table	0.2

Source: Table 4.3 Weather/Climate-related reasons for changes in cropping practices, CCAFS Lushoto Baseline report.

At this stage the study team began to think more about a 'climate journey' or 'study tour' rather than a visit to a single analogue site by farmers from the benchmark locations, as a way of managing the high levels of uncertainty in the CCAFS analogue tool combined with a highly dissected benchmark topography. Thus, rather than necessarily seeking to visit one analogue site, the idea would be to explore different dimensions of possible future climates and a range of adaptation innovations and responses to different sociological, economic and environmental challenges.

The study team also recognised at this stage the importance of taking farmers from one location to another where they would have some level of familiarity with the farming system as an ethical consideration. Taking farmers to places with very different farming systems and climatic conditions could be overwhelming, rather than motivating, and so a balance is required. 'Ground truthing' is needed - of information and in the selection of study tour locations - with local stakeholders at all stages. In the planning week in Tanzania agricultural

innovation stakeholders supported this process of selection, but ultimately farmers were not involved in selecting the analogue sites and could be in future applications of this approach elsewhere in the world.

Cropping calendars were then reviewed to see whether these could be used to select exchange sites, based on agreement in the models for certain months and if these coincided with growing seasons for key crops at the benchmark sites. Information on the growing seasons for the crops at each site (i.e. a calendar of the different crops being grown and processed over different months) were obtained, but it became clear that a clear definition of 'growing season' would be needed. Differences between the communities in the CCAFS sites in terms of the mix of crops grown were explored. A difference between using the 'lens of the crop' approach to select a CCAFS site or to select communities *within* the CCAFS site was discussed. The team noted that they could foresee difficulties for diverse farming systems and possible issues in situations where certain crops become unsuitable to future conditions. In other words, adaptation may require diversification *out of* current crops, rather than continuation with the same ones.

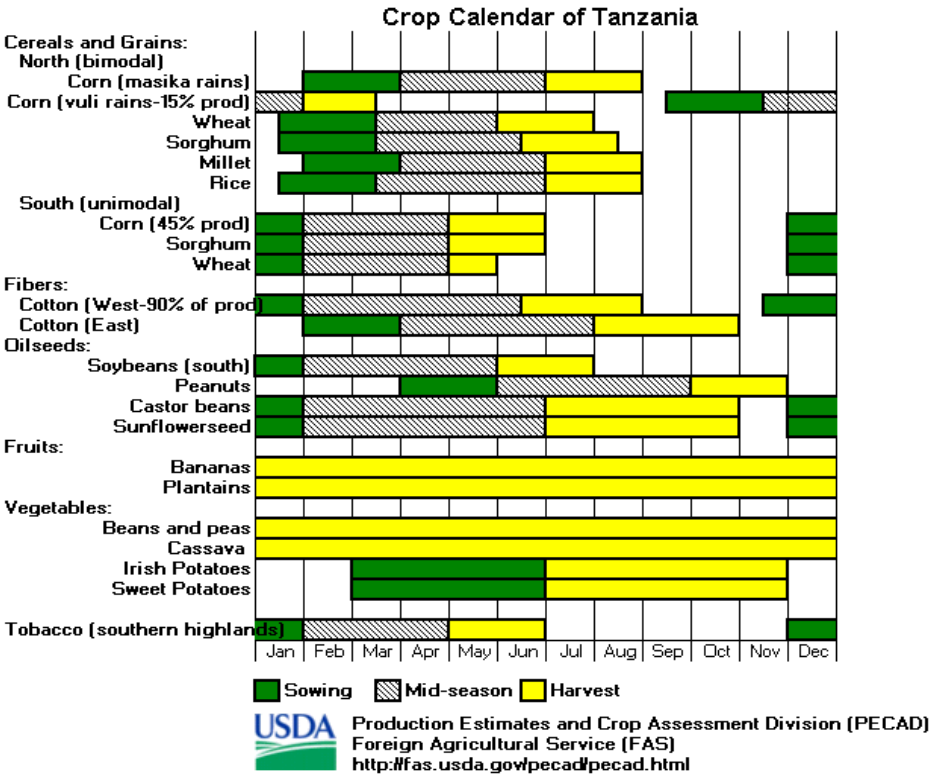
In reviewing the summary of the Lushoto baseline household results it was noted that for Lushoto 50% of respondents produce 5-8 agricultural products and 35% more than 8 products. So although 87.1% of respondents have maize and 75% have beans as main crops (Source: All sites main crops and animals table compiled from Baseline survey), other crops play an important role in Lushoto's farming systems. A general crop calendar for Tanzania was also identified drawing on the FAO website[2].

The crop calendar indicates that Lushoto has a bimodal rainfall pattern. However, in north east Tanzania it has been regularly reported over the last 20 or more years that the short ('*vuli'*) rains are becoming increasingly unreliable[3].If maize is taken as the main crop in Lushoto, then the main cropping period would be defined as lasting from February to August according to the crop calendar below. From the CCAFS precipitation graph there is a relatively low standard deviation (1-3 high confidence) for projections in March—July; higher standard deviation (8) in February and much higher (20) in August. If these standard deviations are being expressed in mm then these higher figures in February and August are even more significant because average rainfall is lower in those months (see rainfall graph below). Interestingly though for Tanzania as a whole, Rowhani et 2011[4] suggest that seasonal temperature increases have the most impact on yields of maize (by 2050 a projected 2 degree C increase in temperature results in a 13% decline in maize yields).

[2] http://www.fao.org/agriculture/seed/cropcalendar/welcome.do.

[3] http://www.ehs.unu.edu/file/get/10565

[4] Pedram Rowhani, *, David B. Lobell, Marc Linderman, Navin Ramankutty 2011 Climate variability and crop production in Tanzania Agricultural and Forest Meteorology 151 (2011) 449–460. http://www.sciencedirect.com/science/article/pii/S0168192310003357



Unimodal and Bimodal Rain Seasons

1. *Unimodal* (musumi) rainfall regime is from December-April in the southern and western parts of the country.
2. *Bimodal* rainfall regime is in the northern, eastern, and northern coast of the country:
   Short *vuli* rains are from October-December and long *masika* rains are from March-May.

Average rainfall

Annual rainfall varies from 200-mm to 1000-mm over most parts of the country.
Higher rainfalls are recorded over the highlands to the northeastern and southwestern parts of the country.
Central Tanzania is a semi-arid region with some parts receiving annual rainfall less than 400-mm.

Crop Characteristics in the Bimodal Regions

The *vuli* rains provide a minor cropping season with planting around November and harvesting in late January/February.
The masika rains provide the main cropping season with planting in late February/March and harvesting in July/August.
The *vuli* season contributes about 15 percent of the national cereal production.
Vuli maize production is typically reported from Mara, Arusha, Kilimanjaro, Tanga, Morogoro, Mbeya, Coast, Kagera, Kigoma,& Mwanza regions.

http://www.fas.usda.gov/pecad2/highlights/2003/03/tanzania/images/crop_calendar.htm

Figure 3: Crop Calendar, Tanzania

Climate data for Njombe and the Southern Highlands was requested and for data for Lushoto climate projections. A data format request table was drawn up – see table 6. The NRI team further explored the idea of climate trends in relation to specific crops, for example, table 4 below shows the temperature and precipitation requirements for maize and beans - the two most important crops for Lushoto.

Table 4: The EcoCrop model of FAO summarizes optimal and absolute conditions for maize and common beans

	Maize		Beans	
	Optimal	Absolute	Optimal	Absolute

	Min	Max	Min	Max	Min	Max	Min	Max
Temperature	18	33	10	47	16	25	7	32
Rainfall	600	1200	400	1800	500	2000	300	4300
Soil pH	5	7	4.5	8.5	5.5	7.5	4	9
Light intensity	Very bright	Very bright	Clear skies	Very bright	Very bright	Clear skies	Very bright	Cloudy skies

Source: EcoCrop/FAO, 2011, http://fao.org/ecocrop

Table 5: The EcoCrop model of FAO summarizes optimal and absolute conditions for arabica and robusta coffee

	Arabica				Robusta			
	Optimal		Absolute		Optimal		Absolute	
	Min	Max	Min	Max	Min	Max	Min	Max
Temperature	14	28	10	34	20	30	12	36
Rainfall	1400	2400	750	4200	1700	3000	900	4000
Soil pH	5.5	7	4.3	8.4	5	6.3	4	8

Source: EcoCrop/FAO, 2011, http://fao.org/ecocrop in Jeremy Haggar and Kathleen Schepp (2011[5])

The climate data for Lushoto (Table 6) and all the other benchmark sites was generated. Comparing this data with the Southern Highlands CCAA sites data suggested that much of the Southern Highlands are colder than much of the Lushoto site, but precipitation could be a reason for the Lushoto farmers to visit the south. The NRI Team considered finding other warmer locations where the visitors could go, perhaps in or near Lushoto benchmark location (e.g. a one day visit during the video training) and in the Southern Highlands.

[5] Jeremy Haggar and Kathleen Schepp (2011) Coffee and Climate Change Desk Study: Impacts of Climate Change in four Pilot Countries of the Coffee & Climate Initiative. http://www.coffeeandclimate.org/tl_files/Themes/CoffeeAndClimate/Country%20profiles/Report%20Coffee%20Climate_Pilot%20Vietnam_Haggar%20Schepp.pdf.

Table 6: Lushoto Projected and Current climate data

			Months											
	Variable	Calcul	1	2	3	4	5	6	7	8	9	10	11	12
Models	tmean	Mean	20.74	18.17	19.43	20.29	21.52	20.58	19.52	18.14	16.82	16.14	16.25	17.03
		Sd	0.92	1.12	0.99	0.80	1.10	0.90	0.77	1.00	0.94	1.00	1.04	1.20
		Min	19.60	15.50	17.00	19.00	20.20	19.30	18.40	17.10	15.10	14.70	13.90	13.50
		Max	24.10	22.00	22.60	23.00	25.80	23.80	22.00	22.10	20.30	20.10	20.10	20.80
	prec	Mean	82.50	66.70	103.00	94.39	74.91	151.57	234.61	239.39	71.87	57.57	46.52	45.13
		Sd	17.50	10.17	16.48	15.91	11.62	18.76	14.25	11.02	6.36	4.84	4.11	4.93
		Min	38	43	64	70	53	118	208	208	49	43	37	36
		Max	126	95	128	123	105	196	265	256	81	73	55	62
Current	tmean		19.50	17.10	18.30	19.10	20.30	19.40	18.50	17.00	15.60	14.90	15.00	15.90
	prec		74	67	104	91	67	135	227	241	74	58	47	45

The NRI team explored what the climate data means for future viability of key current crops, livestock, and natural resources in Lushoto and which other crops might become potential crops for these locations in terms of the climate - although it was noted that market, culture, taste and other factors are likely to be important.

In terms of planning the study tour it is important to consider both the farming cycle in the host and in the visit locations to avoid over-burdening farmers, and also to consider whether there will be crops growing in the fields to see and post-harvest handling to observe.

Graphs comparing current Lushoto and projected Lushoto climate, based on data provided by CCAFS, showed the main rainfall period as June, July, and August. However, local knowledge indicated that March, April and May is the main rainfall season for this part of Tanzania. CCAFS noted that the source of the data used for the graphs were a mean of 689 months between 1922 and 1982, whereas the CCAFS source is a monthly mean from 1950 to 2000 from interpolations of observed data (representative of 1950-2000). However, the graphs still did not match the reality on the ground. The final precipitation graphs produced by CCAFS indicated peak rainfall in the months of March, April and May currently and in the future. Projections for Mbuzii and Yamba village were provided just before the preparatory planning visit.

3.3 Preparatory planning phase

A preliminary planning week was held in Lushoto, with the following aims:

i. Establish the willingness of communities and farmers to participate in the project (Exchange visit)
ii. Rapid rural appraisal of farmers perceptions of climate and other change
iii. Preliminary training/exposure to the use of video as a participatory learning tool

Several key principles were identified as being central to the NRI approach and these were shared with the local partners:

- **facilitating a shared learning process** is important to develop locally appropriate solutions to climate change generated by farmers and other relevant stakeholders
- **participatory video** to enable farmers to document the process themselves and to enable communication horizontally and vertically with other stakeholders in the agricultural innovation system
- **participatory methods** can be developed that are innovative and support visualisation by farmers and communities where literacy rates are not high. For example, modelling of local landscape, farming and livelihood change on the ground by farmers can be facilitated to explore the past, present and a range of future scenarios. This process can potentially lead to greater exploration of non-local factors driving change such as global warming, building on local understanding of localized socio-environmental change.

The planning week revolved around interactions with farmers at two CCAFS site communities (Mbuzii and Yamba) (see section 3.3.2 for selection criteria) and a number of public and private sector agricultural innovation system (AIS) actors (See programme and participants in Annexes 1). Farmers are, of course, other key AIS stakeholders, but for brevity in this report we refer to these other stakeholders (district extension, NGOs and agricultural input suppliers) as AIS stakeholders to distinguish them from CCAFS site farmers.

The original aim of the project was expressed as '*to enable Lushoto Benchmark Site communities to visit communities experiencing the Lushoto community future climate and*

learn about adaptation as a result'. This was shortened by the whole project team in Lushoto to '*To expose communities to their potential future climate and ways of adapting to i*t'.

3.3.1 Introducing the CCAFS analogue tool

During the planning week the CCAFS analogue tool was introduced to a workshop of other AIS stakeholders and facilitators, including the DALDO and agricultural extension officer, representatives from various NGOs and a female representative from the Ministry of Community Development, two private sector representatives, as well as facilitators and representatives from SARI and African Highlands Initiative - A discussion was facilitated on climate change causes and impacts to develop a more shared understanding and for the research team to understand current knowledge amongst stakeholders. This was led by the ARI Uyole representative. During the discussion a limited number of power point slides on climate change, global warming and the impacts of climate change were shared.

AIS stakeholders were aware of 'climate change' and 'global warming', but there were very differing explanations of the causes. Local environmental degradation was generally reported as the primary driver, while global greenhouse gas emissions leading to a heating of the atmosphere was reported by just one NGO participant.

Later presentation of the analogue maps and graphs highlighted the notion of uncertainty in relation to modelling projections (e.g. the different GCM projections were shown in the form of temperature and precipitation graphs for Lushoto benchmark site) and the difficulties of building scenarios in areas of highly dissected topography were discussed at length by the group. The conclusion was that different dimensions of the potential future climate could be explored, and significant weight has to be given to a broad range of learning opportunities that might exist (e.g. in adaptation projects, mitigation initiatives, farm level technological as well as institutional innovations).

The facilitated discussion on climate change was followed by a basic introduction to the Farms of the Future approach (climate analogue tool and farmer exchanges), including an explanatory hand-out.

To avoid overwhelming the workshop participants, only a limited selection of the climate analogue graphs and maps were shared during the week. The map for the Lushoto site and its analogue sites (based on annual precipitation and temperature) were shared, as well as graphs for current and projected precipitation and temperature for the Mbuzii and Yamba communities. The maps based on precipitation and temperature for particular parts of the year (loosely indicating the growing season) were shared with the project team and facilitators to illustrate the projected changes in climate over different seasons. Some of the potential 5% analogue sites shown on the combined precipitation and temperature maps did not appear on the other maps (e.g. precipitation May-Oct).

Climate projections and farmers' perceptions of historic change were explored: Farmers (and other AIS actors) appear to be reporting that in recent years temperatures have been rising (and this trend follows the projections in the CCAFS models) and rainfall is decreasing (this historic trend is the opposite to that which is predicted for northern Tanzania although fits with CCAFS's future projections for Mbuzii and Yamba see graphs 2030). While historic trends and future projections certainly do not necessarily have to fit, it is also the case that a change in the direction of travel in recent climatic changes, as observed by local people, makes explanations and discussions of future change fairly complex - particularly in a highly dissected landscape (See graphs in Annex 1).

The topography of the Lushoto site creates challenges for the use of the climate analogue tool. The highly dissected nature of the landscape of the Lushoto site means that within short distances there can be major differences in altitude and consequently climate. The topographical and associated climatic variation means that there are further issues to be taken into account in identifying a visit location. A visit location has to have enough similarity to farmers' current climate and wider context, so that farmers can relate to it and do not feel overwhelmed and helpless, but the visit location also needs to indicate the projected future trends. In a location with the topography of Lushoto, this can be difficult even when specific village coordinates and climate data are used.

A further question arises as to whether the team visits sites where farmers are supported by projects or are engaged in autonomous adaptation – it may also be the case that in a chosen analogue site that other processes of localized environmental degradation may be occurring and so there are no positive stories for farmers to learn from. While farmers may feel motivated to act, on the other hand positive solutions may not be on offer.

For the 'Lushoto' graphs it was not initially clear whether this refers to the whole site or to Lushoto town, but the CCAFS team later clarified that this means a centroid coordinate of the 10 x 10 block. A question arose during the planning week as to the source of data for the Mbuzii and Yamba precipitation and temperature graphs. The NRI team requested clarification as to whether the climate data based on Lushoto town data has been extrapolated to the villages according to altitude? CCAFS have indicated in response that this data comes from WorldClim where "current" represent the period 1950-2000[6].

The project team requested that the CCAFS team produce analogue maps for the Mbuzii and Yamba villages if possible.

3.3.2 Selecting benchmark villages

The project team and facilitators agreed the criteria for selecting villages within the benchmark site. Mbuzii and Yamba were selected based on the following criteria:

- Zone (include both humid warm and humid cold)
- Accessibility (relatively accessible from Lushoto town)
- Overall wealth levels and diversity of crops

3.3.3 Participatory modelling of landscape, livelihood and climate change

A participatory tool was devised by the NRI team to facilitate exploration by villagers in the site of their changing landscape, livelihoods and climate. The group comprising broader AIS stakeholders and project team members practised the modelling method prior to visiting the local communities.

The project team requested the following mix of participants for the modelling and participatory video in the villages:

- 10 men and 10 women
- Elders and youth
- More wealthy and less wealthy

The modelling method was then introduced to farmers in both of the selected communities – Mbuzii and Yamba.In Mbuzii the farmers were asked to construct a model showing how their

[6] See: http://www.ccafs-climate.org/media/ccafs_climate/docs/worldclim_IJC.pdf

village is in the present, then in the past and also in the future. The groups split, with women and men producing their own models and also looking at the models constructed by the other group. There were discussions within each group particularly about the future – and often varying according to how far the discussion moved into a call for action on well-known environmental challenges (e.g. protecting water sources, preventing deforestation) to representations of a fairly negative future scenario. There were no major differences between the models of the women's and the men's groups – rather there were slight differences in emphases in terms of the trends discussed and also when discussing the future. However, the time for conducting this exercise was fairly limited and in this case it served more as a means of introducing the external team to the village groups and to begin thinking about processes of change, not just in the past, but also in the future. Further, it provided an opportunity to mention the study tour idea and to explore interest and whether villagers had travelled outside their area. In an ideal world it would be better to have more time to do this type of exercise more thoroughly.

Following team reflections, the Yamba farmers were asked to start in the past and then move through the present and continue to a range of future scenarios, as this seemed a more logical approach to showing a process of change over time and clearer to the villagers being asked to construct the model. Facilitators for the discussions were drawn from the broader AIS stakeholders.

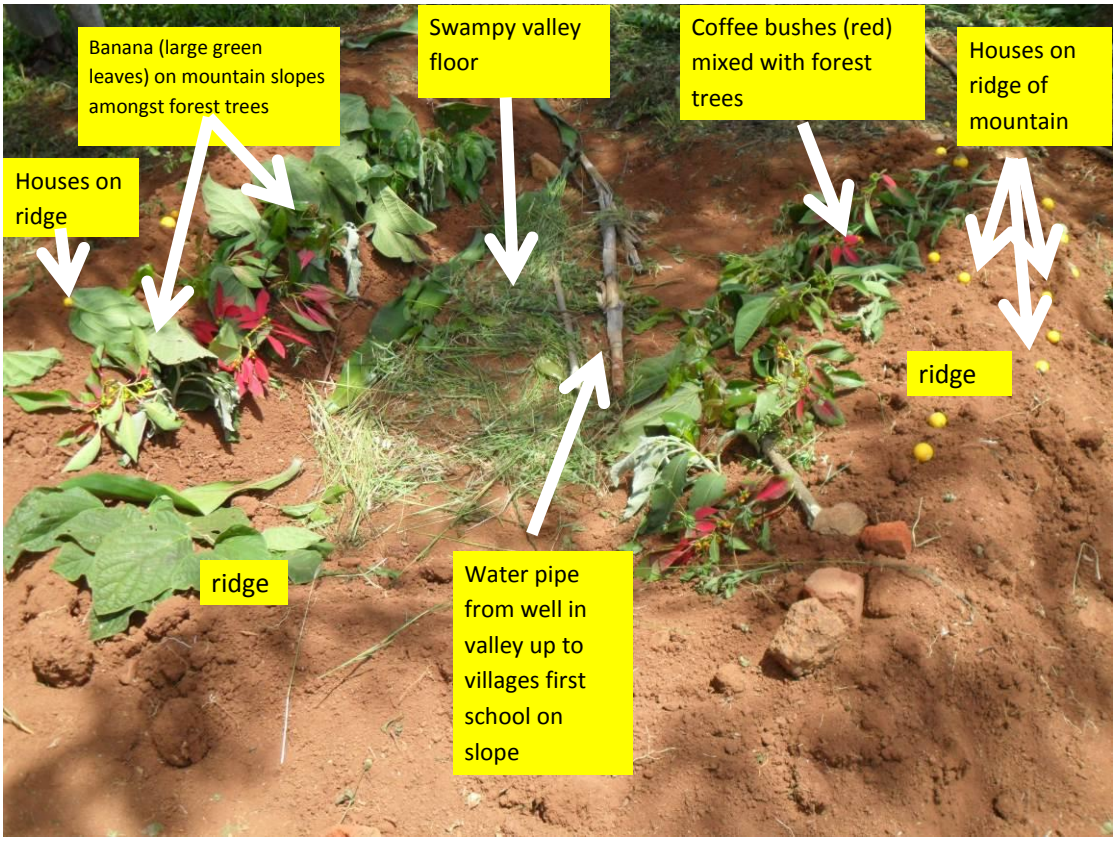


Photo: Participatory modelling showing Mbuzii village in the 1950s

3.3.4 Video documentation by farmers

Two female and two male farmers in each community were given a five minute on- the-job introduction into how to operate user-friendly (Flip) and relatively low cost video cameras. These farmers then filmed the making of the model and the discussions. While the footage is fairly basic, the exercise gave the farmers a taste of what the cameras are for, so that they could use them in the study tour. However, this did not represent 'training' as there was not sufficient time. The study team realized that further training would be needed and this was planned for the period between the preparatory planning week and the actual study tour.

Photo: Mbuzii villagers trying Flip cameras for the first time

Photo: Mbuzii women film their focus group discussions triggered by the modelling

3.3.5 Selecting participants for the study tour

Criteria were agreed for who should participate in the farmer exchanges:

- Gender balance
- Spread across different ages
- 50% of farmers surveyed in CCAFS survey
- Farmers demonstrating capabilities in filming.

Criteria were identified to guide the selection of AIS stakeholders, as well as interest in participating in the study exchanges:

- Coverage of public, private and NGO sectors
- Interest to joining the visit and the aims of the project

3.3.6 Finalizing the study tour programme

Mbinga was selected as the closest analogue to the Lushoto communities. This followed from discussions on the climate analogue tool and 'ground-truthing' based on the local knowledge across Tanzania of the AIS stakeholders. This site falls within the 5% areas of lowest dissimilarity (combined precipitation and temperature models).
Following fieldwork in the two communities of Mbuzii and Yamba, the project team and facilitators identified *additional* criteria for selecting the analogue sites. The criteria are as follows:

- Similar local environmental challenges and examples of responses
- Learning opportunities (farm level innovation, institutional level innovation and other)
- Farming system potentially analogous to Mbuzii and Yamba in the future (2030)
- Feasibility (N.B. appropriate timings should be established for both sets of villages for their activities and to avoid the visitors visiting a location at a time of year where climatic conditions are different to the analogue model)
- Cost-effectiveness
- Similar social challenges, population pressure, land fragmentation and responses

Using the additional criteria, a table was constructed which describes the characteristics of a range of potential visit sites that fall in the 5% lowest dissimilarity (closest analogues) and 80% agreement between the models (table 8). This exercise was important to draw on local knowledge and identify learning opportunities, which ensure that the visit is likely to be valuable to participants.

The project team (i.e. NRI team, together with partners Juma Wickama, African Highlands Institute – lead organizer of study tour and facilitator; Lebai Nsemwa, Uyole, lead Tanzania participatory video facilitator; and George Sayula, SARI, co-facilitator and lead on CCAFS on-going action research programme in Lushoto) with support from Maren Radeny, from CCAFS East Africa developed a study tour programme (table 9). Local facilitators were found at locations where the project team do not have existing links. The facilitators were informed as to the aims, duration and date of the proposed visit. The CCAA groups were approached by Lebai Nsemwa, who has worked with them. The local facilitators were asked to prepare a draft programme in dialogue with the project team for the activities at their site. The farmers at each host location were prepared for the visit of the Lushoto farmers. On return to Lushoto, it was agreed that the representatives who had undertaken the exchange visit would share their videos with their own communities and a facilitated discussion will be documented.

It was estimated that approximately 16 farmers could be invited to participate in the exchange visit: 8 farmers from Mbuzii village and 8 from Yamba village. Half of the farmers invited would be drawn from the **on-going Participatory Action Research farmer groups**. A gender balance was agreed in selecting the participants. The AIS stakeholders that had joined the preliminary planning week were canvassed as to their interest in participating in the exchanges and then a selection made to provide coverage of different sectors and to build on existing enthusiasm and capabilities. The Lushoto DALDO (District Agricultural and livestock Development Officer) was invited to participate in recognition of his power to implement findings, and he expressed strong interest, but due to other commitments was not available at the time of the study tour).

A project facilitation team was established, with clear action points outlined pertaining to organization of the study tour and conducting the training of farmers in the interim period (including making a film about change in their own community to show on the study tour).

At this stage some key learning points were identified:

- ❖ It was proposed that the AIS stakeholders should be matched where possible with the same type of stakeholder in the host area (e.g. private sector would link with a local private sector stakeholder; agricultural extension workers from Lushoto would link with those working at the host destination). It was noted, however, that this requires some additional planning, but would be important to ensure that they learn from the process and to give farmers space to engage with other farmers without feeling intimidated.
- ❖ It was noted that both TV/camera and TV/disc/DVD options should be explored at host sites as well as the availability of a generator to enable the showing of videos.
- ❖ Local facilitators would play an important role in planning and implementation of the visit and would need to prepare a programme for the visit.

A sub-group of the AIS stakeholders and facilitators discussed the findings from day 2 of the community fieldwork – see table 7 for a summary of the evaluation.

Table 7: Summary of the evaluation discussion for the community fieldwork in the planning phase

What worked well	What did not work so well	What to change
• Timing was better • More focused on our achievements • We achieved our aims • Chronological approach – *to 3D modelling* - worked better • 3D Model helped in exploration of future scenarios • Having more clearly defined roles helped • Men and women groups presented to each other	• Late departure due to groceries • Return route (road more rough) • Few elders in women's group • Some don't feel free to speak in presence of Mwalimu (the teacher) • Unfortunately women's model had been cleared before they presented to the men's group (need clear communication within the team)	• More realistic departure time • Manage the presence of 'Mwalimu' and other dominant characters • Clearly documented protocol/method is needed, including a short checklist • Need to agree who needs to know what regarding local and global causes and responses to climate change • And how and by who this is communicated

Photo: Juma Wickama, African Highlands Initiative, explains the climate analogue maps to the broader AIS stakeholders

Table 8: Climate characteristics and potential learning activities and sites at analogue sites and locations en route

Site	Temperature	Precipitation/rainfall	Seasonal precipitation pattern	Farming systems & learning opportunities	Detailed learning opportunities	Environmental challenges and responses	Social challenges and responses
Mbinga, Southern Highlands	Higher	?	One season only	• Landscape more or less the same as Lushoto • More erodible soils, • Beans, bananas, coffee, well conserved by Matengo pits	• Unique soil conservation measures • Possibly maize, beans coffee opportunities	• Deforestation • Soil erosion • Matengo pits (local knowledge solution)	• High population density, but less than Lushoto • Land fragmentation less than Lushoto • Water situation not so severe
Rungwe	Kapugi (CCAA village), higher	Higher	One season	• CCAA site • Main crops are similar to Lushoto, but crops are healthier	• Bananas, beans, • Weather station • Similar farming system to Lushoto • Fairtrade tea •	• Erosion less than Lushoto • Permanent crops eg tea • Landscape less steep	• High popn density, but probably less than Lushoto
Taita Hills, Kenya	Higher	Lower	2 seasons	• Similar cultivation system			
Ulugurus, Morogoro	Warmer	Could be lower?	2 seasons	• Learning opps (e.g. variety of enterprises, SACCOS, WWF/Care programme) • Maize, beans and fruits, bananas, oranges, pineapples, sugar cane, strong SACCOS and warehouse receipts (Benki Mazao) – link with Oxfam in Lushoto, market centres	• Maize, beans, fruits, pineapple • Market centres, SACCOS and Benki Mazao (warehouse receipts) link with Oxfam? – 40-50 km from Morogoro town • WWF/Care – soil conservation and selling water resources	• Soil erosion • Deforestation	• High population density • Diverse crops and more market opportunities
Kagera	Warmer	Wetter if as Lake Victoria (depends on	2 seasons	• Banana, good coffee management, cassava, sweet potato • VI AgroForestry smallholders and carbon credits project			

		distance to lake)					
Mwitikilwa Mufindi district	Lower	Higher	1 season		• Different maize and bean varieties: beans did well, farmers impressed – can see in farmers plots, still in fields by June as rains take longer there. Maize less successful. • Close to government forest: community-government interaction including tree planting on large-scale on their lands, targeting the timber industry • Small weather stations established (rain gauges and thermometers) per community • Ngoma: Dance/singing group that communicate on CC • Green Resources (Norwegian company) – leased land, planted exotic variety of trees and started selling land • Plateau, some steep slopes. • *PV exposure but no videos (so opportunity for analogue site learning)	Soil degradation due to over use	Access to land for farming limited due to widespread forests owned by government*
Nyombo, Njombe district	Lower	Same or higher	1 season	• Maize, beans, round potatoes, avocado • Village weather station • SACCOS • Cost-sharing (power tiller) - farmers and district • Cultural tourism	Same agroecological zone. Farmers tried maize, potatoes and beans, round potatoes under CCAA project	Land degradation	• Much lower population density • Land availability not yet an issue • Planting of trees by individuals may result in limited access to land for farming

4. The Study Tour

4.1 Aims of the study tour

The **aims** of the study tour were originally formulated as: 'to enable Lushoto site communities to visit communities experiencing the Lushoto community future climate and learn about adaptation as a result'. This was shortened by the whole project team in Lushoto to the following*:* '***To expose communities to their potential future climate and ways of adapting to it*'.**

4.2 The Study Tour Itinerary

Table 9 below shows the programme that was followed in the Farms of the Future Tanzania study tour, including information on the preliminary and post tour activities**.**

The preparation during previous week comprised farmers in Mbuzi and Yamba being trained in the use of user-friendly video cameras to document their experiences for sharing with the rest of the community and to enable them to produce a video of their landscape, livelihoods and climate change over time (past, present and future) based on the model made in the planning week. This work supported village research and reflection and practice in making the video – the videos were shown in some of the study tour host communities as well providing a means for the CCAFS sites farmers to show where they come from and the challenges they face.

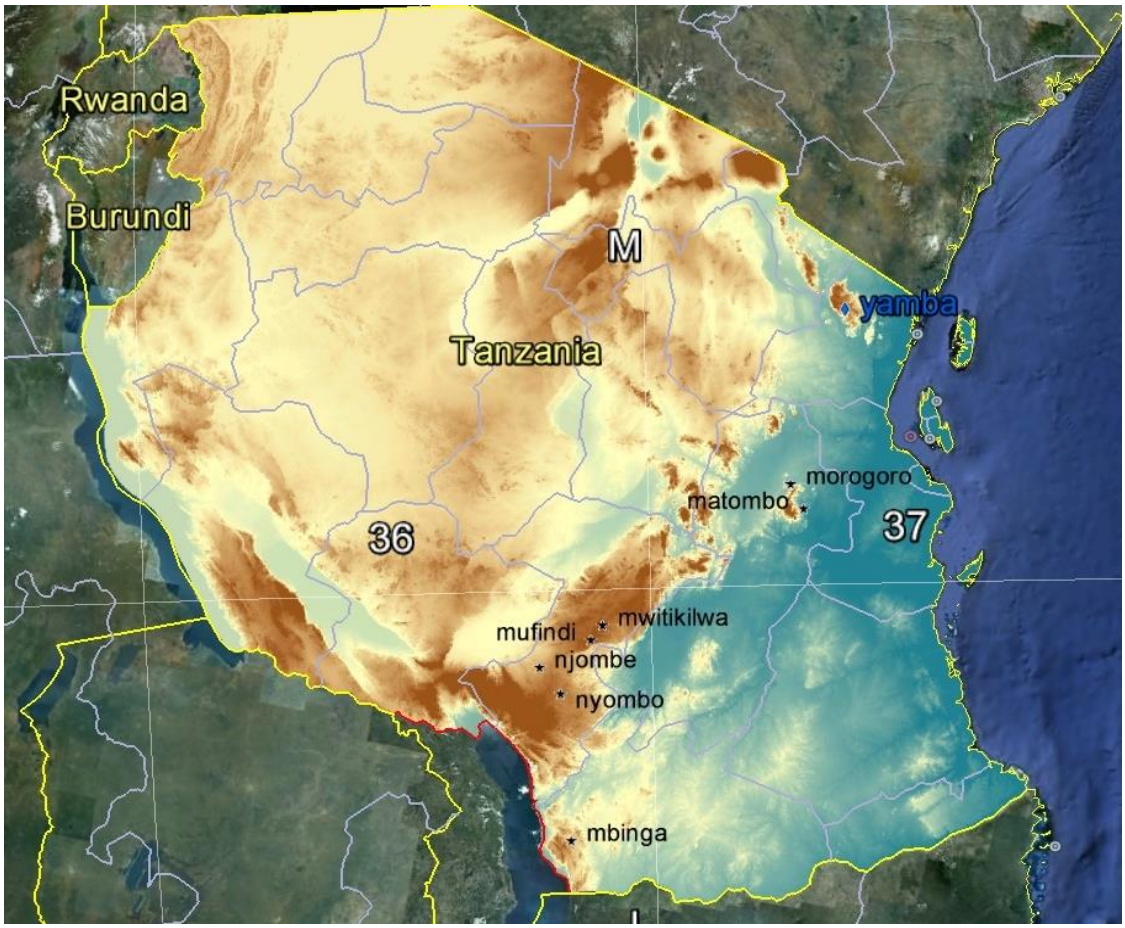


Figure 4: Map of Tanzania showing places visited on the study tour (Extracted from Google map prepared by Flora Mer, CCAFS).

Table 9: Farms of the Future Study Tour	
Day	**Activities**
Farmers receive more training in Lushoto and make videos of their own communities and the changes they see occurring as a practical exercise giving them experience in filming in the field, but also to produce films to show to the study tour communities (time allowing).	
Day 1: Travel from Lushoto to Morogoro	
Day 2: Kinole, near Morogoro town	Visit to District Agricultural and Livestock Development Officer (DALDO) and District Executive Director (DED) for Morogoro district
	SACCOS visit
	Market visit
Day 3: Morogoro- Mafinga	Individual farmer evaluation on bus to Iringa; Individual AIS evaluations on bus to Iringa
Day 4: Mwitikilwa village, near Mafinga, Mufindi district	Visit to DALDO and office of DED for Mufindi district
	AIS, men and women farmer groups – expectations and adaptive capacity discussions
Mwitikilwa village	Showing of Mbuzii and Yamba village films to Mwitilwa villagers
	Weather station visit
	Bean trial visit
	Tree nursery visit
	AIS, men and women's group discussions reflecting on visit
Day 5: Nyombo village, near Njombe town	Visit to DALDO for Njombe district
Njombe town	Mariet value chain social enterprise visit
	Visit to Input supply Stockists
Nyombo village	Weather station visit
	Avocado trial
	Banana varieties trial
	Maize fertility management
	AIS, women's and men's group discussions to evaluate visit
Day 6: Sepukila village, near Mbinga	Matengo pits/ Ngoro (Traditional soil and water conservation technique)
	Coffee nursery
	Stoves
	AIS, men's group and women's group discussions to evaluate visits
Masasi village, near Mbinga	Water source
	Fish ponds
	Biogas
	AIS, men's group and women's group discussions to evaluate visits
Mtama village, near Mbinga	Bee keeping
Day 7: Mbinga and return to Njombe	Evaluations at DALDO's office (men's group, women's group, AIS)
Day 8: Njombe – Morogoro bus journey	Farmers priorities for video footage to be included in the videos recorded on bus and discussed at Morogoro
Day 9: Morogoro	Nane Nane show ground – Lushoto district permanent site which included trees (eg Madagascar nut) and permanent crops (eg coffee and banana)
	Sokoine University of Agriculture (SUA) – farmer training centre – discussions with SUA staff-
	Rodent control centre
	Evaluations and editing at Morogoro by facilitators
Day 10: Return to Lushoto	Further editing of videos
Day 11: Lushoto	Editing of video footage with farmer input and rest day for other participants
Day 12: Mbuzii and Yamba	Feedback sessions at the villages A wrap up meeting on 2nd June 2012 at the AHI Office Lushoto with Juma, George, Lebai and NRI team

5. Findings

This section presents the findings of the research team based on an analysis of the views expressed by the participants in reflection and evaluation exercises before, during and after the study tour and drawing on the observations of the team. The main areas of learning by farmers – as identified noted by them – are synthesized and discussed in relation an adaptive capacity framework, which itself has been developed drawing on other frameworks and on team insights.

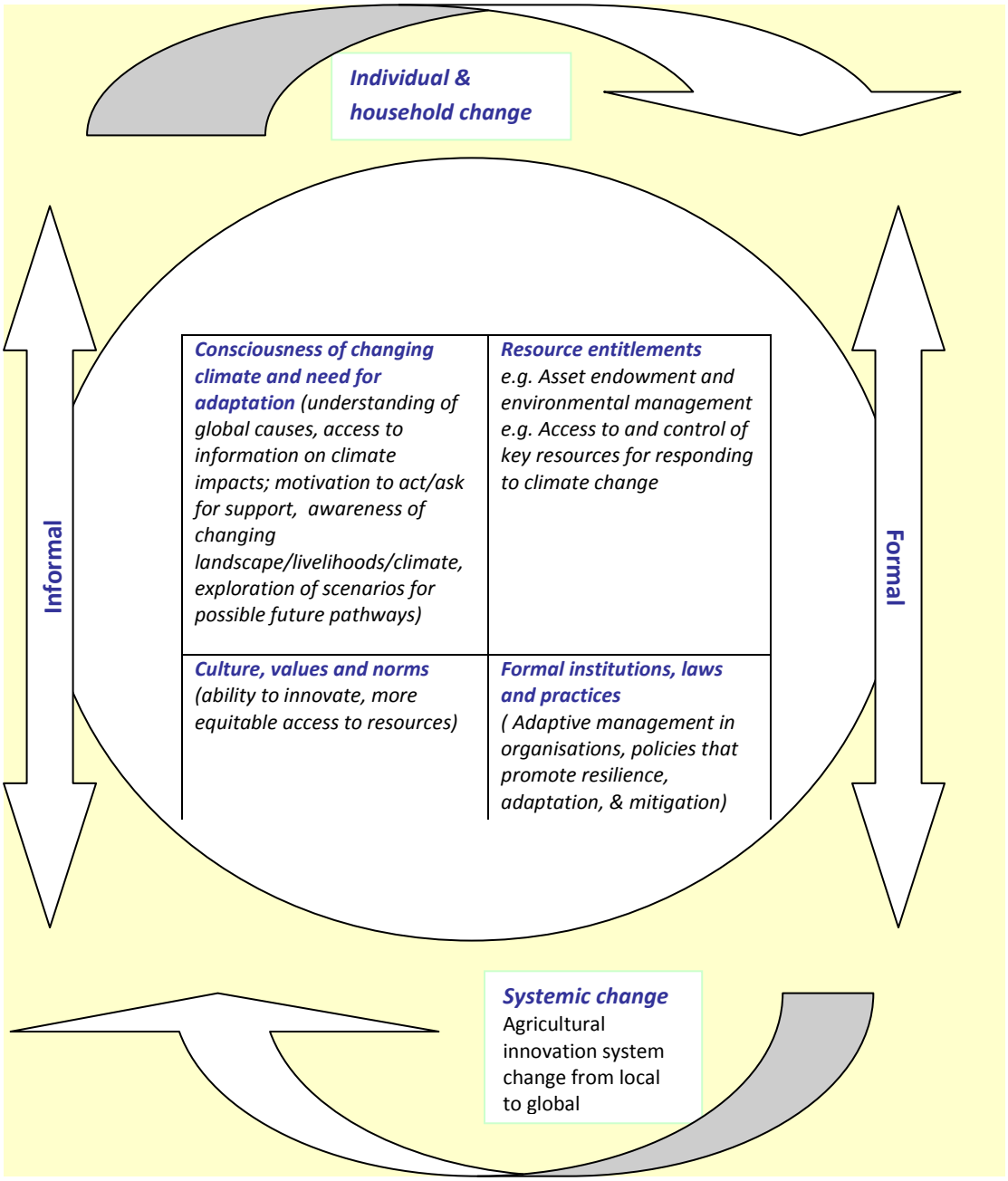


Figure 5: Adaptive capacity framework

Source: Own work, drawing upon the ACCRA adaptive capacity framework (ref) and the OXFAM MELKS engendering change approach (ref). We have designed this to be relevant for the study tour evaluation.

It was not anticipated that the project could achieve adaptive capacity strengthening in all components (e.g. in building assets or changing access to assets), but ideas could be seeded and more information gained that could later contribute to these goals. More progress would be feasible on aspects such as

increased consciousness of the changing climate, more access to climate information, willingness to act etc. In particular **the study tour appears to help in relation to** the aspects outlined in the top left hand box – **consciousness of climate change and the need to act, but could also influence the other norms, values and practices of the other boxes.** The framework emphasizes the need for change both at the individual level and household level, but also at the broader, systemic level – hence the need to involve a broader set of actors in the process.

But crucially, it is the on the ground presence from partners, CCAFS and other agricultural stakeholders, which provide mechanisms for future support to the participants.

The project also aims to improve understanding of local practices and available tools for enabling change, as well as cultural, economic or institutional obstacles to such adaptive change. We reflect on these throughout this section identifying practices that the study tour participants deemed to be of interest for adaptation and also where they identified obstacles to achieving changes.

A fuller assessment of impact would require funding for a baseline (which was not available) and a later evaluation exercise involving collective reflection by participants to assess whether and how much the study tour contributed to later change at the village level in responding to climate change.

5.1 Consciousness of the changing climate and the need for adaptation

This section reviews five aspects of consciousness and learning on climate change and the need for adaptation, which emerged from the farmers and stakeholder views expressed during study tour, namely: i) consciousness of climate change and access to information; ii) understanding of landscape, livelihood and climate change; iii) understanding global causes and potential impacts; iv) exploration of a range of potential future scenarios; v) motivation to act, articulation of demand for support and dependency issues.

5.1.1 Consciousness of the changing climate

Lushoto farmers were already **conscious of changes within their climate**, but this awareness was reinforced by the discussions prior to and during the study tour. Visits to community managed weather stations were important in encouraging the farmers to consider more systematic reflection on their already variable climate and the possibility that they too could manage a weather station. The participants thought this would help them to understand their own changing weather patterns, but also would support the government to gather data from the local level.

> 'The [weather station] *equipment is good as it enables the farmer to know the changes in climate and how she or he should start cultivation or planting. Therefore this equipment has impressed us, which is explaining climate change" (Female farmer,* Lushoto).

The Lushoto and host farmers discussed how they predict weather (e.g. coming rains) by observing biological indicators associated with birds, insects and trees. Both groups said that they know these natural signs, but were interested in how each other do so. In Lushoto some of the CCAFS site farmers with expertise in weather forecasting, are already meeting regularly with local meteorologists.

> "*So according to our subject of climate change this helps to see the flow of rain, increase in temperature and humidity in a particular area; thereby enabling them to change quickly as to what they should do as a result of changing weather from one year to another. What can be implemented is to establish weather stations for recording weather at village level, as we saw in our colleagues areas"* (district extension officer).

When shown the video footage of the study tour, CCAFS benchmark site community members were also impressed with the rain gauge, although there was perhaps some over-estimation of the extent to which the weather station could support response farming.

> *Even that rain gauge is good because we will know that the rain at Mbuzii is too much, if we are planting beans it should be the short term varieties. We should plant the yellow beans as they require only a short time* [to mature]' (Lushoto villager watching video footage)

Beyond the farmer level, **other AIS stakeholders also developed a greater awareness of climate change** as a result of the focus given the topic during the project and the study tour process. The Community Development Officer, Lushoto reflected on the importance of livelihood diversification to increased climate resilience:

> *"I have learnt that …. You can be farming, but you can also keep fish or livestock. You can do some other activity, which are far from agriculture, as a result of climate change. You can grow maize and the rain does not fall. So if you wholly depend on agriculture your food security becomes very small. Therefore it is good for the farmer that you have different activities which give you income instead of only farming".* (Community development officer).

Photo: Visiting the community managed weather station

5.1.2 Farmer reflection on change in their village and area

A modelling exercise was conducted in each village prior to the study tour and this *reinforced* the analyses of male and female farmers of how their area is changing. Women and men created separate models and discussed these, although time was limited for more detailed discussion. The process of modelling helped to communicate the key trends at work to the outside stakeholders and facilitators.

The study tour also enabled participants to see different landscapes, with differing levels of population. Reflecting on both of the modelling exercise and the study tour, an NGO stakeholder commented that the major the limited land available in Lushoto is a constraint on environmental conservation and that outmigration often becomes necessary.

> *The importance of conserving the environment is there, and a lot of people relate it to food security. But also I see that environmental conservation goes hand in hand with availability of adequate land. if land is limited environmental conservation can be very difficult and maybe it may necessitate people to completely stop depending on land and on other things which will enable them to get that cash and then to buy their food. Because it becomes very difficult for someone to think where shall I get firewood when he does not have somewhere to plant trees. I have seen when we went to Kinole that they have been able to conserve because they have land they have several opportunities for earning.... I have gone to Mbinga and I have seen they have plenty of land. Therefore it is sort of a condition that in order to conserve the environment you have to have adequate land or else you should leave and seek other opportunities for ....".* (NGO participant)

Beyond an increased awareness of their own changing climate, it is also important to consider how far participants understand the global causes of climate change and its potential impacts. There are difficulties in explaining climate change as a global 'human influenced process', because it requires some level of formal education to understand the science. Explanation may make smallholder farmers and other AIS stakeholders feel somewhat powerless to respond. The impacts of climate change will intersect with on-going processes of local environmental, social and economic change in a complex system, with some effects being enhanced and others dampened, which also adds to uncertainties looking forwards.

How far is it necessary to understand the global causes of climate change as a precursor to discussions about what will happen in the future? It is important for farmers to understand the *global* nature of climate change, because otherwise discussions of trends in climate at the local level tend to focus only on recent trends or to be conflated with climate variability, instead of focusing on how the future could be *different to the past* and/or that the changes could be on a different scale to that which has been experienced to date. Encouraging a forward-looking analysis of possible future scenarios is a critical element of strengthening adaptive capacity and therefore this requires some understanding of what will be the contributing factors to future change. It is not possible to predict how a complex, adaptive system will change, but you can identify some trends that might indicate whether a system is moving towards or away from social, economic and environmental sustainability (and tipping points), with more significant change in the system triggered by less predictable factors. To build farmer agency it is therefore important to strengthen their understanding of the *direction of change* and the *magnitude of that change*.

However, understanding the global causes, potential impacts of climate change and possible scenarios is not an easy task and is therefore something that requires sufficient time – something that was not available in this process, but could be elsewhere. There was only limited time during this 'farms of the future' process in Tanzania to explain both the global causes and the longer term projections for Lushoto to farmers, because existing levels of understanding of longer-term climate change, as opposed to climate variability, were low, and due to limited time and resources available for the preparatory stages. **The development of participatory tools, materials and programmes to explain global climate change and the science involved and the possible impacts and uncertainties are sorely needed, but need to take account of the risks.** However, communicating a clear message is particularly difficult in some situations, for example where the projections are less certain and where the local context is *highly* complex (e.g. the topography is highly dissected). There are risks that farmers will be confused or worse misled – hence this process of communication requires careful thought and design. The trialling of the Farms of the Future methodology in Tanzania revealed the challenges involved in producing projections and handling uncertainties very clearly.

The topography of Lushoto creates challenges which may have implications for the usefulness of the CCAFS analogue tool. The projections for Lushoto (Centroid point) were for increased rainfall, whereas the graphs for the particular villages participating in the study tour, Mbuzii and Yamba. showed less rainfall by 2030. These graphs of projected precipitation at village level were only obtained quite late on in the preparatory planning week. The latter are more consistent with the trends experienced by local people (declining rainfall), but were in contrast to the widespread projections of *increased rainfall* across this region of East Africa. Finding locations which fit both temperature and precipitation projections was not easy. For example, one of the possible analogue CCAA sites, fitted the precipitation projection, but was colder – whereas the farmers in Lushoto had been told their climate would be warmer. There is a risk that some complex projections and the difficulties of finding a 'future climate' might just confuse farmers if it the climate analogue tool is the guiding principle of discussions. The study tour locations were partially based on the climate analogue tool modelling, but also on other factors.

The idea of a '**climate journey'** thus arose: i.e. visiting locations with different climatic conditions and observing different types of adaptations, as a way of encouraging farmers (and crucially other AIS stakeholders) to consider a wider range of options than previously and **to scan the horizon on a longer time scale**. The idea was to try to motivate the participants to act and innovate. This requires a culture change as well as resources. For the other AIS stakeholders cultural change in their organisations may take time, as organisations can be 'sticky', with inertia flowing from rules and entrenched ways of doing things becoming hard to shift. Many smallholders are **understandably 'risk averse' and 'resource constrained'**. Identifying and working with '**deviant' farmers** is one strategy used in agricultural development, as a source of potential local adaptation, but the question of resources is also important. Those with fewest livelihood assets are less likely to be able to adapt which involves taking risks.

The study team conclude that use of **the analogue tool should be in a 'light touch way'**: i.e. more for selection purposes of study tour location, than for discussion with farmers and as a learning tool rather than one of prediction. Even where climate projection may be more certain (for other locations or in the future), it is always the case that other factors may be more important in shaping change in a particular territory and for particular communities and that social, economic and environmental factors will interact to co-produce unpredictable futures.

In characterising possible visit locations in discussion with AIS stakeholders, a number of criteria emerged as most useful developing an itinerary (see table 10 below).

Table 10: Possible criteria for selecting locations
Farming systems (to support farmer learning in a study tour, it is necessary that a certain level of familiarity with a farming system is part of the selection process - in choosing where to visit - to capture the interest of farmers.
Details of possible learning opportunities (drawing on local knowledge of AIS stakeholders and participants, and potentially farmers where time allows, possible learning opportunities can be identified in planning discussions). Specifically, a learning opportunity could include: i) experiencing an aspect of the future climate as projected by the analogue tool and to observe the practices adopted locally; ii) being able to visit a project where adaptations are being promoted or generated that could be relevant to the visitors; iii) visiting to places with similar social and environmental challenges and autonomous responses.
Environmental challenges and responses (e.g. similar challenges with levels of deforestation and/or positive responses to afforestation or forest conservation etc).
Social challenges and responses (e.g. levels of population density, land tenure arrangements, economic wealth and wellbeing etc).

A difficulty arose in planning, in that the closest and clearest analogue site for Lushoto communities was at the opposite end of the country in southern Tanzania, near the border with Mozambique. The need to travel such a long distance – to reach the required climate analogue site - eventually created a real strain on the tour part. Yet its inclusion was unavoidable if the outputs of the climate analogue tool were to be used.

The study tour enabled farmers to explore future scenarios, by seeing different current scenarios across Tanzania and discussing with their peers what might happen in Lushoto. Farmers drew comparisons about the resources available and climate differences they experienced on the tour and explored diverse scenarios. The initial participatory modelling created heated debate about what might happen '*without action being taken'* and what would happen *'with action'* (of different kinds and by varied actors). With more time to build these scenarios and to discuss pros and cons and potential strategies this could be a very useful tool for facilitating debate. The **combination of modelling and study tour was novel**. The project facilitated a (limited) discussion of the past, present and future possible scenarios and then conducted a study tour to enable farmers to identify new ideas, to be inspired and motivated to change, **encouraging forward-thinking and comparisons to others may help farmers to read the world differently** by experiencing other landscapes, agricultural practices, cultural norms and ways of organising. With more time it would have been useful to conduct a follow-on exercise to see how farmers viewed their own landscape (possibly differently) to before the study tour in the initial exercise. The 3D modelling aspect is particularly useful in highland areas to capture differences according to altitude than would be possible on a flat map.

> '*I ask us too of Yamba village we should conserve our environment by planting trees" (female farmer, Yamba Village).* Another Lushoto farmer stated that: "*I was very happy with this trip and I have learnt a lot…We should be able to pay for our children's education and for ourselves we should be able to meet our life's needs and also to improve the condition of the environment of our area".*

Motivation to act, articulation of demand for support and dependency was another dimension of adaptive capacity building that emerged as an aspect of the Farms of the Future project. Seeing and hearing positive explanations of the weather stations has helped to create demand for the equipment amongst participants and training from CCAFS in how to use the equipment. Other farmers said that they would share with their community the things they had learn, such as growing short duration varieties of avocadoes, maize and potatoes.

The farmers said they were motivated to act following the trip. Some indicated that they needed external support to act. For example, after being shown the study tour footage, an Mbuzii villager said they needed external support. But others thought they should not rely on external assistance, for example, there was significant interest in establishing a SACCOS (savings and credit group) on return form the trip, to improve their farming and environmental management. However, one farmer noted that the farmers running a tree nursery knew how to collect seeds themselves from the trees and plant them in sleeves until ready for planting and said that they should not rely on experts only to obtain seed.

> *"From conserving the environment, there are trees which can thrive here, but we do not have them. If we get seed we can develop ourselves more. Those trees are cinnamon, they thrive well. Me I have tried. I have some 6 plants, trees of cinnamon. The other tree is cloves. From the same conservation of the environment it is a good tree, which is also a cash crop. That cinnamon and cloves; there is a colleague who has tried cloves and the plant is thriving well. I request if there is a possibility we should be given seed and we put in the nursery".* (male villager, Mbuzii)

"Yesterday I visited the areas of Kinole ..The thing which has made me happy is natural vegetation - our colleagues have tried to maintain their environment and now they have got development due to their improved farming and the care of their soil. The farmers themselves have strived to form their own SACCOS. And we too if we strive we can form our own SACCOS in Yamba and it can help us" (male farmer, Lushoto)

It is important that such a study tour is *embedded* in on-going support to disadvantaged smallholders. A balance is needed between avoiding raising expectations and providing follow-on support to capitalize on this raised demand. A female farmer from Lushoto was keen to learn more about the food processing social enterprise, because she was keen to try and process flour back at home, but she thought she would need 'sponsorship'. Both the entrepreneur and the Community Development Officer suggested to her that she should not wait for external support, but could form a group. Similarly, the CCAFS participatory agricultural lead, from SARI, encouraged Lushoto farmers not to rely on him for environmental conservation, but suggested that they should also try to respect their own bye-laws.

"The important things which impressed us; first is the formation of the SACCOS, planting of trees, production of improved coffee, ngoro farming, and bee keeping. The challenges which face us in implementing these things; the first is training the second is capital which is needed. For instance; bee keeping also requires training it requires capital like buying hives, buying equipment for harvesting and other things" (male farmer, Yamba Village).

5.2 Assets and institutions

A particular effort was made in this study tour to identify a broad range of learning opportunities that not only encompass particular technologies, but also other institutional innovations. Technology transfer is unlikely to be the solution to agricultural adaptation, because of the uncertainties involved which require *localized* processes of innovation. Further, while the endowment of a particular territory is relevant (e.g. the quality of soils, type of naturally occurring vegetation), as important is how resources are managed and who has access/control.

5.2.1 Environmental conservation

During the evaluation in Mbinga many of the farmers and agricultural stakeholders noted the importance of environmental conservation, identifying specific practices to try in Lushoto, but also discussing the relationship between conservation, land availability, and diversification of income sources. An Mbuzii farmer who had not participated in the study tour, but who viewed the video of the study tour participants said that the changing climatic conditions have affected their ability to grow coffee, and commented that the tree nurseries could be a potential adaptation. Several participants commented on the differences in environmental management that they had observed in the Uluguru Mountains compared to Lushoto and the Usambara Mountains.

"*We were growing coffee. Currently our areas have become very hot. For instance here at Mbuzii, coffee is no longer there. Coffee has migrated to our colleagues as a result of hot conditions which have entered. But now there is a lesson which is there, which we have seen - tree nurseries. Those are a certainty they will give us success, for first environmental conservation"* (Mbuzii villager)

"I have gone to Kinole. The things which made me happy are natural vegetation. Natural vegetation has been very good because there are some hills with trees looking like a traditional healer's place for healing "vilinge", and at ours such things are not there…. Even other natural plants .. I can see there are many in these fields. The fields are well cared for they do not burn haphazardly as at ours and their livestock keeping is not haphazard. I pray we should go back and emulate such things. And I have been very happy to see a lot of grasses along the way. They are not slashed indiscriminately and the grasses provide forage. They are protecting the good soil well. It is not carried away by soil erosion. I shall imitate this example so that our place becomes like Morogoro, we should take to our village Mbuzii. That is why here the rain falls as it is supposed to. Rivers are full of water (here) in some places (at ours) even springs are not there because of cultivating near rivers and the mountains are not burned indiscriminately" (Lushoto male

However, as well as expressing admiration for the collective activities of the farmers at Kinole, including the SACCOS and their environmental management, a female farmer from Lushoto did point out that the weather is favourable at Kinole and she wondered if the cooperation will be sufficient amongst Lushoto villagers to achieve better environmental management. Some of the constraints she notes are the more favourable weather at Kinole, but also the ability and willingness to work collectively. The Lushoto agricultural extension officer, Abeid Kkungulia, was also positive in his evaluation of the environmental management in the Uluguru Mountains, noting the soil and water conservation measures, fruit tree and pineapple cultivation, which could be taken up to help prevent soil erosion in Lushoto. An NGO participant also praised the environmental management observed at Kinole, noting that there are knowledge gaps in Lushoto regarding which trees should be planted and where, how to establish small groups to manage tree nurseries etc.

Now I do not know if our leaders in Mbuzii village will be able to train/teach in their village so that they should not graze haphazardly in our environment. Thank you very much to the chairman or secretary of our village Mbuzii if he will have the capacity to teach his people so that they can emulate the example of Kinole; they do not graze haphazardly; they do not cut trees anyhow.… I do not know if we will return to Lushoto and be able to return our environment to be like that of Kinole; we should not graze haphazardly, we should not cut trees anyhow; we should have a SACCOS like our colleagues to improve the farmers' livelihood and workers likewise. I do not know if we will have as good cooperation as that. If we can have cooperation like that of Kinole, then our village Mbuzii will be good people we will have motor vehicles like our colleagues in Kinole and other things. Truly I have been very impressed" (female farmer, Lushoto)

"This forest in this area they kept it very well natural. Comparing to Lushoto; that Lushoto has so many terraces because of too much deforestation. Here they don't use terraces but they use intensive agriculture, so they grow different kinds of crops, like herbs, medicinal plants and food crops, together. So I found this village more wealthy…By looking the houses it is bit strange but the way they are it look like they are very rich. But in the future these people here they need to take much care of the natural forest, because it seems they are cutting a lot of trees and indigenous trees they are trying to introduce all this kind of exotic trees' (Lushoto farmer)

5.2.2 Soil and water conservation - Matengo pits

A traditional soil and water conservation technique, which ispractised and demonstrated by the Mbinga farmers at the analogue site, was highly valued by the visiting Lushoto farmers. The interest of the Lushoto villagers could be seen from the rigorous questioning they carried out of the presenters and their keenness to have a go themselves at making a matengo pit, as well as prioritizing this in their evaluations of all the learning opportunities and requesting it should appear in their video for showing to the wider community at home.

> *"This [ngoro] I have seen is easier than at ours. There we use three methods; we use the method of arranging grass in squares in areas depending on the percentage of slope, arranging grass in squares and to dig contours depending on the percentage of the slope and to construct terraces and to plant trees in slopes of 55% and above. Therefore this, if we take it, it will ease our task to make there at ours" (Male, Lushoto farmer)*

Diverse other AIS stakeholders were also positive during the evaluation about the matengo pits and their potential for application in Lushoto.

Photo: Making Matengo pits, Mbinga, Southern Tanzania

> *"At ours* [Lushoto] *people burn grasses with fire, but here people dig up and bury them. They get fertility so someone does not spend a lot buying fertilizers, which are in shops - instead they think about using compost which is natural. And the ngoro farming has also impressed me as I have seen that so you can make a pit for conserving water, and thus irrigate naturally. That has surprised me. I am very happy....."* NGO representative

Photo: Hillsides of Mbinga, Matengo pits

5.2.3 Forestry and cropping innovations

The farmers viewed a range of forestry and cropping practices in different locations on the study tour. There were diverse and rich comments – positive and negative – on what they had seen and whether the practices are relevant for Lushoto. For example, in reflections on Kinole, Morogoro, tree coverage and intensive cropping of cloves, black pepper, fruit trees were seen as very beneficial and associated economic benefits were identified, with several farmers noting that they would aim to plant fruit trees on return to Lushoto. But the risks relating to exotic species were noted by one Lushoto farmer.

> *"There is need too to assist people to do environmental enterprises. This I mean for instance tree nurseries. Tree nurseries should be a business with efficiency. That is producing seedlings of good quality cheaply. It should be done as a business" (NGO represenattive*

The study group visited a tree nursery and were very positive about it, although one AIS stakeholder noted that farmers needed support to establish these and they tend to be more effective when run as an enterprise.

As well as the many positive reviews of the environmental conservation carried out in the Ulugurus and in the tree nursery seen elsewhere, access to land and alternative sources of income generation are desperately needed to enable farmers to take up such practices, with the former being a significant constraint in Lushoto. An NGO representative explained that where land is limited, environmental conservation is difficult and villagers may have to leave the land to find other sources of income to buy food. Access to firewood becomes difficult. In Morogoro, villagers had greater access to land and were able to diversify their sources of income – in Lushoto this is more difficult and farmers will need to be linked to external organisations for seed funding and training. An NGO representative reflected on what this means for his organisation – they should be able to help train farmers to work collectively and be able to provide support on a basket of options. Essentially this means a responsive model for NGOs - providing support to farmers according to what they request help in.

Photo: Viewing the potato trials

"I see there is a problem - people do not have adequate information. Farmers need links to different institutions, financial institutions, for instance, to get capital to start up projects - as we saw CARITAS the way it helped to start fish pond farming. We [Rural Resource Centre] *need to look for people or institutions which can link villagers on this study tour to organisations. And this I know is possible and we will do it. There is also a need for training - beginning with training of people to organize themselves, so that they can do something together and make decisions together. People need links to markets which are profitable markets and to be efficient. This I see we can do. There is need too to assist people to do environmental enterprises, such as tree nurseries. These enterprises, such as bee keeping, can provide alternative sources of income. The work of NGOs like RRC will be to make package or a basket (of options). Someone comes and picks that which he can implement and we should be able to help whatever it is… brick making, gardening, beekeeping, fish cultivation..so people should have a place from where to choose and get away from wholly depending on tilling the land alone* (NGO representative)

Photo: Visiting the crop trials (short duration avocado)

In terms of cropping and livelihood diversification, there were different lessons. There was only limited time to see crops in the field and in some village the main fields were some distance from the village and only accessible on foot. Interest was shown in several of the trials, for example, a round potato variety and coffee varieties, but more time was needed for the visitors to explore the crops and varieties available. A seed fair might have been a useful means for the visiting farmers to access the wide range of diversity available. A detailed explanation of the benefits of bee keeping as a means of livelihood diversification attracted interest amongst a number of male farmers. Reflection and learning can also be stimulated by visiting and observing failed innovations, as much as successful ones. The phaseolus bean trial at Mwitikilwa village were dependent upon a variety released by ARI Uyole and had been tested by the Upendo group, but the trial had <u>not</u> been successful and the Lushoto farmers were puzzled, commenting that their beans grow well, and this may illustrate the risks of innovation,

"This year I do not know if a calamity has occurred or what should we say because the rain after planting beans usually the rain declines a bit. Now after planting the beans and they have germinated/ emerged there was a lot of rain more than in other years. That is why some of the beans rot underground and did not emerge. And there when they had emerged rain came again in the beginning of May and it was a lot, some of the flowers some of the beans were dying burnt by rain when it is plenty". Bean farmer, Mwitikilwa, host village.

"*In this training visit I have learnt that it is important that a farmer should have some other activity besides producing crops for food, to ensure food security and income. For instance you can be farming, but too you can be keeping fish or keeping livestock or you have some other activity, which are far from agriculture as a result of climate change; for you can grow maize and the rain does not fall. So if you wholly depend on agriculture your food security becomes very small. Therefore it is good to have diverse activities"* District community Development Officer, Lushoto.

but also encouraged the Lushoto farmers to reflect upon their own varieties. A problem was encountered for the study tour, because the examples of bean trials at Mwitikilwa which had been more successful were further away than could be reached in the time available. However, important lessons could still be drawn from the robust discussions on bean varieties and cropping practices. When quizzed by the visitors as to why their bean trials had been struggling, the host farmers admitted they were unsure but indicated high rainfall levels and rainfall unpredictability had exacerbated plant diseases.

However, there were also successful innovations, such as the avocado trial in Njombe, which Lushoto farmers evaluated positively, because they enable farmers to obtain fruits more quickly – something that is important as the climate changes and becomes less predictable. Similarly, other shorter duration varieties of maize and potatoes had been observed and were valued for the same reason.

"Bigger trees they are not there. Those trees are small because they are improved which were brought to us by experts, researchers from Uyole. In the past we had local trees which are big. Those trees grow up to 10 years and they have still not begun bearing fruits. The researchers discovered a strategy that we plant that seed, after the tree/seedling has grown we graft and I myself am expert in grafting. After three years after you have planted that tree it starts to bear as you saw those fruits. This is the third year fruit they have borne fruit and over the years it will continue to grow, but they do not become such a big trees as to frighten" Host farmer,, Njombe Village.

"We saw that there is seed of avocado of short duration, of potatoes of short duration of maize of short duration. Now for this system and for the change in climate now for this system we shall take this system we will go back where we come from in Lushoto and mobilise each other as possible so that we also take this system for these seeds of short duration instead of going with that seed of long duration because those do not remove poverty nor to deliver a farmer" Male farmer, Lushoto farmer.

CCAFS is already promoting short duration varieties in Lushoto as part of the participatory action research process, and so the study tour would bolster the value of such activities and might encourage the farmers to further innovate themselves having seen positive demonstrations elsewhere.

"We have seen that in this climate change that there are crops which can deliver the farmer; because for instance they were saying avocado here can stay for 20 years but now this type/seed they have been brought can stay for 3 years; don't you see that they have been delivered! They say potatoes; there are two different seeds/varieties they have said CIP and Kikondo. They say these are seeds which yield well more than the local seeds which they had here; therefore this shows us that these seeds also help to deliver someone. You wait for 3months you do not harvest but you get improved seed in one and half months you have harvested and more harvest. So we have seen that climate change can be fought with different types of seed, modern/improved", Msle farmer, Lushoto farmer.

Photo: Coffee nursery

"Here at ours we were growing coffee. Currently our areas have become very hot. For instance here at Mbuzii, coffee is no longer there. Coffee has migrated to our colleagues as a result of hot conditions which have entered. But now there is a lesson which is there, which we have seen; tree nurseries. Those are a certainty they will give us success, for first environmental conservation". (Lushoto community member)

A coffee nursery run by a Farmer Field School group at Sepukila village, in Mbinga, Southern Tanzania (analogue site) was one of the highlights for the visiting Lushoto farmers, because of the improved Arabica coffee seedlings produced from cuttings. Many of the visiting farmers requested that this should be included within the video footage to be shown in their home communities on return.

"This new coffee one tree can yield 7kg and then this coffee in most cases it is first grade. That is why you hear our colleagues are benefitting from coffee. We here it is always third grade! But this coffee is heavy and of (high) quality. They said it was first grade frequently. Therefore there third grade (coffee) is not there. So we should try this and see if we also can succeed" Male farmer, Lushoto farmer.

"*Nurseries for coffee seedlings through cuttings…truly this was a good thing which we found we do not have. The things we have seen we will not be able to do which are outside our capacity is the expertise of preparing a nursery for coffee seedlings using cuttings. We are requesting the concerned (project) and agricultural experts they should help us with something like this so that we also should be able to accomplish"* Female farmer, Lushoto

Similarly, community members who had not participated in the study tour viewed the coffee nursery in the video footage and were positive that such an innovation could assist them. Coffee is grown less in Lushoto partly due to hotter conditions according to one participant, although unfavourable market conditions could also be another factor.

Interestingly, the study tour led the Lushoto farmers to share with each other innovative practices that they had heard of in their own area. For example, fish keeping was positively appraised by several farmers, and one Lushoto farmer mentioned that he knew of a farmer in his own village who was experimenting with fish keeping and sale of fish products.

"*that pond I have seen there. Our colleagues are keeping fish; small valleys we have. For instance me here if I speak, even if I get that seed/fingerlings I am sure because this is an exercise which is very good. There is a colleague of ours who is trying. Usually every year he brings us fish products here from his ponds. We have him here in Mbuzii. Me I have seen those*" (Male Lushoto farmer)

5.2.4 Access to finance

Access to finance is an important element in adaptation to a changing climate – as there will be some changes which farmers make which will require seed funding or access to credit. The visit to Kinole village, for example, included presentations from a successful savings and credit (SACCOS) group – a scheme which has enabled them to invest more in environmental conservation practices. The links between income, livelihoods, markets, agriculture and environmental conservation were noted as well, with reduced youth outmigration being attributed to more secure and diversified livelihoods, environmental conservation and the SACCOS scheme.

"Another thing is environment care. Environment is also cared for through this SACCOS. The SACCOS gives various loans for instance for buying trees (seedlings) and money for their various field activities and what. All these have heartened me that SACCOS awakens citizens' lives". Male farmer, Lushoto

"Me what I saw is environmental protection at Kinole and caring for fruit trees. This is very important as it makes those forests enable availability of rain… crops too because without rain you cannot harvest anything. And without trees you cannot conserve the soil. So all those things are related..Yes the basic thing is we take this knowledge and take it back with us and work on it so as to improve the environment at ours. The environment should be like that of our fellows as we saw it. Because we saw many things like we saw the market. The market too depends on agriculture. We must have fertile soil so as to get crops so we can make markets. And markets too are a part of income. SACCOS comes from agriculture because agriculture itself is what gives the farmer what gives the farmer income. We have seen many youths [in Kinole] *which is different from at home where many youths have gone to the towns to earn income, leaving the elderly and women at home. If the soil is improved and they farm and get income they would not be going away to go to towns",* Male farmer, Mbuzii village, Lushoto.

5.2.5 Access to and control over livelihood resources

Access to and control over resources is critical for *equitable* development. Positive collaborations were noted in various study tour locations, as being important for securing livelihoods, but also as a means to support specific groups. For example, young people were given employment by the SACCOS scheme in Kinole village.

In such a brief initiative, it is limited how far entrenched gender norms which underpin discrimination can be challenged, but giving women and men farmers' equal status in the study tour and training both groups in using the videos is an important demonstration that the voices of women and men are important.

> *"We have learnt in this group of Mariet food processing that women can be successful if supported. It appears that these women had collaboration with their men. They sat down (and) talked they both had the ambition together to form this group. Therefore after forming this group they managed to establish contacts with different farmers so that they bring their products here and they should be able to process them and let us say as their marketing centre. Therefore under this situation it seems this group is adapting well to climate change that as they continue to educate farmers; farmers are continuing to improve their products and this processing plant continues to get market"* NGO representative, Lushoto

Positive reflections were made by study tour participants about the success of a women's group in food processing. This visit also sparked discussions involving the district community development and women farmers, regarding successful women's vegetable marketing groups in Lushoto and about how to successfully get organized.

The study tour did not necessarily challenge prevailing gender norms about appropriate roles in farming for women and for men – more time would be needed to achieve this and potentially a more central focus given in the study tour. Indeed, study tours could be organized that place this issue at their heart – as opposed to climate change. It is likely to be easier to break out of fixed views on gender roles by meeting individuals and visiting communities where different gender relations are in evidence and by visiting positive role models and successful groups to see what can be achieved, with benefits brought to both women and men.

> *"In our trip when we left Njombe to go Songea to Mbinga there, we went to our colleagues. They cultivate ngoro farming. But that farming is more suitable for women. For us men it is the coffee crop. Coffee from cuttings/seedlings. We have found that it is a very good system. It is the picture we should show to our colleagues home there so that they see an example of that. Thank you very much"* Male farmer, Lushoto

5.3 Ways of organising for collective action

One of the clearest lessons identified by the Lushoto farmers from the study tour was the importance of organizing for collective action. Quite often the innovations 'observed' are part and parcel of group formation and collective initiatives. One farmer noted that the SACCOS group in Kinole village started small – and so they could too – and had been very successful. Others also concluded that collective action can support entrepreneurial activity and that leadership and cooperation is essential.

> *"This SACCOS …they started with very small shares. So I see even we can start. And also it has risen to reach a large share. From shillings 5,000 up to shillings 100,000 this has given me encouragement that even we can because you can start your SACCOS by even having a share of shillings 1,000 for each member"* Male farmer, Lushoto

The Farmer Field School (FFS) approach – as seen in Mbinga – was widely admired by visiting farmers and other AIS stakeholders. The key elements of the FFS approach were outlined by the local agricultural extension officer while at the host village of Sepukila. Advice and

support on farming and environmental conservation were given by extension officers at district and ward levels. Each group establishes a constitution and a bank account, with some seed funds made available to support activities such as the coffee nursery or pasture establishment etc. The group make two plots – one using their traditional farming system, another involving newer practices, and then through a learning by doing process integrate these together. In Sepukila the farmers (male and female) have integrated Matengo pits, ngoro and agroforestry.

However, groups do not necessary run smoothly and good governance and leadership is essential – as noted by one NGO representative.

> *"Challenges! The challenges which I see are market infrastructure such as roads, roads. We have seen almost everywhere market infrastructures are still not very good. And then ensues the issue of capital. The fiscal services are still a challenge. And then organisationally – for people to organise can be a challenge. People should be organised and improve especially the leadership and governance of the groups or SACCOS or VICOBA or whatever"* NGO representative, Lushoto

Collective action at the local level is not sufficient - there is also a need for political will and consolidated action across scales.

> *"The challenge which will ensue in implementing this, is that this requires consolidated efforts; which includes political will because you reach a stage the experts directs this a politician comes and says do not disturb my politicians (citizens/voters). Therefore consolidated efforts are needed in order to be able to implement adaptation to climate change. The efforts of one individual or a small group will not be sufficient"* Agricultural Extension Officer, Lushoto

5.4 Innovation

The ability and willingness to innovate is included as a key part of the adaptive capacity framework. The study tour did seem to encourage a willingness to innovate at least in the discussions of the study tour participants. However, the extent to which they have the capability to innovate depends to some extent on the resources they have with which to take more risks and the support provided (e.g. access to information or seedlings). Thus, this aspect of adaptive capacity is easier to assess after a longer period and should consider the contextual factors that will support or constrain the participating farmers', other AIS stakeholders and their local communities over time.

5.5 Flexible, and forward-looking decision making and governance

The study tour encourage farmers to explore more systematically and collectively the potential future scenarios they face, and with a focus on the changing climate. However, while there is greater willingness to act according to the study tour participants, leadership, good governance and collective action, and external support are needed. It is very important to involve agricultural system stakeholders beyond the farmer level in order to also build understanding, willingness to act and to support the creation of new or improved linkages across scales between farmers and these stakeholders. Many of the participating farmers referred to the study tour as being well run in the sense that links were made between farmers and AIS stakeholders are important and mostly the participants were treated as having equally important contributions to make. Participatory processes have in the past been criticized for failing to adequately take into account the identity and status of facilitators and external actors in externally

> "*I have been made very happy to be able to get an opportunity for training off different aspects and the communication between us and our experts so that when we get stuck in our development we should be able to communicate and to correct that which is making us get stuck*" Male farmer, Lushoto.

driven processes. It is good that (despite failings in communication and logistical organisation) that the participants were positive about the relationship between themselves and the 'leaders' i.e. the AIS stakeholders and facilitators. However, if involving other AIS stakeholders there are risks that their presence could dominate discussions – instead their objective should be to question how they work and to participate as a learner just like the farmers, rather than as an expert teacher on a study tour of this nature. The increased uncertainties created by a changing climate, requires coordinated action that reaches across scales, but also means that extension workers and those providing advisory services will have to take on different roles, moving from teachers, to facilitators of farmer's own learning and experimentation. During the participatory modelling exercise at the very beginning of our process, there was some lack of clarity over the definition of roles, but with some coaching this improved, so that AIS stakeholders began to make this shift to a more learning oriented and facilitative role.

By having separate women's and men's groups it was possible to encourage women to have the freedom to speak out with greater confidence in discussions and community visits. Important signals were given that women's voices are just as important to the men's (e.g. the men's group listened to the women's group summaries of discussions, as well as vice versa; in evaluating the study tour women were asked the same as men for their views; in asking women to film as well as men etc). In the showing of the video footage back in the Lushoto communities, the wider community would also hear and see that the women were given equal status to the men during the study tour. There were some issues encountered as regards women not being allowed to participate by their husbands and this is a challenge for a study tour in any situation of entrenched gender inequality. More time is needed however for proper analysis of women's and men's perspectives and where the differences and commonalities lie.

5.6 Summary of the evaluations by participants

In the men's group evaluation a list was agreed of the most important lessons, and these were the SACCOS, tree planting, improved coffee cultivation, *ngoro [use of matengo pits]* farming and beekeeping.

> *"The important things which impressed us; first is the formation of the SACCOS, planting of trees, production of improved coffee, ngoro farming, and bee keeping. All these things are possible; it is possible to implement them. The challenges which face us in implementing these things; the first is training the second is capital which is needed for instance; if you want to form a SACCOS you must have a building, you should have training.; and also in initiating improved coffee farming you must get training and different implements from experts. Bee keeping also requires training it requires capital like buying hives, buying equipment for harvesting and other things. All these are the challenges we face for now. Thank you".* Male farmer, Lushoto.

In the women's group evaluation, a female farmer from Yamba village, and women's spokesperson for this exercise, identified the matengo pits or ngoro farming, which prevents soil erosion, coffee farming practices, the weather station and cooperation of groups as priority needs for adaptation.

"The important things that we saw and which impressed us in our trip regarding agricultural issues is how our colleagues have used their traditional way of farming called ngoro which prevents soil erosion. The other thing is making of nurseries for coffee seedlings through cuttings. Another thing which we have seen and been impressed is the equipment for measuring weather conditions, use of weather. This equipment is good which enables the farmer to know the changes in climate and how s/he should start be it cultivation or planting. Therefore this equipment has impressed us, which is explaining climate change. Those are important issues we have seen in our colleagues activities. Also cooperation of groups which has helped them in forming their SACCOS, which has helped them in their difficult conditions. It has unstuck them in ...it has given employment to youths and the residents there as a whole. Therefore it is something that deserves our emulating" Female farmer, Lushoto.

Table 11 below summarizes the evaluations of the farmer participants of the study tour and the specific things they learned.

Table 11: Summary of the evaluation

Men's Group Evaluation
• Overall positive appraisals • Positive communication between farmers and 'experts' • Good cooperation between farmers • Leaders and participants treated as equals • Matengo Pits Soil and Water Conservation method • SACCOS Tree Planting • Production of improved coffee • Beekeeping • Need for training (e.g. improved coffee farming), capital (e.g. buildings for SACCOS, hives, tools etc). • System of agricultural learning
Women's Group Evaluation
• Matengo Pits Soil and Water Conservation method • Coffee Nursery and cuttings • Weather Station • Cooperation of groups in forming SACCOS • Need for support from agricultural experts (e.g. how to prepare a nursery for coffee seedlings), Training (e.g. how to make weather station equipment), Capital • Pleased to see a national park for the first time

The final evaluation of the other AIS stakeholders in the study tour and the things they learned most from are summarized in table 12.

Table 12: Other AIS stakeholders' evaluation

Evaluations of stakeholders
• Importance of growing more crops and diversifying agricultural income sources (e.g. beekeeping, fishkeeping) and non-agricultural activities to reduce vulnerability to climate change • Potential to plant many crops that yield highly • Weather station is valuable at village level – to see the flow of rain, changes in temperature and humidity in a particular area and learn how to adapt • Conservation of roadsides to avoid soil erosion – a problem in Lushoto • Matengo pits to conserve soil • Positive meeting fellow service providers and experts to exchange experiences • Important to conserve the environment for food security purposes, but requires sufficient availability of land • Where land is limited people may have to exit agriculture and rely on other cash generating activities to buy food and firewood (difficult to plant trees without land) • Farmers lack information – NGOs can support them by sharing information and linking them to financial institutions (e.g. we saw how CARITAS helped to start fish farming with fish ponds) and projects • Need for training • Need to begin by training people to organize themselves, so that they can work together and make decisions together. This is a potential role for NGOs. • Link farmers with profitable markets and with efficiency. • Assist people with environmental enterprises (e.g. tree nurseries that are run as businesses selling good quality seedlings cheaply and thus supplying other farmers) • Enterprises, such as beekeeping, tree nurseries are important alternative sources of income • NGOs should be able to support farmers with a basket of options like these to be able to respond to requests (demand driven) and can provide tailored support. • Impressed with SACCOS (intending to establish own groups) and environmental conservation (e.g. roadside conservation) • Important to change the condition of the environment first of all • Potential for cultural tourism linkages between Lushoto and the Udzungwa Mountains – find an agent so that we can bring more guests here to this region to support community tourism • Conserve the environment – prevent burning grass with fire, dig and bury the grass instead (training) and to avoid high cost fertilizers (make compost instead) • Tree planting (seen wattle, pine trees planted and were thriving in their areas) and slowing the rate of tree cutting at the same time. Initiate small tree nurseries • Protecting water sources especially important • Cost of inputs (e.g. fertilizers) is a challenge – they are being sold too expensively and there are fake pesticides as well • Avoiding political interference is important – consolidated efforts are needed to avoid this (individual, small group efforts are insufficient)

6. Reflections on the Farms of the Future components and recommendations

This section provides reflections on the different components of the Farms of the Future approach drawing on the Tanzania experience.

6.1 Reflections and recommendations in using the analogue tool

The analogue tool, when presented as a tool for identifying climate analogue sites, would seem to be a scientific means of selecting locations to visit. However, this case is undermined when the criteria used to generate findings – e.g. the level of dissimilarity or how fine grained the analysis – is changed in order to fit a certain location within the selection criteria. It is **important to establish robust criteria for selection and to ensure that various factors influencing the agricultural innovation system are taken into account.**

Initial explanations from some AIS stakeholders in the planning workshop associated the changing climate more with localized processes of environmental degradation than the greenhouse effect. M**ore needs to be done to innovate in terms of visual and practical methods for explaining a scientific process to agricultural stakeholders**, particularly to farmers who may have limited formal education and literacy.

The other AIS stakeholders were also shown the climate analogue maps and graphs, and these did play a part in guiding the discussion on where the study tour should go. However, farmers should also be given the chance to discuss where they would like to go. **Future 'farms of the future' projects should seek to consult smallholders on the study tour itinerary** drawing on the findings of the climate analogue tool but also by drawing up other important criteria and contacts (of facilitators, farmers, other stakeholders).

The analogue maps and graphs had already been used by the NRI team to explore whether the CCAA sites were possible analogues. However, the process of applying the climate analogue tool with CCAFS illustrated that the tool is not yet ready for use as a 'predictive tool'. **The analogue tool should be thought of and presented as a should be used as a 'learning tool' to spark awareness raising, discussion and to inform discussions – which may lead to identification of possible solutions – it should not be presented as a means of predicting and showing future climates as the reality is rarely this simple.** In other words it cannot be used to predict where future climate conditions can be found. Several anomalies and surprises occurred which undermined the confidence of the team in the modelling, and showed **the critical importance of ground truthing modelling data.** However, this requires resources and time.

The complexities associated with dissected landscapes and variation in altitude also lessen the usefulness of the tool in identifying future climates. CCAFS modelling team recognises that the analogue tool does not produce the 'truth', but provides average findings across a large set of GCM models, but even so the prediction of Laikipia as an analogue of Lushoto, the presentation of the growing season in the wrong part of the year, and changing colours to show higher or lower dissimilarity between maps indicate severe limitations with the accuracy of the models to date In Ghana new analogue maps were sent to the NRI team *after* they had gone to the field and did not receive them until after the planning week.

Given the skills required to understand and engage with the technical outputs of the climate analogue tool it is very important that **CCAFS consider building the capacity of district agricultural officers and NGOs to use this tool effectively** and to ensure that any modelling data is thoroughly ground trothed.

In the planning discussions about where to travel to the question arose as to whether it is more valuable to visit sites where farmers are not participating in an external project, or to visit a climate adaptation project where the hosts will have consciousness/awareness of climate change and may have been interesting adaptations to share as a result. For the former group – farmers not participating in an external project, is it valuable to visit farmers living in degraded environments, for example, to encourage visitors to act, or to visit places where more successful adaptation is occurring. The answer to this question may be practical more than anything – **a host organisation is really needed to organise the logistics and to prepare the host communities** and this often involves project type interventions. It certainly **helps to include hosts farmers who have a strong awareness of climate change, as** in Mwitkilwa village, as they are then part of a horizontal extension approach to raising consciousness of climate change. They may be better able to explain to peers how the climate is changing (beyond climate variability) and more convincing of the need to act (particularly where they have successful adaptations to demonstrate) than external NGOs and government extension staff.

It is important to visit *groups of farmers*, rather than 'model farmers', because : i) while it is good to encourage aspiration and for farmers who have been successful to share their findings, if an individual 'model' farmers has higher levels of resources than others within their own community and compared to the visitors then the latter are less likely to identify with them and to learn from them; ii) it is important that the farmers have plenty of time for 'free association', i.e. time to talk freely without intimidation from the presence of other AIS stakeholders and facilitators. For this to happen requires sufficient numbers of farmers (and for AIS stakeholders to be matched with local counterparts, as well as coached in study tour ground rules of 'listening to farmers', rather than having the role as experts.

6.2 Reflections on the study tour component of 'farms of the future'

The question arises: 'What does the climate analogue modelling add to a study tour process?' It might have been possible to organise a study learning tour without use of the climate analogue tool, given that farmers will learn from other farmers wherever they go. However, where a project has a specific agenda – e.g. promoting climate change adaptation - there is an attempt to focus farmer learning on that topic. In this situation it is not possible to systematically assess the contribution (nevermind) attribution of this particular initiative to overall adaptive capacity, given the lack of a baseline for the activity. There is a CCAFS baseline and planned monitoring exercise after 5 years, which could ask farmer study tour participants to recall the study tour and judge whether it influenced their thinking and any follow-on decisions. However, the project, the topic, and the study tour have numerous factors influencing their trajectories and so it is important to recognize the complexity which affects how success can be measured. The most effective approach in future study tours would be to allocate more time to the pre and post assessments by the participants and to **integrate a form of 'light touch' outcome mapping in which different groups would identify areas of behaviour change to track.**

Quite often because it is difficult to assess contribution and certainly to attribute change to networking and exchange type interventions they are less likely to be funded and efforts should be made to capture their value in the broadest sense. The **documentation of the process using video is useful in capturing clearly the views of participants at the beginning, during and after the study tour**. This material could be used at a later date to reflect upon what has changed – as a prompt to participants to remember what they experienced and to spark discussion on what it has meant for them. **To assess outcomes would require some exploration of what happens next** – and this also depends somewhat on the support given by CCAFS for the villagers in participatory action learning.

Straightforward technology transfer opportunities are likely to be limited arising from a study tour, and each new technology has to be appraised by farmers and other AIS stakeholders with awareness of the changing climate – to avoid the risk of mal-adaptation. The shorter term outcome which could be achieved by such an initiative is raising awareness of climate change and the potential impacts on the part of farmers and AIS stakeholders, so that **farmers can appraise new technologies**

and innovations from a more informed standpoint. Further, they are encouraged to learn from their peers and to innovate.

Many lessons emerging in terms of organizing the logistics and in facilitating a study tour, such as ensuri**ng clear communication between the facilitators with regular meetings to agree next steps** – as there will always be changes required in practice during the study tour (e.g. to itinerary, if someone falls sick, if the road is impassable, if a meeting with officials takes longer than expected etc). Essentially, **more preparations prior to the study tour** were needed to ensure a smooth process and a more **appropriate vehicle(s)** should have been selected for such a long visit. The distances travelled – in order to reach the analogue site of Mbinga – were very long and this made the study tour hard work for the participants. The facilitators have a responsibility to the participants to ensure that the study tour is not too gruelling and is conducted safely, as well as offering high quality learning opportunities. It should not be under-estimated how complex a challenge this can be.

During the study tour and between study tours (when a series of study tours are envisaged), **systematic opportunities should be given to allow the facilitation team to reflect upon what works well** and what is to be avoided in terms of logistics and planning, but also in how to maximise learning opportunities for participants.

6.3 Reflections on the use of video

Despite more than a decade of experimentation with participatory video in international development, there is still regular confusion between video documentation by farmers as a tool to support their own research and communication (participatory video) and social documentary (whereby outsiders take the role of filming and make decisions on editing). **Greater clarity is needed amongst those using video as to what its main purpose is and how footage will be used and who owns it**. Too often additional uses of footage are made which are inappropriate.

Table 13: Use of video in development processes

	Key features	Primary audience	Roles
Social Documentary	Anthropological techniques of participant observation and ethnography	External to village	External person films and directs
Participatory video	Facilitation of farmer led enquiry and filming	Farmers themselves (although others will be interested in the footage)	Farmers trained to use cameras and play a major role in editing (choice of what goes in the footage)
Public Relations	External objective guides what is filmed and shown often to paint a positive picture of a project or organisation	External to village	External person films and directs

In this project we have employed video as a means by which farmers can document their own work and can use the video footage to communicate with other farmers and agricultural innovation stakeholders in their own area and beyond. This was successfully achieved, with films being created by the study tour participants and shown back to their communities in Lushoto on return.

Initially, the farmers received a taster of the video in the participatory modelling session and then received follow up training in Lushoto prior to the study tour.

Because the modelling and participatory video methods were successful, an idea emerged that the farmers should be trained to use low cost, easy to use cameras (Flip cameras) and to capture scenes and explanations about change in their village based on the information in the models they had already created. These videos were shown by the Mbuzii and Yamba farmer representatives when they travel on the farmer exchange – to show the host farmers where they come from. Because of time constraints these films were only shown in one village on the study tour, but they are useful discussion tools for the villagers themselves and for CCAFS benchmark site managers. Ideally, more time would be given to this stage of training the farmers than was allowed for due to limited resources, because of the central role of the video in this process.

Farmers that showed a facility for filming during the preparatory work were asked to use the camera during the study tour. One or two women and one or two men primarily did the filming during the study tour. The team made a particular effort to ensure that both female and male farmers were involved – to build the confidence of individuals and to reinforce the message to the whole group that women's voices and participation are as equally valued as those of the men.

Adequate time for training of farmers in filming is advisable. During this Tanzania study tour the farmers needed more guidance on how to film action and people speaking (e.g. presenting a model or demonstrating a piece of equipment or farming technique). For example, it is important to stand near to the person speaking in order to capture their words, but to stand to one side so as not to intimidate the speaker. '**Editing in camera' is really necessary**: i.e. ask those filming not to take non-stop footage, but to think about the purpose of the filming. Although it is not always possible to predict what will be useful, it is possible to direct sometimes, e.g. asking someone to summarize a discussion rather than filming all of the debate of a group. The risk, if this is not done, is that there will be so much footage that it cannot be used properly. However, these 'editing in camera' skills require training. Another lesson following the Tanzania study tour was the realization that **the number of cameras being operated should be limited and each camera clearly labelled**. This will also help to **restrict the amount of footage gathered**.

Participation of all farmers in the editing process is desirable, but time needs to be allocated to it at the end of a study tour. Towards the end of the study tour the participants were asked what footage they would like to have included in the film. Given more time the group would have all participated in the editing process, but this was not possible in this field trip. However, one or two farmers who had been most involved with the filming did support the editing by the facilitators. It is also important to remember that footage has to be downloaded each evening during the study tour to ensure that copies are made on laptops, and this takes time and requires electricity, which can be a challenge where supply is lacking or not consistent.

It is also important to consider how the files will be shared. Internet file sharing sites can be used, but they can tie up broadband capacity and it is difficult to send large files without glitches. Burning footage onto DVDs is another possibility, but they may also not be big enough. **A good alternative is to use high capacity flash drives for sharing** video files**.**

Community showbacks are important element of this process, so that other village members can see and hear the study tour. On return to Lushoto the films were shown to the farmers in each village. This is an important stage in the learning process and time is needed to plan the feedback and allow for discussions. If study tour participants are given copies of their footage on DVDs, it is possible that they could be supported to **view the material on further occasions within the village** or may have facilities in the village to do so themselves. DVDs were produced in this project with the footage and given to the Mbuzii and Yamba villagers so that they can continue to view the films.

As well as the farmer footage, the other AIS stakeholders were given basic training in using the same video cameras and they were encouraged to film their journey and discussions. With more time and resources **farmers and other AIS stakeholders could have been trained in editing to make their own videos, backstopped by facilitators.**

Three Flip video cameras remain with participants in Lushoto – one with each group of farmers and one with the CCAFS participatory action research facilitator.
One of the most critical elements of facilitating a participatory video process is ensuring that there is clarity over the intended purpose and agreed uses of the material generated T It is important that this is made clear to all stakeholders in a process. In Tanzania huge amounts of valuable material has been collected. However, the material was envisaged as having different and specific audiences.

a) the farmers' own videos were never intended to be public material, but were part of their own process of capturing experiences from their journey to share back in their villages. More editing will be needed if their material is to be shared more widely via the CCAFS internet site.

b) the process videos are additional to the farmers' material and are intended to demonstrate the visually the process used during the planning week, during the journey itself, and during village feedback. The materials are intended as a supplement to written reports, rather than as stand-alone films. While portions of the material can be used to illustrate part of the practical exchange process, the different clips will need explanatory footage if to be shared on the CCAFS website.

To produce a more polished documentary – that some might expect to emerge from such a process – would require more resources than are available to this project. **Ultimately copyright of the video footage taken by the farmers belongs to them. Therefore, we requested their permission (signed letter of agreement) that the footage could be used for wider usage**.

A final reflection may be pertinent on 'who drives the agenda' in such participatory learning and video processes'? **A more deeply participatory process would perhaps enable farmer supported learning as driven by their own priorities**, rather than having a pre-set agenda such as climate change adaptation, but funding for this kind of open process and for follow-on support is rarely made available. There is also a question about how this problem could be overcome given that anthropogenic climate change is a phenomenon identified through global scientific research and as we have seen local knowledge of the global phenomenon is incomplete. How then, would it be possible to have a completely open process if it is known that, in general, adaptation will be needed?

Capacity building and **follow on support (e.g. in use of video, sharing of footage) always requires significant investment to ensure that the communications and learning benefits of study tours and exchanges are captured and sustained.**

7. Conclusions

There are limits to what can be achieved by a study tour. To achieve adaptation may require fairly structural and broader policy and institutional challenges beyond the local. However, as a learning process a study tour can enable farmers to learn to begin to read the world differently. It can help them to think critically about their future and encourage them to act. Their evaluations indicate positive learning outcomes in terms of particular farming and forestry practices, environmental management techniques, and ways of organizing.

The analogue tool is useful as a learning tool, but it is important that all participants appreciate that it is not a predictive tool, because of the range of possible future scenarios, uncertainties in the models and particularly in highly dissected landscape situations. While the analogue tool was useful in selecting visit locations, other criteria were just as important in finding useful learning opportunities (e.g. similar socio-economic or environmental challenges, and existing connections to projects). It is important also, because of the uncertainties in the modelling, but also in the change processes at a local level that are multi-faceted and unpredictable, to move away from the notion of single exchange visits or seeing through the 'eyes of the crop' in modelling against growing seasons etc. Instead 'climate journeys' should be considered that take in different aspects of possible (climate) futures to encourage willingness to act, an ability to demand support, desire to innovate, increased information on climate, knowledge of farming and environmental management practices used elsewhere that could be adapted. It is important not to undervalue the process of farmer led enquiry itself, which encourages forward thinking and innovation – seeing others already adapting or sharing ideas and information will be a critical factor in sparking adaptive action.

Video is a highly useful approach to enable farmers to document their own learning in any process, but particularly in a study tour where farmers can share their learning more easily with their own communities (and potentially beyond). It is important that diverse AIS stakeholders are involved in the process to encourage action beyond the community level to address climate change concerns.

Photo: Lushoto dissected landscape

Photo: Mbuzii villagers trying Flip cameras for the first time

Annex 1: Data format request

Planning week participants

Name	Position
Maren Radeny	CCAFS Science Officer, East Africa
Juma Wickama	African Highlands Initiative, Lushoto
George Joseph Sayula	Agricultural Research officer (CCAFS local site team leader)
Eliezer Aisasia Moses	DALDO- LUSHOTO
Tumaini Gwatalile	Community development Officer
Jerome Mwamboneke	Friends of Usambara Society cultural Tourism
Mugyabuso, A	The Registered Trustees of Rural Resources Centre - RRC
Bashiru Hassan Makau	Private input stockist (and former forester)
Nsemwa, L.T.H	Researcher/PV trainer ARI Uyole
Richard Lamboll	NRI team
Nick Quist Nathaniels	NRI team
Valerie Nelson	NRI team
Abeid Kiungulia	DEO Lushoto
Eustard Rwegoshora	Lushoto Business & Technology Incubation Centre
David Mkami	Chair of Lushoto branch Tanzania Chamber of Commerce, Industry and Agriculture (TTCIA)

Planning week programme

Day	Activity
Monday: Planning with project team and local facilitators	Introductions Exploring the climate analogue tool and farmer exchanges Discussing agenda for Tuesday workshop Afternoon visits to AIS stakeholders
Tuesday: Workshop with project team, local facilitators and AIS stakeholders	1. Introduction to workshop 2. Introducing CCAFS programme 3. Lushoto Baseline Study *Tea break* 4. Discussion on climate change 5. Introduction to 'Farms of the Future' 6. Next steps *Lunch* 7. Practising fieldwork (participatory model and video) 8. Video showbacks 9. Planning community visits (Wednesday and Thursday)
Wednesday: Visit to Mbuzii community	Modelling of landscape and climate change (past, present and future) and documentation by farmers themselves using participatory video
Thursday: Visit to Mbuzii community	Modelling of landscape and climate change (past, present and future) and documentation by farmers themselves using participatory video
Friday: Wrap up sessions	Morning meeting of project team and facilitators to draft study tour/exchange programme Afternoon session of showbacks of farmers films of the modelling and discussions Selection of wider AIS stakeholders to join study tour Final planning for study tour and review of budget