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Assessing the economic costs, benefits and drivers of sustainable land management for farmers in Ntcheu District, Malawi & Lushoto District, Tanzania

CIAT Working Paper

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Acronyms and abbreviations

AGORA	Acting Together Now for Pro-poor Strategies Against Soil and Land Degradation project
BAU	Business as usual
BCR	Benefit-cost ratio
CIAT	International Center for Tropical Agriculture
ELMO	Evaluating land management options
Ha	Hectare
IRR	Internal rate of return
Km	Kilometre
MWK	Malawi Kwacha (at the time of writing, USD 1 = MWK 69**7**)
NPV	Net present value
PPP	Purchasing power parity
SLM	Sustainable land management
TLU	Tropical livestock unit
TZS	Tanzania Shilling (at the time of writing, USD 1 = TZS 2,171)
USD	United States Dollar

Maize crops in Malawi

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Demonstration plot

Summary

The study was motivated by the apparent contradictions that exist between what research recommends, projects promote and donors invest in as being the most effective sustainable land management (SLM) options, and those which farmers actually carry out. It contends that much of the received wisdom and many of the commonly used assumptions that guide the design of SLM interventions do not, in fact, provide the most accurate explanation of farmers' decision preferences. As a consequence, SLM investments run the risk of missing their conservation and development targets (or, at the worst, of even serving to worsen the status of farmers' lands and livelihoods). To these ends, the research sought to investigate the costs, benefits and economic drivers that shape farmer's willingness and ability to invest in SLM (or, conversely, encourage or even force them into situations which result in land degradation), and which, ultimately, determine how the success of SLM should be judged in economic terms. An integrated research methodology, combining quantitative, qualitative and participatory methods was used to investigate SLM costs, benefits and economic drivers for farmers in Ntcheu, Malawi and Lushoto, Tanzania.

The results confirm that nearly all farmers in the two study sites are well-aware of the gains associated with SLM, and are applying some form of land, soil and water conservation or soil fertility management technique on their farms. Most make a positive (albeit often somewhat modest) contribution to farm profitability. A key finding is however that many of the SLM techniques that are most commonly practised and which farmers express the greatest preference for are not those which yield the highest production gains, generate the greatest income, or entail the lowest costs (the characteristics that would traditionally be deemed important when land management interventions are selected and designed). Meanwhile, other apparently profitable SLM techniques show relatively low rates of adoption.

It is clear that, while perceptions of economic gain and loss are key to farmers' decisions to adopt or reject particular SLM techniques, it would be over-simplistic to assume that these concepts refer only to efforts to maximise short-term income and production or to minimise cash expenditures and direct outlays. When asked to enumerate and evaluate the key characteristics that drive land management decisions, farmers also highlighted a wide range of non-monetary economic factors that they seek (or look to avoid) when they make land management choices, and which indicate the relative desirability (or not) of different SLM options to them. It is these attributes and characteristics which determine whether an SLM option can be deemed to be economically attractive, viable and sustainable.

The research also shows that in most instances there is a broad correspondence between the SLM options that farmers take up and their stated preference for different techniques. However, in a number of cases, even where awareness of a particular SLM technique is high, preferences are positive and profitability is great, farmers do not invest in it. Conversely, some of the SLM practices that farmers indicate a relatively lower preference for (and which are less profitable) show higher levels of uptake. These divergences can be explained by the often substantial gaps that exist between what farmers would like to do, and what they are actually able to undertake. Farmers are not necessarily able to choose the land management options that they consider to be most effective for SLM or most desirable in economic terms, but engage in those that they can achieve, given their economic circumstances, endowments and the resources available to them.

Two main categories of economic influences or drivers are identified, which shape farmers' needs and preferences, and determine their ability and willingness to invest (or not) in different SLM techniques. The first concerns market access and interactions, and farmers' bargaining power and terms of trade within this external environment. The second relates to livelihood trade-offs and synergies, and the extent to which SLM costs and benefits match up with what farmers actually need and have available to them at different times in the context of the household economy. Both sets of drivers work together to determine the extent to which farmers are forced into a situation where they degrade land in the course of their economic activities, or can invest sufficient resources and capture adequate value-added to make SLM a viable and attractive option.

Unless these broader economic conditions and drivers are identified, and addressed in the land management "solutions" that are presented to farmers, SLM interventions are unlikely to be either acceptable or effective. Yet conventional biophysical and socio-economic survey techniques remain ill-equipped to uncover this information. There is a need to adopt a much more holistic research approach. The study described in this report illustrates the advantages of employing integrated research methods which do not look only at numerical measures of SLM uptake and financial profitability, but also seek to determine farmers' economic preferences and perceptions, as well as to identify and explain the underlying economic drivers and structural conditions which variously enable, constrain, encourage, discourage or even force them to make certain land use decisions.

Bean power in Tanzania

Tubers in East Africa

BACKGROUND: economics in the AGORA project

The project Acting Together Now for Pro-poor Strategies Against Soil and Land Degradation (AGORA) aims "to improve the lives of the rural poor by mitigating or reversing the land degradation that threatens their livelihoods and the underlying natural resource base, and to sustain long-term productivity of their landscapes". Working in Malawi and Tanzania to identify the factors that drive land management decisions, especially those that influence the adoption of sustainable land management (SLM) practices, AGORA seeks to facilitate a process by which farmers are empowered to work together with other stakeholders to design and implement equitable solutions to land degradation and associated development problems.

Generating and communicating the information that is required for decision-makers to formulate more inclusive, effective and sustainable SLM policies and plans, and for local landholders to more meaningfully engage in and benefit from these initiatives, is a key part of the project. Recognising both that land degradation is an issue that is in no small part economic in its causes, effects and potential solutions, and that economic needs and circumstances play a critical role in farmers' ability and willingness to take up SLM, economics forms a cross-cutting topic. Of particular concern is the need to better understand the economic drivers of land management decisions, at the same time as helping to identify practical measures and instruments that will serve to make SLM more economically attractive, viable and sustainable for farmers.

AGORA adopts the stepwise approach to addressing the costs and benefits of sustainable land management that was recently developed by CIAT (see Emerton 2014a; Figure 1). This includes:

(1) documenting the economic conditions and drivers of local land use decisions in Lushoto and Ntcheu Districts; (2) tracing the monetary and non-monetary costs and benefits of land management alternatives for farmers; (3) establishing the economic conditions that characterise possible future land management scenarios for different stakeholders across the study landscapes; (4) valuing the agroecosystem services provided by farmers in the survey villages, and their economic linkages with other sectors and stakeholder groups; and (5) identifying needs, niches and opportunities to enhance SLM economic incentives and financing mechanisms for farmers in Lushoto and Ntcheu Districts.

Adapted from Emerton 2014a.

Figure 1. Stepwise approach to addressing the costs and benefits of sustainable land management

The current document reports on the first two of these steps. It describes the economic context within which farmers operate in Lushoto and Ntcheu Districts, and assesses the economic costs, benefits and drivers that influence their land management decisions and which encourage and constrain SLM.

Farmer in Lushoto

INTRODUCTION: conceptual framework, methodology & definitions

Research question

The research investigates the multiplicity of economic factors that interact to shape farmers' land management choices. It was prompted by a long history of SLM interventions in the two study sites (Lushoto, Tanzania and Ntcheu, Malawi) that have exhibited less-than-enviable success rates in terms of long-term adoption by farmers and lasting impacts on land degradation and local livelihoods. Discussions with key stakeholders and a review of the literature showed that many of these efforts had been based on rather one-dimensional assessments of farming conditions, and over-simplistic diagnoses of the land management challenges that farmers face. Furthermore, it quickly became apparent that different actors' perceptions of assumed land management problems and their recommended solutions often diverged considerably. Particularly notable were the seeming contradictions between what research had recommended and development projects had promoted as being the most effective and desirable SLM options, and those that farmers had actually chosen to carry out (see, for example, Emerton 2014b; German et al. 2010; Kaswamila 2013; Mbaga-Semgalawe and Folmer 2000; Mowo et al. 2006; Peterson et al. 2014; Tenge 2005; Vigiak et al. 2005; Wickama et al. 2004, 2014a).

This raised an important question: *whether the research methods, assumptions and received wisdom that are commonly used to design and conceptualise SLM interventions actually provide the most accurate explanation of farmers' decision preferences (or, indeed, serve to identify the most appropriate ways of addressing the drivers and conditions that lead to land degradation occurring in the first place)?* To these ends, the study sought investigate the costs, benefits and economic drivers that shape farmer's willingness and ability to invest in SLM (or, conversely, encourage or even force them into situations which result in land degradation), and which, ultimately, determine how the success of SLM should be judged in economic terms.

These issues and concerns are not limited to the AGORA study sites (see, for example, Barungi and Maonga 2011; Halbrendt et al. 2014; Kassie et al. 2009; Lovo 2013; Nakhumwa and Hassan 2012; Ngirwa et al. 2014; Pannell et al. 2014; Ward et al. 2016). To a large extent, the situation that can be observed in Lushoto and Ntcheu Districts is indicative of that which pertains in SLM research, planning and implementation more generally. On the one hand, recent years have witnessed a gradual – and altogether welcome – shift in the discourse surrounding SLM, in sub-Saharan Africa and elsewhere. There has been a growing recognition that land degradation should

not be seen solely as a result of technological or informational failures, but rather as being fundamentally social and economic in its causes, effects and potential solutions (Barbier 1997 Emerton 2014a;). The farming "improvements" and technological "fixes" that have traditionally been offered as solutions have begun to be supplemented with efforts to overcome the market, institutional and governance conditions which serve as constraints to farmers investing in sustainable land management place (Gebremedhin 2004; Giordano 2003; Pender et al. 2006).

Regrettably, the research paradigms and methodologies that are used to design, inform and analyse land management interventions have however been slower to take this broader perspective on board. It is possible to discern something of an over-reliance on (and over-confidence in) the generation of "hard" numbers and data, which describe and classify the effects of land degradation and the characteristics of the farmers that suffer it, but do little to explain the reasons why it occurs in the first place (Bojö 1991; Emerton et al. 2016; Nakhumwa and Hassan 2012). Agricultural research still tends to be fairly narrowly oriented towards finding the "best" farming techniques and technologies; meanwhile, received economic wisdom tells us that as long as these options are more profitable in cash terms than (unsustainable) land use alternatives, they will be taken up by farmers (Barungi and Maonga 2011; Lovo 2013; Mangisoni 2009; Mazvimavi 2011).

Yet it has become increasingly clear that the social and economic drivers of farmers' land use decisions are multifaceted and complex, and that the underlying causes of land degradation go far beyond weak knowledge of the "advantages" of sustainable land management practices, ignorance of the "best" technologies or most "profitable" crop mixes, or lack of access to "appropriate" inputs, equipment and training (Jones 2009; Kaggwa et al. 2009; Pandey 2006; Tisdell 1996). It is also evident that both methodological and informational gaps still exist as regards efforts to investigate these drivers. While the suite of biophysical and socioeconomic survey techniques that is now routinely used to research land degradation and SLM undoubtedly provides a good – and wholly necessary – set of tools for observing and recording farm and farmer characteristics and conditions, by itself it is not sufficient to inform effective, long-term solutions (Emerton 2014a).

In particular, it remains a challenge to evaluate land management options from farmers' perspectives, so as to better understand (and then address) the intricate array of factors that interact to shape their preferences for different techniques and outcomes, offer particular constraints or opportunities and, ultimately, drive land management decisions (Tenge et al. 2007; Wickama et al. 2014b). As a consequence, research findings are often partial, sometimes misplaced, and frequently fail to adequately identify or explain the factors that serve to drive, encourage or even force decisions which lead to land degradation (Halbrendt et al. 2014; Tennant et al. 2014). It is therefore perhaps hardly surprising that many of the cleverly designed, technically sound and seemingly profitable projects put in place over the years have failed, because they did not in the event prove to be acceptable, feasible or sustainable for the farmers who were expected to adopt them (Emerton et al. 2016).

"Magic beans" in Malawi

Data & methods

In response to these perceived gaps in research data and coverage, the current study adopts an integrated, holistic approach which incorporates a variety of methods, outlooks and indicators. The intention is to allow for a much broad range of influences on farmers' land management decisions to be investigated than would normally be the case in a more conventional economic analysis. This document draws on data collected via a variety of quantitative, qualitative and participatory survey techniques, each aiming to elicit information on different topics or according to different perspectives (Table 1).

Table 1. Summary of survey techniques used in the economic assessment

Survey technique	Sample selection	Sample size	
		Lushoto	Ntcheu
Focus group discussions	Separate women, men and mixed groups	12 groups	12 groups
Household questionnaires	Stratified random sample of men and women farmers of varying socio-economic status	159 farmers	312 farmers
Farm budget assessments	Mixed groups of men and women farmers of varying socio-economic status	42 farmers	20 groups
Evaluating Land Management Options (ELMO)	Purposive sample covering range of SLM practices	20 farmers	50 farmers

- **Focus group discussions** were held separately for men, women and mixed groups in each of the eight survey villages in the two sites. These comprised a preliminary framing and scoping exercise with which to generate coarse grain information on land management context and drivers, and to inform the focus and content of subsequent data-gathering exercises. Topics of discussion included the status and composition of local livelihoods, farming systems, market conditions, trends in land productivity and farm income, land degradation causes and manifestations, and SLM practices;

- Picking up on key topics identified in the focus group discussions, **household questionnaires** were administered to 471 men and women farmers of varying socio-economic status in the study landscapes. Detailed quantitative data were collected on household economic characteristics and endowments, livelihood and income sources, farm production, SLM knowledge, awareness and adoption. Data were analysed overall and at a disaggregated level according to gender and wealth/poverty status;

- For a selection of the SLM techniques elaborated in the household questionnaire survey, **farm budget assessments** conducted with mixed groups of men and women farmers of varying socio-economic status in each of the eight survey villages in the two sites. The input requirements of different SLM techniques were costed, and additional production, outputs and impacts on crop productivity were valued;

- **Evaluating Land Management Options (ELMO)** was carried out with 70 farmers in the eight survey villages, covering a representative range of the SLM techniques for which data on uptake levels, costs and benefits had earlier been gathered. ELMO is a novel method that has been developed under the AGORA project (see Emerton et al. 2016). It uses participatory techniques to investigate farmers' own preferences and perceptions of the economic advantages, disadvantages and trade-offs associated with different land management choices as they relate to their own needs, aspirations, opportunities and constraints; and

- A variety of **community consultations and stakeholder interviews** were held in Lushoto and Ntcheu Districts and at the national levels in Tanzania and Malawi, with line agencies, non-governmental organisations, land management experts and other groups working in areas relevant to SLM.

Not only were these integrated survey techniques intended to capture different types of information and perspectives, but they were also designed to deliver an iterative, phased approach to investigating the economic factors that shape farmer's willingness and ability to invest in SLM (Figure 2).

Figure 2. Integrated approach to assessing SLM costs, benefits and economic drivers

The initial focus group discussions therefore identified key livelihood sources and topics to be further investigated in the household questionnaires, as well as providing a preliminary list of SLM techniques to be included. Building on this, the household survey collected quantitative data about farmers' livelihoods, farming systems and SLM practices. The most common SLM techniques were then subjected to a more detailed financial analysis via the farm budget assessments. The ELMO exercise then focused on investigating farmers' preferences, perceptions and trade-offs for a sub-set of these costed SLM techniques. The focus group discussions held as part of, and alongside, ELMO also enabled information to be compiled on the broader economic conditions and drivers that variously constrain and enable SLM.

There are certain limitations to the study that should be made explicit at the start. Many arise from the fact that this integrated economic methodology was being developed and piloted for the first time under the AGORA project. Certain gaps, mistakes and inconsistencies inevitably arose.

In order to avoid duplication and respondent fatigue, the household questionnaire data for Ntcheu was drawn from two separate SLM surveys that had recently been carried out by CIAT for other purposes. These questionnaires were not identical to each other, or to the Lushoto questionnaire, meaning that not all of the data gathered were consistent or could be aggregated / compared.

Ideally, every one of the SLM techniques identified in the questionnaires as being used in Lushoto and Ntcheu would have been followed up in the farm budget assessments and then in ELMO. This would have yielded a full set of data for comparison. Because of time and budget constraints, as well as due to a wish to focus on those practices that farmers were most familiar with, this was not done. Each step of the data collection process narrowed in on a progressively smaller sub-set of SLM techniques (22 SLM techniques were identified and investigated in each site via households questionnaires, the farm budget assessment focused on 10 SLM techniques in Lushoto and 8 in Ntcheu, and the ELMO exercise covered 7 SLM techniques in Lushoto and 8 in Ntcheu, not all of which overlapped with those considered in the farm budget assessment). The farm budget assessment and ELMO survey samples were also fairly small, and therefore cannot therefore be taken as being significant. No detailed statistical testing or analysis of correlation was undertaken. Although expressed in a numerical format, the results provide only an indication of likely trends and observed patterns.

Terminology

This paper takes the definition of SLM given by FAO/TerrAfrica, as: "the adoption of land use systems that, through appropriate management practices, enables land users to maximize the economic and social benefits from the land while maintaining or enhancing the ecological support functions of the land resources" (FAO 2007).

Twenty nine of the most commonly used integrated soil fertility management and land/soil and water conservation practices in Malawi and Tanzania were investigated over the course of the study: agroforestry; basins; box ridges; burying weeds; chain boxes; composting; conservation agriculture; contour marker ridges; contour planting; crop residue incorporation; crop rotation; cut-off drains; enclosures/set asides; fallowing; *fanya juu* terraces; farmyard manure; grain-legume intercropping; grass strips; green manure; lime; *matengo* pits; mulching; natural trees on-farm; rainwater harvesting; ripping; *sasakawa*; stone bunds; terraces; woodlots (for definitions and more detailed descriptions see Annex Table 9, WOCAT 2016).

Sharifa Juma cava terrazas para detener la erosión del suelo

Nema Obeti with her coffee plants

"Magic beans" in Malawi

CONTEXT: overview of the study sites

Human & physical landscape

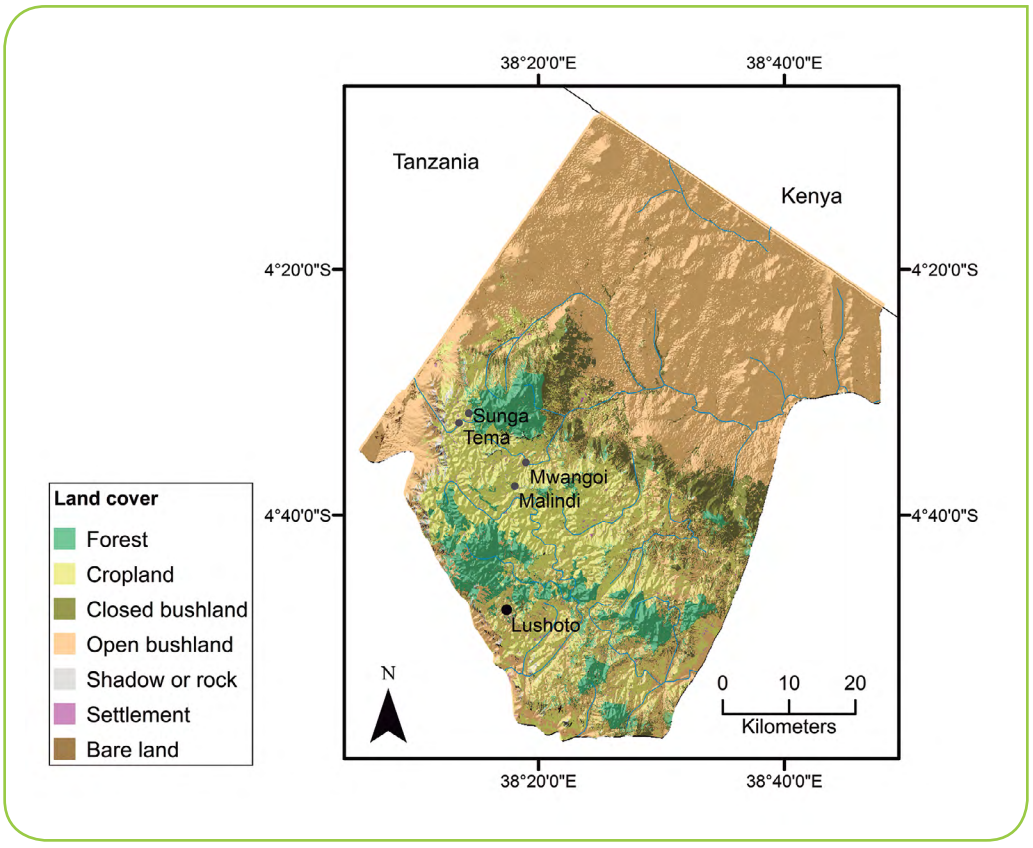
The research was carried out among smallholder farmers living in eight villages: Malindi, Mwangoi, Sunga and Tema in Lushoto, Tanzania and Gwauya, Kapulula, Malaswa and Mpulula in Ntcheu, Malawi (Figure 3). Lushoto District is situated in Tanga Region in northern Tanzania. It is bounded on the north-east side by the border with Kenya, while the main Arusha-Moshi-Tanga/Dar es Salaam road marks the south-western limit. Lushoto is has a steep and rugged topography (Peterson et al. 2014). Highland areas above 1,000 metres cover about 75% of the district (Lushoto District Council 2016). Slopes of 45-55% are frequent (Lyamchai et al. 2011) and in many cases the land gradient goes up to 60% or more (Tenge et al. 2005). Annual rainfall varies between 900 and 1,300 millimetres, depending on the agro-ecological zone (Sijmons et al. 2013), and is divided into two distinct seasons: the long rains (masika) from March to June, and the short rains (vuli) from October to December. Although predominantly rural, the District is heavily populated. The 2012 average population density of 120 persons per km2, was around one and a half times greater than that for Tanga Region as a whole, and almost twice as high as the national average for mainland Tanzania (NBS 2013).

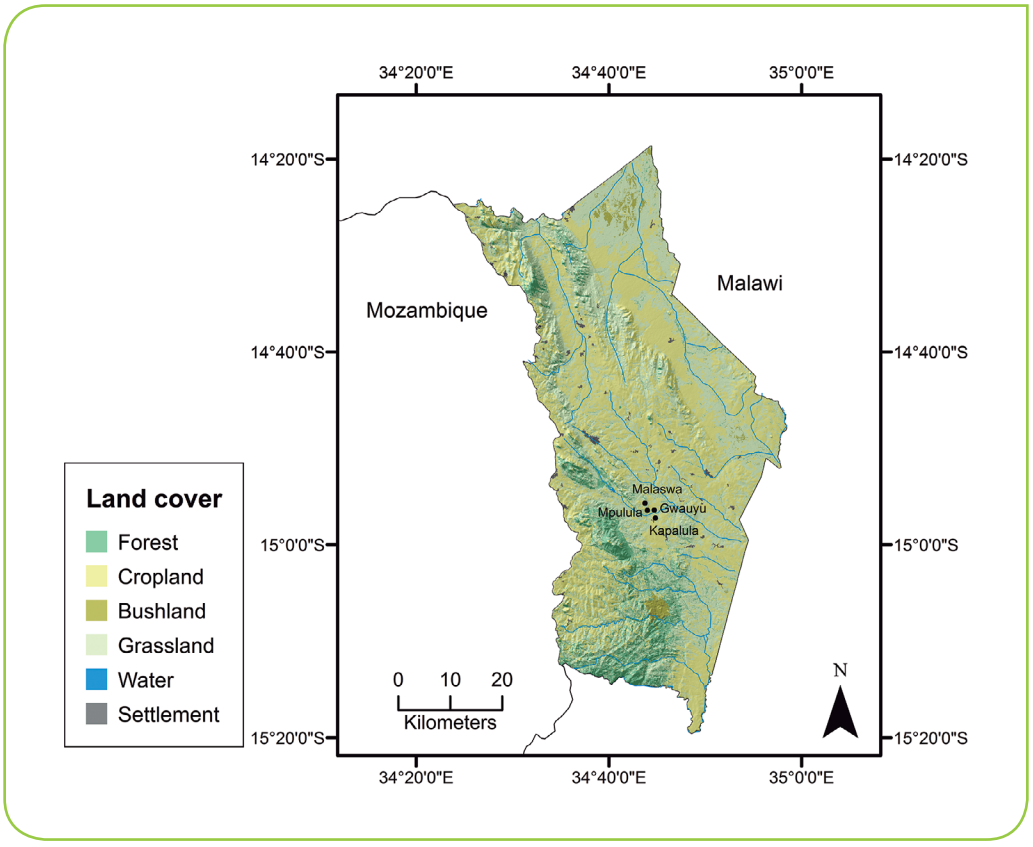
Lushoto is a high-potential area, with fertile soils and a favourable climate for agriculture (Gorter 2012). While more than two thirds of the land is considered suitable for arable farming (Lushoto District Council 2016), less than a quarter is actually planted to annual crops and vegetables (MAFSC 2012). This is because large areas of the district are under forest (an estimated 12% according to District Council figures) or have been gazetted as wildlife conservation areas (around 60%). Agriculture dominates the economy, forming the main occupation for an estimated 85% of the rural population (Lushoto District Council 2016). The main food crops are maize, rice, potatoes, beans, cassava and bananas, and vegetables, fruits, Irish potatoes, coffee, paddy, tea, sisal and cotton are all important cash crops. Farms in Lushoto provide a steady supply of fruits, vegetables and other products that are sold in other towns and cities in northern and central Tanzania.

Ntcheu is located in the south-west of Malawi, in the far south of the Central Region. The district is bisected west to east by the main Lilongwe-Blantyre road, and the Mozambique border marks its western edge. There are two pronounced terrain patterns: the fertile and relatively flat Bwanje valley in the eastern part of the district (mainly situated between 400-600 metres above sea level), and the Kirk Range, an upland area with

steep slopes, that runs along the west side (600-2,000 metres). Overall, Ntcheu is characterised as semi-arid (LTSI 2014a), with a single rainy season that runs from December to April. Annual rainfall ranges between 600-1,200 mm, with the upland plateau generally having a higher precipitation as compared to the lowlands and valleys (Economic Planning Division 2009). Land use is dominated by mixed smallholder cultivation and miombo woodland, with a small area of pine forest plantation (LTSI 2013d).

In 2008, both population density and growth rates in Ntcheu were slightly below the national average, at 138 persons/km2 and 2.5 per cent respectively (NSO 2009). Some areas of the district were even recorded to be experiencing negative growth rates due to outmigration, and because of the repatriation of Mozambican refugees (Economic Planning Division 2009). Livelihoods are based around farming (Mkandawire 2010), with more than 80 per cent of the population engaging in agriculture as their main occupation (NSO 2012). The main rainfed crops are maize, beans, groundnuts, potato, millet, cotton, soya beans, cassava and sweet potato, with irrigated vegetables also cultivated in valley bottoms. Many of these products are traded at markets along the main road, before being transported onwards to Blantyre, Lilongwe and beyond (Economic Planning Division 2009; Nanthambwe 2013).





Lushoto land cover was mapped in 2014 and shows major land cover categories. Ntcheu land cover for 2010 was obtained from GLC30.

Figure 3. Location of study sites

Household economic endowments & assets

Table 2 shows the 2015 population of the survey sites. The study villages span a wide range of settlement densities. At the aggregate level, at 385 persons/km2, the Lushoto survey site is almost three times more densely populated than the Ntcheu one (137 persons/km2) and as compared to Lushoto district as a whole (130 persons/km2). This reflects the relatively high agricultural potential (especially for Mwangoi and Sunga Villages), as well as proximity to Lushoto town (the district headquarters). Meanwhile, the generally lower population density in the Ntcheu survey site (especially Malaswa and Mpulula) is no doubt linked to the more marginal nature of farming and the less-intensive forms of land use that are practiced.

Table 2. Population in the survey sites (2015)

	Area (km2)	Persons	Households	Density (persons/km2)
Lushoto				
Malindi Village	9.3	2,278	673	244
Mwangoi Village	6.1	6,162	1,397	1,007
Sunga Village	1.0	2,177	464	2,160
Tema Village	16.1	1,896	372	118
All study villages	32.5	12,513	2,906	385
Survey site wards	**272**	**65,975**	**14,038**	**243**
Total District	**4,092**	**533,415**	**113,493**	**130**
Ntcheu				
Gwauya Village	1.1	437	93	397
Kapulula Village	1.4	620	132	443
Malaswa Village	7.4	616	131	83
Mpulula Village	6.2	526	112	85
All study villages	16.1	2,199	468	137
Survey site TAs	**777**	**77,031**	**18,341**	**99**
Total District	**3,424**	**563,989**	**135,262**	**165**

Based on data presented in NBS 2013 and NSO 2009, projected to 2015 levels using specified District growth rates.

Table 3. Summary of basic household characteristics in the study villages

		Lushoto	Ntcheu
Labour			
Household size	(no. persons)	5.7	5.2
Dependency ratio	(non-workers : workers)	1.52	1.22
Land			
Farm size	(ha)	0.9	1.7
Land area/capita	(ha)	0.19	0.35
Plots of land	(no.)	2.8	2.1
Farmers with hillside plots	(% farmers)	97%	72%
Farmers with valley plots	(% farmers)	60%	56%
Farmers practicing irrigation	(% farmers)	58%	33%
Livestock			
Farmers with livestock	(% farmers)	88%	75%
Herd size	(TLU)	1.17	1.35

From household questionnaire surveys.

Table 3 summarises basic household characteristics in the study villages. Average household size (5-6 permanent residents[1]) and age-dependency ratios[2] (1.5 in Lushoto and 1.2 in Ntcheu) are similar, but slightly larger than the figures recorded for other rural areas in Tanzania's Tanga Region and Malawi's Central Region (see NSO 2012, NBS 2013 and 2014a). Just over a fifth of households in the Lushoto study villages are headed by women and a third in Ntcheu, closely mirroring regional statistics. Female-headed households tend to be smaller in absolute terms than male-headed ones in both of the study sites, as well as having a higher proportion of dependents as compared to adult working-age residents. A similar situation holds for poorer households, although in Lushoto the differentiation between richer and middle households is far less clear-cut than is the case in Ntcheu. The implication is that productive labour remains relatively scarcer for poorer and female-headed households, who must also meet the demands of a larger number of dependents from this limited labour base. As described below, this pattern of lower access to resources and inputs is also clearly discernible in relation to other factors of production and economic assets (Figure 4, Figure 5; Annex Table 10, Table 11).

At 0.9 ha, average farm size in the Lushoto study villages is slightly lower than in other parts of the district (as recorded in MAFSC 2012), whereas in Ntcheu the landholding of 1.7 ha per household is almost twice that recorded for rural areas of the district as a whole (see Emerton 2014b; NSO 2012). A common factor in both sites is, however, that farms have reduced in size and become increasingly fragmented over time. This is particularly the case in more land-scarce Lushoto, but is also identified to have taken place in Ntcheu. Whereas in the past, holdings tended to be larger and composed of contiguous fields, most farmers now cultivate several small plots: in Lushoto an average of three 0.34 ha plots per household, and in Ntcheu an average of two 0.65 ha fields. On the one hand this is a natural response to the problem of increasing land scarcity – larger, consolidated plots are simply no longer readily available.

It is also a strategy to spread risk and increase resilience. Cultivating several plots, especially if these are divided between upland and lowland areas (see below), offers the opportunity for farmers to diversity both the range of crops they grow and the time period over which they are harvested. It helps to even out the availability of food and income across the year, and also offers a source of fallback should one source of production fail (or its market collapse) – an all-too frequent event in both study sites. It should however also be noted that farming multiple plots comes at an additional cost. Fields are often fairly dispersed, and located at quite some distance from the homestead. This means that labour must be spread across a relatively wide area, and requires additional time to be invested in transporting crop inputs and outputs between fields.

In both sites, different parts of the landscape offer quite different farming opportunities. Hillside fields are almost exclusively rainfed, are often located on slopes, and tend to be characterised by relatively poor soil fertility, a higher risk of erosion, and thus lower and more uncertain yields. In contrast, valley-bottom lands are flatter, with moister and more fertile soils, and are frequently situated close to rivers or in seasonally flooded areas meaning that they are relatively easy to irrigate (or even that manual irrigation is unnecessary). In Lushoto, more than three quarters of valley-bottom plots are irrigated, while in Ntcheu around a half are. A relatively wide range of vegetables (typically including potatoes, cabbages, carrots, onions and tomatoes) can be grown across the year, while hillside cultivation is mainly limited to single harvests of maize, beans and a few rainfed vegetables. The reliability, productivity, ease of cultivation, crop-growing period and range of crops grown – as well as, ultimately, the profitability – of valley-bottom cultivation is thus much greater than for hillside plots. It is perhaps unsurprising that, where people have access to valley plots, they will tend to concentrate their labour, fertiliser and other cash investments on them, because the pay-off is so much higher than for hillside farming.

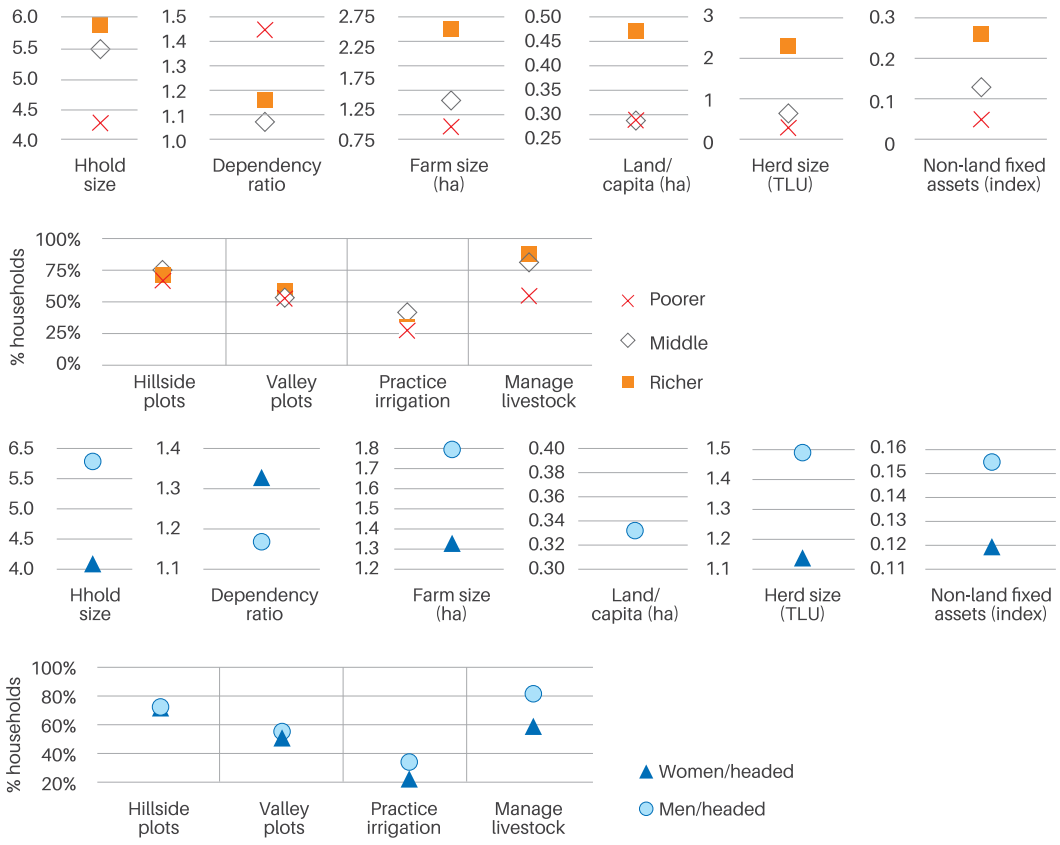
With few exceptions, farmers stated that they would ideally choose to cultivate plots in both upland and lowland areas. In reality, not all farmers do: valley-bottom farms are scarce in both sites. While the vast majority of farmers (almost all in Lushoto and just under three quarters in Ntcheu) carry out hillside farming, only around 60 per cent are able to cultivate valley-bottom fields.

1 People who live at the homestead for the majority of the year.

2 Number of dependents to each working-age member. Working-age is defined as 15-64 years, in line with the age range used in Tanzania's 2012 Population and Housing Census (NBS 2013) and Malawi's Third Integrated Household Survey (NSO 2012).

From household questionnaire surveys.

Figure 4. Lushoto variation in household economic and livelihood indicators by wealth & gender



From household questionnaire surveys.

Figure 5. Ntcheu variation in household economic and livelihood indicators by wealth & gender in

In both sites a much lower proportion of female-headed and poorer households have access to valley-bottom plots and irrigated fields, as well as reporting smaller farm sizes[3] and fewer plots overall. In Lushoto, in particular, men tend to control lowland farms, leaving women in less productive hillside areas. Rental and sale markets for valley-bottom land are also limited, and prices are high enough to be beyond most people's means. In Lushoto, one response has been for farmers to come together to jointly cultivate lowland areas, sharing in both the costs and the harvest. Another alternative is for a person who owns valley-bottom land but lacks labour to invite friends or relatives to assist in cultivating it, usually under some kind of profit-sharing arrangement.

Cash & non-cash income sources

	Lusho-to	Ntcheu
Total income⁎ (2014 USD/year)		
Per household	1,620	1,567
Per capita	342	311
Per capita (PPP Internat'l USD)	954	815
% total income⁎ contributed by⁎⁎:		
Home crops	32%	54%
Crop sales	30%	15%
Livestock	11%	6%
Casual labour	12%	5%
Other off-farm	14%	20%
% hholds earning cash from:		
Crops	70%	74%
Livestock	45%	36%
Casual labour	44%	27%
Other off-farm	45%	61%

⁎ Cash earnings plus value of home-consumed production; ⁎⁎ averaged across all households, not just those engaged in activity. From household questionnaire surveys.

Figure 6. Summary of income sources in the survey villages

At around USD 1,600 (TZS 2.8 million in Lushoto and MWK 684,000 in Ntcheu), average annual total income[4] per household translates into per capita values of USD 342 and USD 311 respectively (USD 954 and USD 815 when adjusted for purchasing power parity and expressed in international USD[5]) (Figure 6). This is in line with the consumption/expenditure figures recorded for rural areas of Tanga and Central Regions

3 It should be noted that average landholdings per capita are markedly higher for female-headed households in both sites, even though absolute farm size and number of plots are lower. This is because female-headed households tend to be much smaller.

4 "Total" income includes cash earnings from crops, livestock, casual labour, employment, trade and business, plus the value of home-consumed farm production.

5 USD values which have been converted using the official exchange rate in each country cannot, strictly speaking, be compared directly with each other. They have relevance only in the context of the country for which they have been calculated. This is because real price levels differ between Malawi and Tanzania, and the exchange rates that prevail are subject to controls and distortions. An international USD has the same purchasing power as the USD has in the United States, and is a commonly accepted numéraire for cross-country comparisons or aggregations of economic statistics.

as a whole (as expressed in NSO 2012 and NBS 2014b, converted to 2015 levels using CPI deflators taken from IMF 2016). There are however noticeable differences in both the composition and level of income between different types of households. While it is perhaps self-evident that total income and cash earnings vary in direct relation to household wealth status, figures are also markedly higher for male-headed households (USD 1,725 in Ntcheu and USD 1,856 in Lushoto, as compared to USD 1,217 and USD 1,071 for female-headed households)[6] (Figure 7, Figure 8).

In both study sites, arable agriculture forms the basis of most households' livelihoods (although is by no means the sole source), contributing between 60 per cent (in Lushoto) and just under 70 percent (in Ntcheu) of total household income (Figure 6). Around 70 per cent of farmers generate cash earnings from selling crops, which contribute an average of 45 per cent of cash income in Lushoto and 32 per cent in Ntcheu. While crops contribute a similar proportion of total household income overall, the relative share from crop sales tends to be greater for richer and male-headed households, whose participation in crop marketing is also higher. In contrast, home consumed crops are comparatively more important for poorer and female-headed households.

Although a substantial majority of farmers rear livestock (88 per cent in Lushoto and 75 per cent in Ntcheu), direct contribution to household production and consumption is relatively small (just 11 per cent of total income in Lushoto and 6 per cent in Ntcheu). Only around a half of livestock keepers market their produce, and households most commonly keep poultry. The relatively higher values in Lushoto are mainly due to the much higher incidence of cattle ownership and greater participation in dairy production (for both home consumption and sale). In Lushoto, 68 per cent of livestock keepers manage cattle (as compared to 20 per cent in Ntcheu), almost two thirds of whom keep cross-breed or grade stock. Overall, respondents in both sites however emphasised the role of livestock (particularly cattle and smallstock) as a source of security and status as being of primary importance, not their contribution to production and consumption per se. Animals are used a store of wealth, and also typically serve as assets that can be liquidated and quickly converted into cash in times of emergency or to meet sudden or unplanned cash needs (for example should crops fail, when there is illness, or if there is a need to pay school fees or to build a house). For female-headed and poorer households, the lower incidence of livestock ownership and smaller average herd size is therefore manifested not just in a smaller livelihood base, but also via more limited reserves.

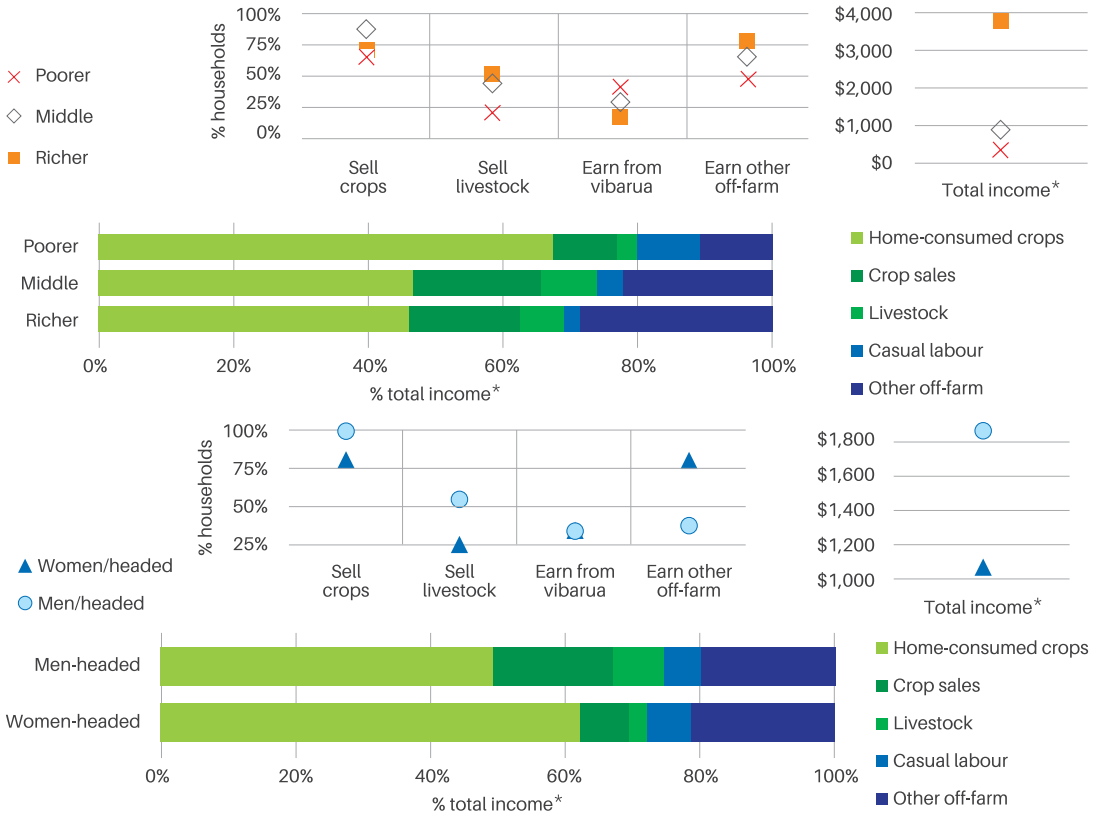
Few, if any, households are able to meet all their consumption and cash needs from farm production alone. In Lushoto, a third of farmers (and around half of female-headed and poorer households) stated that they experience serious food and cash shortfalls every year, lasting an average of 3-4 months. In Ntcheu just under two thirds of households are in a food deficit situation for more than half of the time. This makes it necessary to supplement farming with other income-earning activities, so as to be able to purchase additional food and to meet other cash needs. In both study sites, around a quarter of the value of total annual income is typically contributed from non-agricultural sources – and, at certain times of the year, off-farm earnings offer virtually the only means of sustaining the household.

It is commonplace for farmers in Lushoto and Ntcheu to hire out their own labour or that of other household members. This usually takes place on a seasonal basis, during the pre-harvest "hungry season" and at other times when food and cash are particularly scarce. In Lushoto 44 per cent of farmers regularly earn income from vibarua, and in Ntcheu ganyu provides a source of earnings for 27 per cent of households. The rates of participation are higher for female-headed and poorer households in both sites (including more than half of poorer households in Lushoto and almost 40 per cent in Ntcheu), for whom other sources of cash income are often unavailable.

6 As is the case for land, this does not however translate into a significant difference in per capita income in Ntcheu (although does show a clear difference in Ntcheu). This is largely because of the smaller size of female-headed households.

* Cash earnings plus value of home-consumed production. From household questionnaire surveys.

Figure 7. Lushoto variation in income sources by wealth & gender



* Cash earnings plus value of home-consumed production. From household questionnaire surveys.

Figure 8. Ntcheu variation in income sources by wealth & gender

These types of casual (usually agricultural) labouring opportunities offer an important (and easily accessible) way of earning income, especially at times of the year when other sources of food or cash are in short supply, and for farmers who are unable to access valley-bottom plots. For those households that do participate, sales of casual labour tend to be of major significance to the household economy, contributing an average of almost 60 per cent of cash income in Lushoto and just under 50 per cent in Ntcheu (rising to 80-90 per cent for poorer and female-headed households). For some farmers they comprise the only reliable source of cash – for example, for 7 per cent of households in Lushoto and 6 per cent in Ntcheu, vibarua and ganyu contribute 90 per cent or more of total annual earnings.

Temporary or permanent labour migration is also widespread in both sites. It is particularly common for (mainly young) men to work outside the village for short periods in order to earn cash, and then to return at times of peak on-farm labour demand. Longer-term migration is also prevalent. In Lushoto all households have members who live and work elsewhere for 6 months or more of the year: an average of 1.9 temporary residents, or 1 person for every 3 permanent residents. In Ntcheu 18 per cent of households earn income from remittances, which contribute an average of 53 per cent of total cash earnings. In contrast, very few households have members who are in formal, regular employment (although this tends to be a very important source of earnings for the minority who do). Just nine per cent of households in Lushoto and 11 per cent in Ntcheu have one or more members with a salaried job.

Various other off-farm sources provide regular or occasional cash earnings. In Lushoto 37 per cent of households are engaged in businesses additional to farming, and in Ntcheu a quarter participate in petty trade. Off-farm income activities range from occasional sales of small handicraft or food items, through small-scale enterprises which are run on a collective basis or by farmer groups (such as beekeeping and poultry-raising), to the operation of shops, grinding mills, manufacturing and construction businesses. In Lushoto several farmers earn income from trading in other people's farm produce, making an offer on the crop while it is still growing in the field, and then selling it on to external traders after harvest. There are also well-developed markets for various natural resources in both study sites. In Lushoto almost 30 per cent of households generate income from the sale of wood, charcoal, sand, bricks, non-timber forest products and other items, and in Ntcheu the figure is far higher. It should also be noted that natural resources form a key source of household consumption – especially for poorer farmers who are unable to afford purchased alternatives. More than 90% of households in Lushoto and Ntcheu depend on firewood as their main domestic energy, and many also rely on nearby natural forests, woodlands, grasslands and wetlands as a source of construction materials, grazing and fodder, wild foods, natural medicines and other items.

In both sites, richer households show much higher rates of participation in trade and business than do poorer households, and also earn a relatively higher share of household cash income from it. In Lushoto just 25 per cent of poorer farmers generate cash income from off-farm sources (as compared to more than 60 per cent of richer households) and in Ntcheu 45 per cent (as compared to 77 per cent), contributing an average share of 8 per cent and 11 per cent respectively (as compared to 25 and 29 per cent for richer households). While a higher proportion of female-headed households participate in business and trade activities as compared to male-headed households, there is little difference in its contribution to household income.

There is evidence in both sites that different types of households face varying opportunities as regards business and trade, and that the barriers to entry remain high in some cases. Poorer households and women often lack access to the knowledge, training, contacts or investment capital that is required to enter into higher-return activities such as manufacturing, construction and retailing (although frequently provide labour for other people's businesses). They tend to focus more on group rather than individual activities and on those small-scale businesses and trading opportunities for which no additional equipment, funds or knowhow are required, as well as favouring activities that can be picked up and dropped on an irregular basis, as the need arises. Natural-resource-based activities often provide a relatively easy (although typically low return) source of cash for poorer farmers, with firewood trading, charcoal production and brick-making being particularly common among farmers in Ntcheu.

A farmer in Malawi checks her maize crop

LAND MANAGEMENT PRACTICES: on-farm land degradation & SLM uptake

How land degradation is manifested

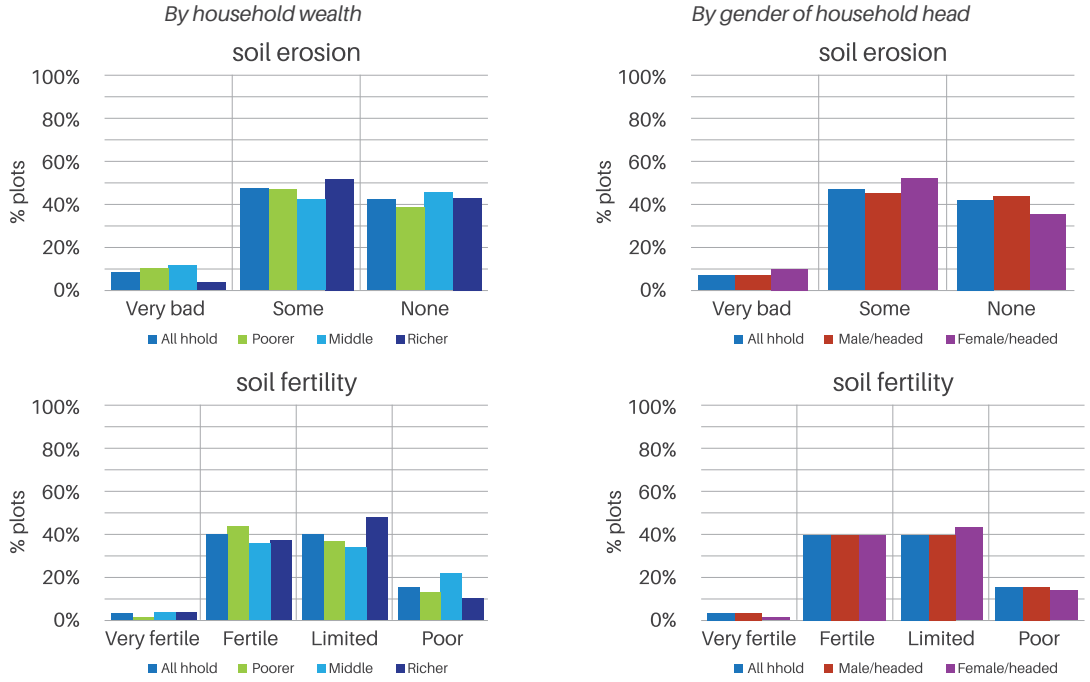
In Lushoto, high agricultural potential and a dense and rapidly increasing human population, coupled with limitations on the availability of cultivable land, have resulted in severe land pressures in many parts of the district. Land scarcity is escalating, plot sizes are decreasing, and smallholder farming has for some time been undergoing a process of intensification. Farms have also been expanding into progressively more fragile areas. Beginning with the introduction of commercial crops in the last century (Wickama et al. 2014a), there has been significant encroachment into forests and protected areas, cultivation has spread along fragile riverbanks, and the dense natural vegetation previously found on steep slopes and in riparian zones is gradually being cleared (Onyango et al. 2012).

At the same time, soil erosion and land degradation have worsened, and are now considered to pose a major problem in both highland and lowland areas of the district (Mbaga-Semgalawe and Folmer 2000). Average rates of topsoil loss on arable land are currently recorded to be between 0.6-1 cm a year (Kaswamila 2013). Soil fertility is also noted as a major concern (Mowo et al. 2006): 90 per cent of soils have been found to be deficient in phosphorous, 73 per cent inadequate in nitrogen, and more than half limiting in terms of magnesium, potassium and calcium (Ndakidemi and Semoka 2006). In response, there has been a long history of SLM interventions carried out by government as well as under the auspices of non-governmental organisations and international development agencies, starting as early as the 1930s (Tenge et al. 2004; Wickama et al. 2014a) and continuing up to today (Mowo et al. 2006; Wickama et al. 2004).

Despite the importance of farming in Ntcheu District, low land productivity remains a major issue (Economic Planning Division 2009; Mkandawire 2010). Both inter- and intra-seasonal rainfall patterns are highly variable, and subject to great uncertainty (LTSI 2014a). Harvests are often wiped out by the effects of extreme weather events: farmers regularly experience the effects of low or delayed rainfall, as well as seasonal flooding and landslides (Msilimba 2007). Meanwhile, many households have no option but to cultivate in agriculturally marginal areas, which are already subject to low and declining soil fertility (Economic Planning Division 2009). Much of the most suitable and highest potential agricultural land is already cultivated, and the moister, more fertile plots in valley bottoms are in particularly scarce supply. The areas that are now being converted from woodland or are farmed under swidden fallow systems tend to be those that are unsuitable for maize production (LTSI 2013d). Cultivation is expanding onto progressively steeper slopes and more

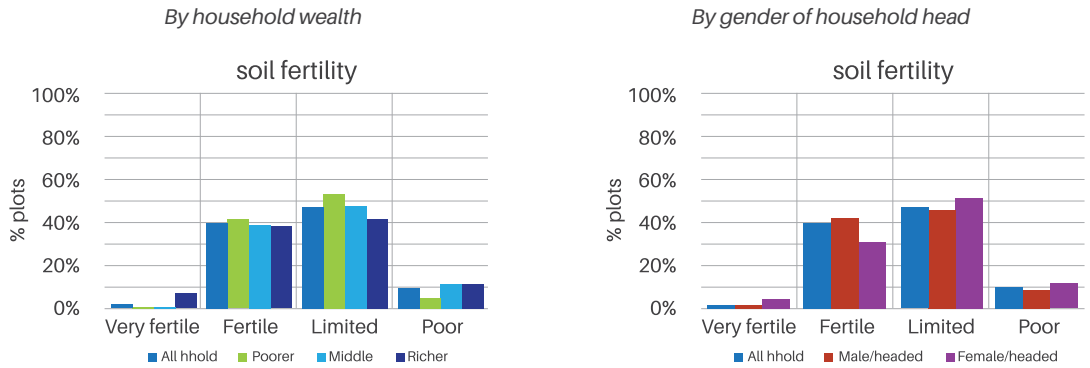
marginal soils. Yet Ntcheu is already characterised as being an area of high erosion hazard (LTSI 2013 a,b; 2014a). Land degradation is a major problem (Klrui 2016), with rivers carrying heavy sediment loads (Economic Planning Division 2009; LTSI 2014a,b), and declining rates of soil fertility have been recorded in many parts of the district (Economic Planning Division 2009).

It is therefore hardly surprising that the majority of farmers in both Lushoto and Ntcheu report that they suffer on-farm land degradation – although it should be noted that in neither site is it perceived to be a universal problem. Just under 60 per cent of plots are deemed to have limited or poor soil fertility and around 40 per cent are recorded as being fertile or very fertile[7] (Figure 9, Figure 10). In Lushoto, more than half of fields display some or very bad soil erosion[8]. It is interesting to note that there is not a great deal of variation between wealth categories in the incidence of farmers experiencing land degradation, although it is slightly more common for female-headed households to farm plots with limited or poor soil fertility.



From household questionnaire surveys.

Figure 9. Status of land degradation in Lushoto



From household questionnaire surveys.

Figure 10. Status of land degradation in Ntcheu

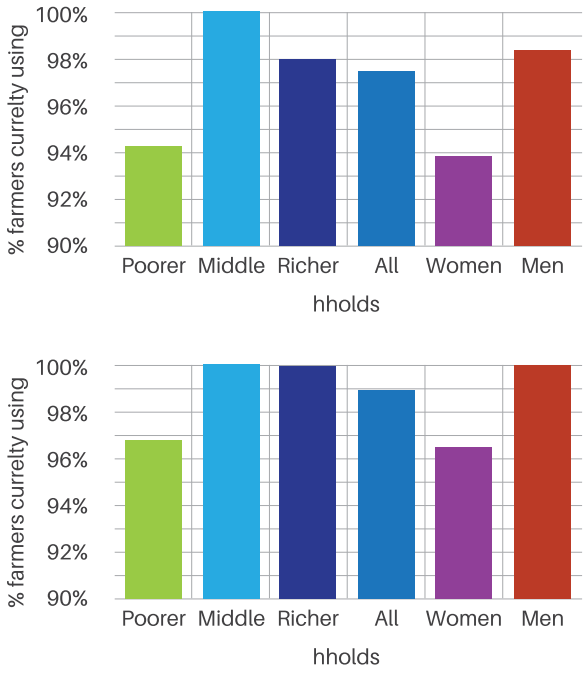
7 Very fertile: does not require manure or external inputs; fertile: requires limited external inputs and manure; limited: requires external inputs or manure every year; poor: cannot produce anything without manure and/or external inputs.

8 The Ntcheu household surveys did not collect data about on-farm soil erosion.

Pressures arising from land scarcity are cited as the major causes of land degradation in both sites. Reflecting the findings of other studies (see above), farmers in the two study sites report that fields are being more and more intensively farmed, and cultivation is expanding into progressively more marginal lands. Farming is now taking place on steep slopes and other ecologically sensitive areas that in the past would not have been deemed suitable for cultivation. The fact that so few people have access to valley-bottom land is seen to exacerbate these problems: farmers have no option but to look for new production opportunities in the lower potential, more fragile, upland areas. It is also reported that farmland is subject to much greater, and more continuous use than was the case even a decade ago. Fields are now rarely left to fallow, and are not alternated between pasture and crop cultivation. In Malindi Village in Lushoto, over-grazing was also identified as a cause of land degradation. Not all cattle and smallstock owners practice zero-grazing, and some livestock keepers must therefore move their herds around in search of ever-more scarce pasture. Crop residues, too, are increasingly required as fodder, rather than being incorporated into the soil.

Participation in SLM activities

The perceived seriousness of land degradation has prompted the adoption of a wide variety of SLM measures in both Lushoto and Ntcheu, some introduced by external agencies and others initiated by local communities themselves. There are are very few farmers who are not familiar with, or practicing SLM in the study sites, a fact that has also been noted by other authors (see, for example, Emerton 2014b; Wickama et al. 2014b). All of the farmers surveyed cited knowledge of a variety of SLM approaches, on average claiming familiarity with 16 techhniques and actual use of 9 (of a total of 22 asked about in each site). Meanwhile, more than 97 per cent of households in Lushoto and 99 per cent in Ntcheu are currently employing some form of SLM on their farms[9] (Figure 11).



	Lushoto
Grass strips	69%
On-farm trees	67%
Farmyard manure	64%
Crop residues	61%
Terraces	59%
Burying weeds	51%
Mulching	50%
Crop rotation	43%
Green manure	38%
Agroforestry	32%
Grain legume	31%

	Lushoto
Compost	27%
Fallow	24%
Fanya juu	23%
Woodlots	22%
Basins	16%
Rainwater harvesting	16%
Contour planting	14%
Conservation agri.	10%
Matengo pits	9%
Lime	6%
Stone bunds	5%

	Ntcheu*
Crop residues	89%
Natural trees	81%
Burying weeds	80%
Contour ridges	71%
Box ridges	64%
Green manure	61%
Crop rotation	57%
F/yard manure	56%
Contour planting	55%
Agroforestry	37%
Grain/leg. intercrop	36%

	Ntcheu*
Mulching	25%
Compost	18%
Grass planting	17%
Conservation agri.	16%
Woodlots	16%
Encl. & s/asides	14%
Basins	13%
Fallow	9%
R/water harvesting	8%
Ripping	4%
Lime	1%

From household questionnaire surveys.

Figure 11. Household participation in SLM

9 It should be noted that these levels of engagement in SLM activities are very high as compared to those reported in the literature for other parts of Lushoto and Ntcheu Districts. For example, a recent study found that only around a half of farmers in other parts of the middle Shire Basin engage in SLM (Emerton 2014b), and the Third Integrated Household Survey for Malawi records that 46 per cent of farmers in Ntcheu employ some form of erosion control or land conservation measure (NSO 2012), as compared to the at 98 per cent recorded in the study villages (Figure 10). Baseline surveys carried out in other parts of Lushoto District found that that less than one third of farmers have adopted improved soil and water conservation practices (Lyamchai et al. 2011). According to Tanzania's Agricultural Census just 22 per cent of farmers in Lushoto District have erosion control measures on their land, while all farmers in the study villages identify themselves to be practicing SLM. It also presents a quite different picture from other parts of Malawi and Tanzania, where SLM uptake has generally been found to be low (Barungi and Maonga 2011; Mangisoni 2009; Nakhumwa and Hassan 2012; Wickama et al. 2014a,b). Two factors likely influence this difference in findings. One is that there has been a long history of land conservation projects and agricultural research in the AGORA study sites: farmers have had a relatively greater, and longer, exposure to SLM than is the case in many other parts of Lushoto and Ntcheu Districts. The current study also took a broad definition of SLM, which referred to a wide range of land management techniques. Other studies often focus only on one or two "major" SLM techniques (such as terracing), and thus count far fewer practices as SLM.

Grass strips, on-farm trees and farmyard manure are the most widely used SLM techniques in Lushoto, with another four practices in addition being applied by the majority of farmers: crop residues, terraces, burying weeds and mulching. In Ntcheu, crop residues, on-farm trees and burying weeds are most common techniques, with an additional five being used by the majority of farmers: box ridges, green manure, crop rotation, farmyard manure and contour planting. Meanwhile, in Lushoto, 10 per cent or less of farmers are practicing conservation agriculture, *matengo* pits, lime and stone bunds, while fallowing, rainwater harvesting, ripping and lime are practised relatively rarely in Ntcheu.

The incidence of SLM practices is slightly lower (although still almost universal) among poorer farmers and female-headed households (Figure 12, Figure 13). Meanwhile, richer farmers tend to invest in a greater range of techniques (an average of 9.6 as compared to 8.1 for poorer households in Lushoto, and 11 as compared to 8.7 in Ntcheu), as do male-headed households (9.1 as compared to 7.7 for female-headed households in Lushoto, and 11 as compared to 8.9 in Ntcheu). This reflects observations made by other authors that there is a genreally higher tendency of SLM uptake among richer farmers and men (see, for example, Asfaw et al. 2014; LTSI 2013d, 2014a, b; Maro et al. 2013; Petersen et al. 2014). In Ntcheu, a recent study found that, in most cases, richer households have better access to the labour, funds, knowhow and other inputs that enable them to optimise production by investing in improved farming technologies (Emerton 2014b).

While there is broad consistency between different categories of households as regards the most and least commonly used SLM techniques (Figure 11, Table 5, Table 6), some differences can be discerned according to wealth and gender (Figure 12, Figure 13). For most SLM techniques, the incidence of use is consistently higher among richer farmers and male-headed households (reflecting the overall uptake rates noted above). In Lushoto it is only the use of crop residues that is noticeably more widespread for poorer and female-headed households (perhaps linked to a lower incidence of livestock ownership, and thus less demand for the use of residues for animal feed), while in Ntcheu poorer households show a marked preference for contour ridges, and female-headed households display higher levels of burying weeds, contour planting, crop residue incorporation and natural trees (Table 4).

Table 4. SLM techniques for which there is a pronounced variation in incidence of use between different types of households

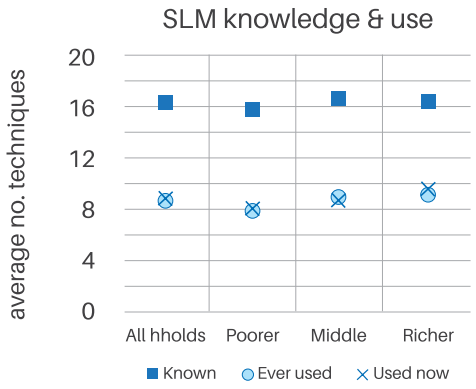
Lushoto		Ntcheu	
Richer	**Male-headed**	**Richer**	**Male-headed**
Fallow	Crop rotation	Agroforestry	Box ridges
Farmyard manure	Farmyard manure	Box ridges	Compost
Matengo pits	Grass strips	Conservation agriculture	Crop rotation
On-farm trees	Green manure	Crop rotation	Mulching
Terraces	Natural trees on-farm	Farmyard manure	
Woodlots		Green manure	
		Mulching	
		Rainwater harvesting	
Poorer	**Female-headed**	**Poorer**	**Female-headed**
Crop residue incorporation	Crop residue incorporation	Contour ridges	Burying weeds
			Contour planting
			Crop residue incorporation
			Natural trees on-farm

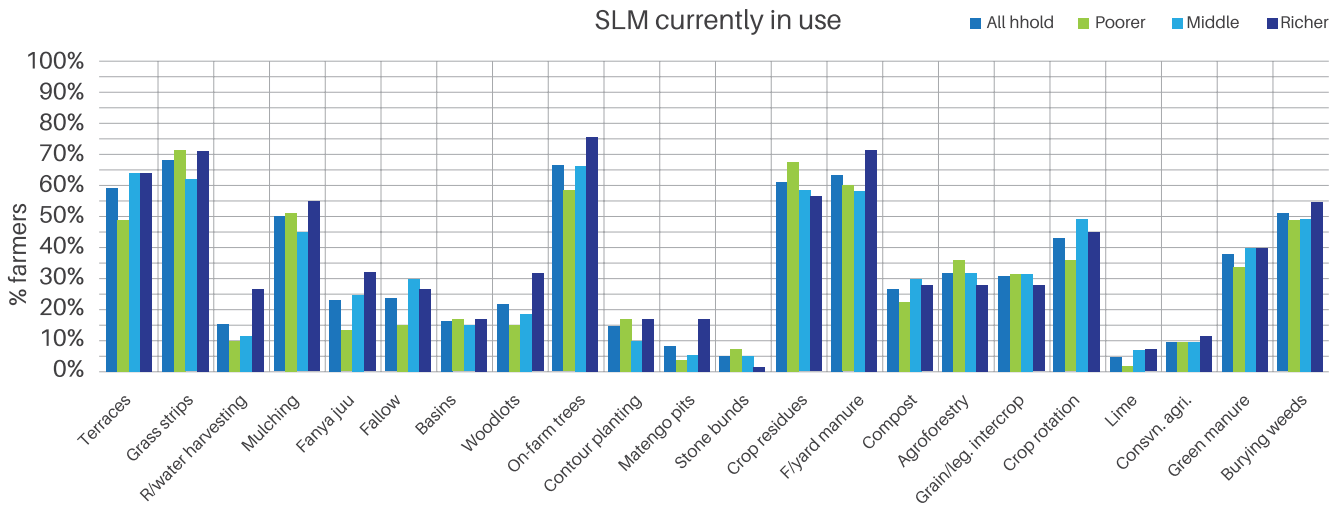
Refers to cases where a 10% or more difference in the incidence of use is recorded between household types. From household questionnaire surveys.

The relative and absolute land area given over to different SLM techniques also varies between different types of household. In Lushoto[10], a substantially higher share of the farm is given over to SLM among poorer households, even though the absolute area is higher among richer farmers (Figure 14). This is hardly surprising, given the relative shortage of land and other inputs for poorer farmers. Fewer differences between male-headed and female-headed households are however discernible in the proportion of farm area given over to different SLM techniques.

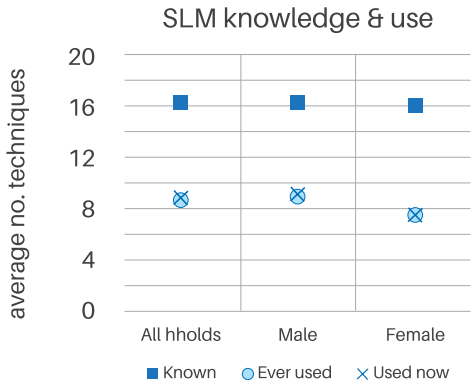
10 This information was not recorded in the Ntcheu questionnaire survey.

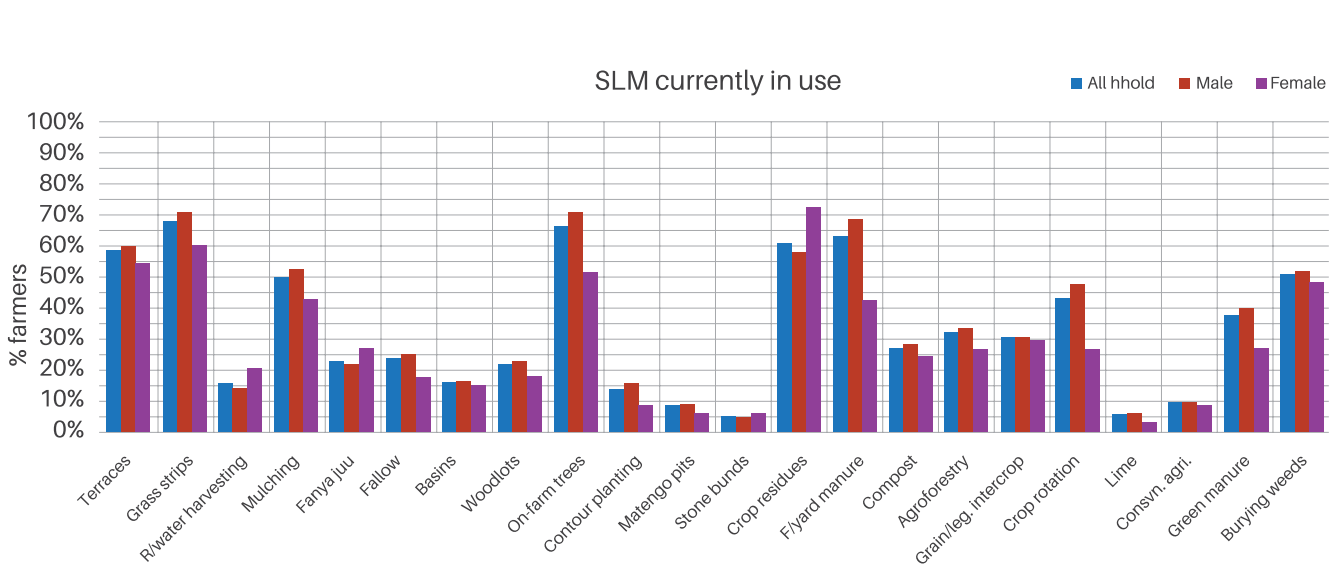
By household wealth





By gender of household head

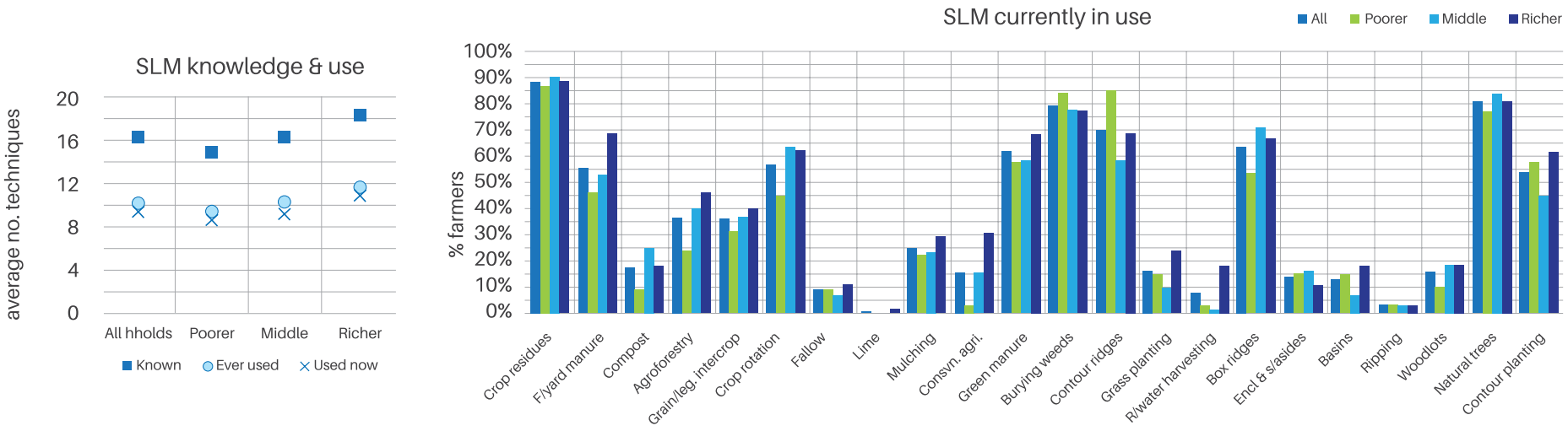




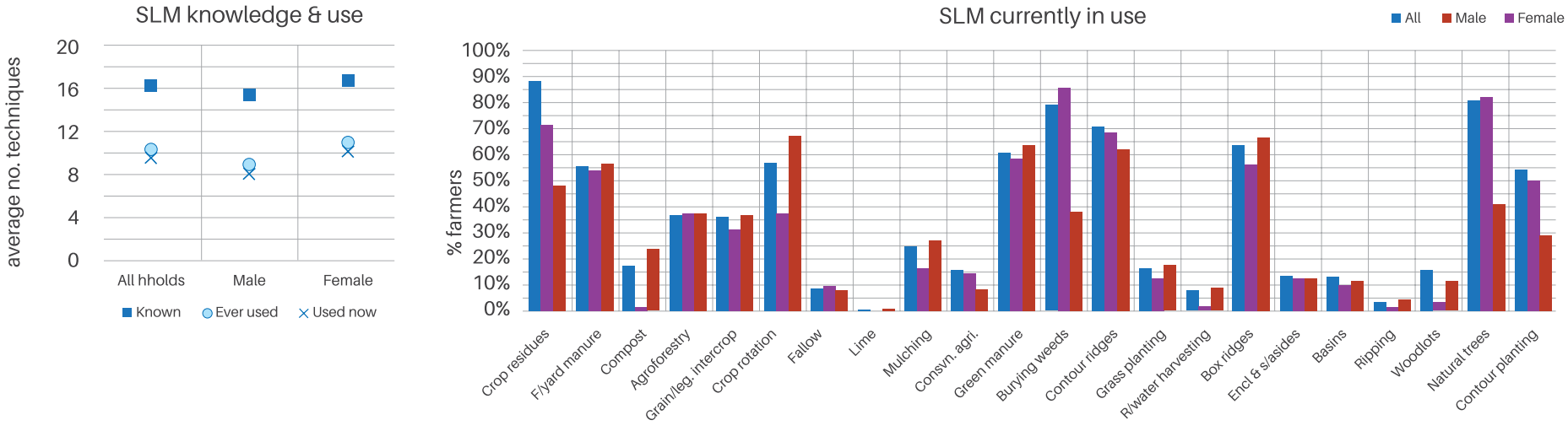
From household questionnaire surveys.

Figure 12. Knowledge and use of SLM techniques in Lushoto

By household wealth



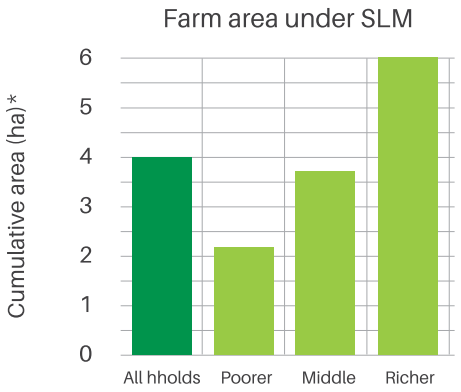
By gender of household head

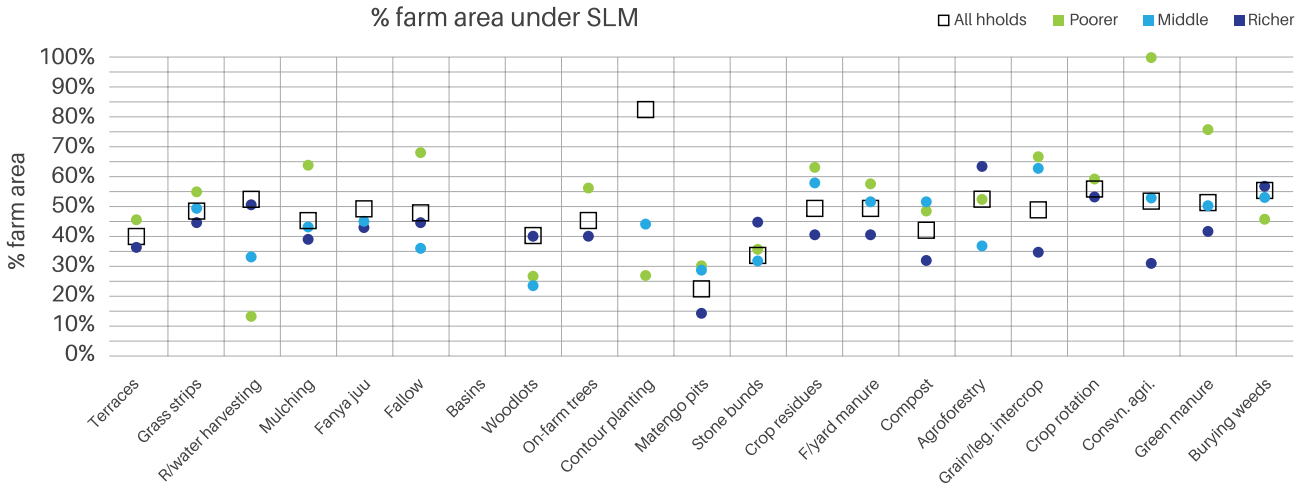


From household questionnaire surveys.

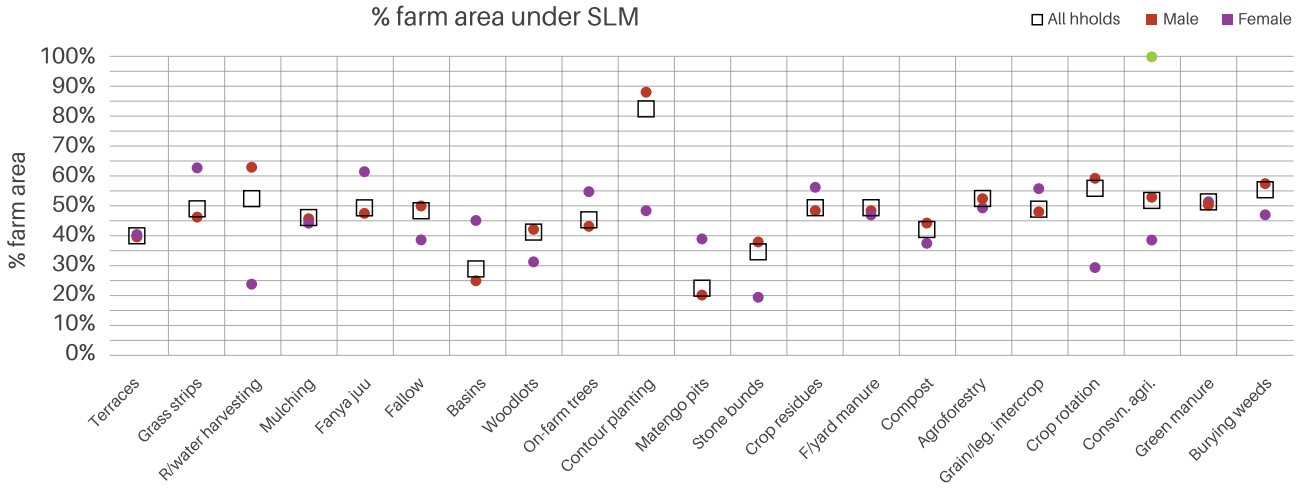
Figure 13. Knowledge and use of SLM techniques in Ntcheu

By household wealth





By gender of household head



* Refers to summed area of all individual SLM techniques, not to actual ground area under SLM: techniques may be combined within one field. From household questionnaire surveys.

Figure 14. Farm area under SLM in Lushoto

Table 5. Most and least commonly used SLM techniques among different categories of households in Lushoto (% households currently using)

	Richer		Middle		Poorer		Female-headed		Male-headed	
5 MOST WIDESPREAD	Natural trees on-farm	75%	Natural trees on-farm	66%	Grass strips	72%	Crop residues.	73%	Grass strips	71%
	Grass strips	72%	Terraces	64%	Crop residues.	68%	Grass strips	61%	Natural trees on-farm	71%
	Farmyard manure	72%	Grass strips	62%	Farmyard manure	60%	Terraces	55%	Farmyard manure	69%
	Terraces	64%	Crop residues.	58%	Natural trees on-farm	58%	Natural trees on-farm	52%	Terraces	60%
	Crop residues.	57*	Farmyard manure	58%	Mulching	51%	Burying weeds	48%	Crop residues.	58%
5 LEAST WIDESPREAD	Contour planting	17%	Contour planting	9%	R/water harvesting	9%	Contour planting	9%	R/water harvesting	14%
	Matengo pits	17%	Conservation agri.	9%	Conservation agri.	9%	Conservation agri.	9%	Conservation agri.	10%
	Conservation agri.	11%	Lime	8%	Stone bunds	8%	*Matengo* pits	6%	*Matengo pits*	10%
	Lime	8%	*Matengo* pits	6%	*Matengo* pits	4%	Stone bunds	6%	Lime	6%
	Stone bunds	2%	Stone bunds	6%	Lime	2%	Lime	3%	Stone bunds	5%

Percentage calculated only for those households asked about the technique. From household questionnaire surveys.

Table 6. Most and least widespread SLM techniques among different categories of households in Ntcheu (% households currently using)

	Richer		Middle		Poorer		Female-headed		Male-headed	
5 MOST WIDESPREAD	Crop residues	88%	Crop residues	90%	Crop residues	87%	Burying weeds	86%	Crop rotation	67%
	Natural trees	81%	Natural trees	84%	Contour ridges	85%	Natural trees	82%	Box ridges	66%
	Burying weeds	77%	Burying weeds	77%	Burying weeds	84%	Crop residues	71%	Green manure	64%
	F/yard manure	69%	Box ridges	71%	Natural trees	77%	Contour ridges	69%	Contour ridges	62%
	Green manure	69%	Crop rotation	64%	Contour planting	58%	Green manure	58%	F/yard manure	56%
5 LEAST WIDESPREAD	Basins	19%	Fallow	7%	Fallow	9%	Woodlots	4%	R/water harvesting	9%
	Fallow	11%	Basins	7%	R/water harvesting	4%	Compost	2%	Fallow	8%
	Encl. & s/asides	11%	Ripping	4%	Ripping	4%	R/water harvesting	2%	Conservation agri.	8%
	Ripping	4%	R/water harvesting	2%	Conservation agri.	3%	Ripping	2%	Ripping	5%
	Lime	2%	Lime	0%	Lime	0%	Lime	0%	Lime	1%

Percentage calculated only for those households asked about the technique. From household questionnaire surveys.

Antonia Steven is an advocate for tree planting

DIRECT COSTS AND BENEFITS: SLM inputs, expenditures, income & productivity gains

Incremental costs, benefits & profitability

The previous chapters have built up a picture of rural communities in Lushoto and Ntcheu Districts that depend heavily on crops for their livelihoods, and yet live in landscapes where there are intense – and growing – pressures on the agricultural land base. Escalating land scarcity, especially a shortage of higher potential arable land, has resulted in a progressive reduction in average farm size, fragmentation of landholdings and expansion of cultivation into more and more marginal areas, as well as unsustainable land use intensification. It has also served to push some of the more vulnerable groups in the community (such as female-headed and poor households) onto more peripheral landholdings, where production possibilities are even more limited and less reliable. In both of the survey sites, more than half of farmers' fields are now showing signs of worsening erosion, declining soil fertility, and, as a result, decreasing farm productivity. In response, the vast majority of farmers in both study sites are investing in a variety of SLM measures.

A sample of SLM techniques was selected from those identified by farmers in earlier focus group discussions and investigated in household questionnaires. The ten SLM techniques chosen for further analysis in Lushoto and eight in Ntcheu are a combination of those that are most widely used, and those about which farmers expressed the clearest knowledge of costs and benefits. The farm budget assessment quantified the direct financial costs and benefits of theses SLM techniques to the farmer, including the labour, equipment and other inputs that are required to establish and maintain the measures, as well as any increase in crop yield[11] and additional marketable outputs for sale or home consumption[12] that are generated. The focus was on quantifying the incremental net benefit to the farmer: in other words looking at what the adoption of SLM techniques adds to (or subtracts from) "business as usual" farm income. The figures referred to below therefore do not refer to total farm income, but only to that associated with the application of the SLM technique.

The farm budget assessment finds that in most cases the additional crop and non-crop income that is generated outweighs the costs of the extra labour, equipment and materials that are require to establish and maintain SLM measures (Table 7, Figure 15). Just two SLM techniques in Lushoto (cut-off drains and terraces) and one in Ntcheu (residue incorporation)

11 In Lushoto crop yield increases were measured for maize and beans, and in Ntcheu for maize.

12 For example firewood, poles, timber, fruits and grass.

show slightly negative average annual returns over the first 10 years of operation (Table 7), and the latter two also show net present losses over a 25 year period (Figure 15). This reinforces the findings of other studies carried out in the survey sites, which find that most – although not all – SLM measures can be considered to be profitable both in themselves and in comparison to existing production systems, when judged purely in financial terms (see, for example Emerton 2013a,b; LTSI 2013c, 2014a; Mwale et al. 2014); Namwata et al. 2012.

It should however be noted that the uptake of SLM typically does not have a huge impact on profitability. Most SLM techniques generate only a relatively modest value-added to farm production – an average of less than US$100 per hectare per year. Just three of those applied in Lushoto generate significant average annual returns within the first ten years of establishment (at least in terms of direct, financial costs and benefits). Agroforestry and grass strips are profitable because of the commodities they produce for home consumption and sale, while crop rotation shows a high return mainly because it generates significant yield enhancements while requiring no additional inputs. Over the longer term, woodlots also show a relatively high NPV, mainly due to the high value of timber production further into the future. Meanwhile, in Ntcheu, the incremental financial impact of SLM remains small. *Sasakawa*, natural trees and (to a lesser extent) box ridges show relatively higher returns as compared to other techniques, largely due to their combining substantial crop yield impacts with low investment and implementation costs.

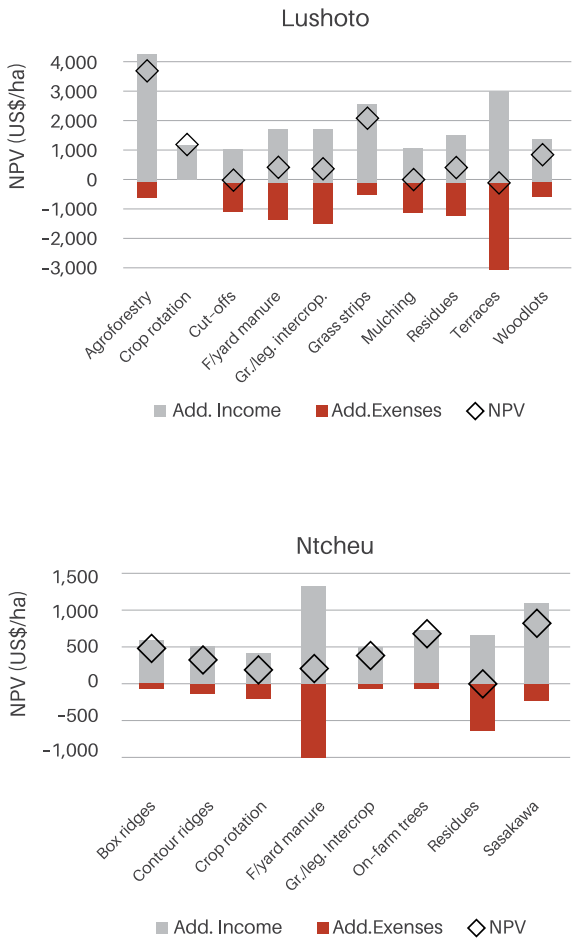
Table 7. Incremental costs and benefits of SLM techniques (average US$/ha/year over first 10 years)

	Hired & own labou	Equipment & materials	Additional expenses	Non-crop products	Yield gains	Additional income	Net annual average value
Lushoto (per hectare of maize or mixed maize & beans)							
Agroforestry	-43	-28	-71	565	150	716	645
Crop rotation	-	-	-	-	143	143	143
Cut-off drains	-57	-72	-129	-	127	127	-2
Farmyard manure	-101	-54	-155	9	199	208	53
Grain-legume intercropping	-89	-86	-175	1	212	214	39
Grass strips	-44	-16	-60	215	102	317	257
Mulching	-56	-77	-133	4	136	140	7
Residue incorporation	-139	-1	-140	-	191	191	52
Terraces	-155	-238	-393	148	232	380	-13
Woodlots	-17	-46	-62	107	-	107	45
Ntcheu (per hectare of maize)							
Box ridges	-9	-1	-10	13	56	69	59
Contour ridges	-16	-2	-18	-	55	55	37
Crop rotation	-26	-1	-26	-	47	47	21
Farmyard manure	-122	-12	-134	73	80	154	20
Grain-legume intercropping	-7	-1	-8	-	55	55	47
Natural trees on-farm	-9	-2	-10	3	80	83	73
Residue incorporation	-77	-1	-78	-	75	75	-3
Sasakawa	29	-2	-31	-	125	125	95

From farm budget assessments.

	Additional expenses	Additional income	NPV
Agroforestry	-572	4,314	3,742
Crop rotation	-	1,206	1,206
Cut-off drains	-1,032	1,069	37
Farmyard manure	-1,303	1,745	442
Intercropping	-1,448	1,798	351
Grass strips	-485	2,635	2,150
Mulching	-1,102	1,179	78
Residue incorporation	-1,159	1,608	449
Terraces	-3,161	3,120	-40
Woodlots	-527	1,434	907

	Additional expenses	Additional income	NPV
Box ridges	-78	594	517
Contour ridges	-140	476	337
Crop rotation	-220	408	188
Farmyard manure	-1,096	1,299	202
Intercropping	-70	476	406
Natural trees	-82	724	643
Residue incorporation	-650	646	-3
Sasakawa	-222	1,087	864



From farm budget assessments.

Figure 15. Net present value of SLM techniques (average US$/ha over 25 years)

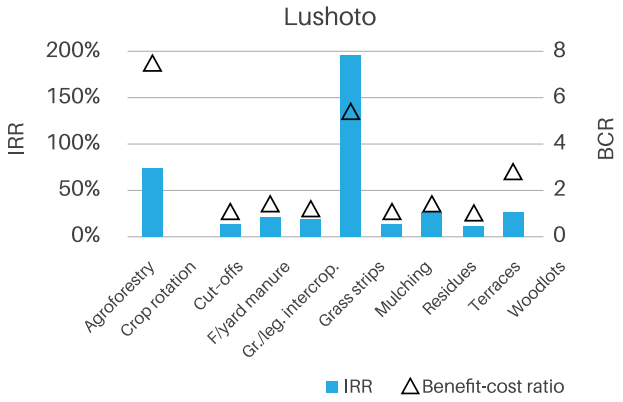
Other measures of investment return & value for money

The farm budget assessment also looked at a variety of other measures of SLM investment return and value for money. Reflecting the positive net present values that have already been noted, SLM techniques return a range of benefit-cost ratios of one or more (Figure 16). Most show impressive internal rate of returns that are well above the assumed prevailing opportunity cost of capital which gives an average discount rate of 10 per cent for Malawi and Tanzania. The two lowest (and negative) return SLM activities, terraces in Lushoto and residue incorporation in Ntcheu show IRRs which are only just below this figure.

It is also useful to look at cash needs and investment capital requirements. Here, the two least profitable SLM techniques (terraces in Lushoto and crop residue incorporation in Ntcheu) display high initial investment costs and long payback periods, while lower initial investment requirements and/or shorter payback periods are a feature of some of the more profitable practices such as grass strips and crop rotation in Lushoto and box ridges in Ntcheu (Figure 17).

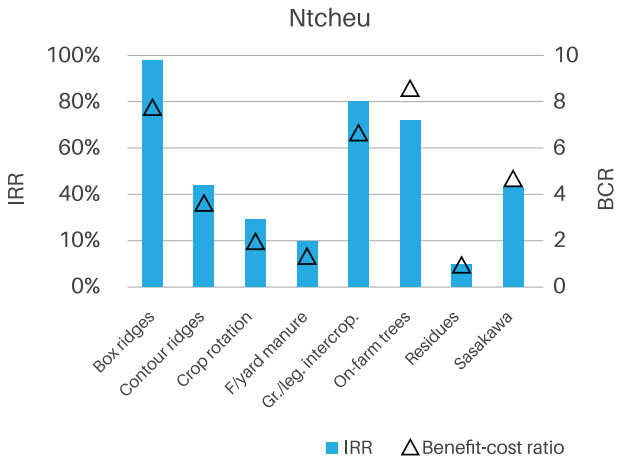
	IRR
Grass strips	197.2%
Agroforestry	74.7%
Woodlots	24.7%
Residues	24.7%
F/yard manure	21.3%
Intercropping	19.4%
Mulching	13.6%
Cut-offs	11.1%
Terraces	9.5%
Crop rotation	N/A

	BCR
Agroforestry	7.5
Grass strips	5.4
Woodlots	2.7
Residues	1.4
F/yard manure	1.3
Intercropping	1.2
Mulching	1.1
Cut-offs	1.0
Terraces	1.0
Crop rotation	N/A



	IRR
Box ridges	98.9%
Intercropping	79.4%
On-farm trees	72.3%
Contour ridges	45.0%
Sasakawa	43.6%
Crop rotation	29.0%
F/yard manure	18.9%
Residues	9.8%

	BCR
On-farm trees	8.9
Box ridges	7.7
Intercropping	6.8
Sasakawa	4.9
Contour ridges	3.4
Crop rotation	1.9
F/yard manure	1.2
Residues	1.0



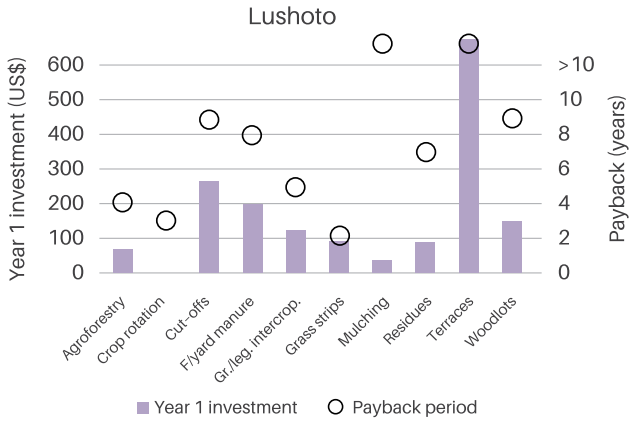
From farm budget assessments.

Figure 16. Internal rates of return and benefit-cost ratios for SLM techniques over 25 years

All of these measures of financial return underline the point that it is not just the amount of costs and benefits or even their build-up that determines the financial viability and sustainability of SLM for farmers, but also their rate of accumulation and distribution over time. There is a great deal of variation in the cashflow trajectories of different techniques (Figure 18, Figure 19). For example, in Lushoto, not only are the benefits from both agroforestry and woodlots generated quite far into the future, but they accrue unevenly, because timber and other products are harvested on an irregular basis. For much of the time, the net cashflow is close to zero or even slightly negative. Other SLM techniques show pronounced peaks and troughs in costs. In the case of cut-off drains, farmyard manure and grass strips in Lushoto, and farmyard manure and *sasakawa* in Ntcheu, this is mainly to do with the need to periodically replace the equipment and tools that are required to carry out the SLM practice. For intercropping and terracing in Lushoto and contour ridges in Ntcheu it is also to do with the periodic repetition of major maintenance tasks, repetition of planting or replacement of physical structures.

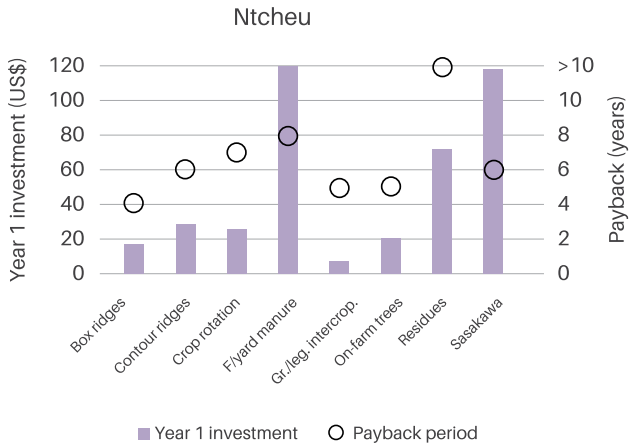
	Invest
Crop rotation	-
Mulching	43
Agroforestry	80
Residues	87
Grass strips	96
Intercropping	121
Woodlots	155
F/yard manure	196
Cut-off drains	268
Terraces	674

	Payback
Grass strips	2 yrs
Crop rotation	3 yrs
Agroforestry	4 yrs
Intercropping	5 yrs
Residues	7 yrs
F/yard manure	8 yrs
Cut-off drains	9 yrs
Woodlots	9 yrs
Mulching	>10 yrs
Terraces	>10 yrs



	Invest
Intercropping	8
Box ridges	17
On-farm trees	21
Crop rotation	25
Contour ridges	28
Residues	72
Sasakawa	118
F/yard manure	120

	Payback
Box ridges	4 yrs
Intercropping	5 yrs
On-farm trees	5 yrs
Contour ridges	6 yrs
Sasakawa	6 yrs
Crop rotation	7 yrs
F/yard manure	8 yrs
Residues	>10 yrs



From farm budget assessments.

Figure 17. Investment requirements and payback periods for SLM techniques

Comparing SLM financial viability & sustainability with actual uptake

Conventional economic wisdom would lead us to suppose that those SLM techniques that give good profits and yield a high rate of return, are low cost to implement, impose a low initial investment burden, and require only a short payback period would be those that would be most attractive to farmers. A broad comparison[13] of the measures of SLM financial viability and sustainability that have been discussed in the sections above with the findings on actual SLM uptake that were presented in the preceding chapter shows that the degree of overlap is patchy at best (Table 8). For the most part, measures of direct financial profitability do not correspond to the SLM techniques in which farmers are actually choosing to invest.

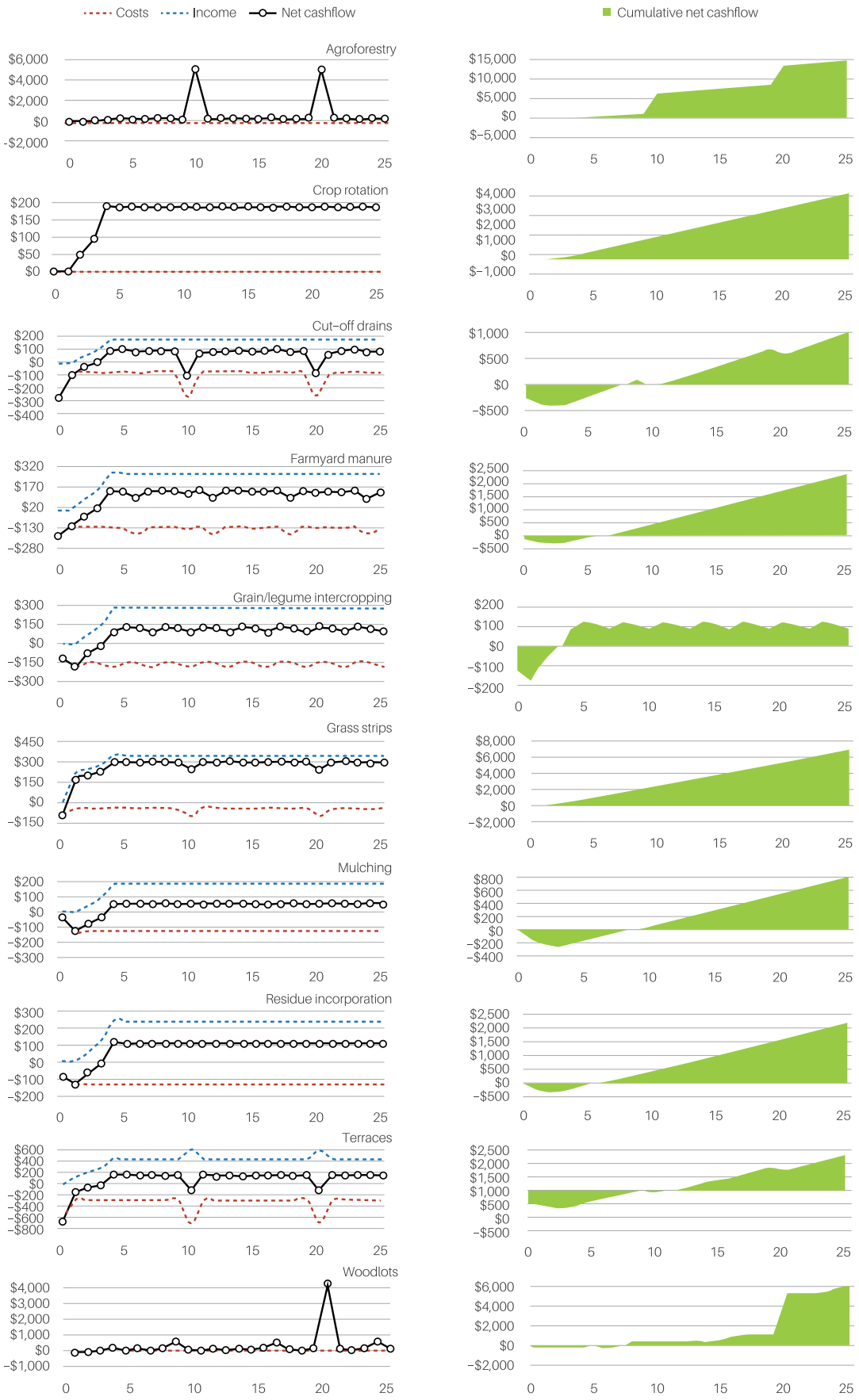
13 It is important to note that no quantitative analysis has been carried out in this respect. This is partly due to the fact the data reflect farmers' perceptions (rather than recorded observations or measurements) over a relatively small sample size. The main reason is however that the research did not seek to use statistical or econometric techniques to demonstrate a numerical relationship, dependence or correlation between farmer uptake of SLM and different indicators of their financial worth, but rather tlo underline the importance of employing a research approach which investigates the broader economic context, drivers and enabling/constraining conditions for SLM as they apply to different farmers.

Some of the most widely practiced SLM techniques are those which display relatively lower rates of return and benefit-cost ratios, higher initial investment requirements and longer payback periods (Figure 20, Figure 21). It is only for grass strips in Lushoto and natural trees in Ntcheu that high financial returns, elevated benefit cost ratios and short payback periods overlap to any great extent with a high incidence of uptake by farmers. Other apparently profitable SLM techniques (such as agroforestry, crop rotation and woodlots in Lushoto and box ridges and intercropping in Ntcheu) show relatively low rates of adoption.

Table 8. Use of SLM techniques measured against indicators of economic desirability

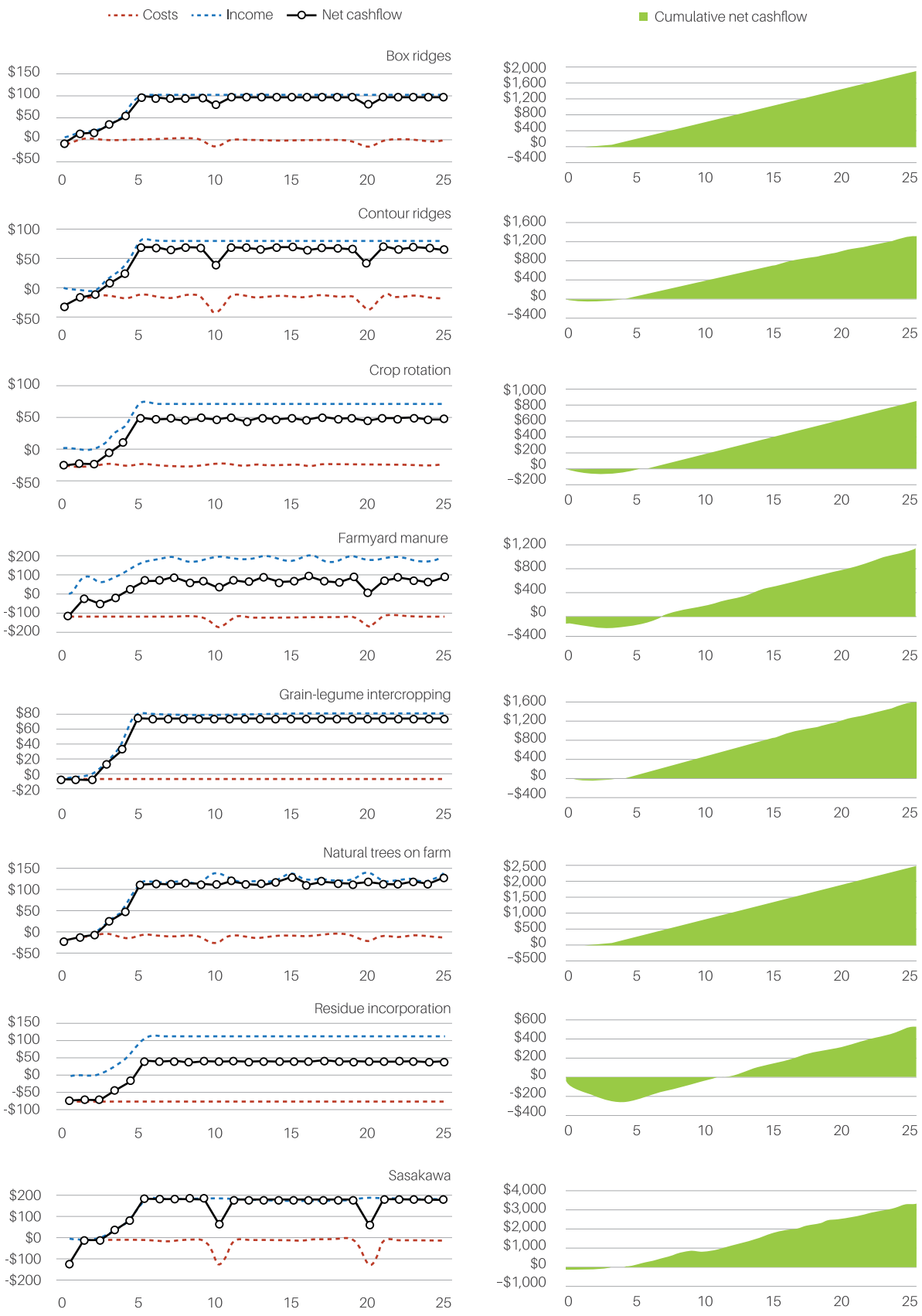
	% households	Average annual return* (US$/ha)	NPV** (US$/ha)	IRR	Benefit-cost ratio	Initial investment*** (US$)	Payback period (years)
Lushoto							
Grass strips	69%	257	2,150	197%	5.4	96	2
Farmyard manure	64%	53	442	21%	1.3	196	8
Residue incorporation	61%	52	449	25%	1.4	87	7
Terraces	59%	-13	-40	9%	1.0	674	>10
Mulching	50%	7	78	14%	1.1	43	>10
Crop rotation	43%	143	1,206	N/A	N/A	268	3
Agroforestry	32%	645	3,742	75%	7.5	80	4
Grain-legume intercropping	31%	39	351	19%	1.2	121	5
Woodlots	22%	45	907	25%	2.7	155	9
Mtcheu							
Residue incorporation	89%	-3	-3	10%	1.0	72	>10
Natural trees	81%	73	643	72%	8.9	21	5
Contour ridges	71%	37	337	45%	3.4	28	6
Box ridges	64%	59	517	99%	7.7	17	4
Crop rotation	57%	21	188	29%	1.9	25	7
Farmyard manure	56%	20	202	19%	1.2	120	8
Grain-legume intercropping	36%	47	406	79%	6.8	8	5

* over 10 years; ** over 25 years;*** in year 1. From farm budget assessments.



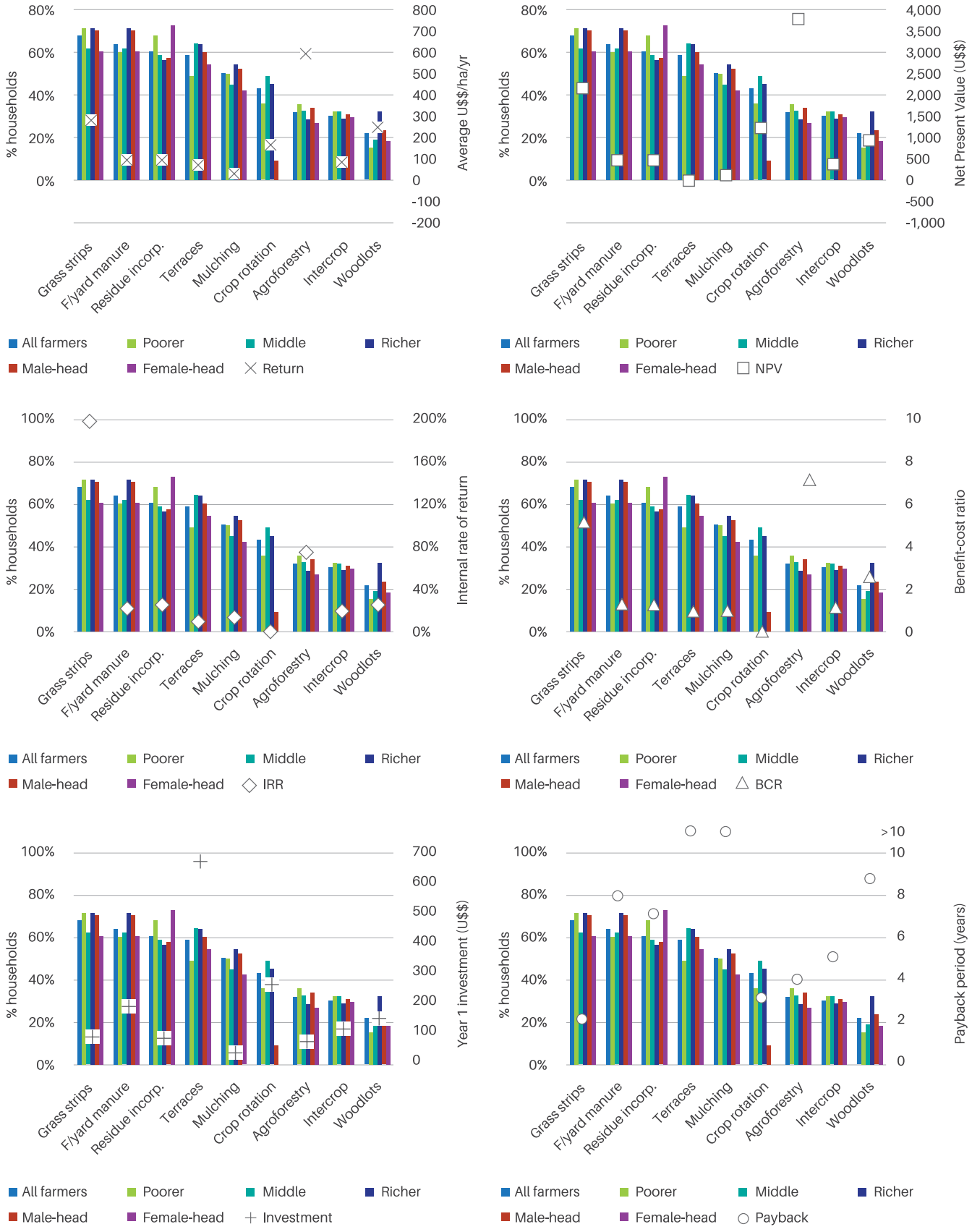
From farm budget assessments.

Figure 18. Costs, income and net cashflow of SLM techniques over 25 years in Lushoto



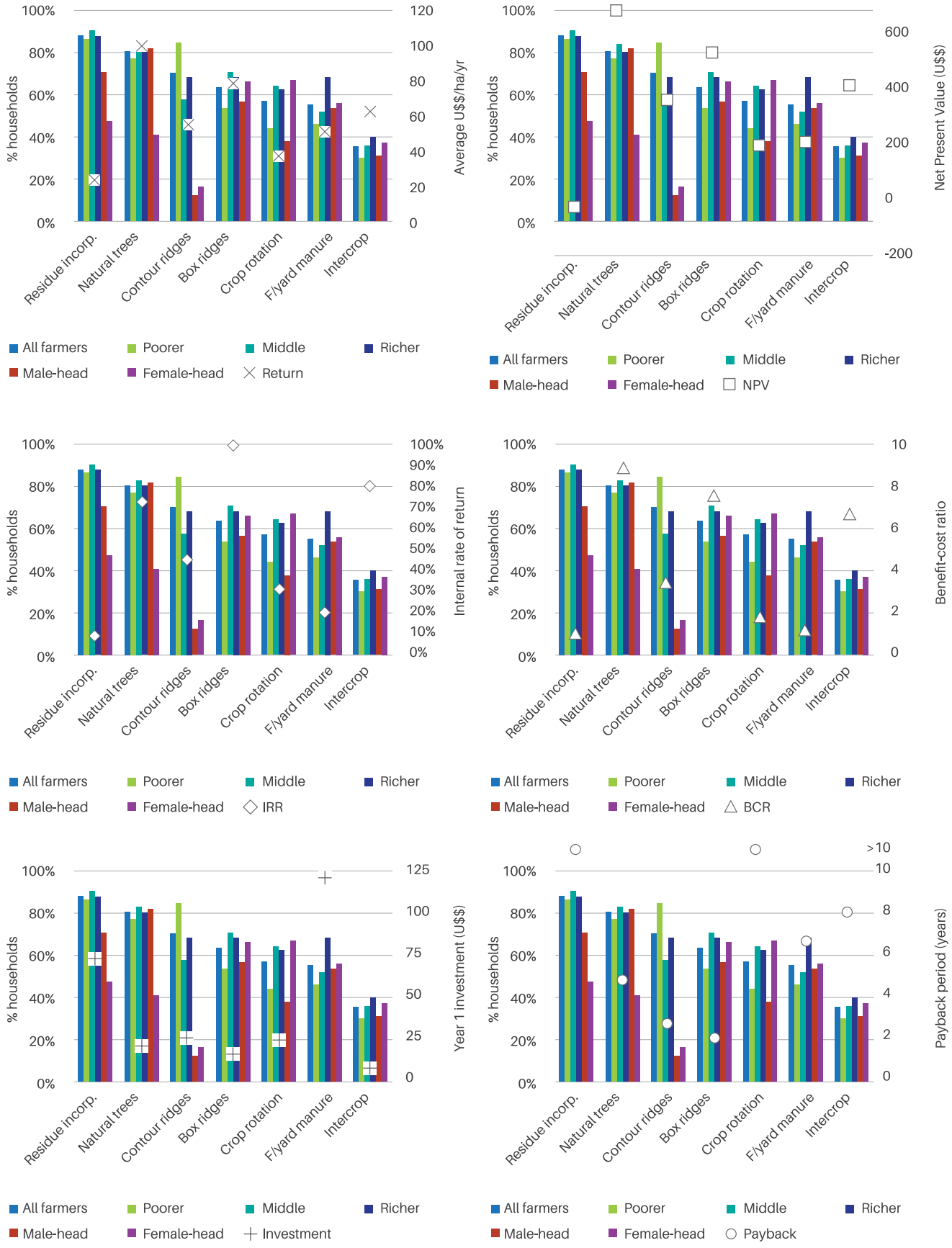
From farm budget assessments.

Figure 19. Costs, income and net cashflow of SLM techniques over 25 years in Ntcheu



From household questionnaire surveys, farm budget assessments.

Figure 20. Lushoto use of SLM techniques measured against indicators of economic desirability



From household questionnaire surveys, farm budget assessments.

Figure 21. Ntcheu use of SLM techniques measured against indicators of economic desirability

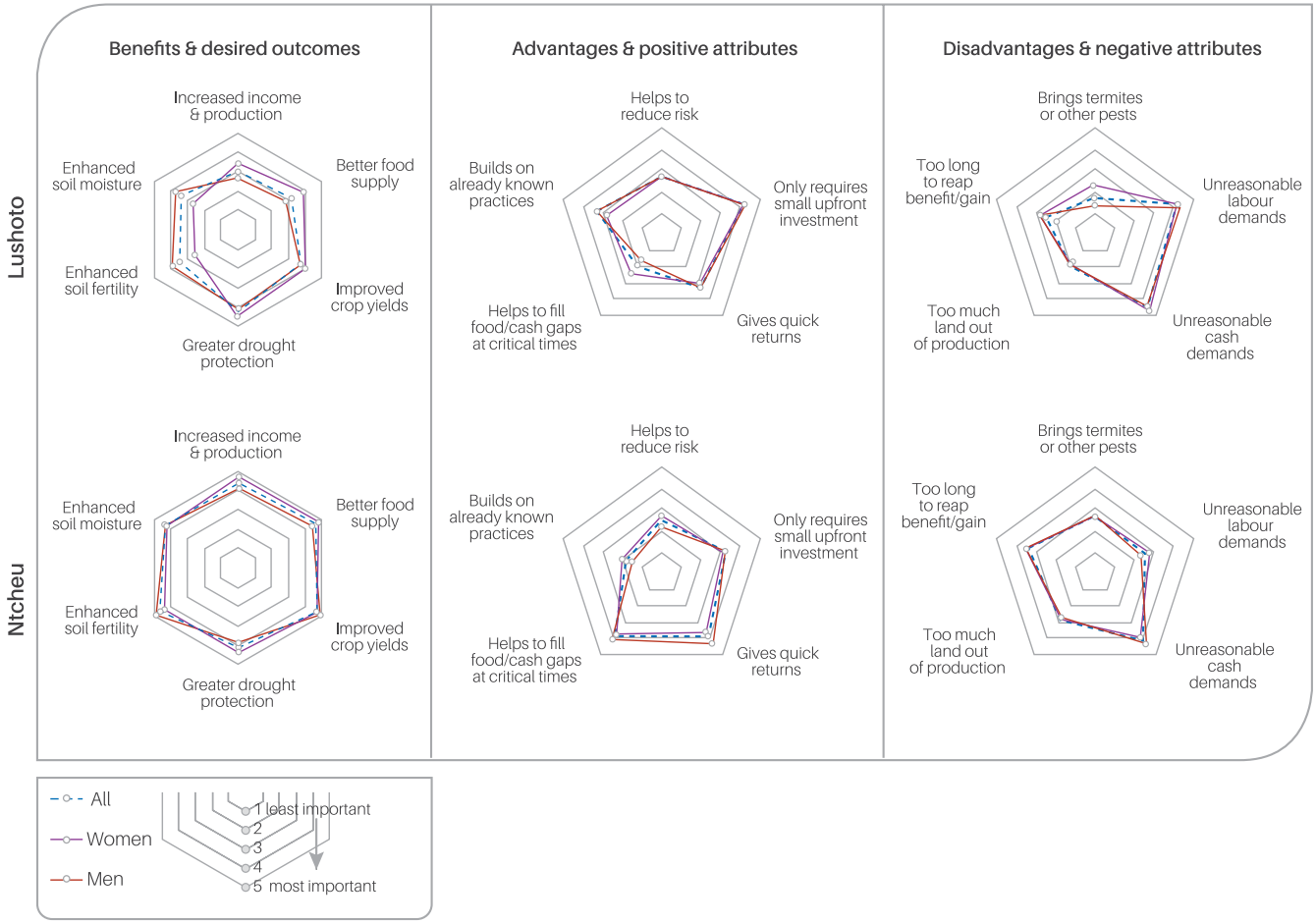
Roots, Tubers & Bananas - Research Program in East Africa.

FARMERS' PREFERENCES: relative economic attributes & advantages of SLM choices

Perceptions of the importance of land management attributes & characteristics

The previous chapters have shown that nearly all farmers in Lushoto and Ntcheu are well-aware of the gains associated with SLM, and are applying some form of land, soil and water conservation or soil fertility management technique on their farms. Farm budget analysis has suggested that most SLM techniques make a positive (albeit often somewhat modest) contribution to farm profitability in terms of costs avoided and/or value-added. It has however also been shown that, while financial profitability may be a necessary condition for farmers to adopt SLM, it does not appear to be the sole factor, and may not even be a sufficient economic reason. The SLM techniques that are the most widely practiced are rarely those that show the highest financial returns, have the lowest costs or yield the most immediate profits, and even those practices which return a modest loss are still widely adopted.

This chapter now turns to the question of what farmers in Lushoto and Ntcheu themselves perceive to be the main costs, benefits and economic attributes associated with different land management choices. One important finding is that, while perceptions of economic gain and loss are key to farmers' decisions to adopt or reject particular SLM techniques, it would be over-simplistic to assume that these concepts refer only to efforts to maximise short-term income and production or to minimise cash expenditures and direct outlays.



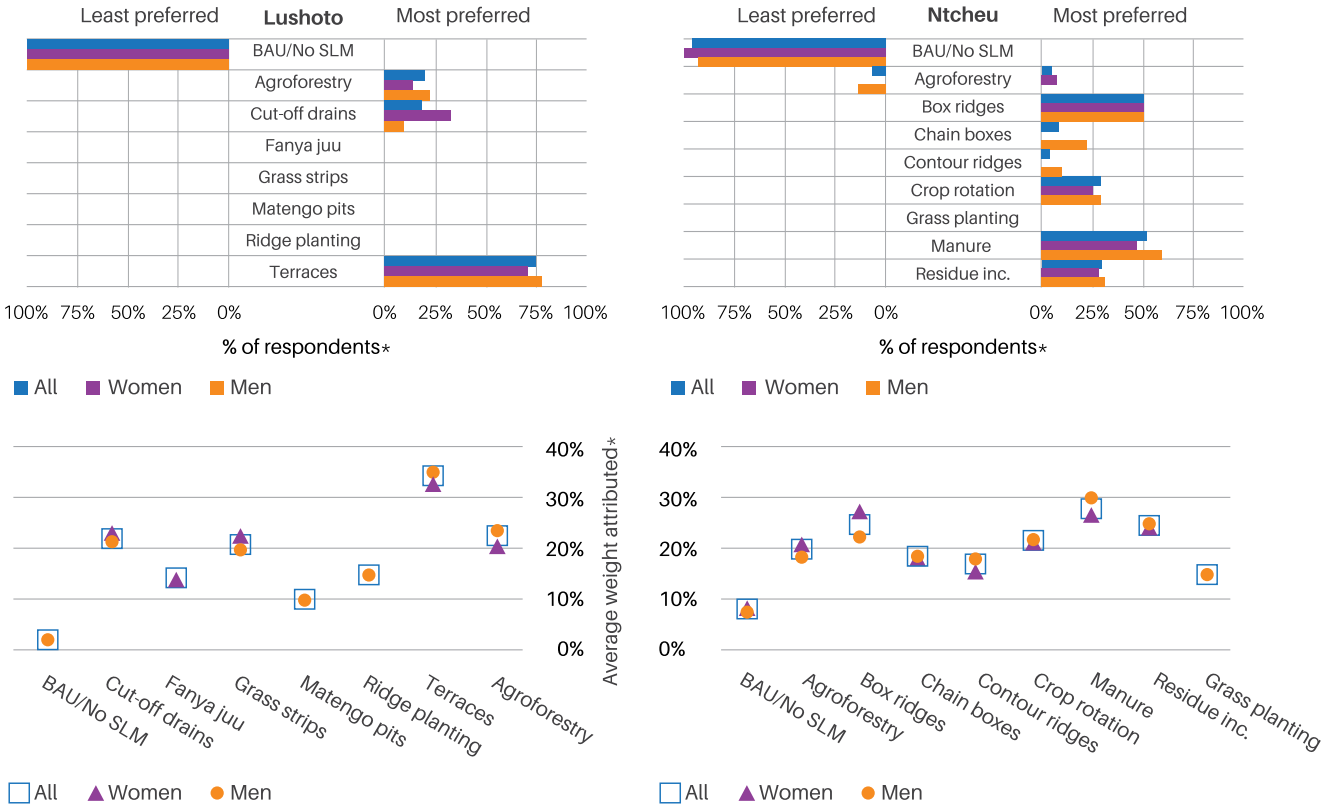
From Evaluating Land Management Options (ELMO) assessments.

Figure 22. Farmer perceptions of the relative importance of different SLM characteristics

When asked to enumerate and evaluate the different outcomes, characteristics and attributes that they seek from SLM (or, alternatively, wish to avoid), farmers in the two study sites also highlighted a wide range of non-monetary economic factors that come into play to influence their choice between different land management alternatives (Figure 22). They identified characteristics such as the ability to generate improved crop yields, better food supplies, enhanced soil fertility and moisture to be as (or even more) important as direct income and production effects. In addition to more conventional financial indicators such as quick returns and small upfront investment requirements, risk reduction was considered one of the key advantages or positive attributes that farmers would look for when choosing between land management options, along with the ability to fill food and cash gaps at critical times of stress and shortage, and possibilities to utilise or build on already-known and trusted farming practices. In relation to the perceived disadvantages and negative attributes of different land management choices, farmers emphasised that it is not just the absolute cost of undertaking a particular SLM practice that is of importance. Rather, it is necessary to consider how the land, labour and cash requirements match up to farmers' actual endowments and ability to free up these inputs. Similar perceptions and preferences are apparent among both men and women farmers.

Overall preferences for SLM

Taking these broader considerations into account, farmers in both study sites express a clear preference for SLM. The "business as usual" (BAU) situation of no SLM is almost universally perceived to be the most undesirable land management option (Figure 23), and is ranked as being least preferred by all women and men farmers in Lushoto and the vast majority in Ntcheu (including all women).



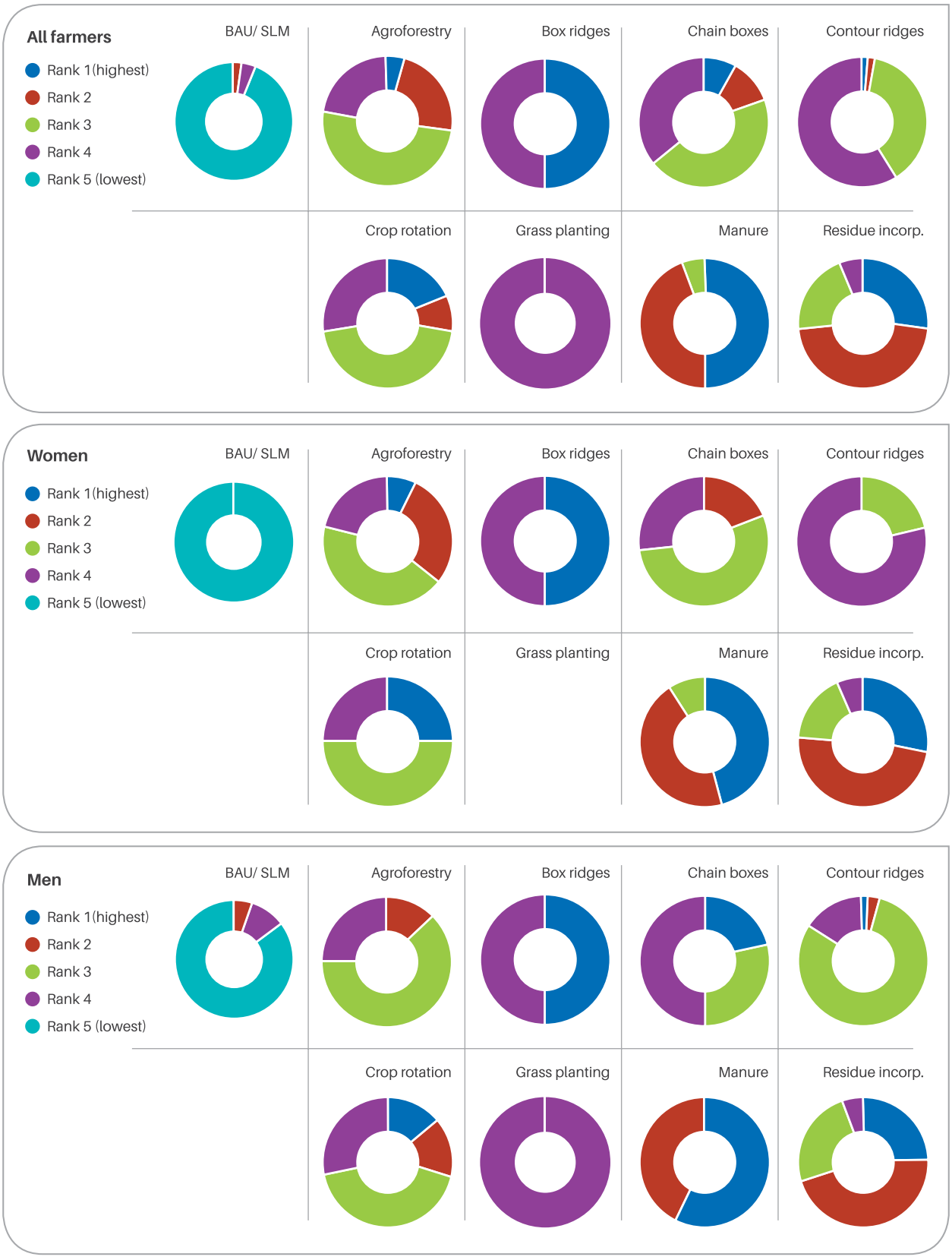
From Evaluating Land Management Options (ELMO) exercises. *Totals exceeds 100%, because different SLM combinations scored in different interviews.

Figure 23. Overall scoring of SLM techniques

Farmers also consistently give a low rank to *fanya juu*, *matengo* pits and ridge planting in Lushoto and to grass planting and contour ridges in Ntcheu (Figure 24, Figure 25). In contrast, in Lushoto, around a half of farmers rank terraces and agroforestry as their first or second most preferred land use option. In Ntcheu the majority of farmers scored box ridges and residue incorporation as their most preferred land management choice, and around a quarter prefer manure and crop rotation above other SLM techniques. There is a generally high degree of congruence between what men and women farmers consider to be the more desirable land use options.

From Evaluating Land Management Options (ELMO) exercises. Shows percentage of respondents allocating different ranks to each SLM technique.

Figure 24. Overall ranking of SLM techniques in Lushoto



From Evaluating Land Management Options (ELMO) exercises. Shows percentage of respondents allocating different ranks to each SLM technique.

Figure 25. Overall ranking of SLM techniques in Ntcheu

SLM costs & input requirements, benefits & desired outcomes, advantages & disadvantages

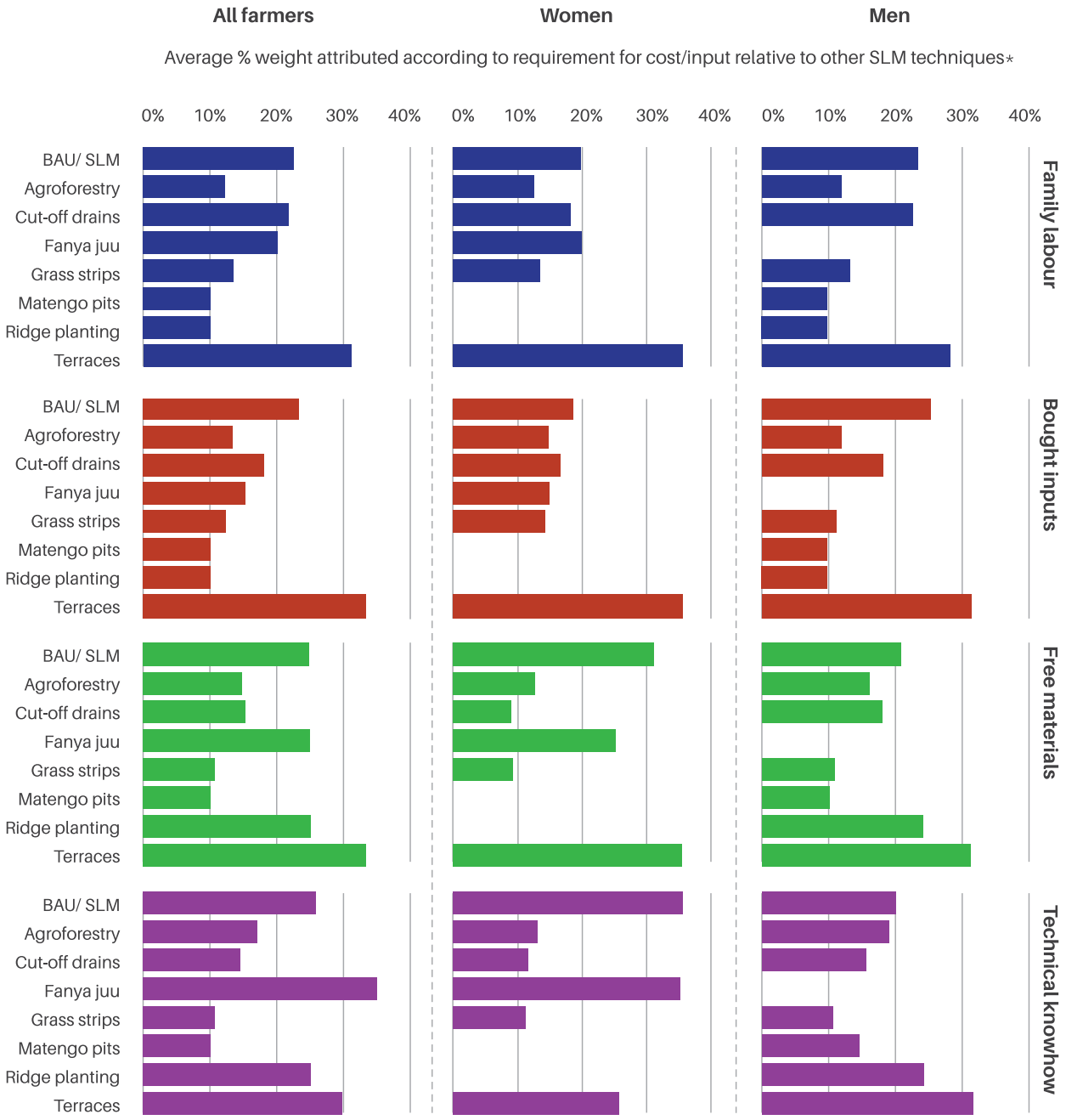
There is also a fairly high degree of congruence between what women and men consider to be the main economic attributes of different SLM options. In Lushoto, terraces (the most preferred SLM technique) consistently come out as having high cost requirements as compared to other SLM techniques in terms of family labour, purchased inputs, free materials and technical knowhow (Figure 26). Their demands for land and labour are seen as being particularly difficult to meet (Figure 32). At the same time, farmers consider that terraces are also able to generate much higher levels of cash income, food supply, crop yield improvements, drought protection, soil fertility than other SLM options (Figure 28).

The cost requirements for agroforestry and cut-off drains (the other preferred techniques in Lushoto) are also seen as being slightly higher than those of other SLM options as regards bought inputs, but comparable in most other respects. Both cut-off drains and agroforestry are perceived to make unreasonable cash demands relative to what is available to most farmers, and the high labour demands associated with cut-off drains are also ranked as a major disadvantage. Agroforestry is however considered to yield relatively high benefits in terms of cash income, drought protection, soil fertility and (especially) soil moisture, while cut-off drains are comparable to other SLM techniques in terms of the benefits and desired outcomes they generate. All three of the most preferred SLM techniques (especially terraces) are perceived to perform well in reducing risk, yielding quick returns and filling food and cash gaps at the right time, although their upfront investment requirements are not scored particularly high as compared to other land management options (Figure 29).

Looking at the least preferred SLM techniques in Lushoto, *fanya juu* and ridge planting are considered to be relatively demanding of technical knowhow and free materials. *Matengo* pits and ridge planting also score low as compared to other SLM options in terms of cash income, drought protection, soil fertility and soil moisture and (for ridge planting) crop yield effects, *Fanya juu*, *matengo* puts and ridge planting are all considered to have relatively few disadvantages as regards unreasonable labour and cash demands, although there are concerns that *matengo* pits take too much land out of production and take too long to yield tangible benefits. On the benefit side of the equation, *matengo* pits are seen as being good in filling food and cash gaps at the right time, as well as performing slightly better than the preferred techniques in terms of only requiring a small upfront investments. *Fanya juu* is also considered to generate relatively high cash income, crop yields, drought protection and soil fertility benefits, and is also scored well in reducing risk, yielding a quick return and filling food and cash gaps at the right time.

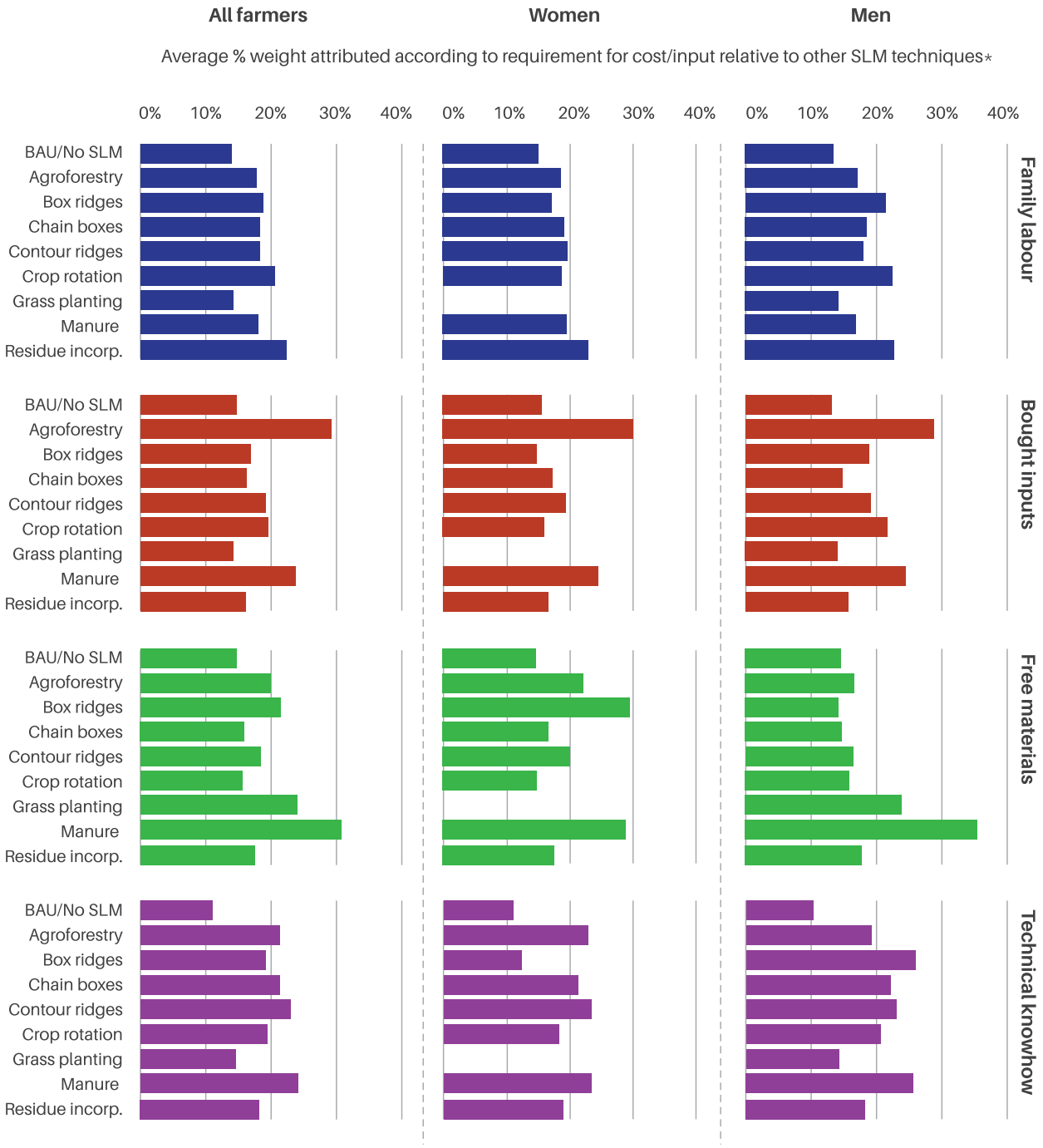
In Ntcheu, the preferred techniques of box ridges, residue incorporation, manure and crop rotation all score particularly high as regards risk reduction, small upfront investment, quick returns, filling food and cash gaps at the right time, and using known and trusted practices (Figure 31). Manure is also perceived to provide slightly higher cash income, food supply and soil fertility (Figure 29). Residue incorporation is seen as achieving a higher-than-average performance in providing drought protection, crop yield and soil fertility benefits, while crop rotation is especially valued for its positive effects on crop yields, and box ridges are also seen to have advantages in terms of drought protection and soil moisture benefits. As regards negative attributes, residue incorporation is thought to run a high risk of attracting termites and other pests, while all of the preferred techniques are considered to place particularly unreasonable labour and cash demands on farmers, as well as having some disadvantages in terms of taking too long to yield benefits (Figure 33).

Farmers perceived there to be few differences in the cost and input requirements of the most and least preferred SLM techniques, with the only notable differences being the much higher demands of manure (a more preferred SLM technique) for free materials and the generally lower-than-average cost requirements of grass planting (less preferred) (Figure 27). Contour ridges, a least preferred SLM technique, ranks relatively well in most respects except for soil fertility effects, while grass planting scores low on cash income, food supply, drought protection, soil fertility and on taking too much land out of production, and extremely low as regards most of the other listed advantages and positive attributes.



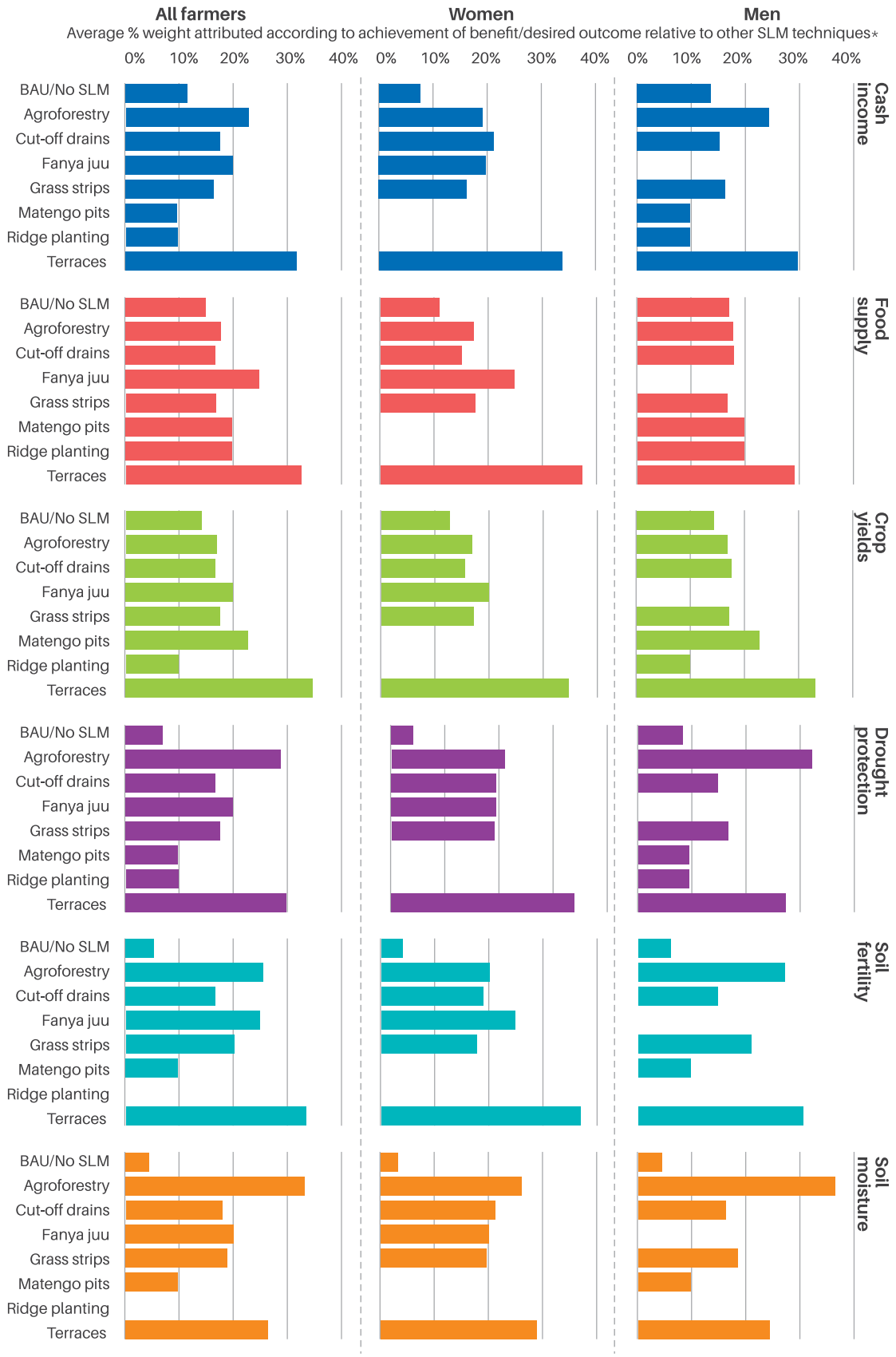
From Evaluating Land Management Options (ELMO) exercises.*Totals exceeds 100%, because different SLM combinations scored in different interviews.

Figure 26. Relative costs and input requirements of different SLM techniques in Lushoto



From Evaluating Land Management Options (ELMO) exercises. *Totals exceeds 100%, because different SLM combinations scored in different interviews.

Figure 27. Relative costs and input requirements of different SLM techniques in Ntcheu

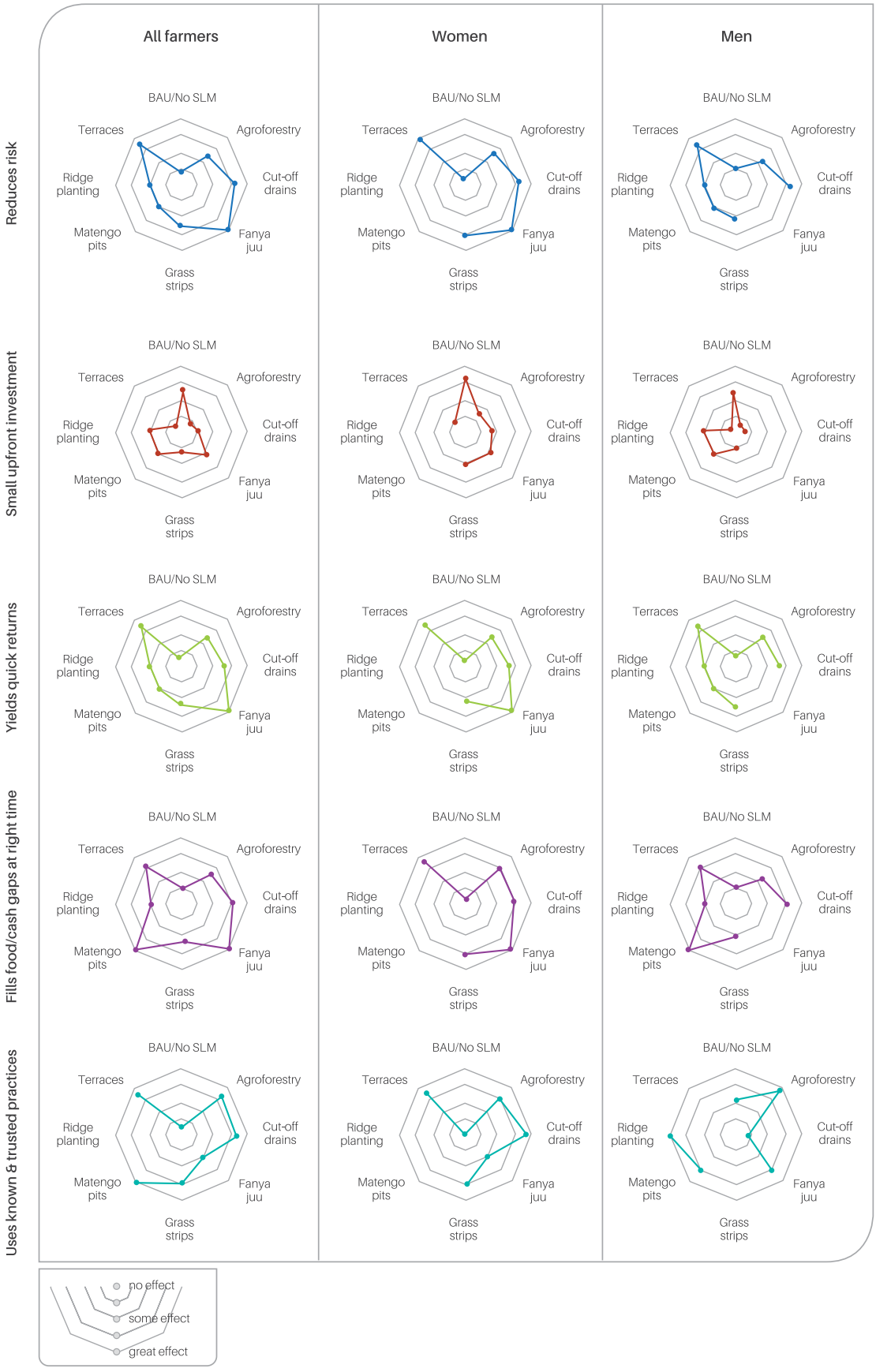


From Evaluating Land Management Options (ELMO) exercises.*Totals exceeds 100%, because different SLM combinations scored in different interviews.

Figure 28. Relative benefits and desired outcomes of different SLM techniques in Lushoto

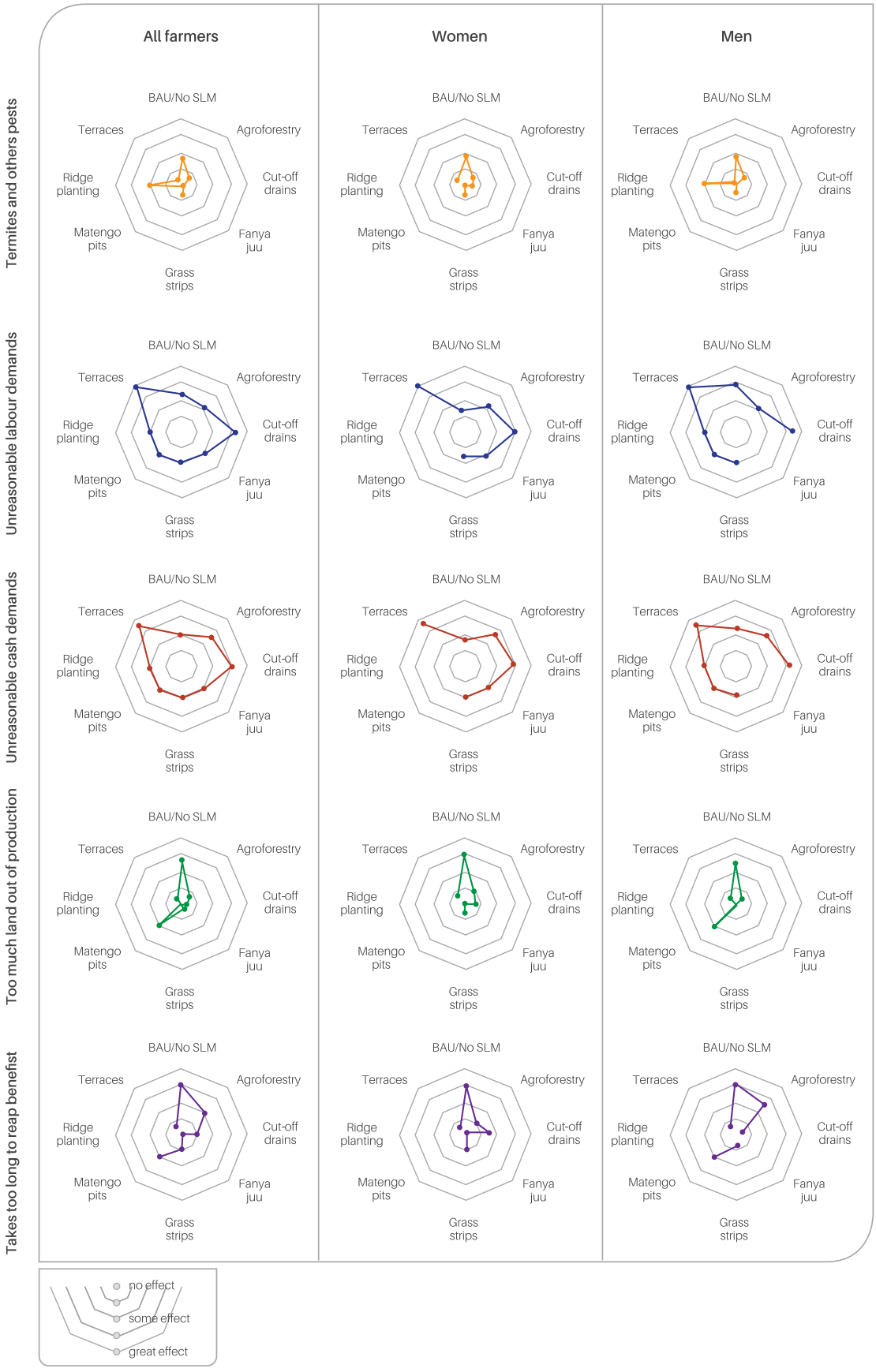
From Evaluating Land Management Options (ELMO) exercises.*Totals exceeds 100%, because different SLM combinations scored in different interviews.

Figure 29. Relative benefits and desired outcomes of different SLM techniques in Ntcheu



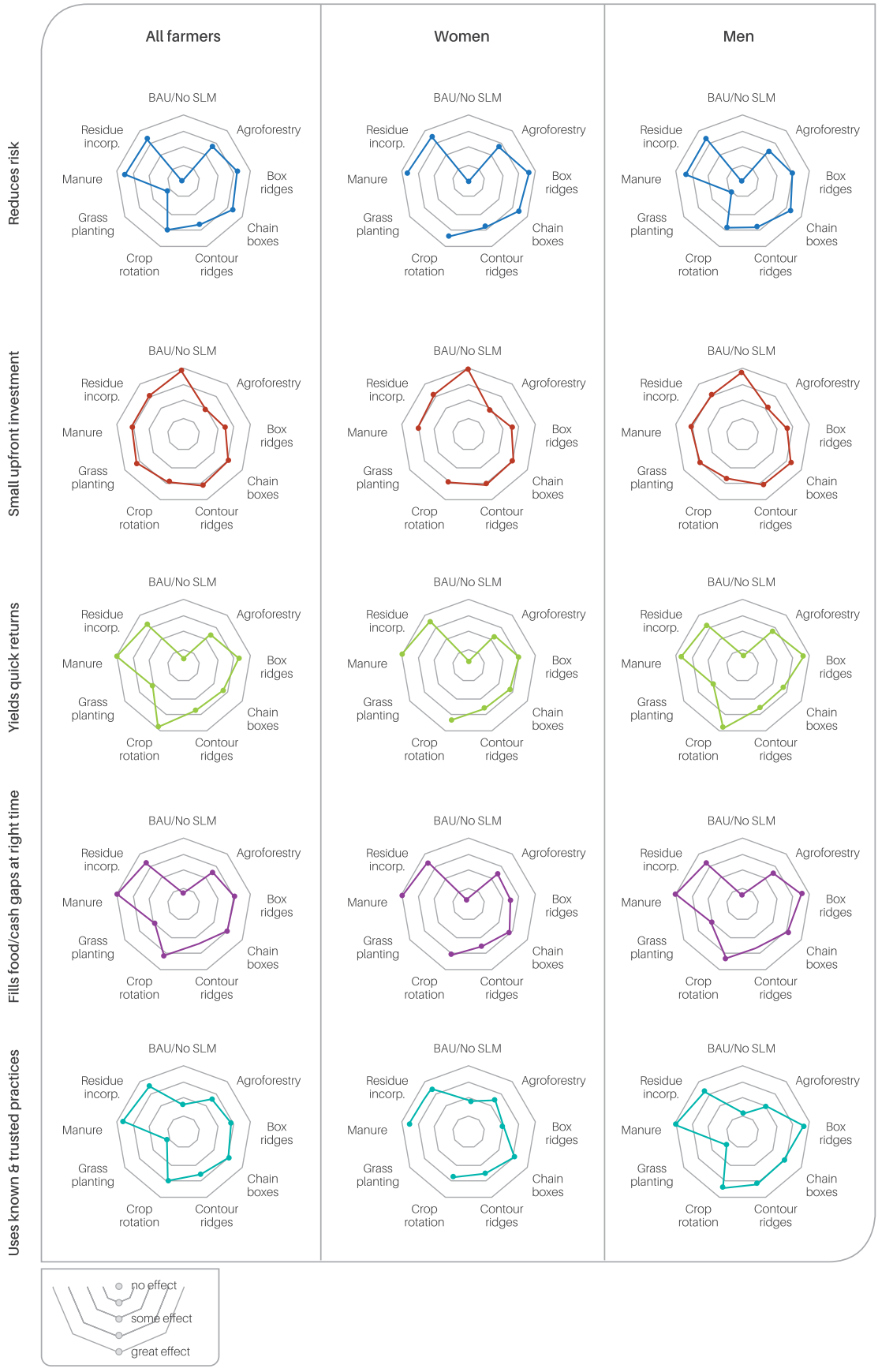
From Evaluating Land Management Options (ELMO) exercises.

Figure 30. Scoring of advantages and positive attributes of different SLM techniques in Lushoto



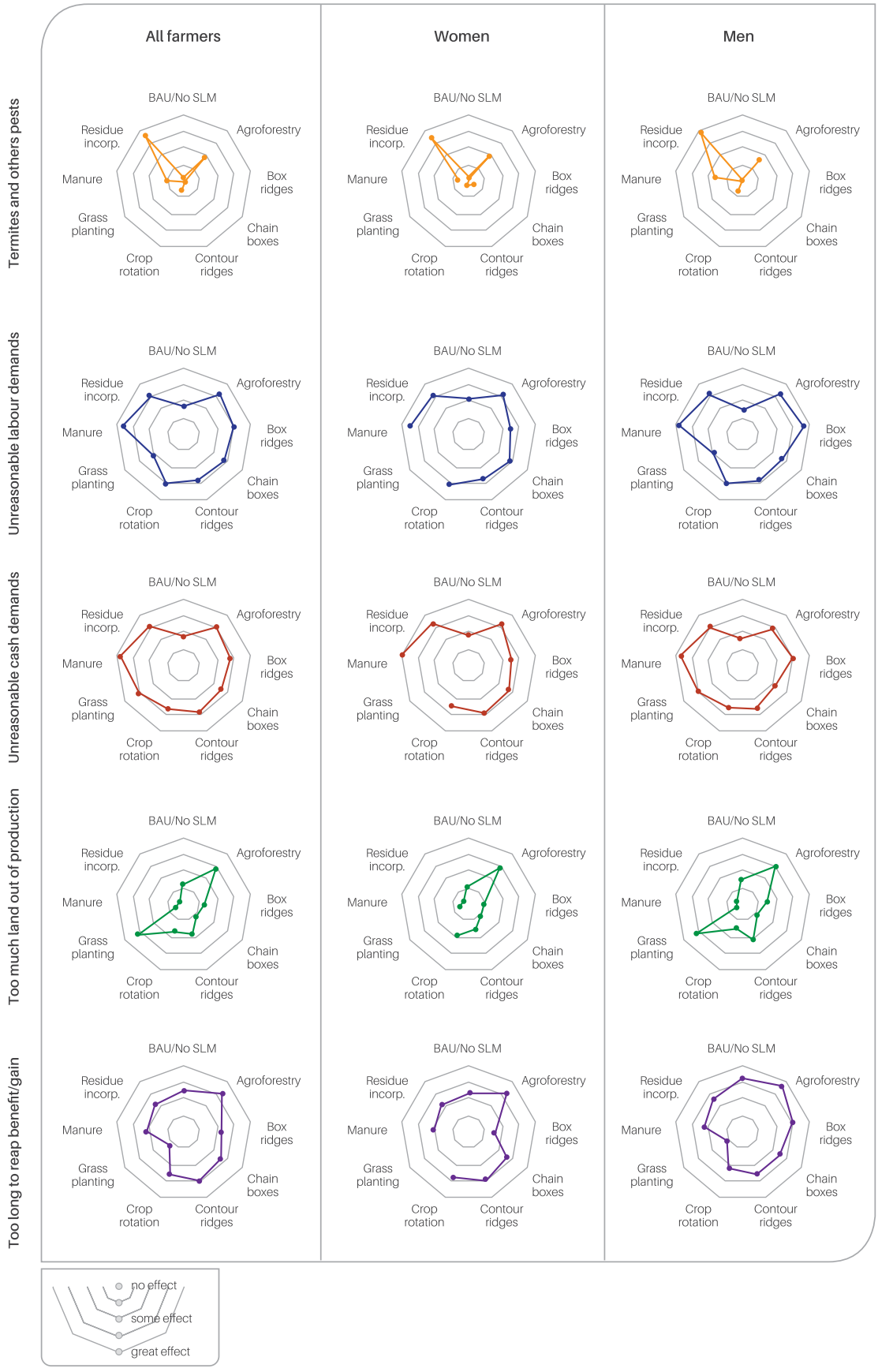
From Evaluating Land Management Options (ELMO) exercises.

Figure 31. Scoring of disadvantages and negative attributes of different SLM techniques in Lushoto



From Evaluating Land Management Options (ELMO) exercises.

Figure 32. Scoring of advantages and positive attributes of different SLM techniques in Ntcheu



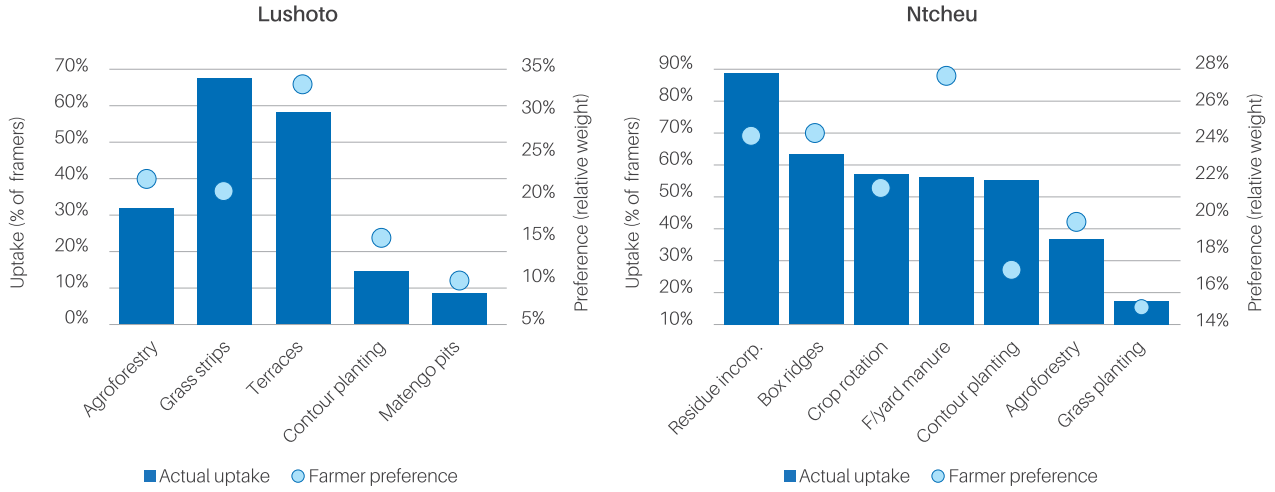
From Evaluating Land Management Options (ELMO) exercises.

Figure 33. Scoring of disadvantages and negative attributes of different SLM techniques in Ntcheu

How SLM adoption levels & financial indicators match with farmer preferences

The analysis of farmers' preferences and perceptions presented above makes it clear that, while a balanced array of benefits and advantages is typically sought, the presence of costs, disadvantages and negative attributes does not necessarily serve to make a particular SLM option unattractive. A broad range of monetary and non-monetary economic factors are considered, weighed-up and balanced when farmers decide which SLM techniques would be most appropriate to their needs and circumstances.

Although the previous chapter underlined that simple financial indicators do not generally provide an accurate measure of SLM uptake, it is interesting to note that in most cases there is a broad correspondence between farmers' stated preference for different SLM options and the techniques that they actually invest in (Figure 34). Thus, for example, expressions of the relative desirability of agroforestry, terraces, contour planting and *matengo* pits matches closely with observed rates of uptake in Lushoto. In Ntcheu the patterns are similar, although less pronounced, for residue incorporation, box ridges, crop rotation, agroforestry and grass planting.



From household questionnaire surveys, Evaluating Land Management Options (ELMO) exercises. Actual uptake based on percentage of farmers practicing SLM techniques. Farmer preferences based on relative weighting – percentage indicates average share of total score allocated to that SLM technique across 5 alternative land management options.

Figure 34. Actual uptake of SLM techniques compared to farmers' stated preferences

It is only for grass strips in Lushoto and contour planting, manure and grass planting in Ntcheu that there appears to be a marked divergence between farmers' stated preferences and actual uptake patterns. For the first two, adoption is relatively high even though farmer preference is only moderate (and, as seen in the previous chapter, profitability is high). For the latter, farmer preferences outweigh actual adoption rates (and profitability is only moderate). Similar, although less pronounced differences can be observed for terraces in Lushoto and agroforestry in both Lushoto and Ntcheu, where farmer preference levels are noticeably higher than the incidence of uptake.

We thus find that, in several cases, even where awareness of is high, preferences are positive and profitability is great, farmers do not invest in a SLM technique. Conversely, some of the practices that farmers indicate a relatively lower preference for (and which are less profitable) show higher levels of uptake, These apparent paradoxes reflect the findings of other work that high awareness levels, high profits or even high levels farmer of preference for particular SLM techniques do not necessarily lead to high adoption rates (Emerton 2013a,b; 2014a; Peterson et al. 2014; Tenge et al. 2004; Wickama et al. 2014b).

These divergences can be explained by the often very substantial gaps that exist between what farmers would like to do, and what they actually are able to undertake, given their economic circumstances, endowments and the resources available to them. Looking side-by-side at SLM uptake rates, financial indicators, farmer preferences and perceptions (Figure 35), we can for instance see that, in Lushoto, high farmer preferences for terraces and agroforestry are reflected in relatively lower uptake levels due to the high investment and maintenance costs (for terraces) and slow delivery of benefits (for agroforestry) which make them unaffordable to many poor farmers. In a similar vein, even though manure is perceived to deliver high or very high levels of benefits in Ntcheu, it also has high cost and input requirements, most notably livestock. Many farmers do not own cattle: it is noticeable that manuring is more widespread among richer farmers, who have a far higher incidence of cattle ownership.

Conversely, there are sometimes SLM techniques for which farmers do not have a particularly high preference, but which are cheap and easy for them to carry out within the bounds of the limited resources that are available to them. Thus, for example, grass strips in Lushoto entail very low investment and maintenance costs and yield high and quick returns to the farmer, as well as generating multiple benefits, being perceived to entail minimal inputs, building on known and trusted practices, and can be practiced without taking much other land out of production.. Even though farmer preferences are only moderate, uptake levels tend to be high because of their accessibility and ease of implementation. The same pattern holds for contour planting in Ntcheu, which also has very low investment costs, shows a rapid rate of return, and builds on known and trusted practices (even though it places relatively high cash and labour demands on the farmer).

Mbuzi village, Lushoto, Tanzania

	Preference[a]	Uptake[b]	BCR[c]	NPV	IRR[d]	Payback[e]	Investment[f]	Perceived benefits[g]	Perceived costs[g]	Perceived (dis) advantages[h]
Lushoto										
Terraces	High	Moderate, higher for richer farmers	Moderate	Negative	Low	Very long	Very high	High delivery of all benefits & desired outcomes	High requirements for all costs & inputs	Very high risk reduction & use of known practices High quick returns & fills gaps at critical times Very high unreasonable cash & labour demands Very low pests, take land out of production
Agroforestry	Moderate	Low	Very high	Positive	High	Long	Low	High drought protection, soil fertility & moisture	Low family labour & bought inputs	High use of known practices High upfront investment High unreasonable cash demands Low pests, land out of production
Cut-offs	Moderate		Moderate	Positive	Moderate	Very long	High		Low technical knowhow	High risk reduction, quick returns, fills gaps at critical times, use of known practices High upfront investment High unreasonable cash & labour demands Very low land out of production, time to reap benefits
Grass strips	Moderate	High, especially men farmers	Very high	Positive	Very high	Moderate	Low		Low requirements for all costs & inputs	High risk reduction, fills gaps at critical times, use of known practices Low upfront investment Low pests Very low land out of production
Contour planting	Low	Low	n.d.	n.d.	n.d.	n.d.	n.d.	Low cash income, crop yields & drought protection Very low soil fertility & moisture	Low family labour & bought inputs High free materials & technical knowhow	Very low land out of production
Fanya juu	Low	Moderate, lower for poorer farmers	n.d.	n.d.	n.d.	n.d.	n.d.	High food supply & soil fertility	Low free materials & technical knowhow	Very high risk reduction, quick returns, fills gaps at critical times Very low pests, land out of production, time to reap benefits
Matengo pits	Very low	Very low, especially poorer farmers	n.d.	n.d.	n.d.	n.d.	n.d.	Low cash income, drought protection, soil fertility & moisture	Low family labour bought inputs & free materials	Very high fills gaps at critical times, use of known practices Very low pests

	Preference[a]	Uptake[b]	BCR[c]	NPV	IRR[d]	Payback[e]	Investment[f]	Perceived benefits[g]	Perceived costs[g]	Perceived (dis) advantages[h]
Lushoto										
Farmyard manure	High	Moderate, higher for richer farmers	Moderate	Positive	Moderate	Very long	Moderate	High cash income, food supply & soil fertility	High bought inputs, free materials & technical knowhow	Very high risk reduction, quick returns, fills gaps at critical times, use of known practices High upfront investment Low pests, land out of production
Residue incorporation	High	Very high, especially for women farmers	Moderate	Negative	Low	Very long	Low	High crop yields & soil fertility		High levels of all advantages & positive attributes Very high pests, unreasonable cash & labour demands High land out of production, time to reap benefits
Box ridges	High	High, especially for richer & men farmers	Very high	Positive	High	Long	Very low	High drought protection & soil moisture		High levels of all advantages & positive attributes Very low pests, unreasonable cash & labour demands Low land out of production
Crop rotation	Moderate	Moderate, high for richer & men farmers	High	Positive	High	Very long	Very low			High risk reduction, fills gaps at critical times & use of known practices Low upfront investment Very high quick returns Low pests High unreasonable cash & labour demands
Agroforestry	Moderate	Low	n.d.	n.d.	n.d.	n.d.	n.d.		High bought inputs	High risk reduction, quick returns & fills gaps at critical times High unreasonable cash & labour demands land out of production, time to reap benefits
Contour ridges	Moderate	High, especially for poorer farmers	High	Positive	High	Very long	Very low			High risk reduction, quick returns, use of known practices Low upfront investment Very low pests High unreasonable cash & labour demands land out of production
Grass planting	Moderate	Very low	n.d.	n.d.	n.d.	n.d.	n.d.	Low soil moisture		Low risk reduction & use of known practices Low upfront investment High unreasonable cash demands, land out of production Low time to reap benefits, pests

From household questionnaire surveys, farm budget assessments, Evaluating Land Management Options (ELMO) exercises. n.d. no data. a Weight allocated relative to 4 other land management options, with percentage showing average share of total score allocated to that SLM technique. Very high >50%; high 25-49%; moderate 15-24%; low 10-14%; very low <10%; b Percentage of farmers currently practicing. Very high >80%; high 60-80%; moderate 40-60%; low 20-40%; very low <20%; c Very high >5; high 1.5-5; moderate 1.15-1.49; low 1-1.09; negative <1; d Based on assumed 10% discount rate / opportunity cost of capital. Very high >100%; high 25-100%; moderate 11-24%; low 0-10%; negative <0%; e Very long >5 years; long within 3-5 years; moderate within 2-3 years; quick within 1 year; immediate: no payback; f Very high >$500; high $200-500; moderate: $100-199; low $50-99; very low <$50; g Weight allocated relative to 4 other land management options, with percentage showing average share of total score allocated to that SLM technique. Very high >50%; high 25-50%; moderate 15-24%; low 10-14%; very low <10%; h Score attributed to level or effect of dis/advantage associated with land management options from great effect (4) through some effect (2) to no effect (0). Very high >3.5; high 2.5-3.49; moderate 1.5-2.49; low 0.5-1.49 very low or none <0.5.

Figure 35. Summary of uptake, economic indicators and farmer preferences for SLM techniques

Roots, Tubers & Bananas - Research Program in East Africa.

ECONOMIC DRIVERS: underlying factors that shape, enable & constrain farmers' land use decisions

The preceding chapters have shown that, although most households in Lushoto and Ntcheu know, use and prefer some form of SLM, these are not necessarily the ones that are most profitable when judged in simple, financial terms. Farmers highlight a wide array of monetary and non-monetary economic attributes which they seek (or look to avoid) when they make land management choices, and which indicate the relative desirability (or not) of different SLM options to them. It is these characteristics that determine whether an SLM option can be deemed to be economically attractive, viable and sustainable.

However, at the same time, the research has also made it clear that in neither study site are farmers necessarily able to choose the land management options that they consider to be the most effective for SLM or the most desirable in economic terms, but undertake those that they are actually able to accomplish. In many cases the choice of SLM techniques is a second best one, because the farmer is unable to access the inputs or bear the costs that would be required to deliver the type and level of economic benefits they most need or desire. Just as different farmers' economic preferences and needs vary, so do their resource endowments and capacities, and thus their capacity to meet their SLM preferences.

The key question now becomes: what determines farmers' needs and preferences for SLM, and which factors serve to variously enable, constrain, encourage or discourage particular land management decisions and choices? A particular concern is to identify where and why farmers are being prevented or discouraged from undertaking those SLM options that they consider to be the most desirable and effective, and to identify where (and what kind of) additional support might be necessary to enable and empower them to do so.

Here, it is impossible to consider the costs and benefits associated with different SLM options apart from other aspects of farmers' livelihoods, or from the broader economic environment within which they operate. The point is that SLM is just one economic option or opportunity that is embedded in a suite of other livelihood activities (and which it typically both supports and competes with at different times). SLM costs, benefits and preferences are neither universal nor immutable, when considered from the farmer's viewpoint. In reality, a wide range of economic stimuli and circumstances variously enable, encourage or even force people to produce, consume and invest in particular ways or at particular levels. Understanding the influence that these broader structural conditions have in determining the most "profitable", "desirable"

or "feasible" land management option is key to understanding the economic drivers of both land degradation and SLM uptake.

Discussions with farmers in Lushoto and Ntcheu highlighted two main categories of economic influences or drivers[14] which shape their needs and preferences, and determine their ability and willingness to invest (or not) in different SLM techniques (Figure 36). The first set of drivers concerns market access and interactions, and farmers' bargaining power and terms of trade within them. These shape farmers' performance and opportunities relative to their external economic environment, and determine whether they are in an economic position to be able to take up SLM, or find themselves in a situation where they have no option but to degrade the land and natural resource base in the course of their economic activities. The second set of drivers relates to livelihood trade-offs and synergies, and the extent to which SLM costs and benefits match up with what farmers actually need and have available to them at different times. It refers more to the internal dynamics of the household economy, and influences the characteristics and attributes that farmers seek in SLM practices, and what their needs and preferences are when they make land management decisions. In turn, both sets of drivers work together to determine the extent to which farmers are forced into a situation where they degrade land in the course of their economic activities, or can invest sufficient resources and capture adequate value-added to make SLM a viable option, given their needs, preferences and endowments.

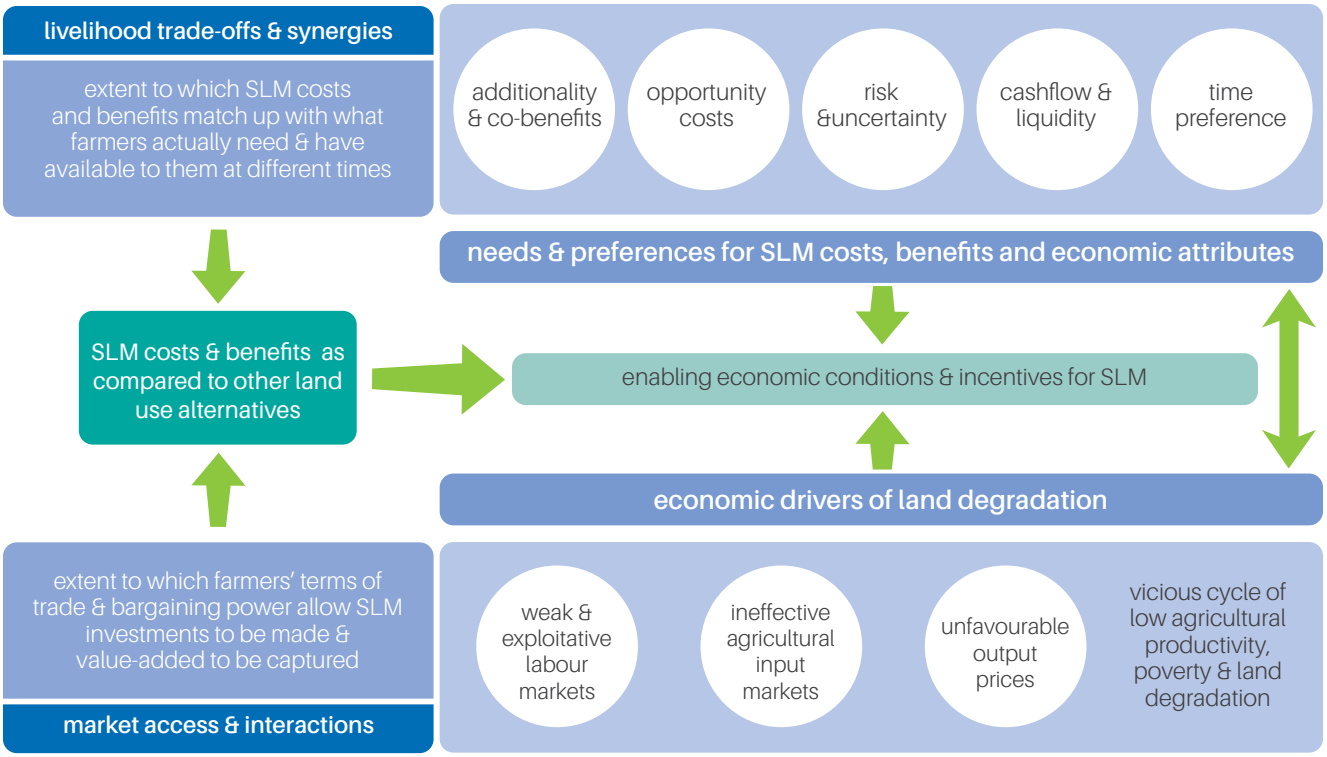


Figure 36. Economic drivers of SLM needs, preferences & decisions

14 The current paper focuses specifically on economic drivers. Other components of AGORA address the social, cultural, institutional, policy and environmental factors that shape (and are themselves shaped by) economic conditions, and which also drive land degradation and SLM uptake in the study sites. These are documented elsewhere (see Rosendahl 2016; Snyder et al. 2016).

Market access & interactions: farmers' bargaining power and terms of trade

While local livelihoods in both Lushoto and Ntcheu are relatively well-integrated into the market economy, most households remain in a weak position to benefit fully from these opportunities, and have only weak bargaining power to negotiate any improvement in the terms of trade they face. Farmers in the study sites confirmed that unfavourable agricultural input, output and labour markets perpetuate the low farm returns and chronic shortages of food and cash that prevent or discourage them from taking up SLM, and instead force them into carrying out unsustainable land management practices. The research findings thus reinforce observations made elsewhere in the literature that poorly performing agricultural markets and distorted prices serve to both undermine farmers' livelihoods and drive land degradation (Nakhumwa and Hassan 2012; Tchale and Wobst 2004), and distort the incentives of poor smallholders away from adopting SLM (Barbier 2000).

Weak and exploitative labour markets

As described in earlier chapters, many farming households in the study sites depend in some way on income earned from local (and sometimes more distant) labour markets. Facing persistent and recurrent food and cash deficits, farmers are forced into vibarua, ganyu and other forms of casual labour in order to survive. Yet the worst cash and food shortages tend to occur at just the time when labour is needed most on-farm. The overall effect becomes a labour dilemma. In order to satisfy their immediate needs for cash and food, as well as to generate the income that is required to buy production materials and inputs, farmers have few alternatives but to sell their labour at the very time when they should be preparing, planting and weeding their own fields. It has already been noted in the literature that this has serious consequences for crop output, leading to a progressively worsening cycle of intensifying cash needs, rising food deficits, diversion of household labour to casual wage earning, and progressive erosion of livelihoods (Edriss et al. 2004).

These effects are exacerbated, and to some extent perpetuated, by the weak and exploitative labour market conditions that farmers face. The problem of low remuneration was repeatedly mentioned. People have to work for long hours and protracted periods to earn enough money to buy food and other basic necessities (let alone to finance purchase of the equipment, materials and inputs that are required for farming, or for SLM). Delays in payment are also common, and employers often renege on the agreed rates. For the most part farmers have no option but to accept these conditions, because they have no other option. In addition, because so many poor farmers are selling their labour at particular times of the year in Lushoto and Ntcheu, buyers have the power to decide what levels and forms of payment they will offer. This confirms the findings of other studies that the amount of casual labour that is supplied to the market frequently exceeds demand, meaning that the bargaining power of casual labourers has become progressively weaker as regards both the level of remuneration received and the range of tasks undertaken (Chirwa 2003; Edriss et al. 2004; Munthali and Murayama 2013).

Ineffective agricultural input markets

Farmers in both Lushoto and Ntcheu mentioned that the high price of inputs acts as a binding constraint to agricultural productivity and farm profitability, as well as forming an underlying cause of land degradation. Most farmers do not apply fertilisers at recommended levels, or – in many cases – do not apply them at all. While indirect fertiliser subsidies exist in both Malawi and Tanzania, these tend to only reach a minority of the population. In Ntcheu, this is said to have resulted in a situation where recipients frequently share the subsidised inputs they receive with other family members – a recent survey in the Middle Shire Basin for example found an average of four households using a single coupon allocation (LTSI 2014b). In other cases, due to needs for cash, recipients sell on their fertiliser and seed coupons to others (particularly richer farmers) at a discounted rate. Most farmers are left with no option but to purchase farm inputs from private traders or government-run shops. Yet prices are considered to be high, and in many cases unaffordable. Supplies also tend to be quite uncertain, with patchy availability, limited choice and often poor quality of inputs. Farmers reported that vendors often (deliberately or unwittingly) sell out of date, expired or adulterated seeds, fertilisers and pesticides. All of these factors have the net result that fertiliser use remains low in both study sites.

There was a general consensus that in both study sites key inputs (most notably fertilizer and seeds) had become more expensive in real terms, and thus less affordable, over time. At the same time, farmgate prices for crops appear to have been falling (this is discussed further below). As noted by others, the rate of increase in input prices has far outstripped that of maize and other outputs (Smale and Jayne 2004). Evidence was also presented in the study sites which supports the claims made by other authors that the effects of rapid inflation, exchange rate depreciation, macroeconomic instability and public spending crises have served to exacerbate land degradation in Lushoto, Ntcheu and nearby areas by undermining agricultural income and crowding farmers out of the input market (Chinsinga 2008; Namwata et al. 2012; Sauer and Tchale 2006). The net result has been a sharp decline in both the productivity and profitability of farming over recent years.

It is worth noting that in both study sites a variety of locally driven arrangements have evolved in response to farmers' lack of finance to purchase inputs. In Lushoto, some shopkeepers offer fertiliser loans, which farmers pay back only after harvest. Interestingly, for the most part no interest is charged – although several people explained that these arrangements did not necessarily serve to improve their financial position, because borrowers would then have to use up all their income at harvest time paying back the loans. Although such responses are less widespread in Ntcheu, some informal fertiliser loan schemes exist between local traders and farmers, albeit usually involving high (and often crippling) interest rates. However, farmers in both Lushoto and Ntcheu state that it is usually only the more affluent households that can afford to take out input loans, or are in a position to be prepared to do so. Risk is cited as a key factor. The risk of not being able to pay the loan back, should the crop fail, is considered to be a very big one. For this reason, it is mainly farmers with other (non-crop) sources of income that can afford to take out input loans.

Forages in Tanzania

Unfavourable output markets

Low crop prices and weak agricultural terms of trade are often singled out as the most important factors that serve to constrain cash income-generation and undermine the profitability of farming. Farmers face very limited markets for their crops (even though, ultimately, farm produce from both Ntcheu and Lushoto is reaching quite far-afield markets in other parts of Malawi and Tanzania). Due to a lack of price information and trading connections, and because of the high costs of transport, most people are constrained from selling their crops beyond the immediate locality. They have no option but to depend on middlemen and external traders who come into the area to buy farm produce.

Farmgate crop prices tend to be extremely low, and in some cases are not even sufficient to cover the basic costs of production. Only a few external middlemen operate in either study site. Because the markets for farm produce are dominated by a small number of buyers, local farmers are forced to be price-takers As well setting prices, middlemen can determine the terms and conditions under which sales take place and payments are made. Traders often take products on credit, and may delay – or even avoid altogether – making payment. Because farmers have no alternative markets for their crops, farmers have little choice but to accept these conditions, and have limited room for negotiation and only weak bargaining power to secure better prices.

Prices also vary considerably over the course of the year. As has already been noted above in relation to casual labour, farmers are typically forced to sell their crops and livestock products immediately after harvest, when prices are at the lowest. Here, again, perceptions of risk and uncertainty exert an influence. Because prices are so unstable, farmers cannot always predict what their future income will be over the course of the year. At the same time, they have no knowledge or control over when middlemen will come into the area to buy crops, and tend to be pessimistic about the likelihood of attracting higher prices in the future. For this reason, people often express a preference for selling their produce immediately after harvest, when buyers are available, or (in the case of Ntcheu) to the parastatal ADMARC. Even though the prices they receive are frequently lower than those on the open market or at other times of the year, it is possible to predict with certainty that output will be bought when offered, and be sure what price will be received.

Because of their effects in undermining farm profitability and earnings, low crop prices and unfavourable output markets serve as a driver of land degradation – a point that has been noted by various

Lushoto farmers working

other authors in and around the study sites (Dzanja et al. 2013; Jere and Maganga 2012; Kambewa et al. 2007; Kambewa and Chiwaula 2010; Pound and Phiri 2011; Sangole et al. 2010; Tchale and Keyser 2010). Farmers' inability to access higher value-added and better markets for their produce poses a serious constraint both to their livelihoods and to sustainable land management. It means that the main concern is often to increase the volume of output achieved from a given land area or to expand the overall area under cultivation (often implying the overexploitation of land and resources), rather than enhance the value-added generated from current production.

Due to their uneven bargaining power, weak capacity and limited knowhow, very few farmers in either Lushoto or Ntcheu are able to move beyond the bottom end of the value chain. Products tend to be sold in small quantities, in a raw, unprocessed form, thus attracting low price premiums The main value-added tends to accrue outside the farm and village levels: to the middlemen, traders, transporters, wholesalers and retailers who are able to access better prices and markets, and to the processors who are able to transform raw materials into higher-value commodities and end-products (LTSI 2014a,b). Farmers, meanwhile, face numerous barriers and difficulties in transforming their products or accessing new markets, so as to add value and capture higher profits. Factors such as the often substantial start-up costs, needs for specialised knowledge, equipment and facilities, and remoteness of these value-added markets and consumers from the village level tend to pose particular difficulties. In addition, poor access to finance, high transport costs, low raw material quality, uncertain supply capacity, and limited processing, packaging and storage facilities are mentioned as key constraints to price and market competitiveness (Kambewa and Utila 2008)

The "vicious cycle" of low agricultural productivity, poverty & land degradation

Farmers' weak position as regards external markets and prices, together with a incidence of household poverty, weak and undiversified livelihoods and persistently low returns to agriculture, remain as some of the most pervasive drivers that encourage (or even force) land degradation in Lushoto and Ntcheu. These conditions also form a barrier to their investing in more sustainable land- and resource-use practices. With farms expanding into ever more fragile and marginal areas, plot sizes shrinking and soil fertility declining, the land is under increasing pressure. More and more labour, fertiliser and other inputs are required to obtain a harvest. As crop production is becoming costlier to carry out, so declining yields and falling output prices are undermining farm profitability. At the same time, as land is being put under ever greater physical stress, farmers' livelihoods are becoming less and less secure.

Facing low productivity, many farmers in both study sites (especially those who lack access to the basic factors of production) are finding it progressively more difficult to generate enough food and cash or to maintain their livelihoods from farming alone. One of the most common responses to dwindling agricultural profits is to look for additional sources of earnings to supplement farm income. People are increasingly forced to seek income elsewhere, especially through selling their own labour. Yet, as described above, participation in ganyu and vibarua activities comes at a high opportunity cost in terms of the diversion of household labour away from farming activities. In many cases it merely serves to reduce farm productivity still further. As income and labour become progressively scarce, it becomes increasingly difficult for farmers to work their land or to invest in the materials and inputs that are required to maintain crop yields, let alone to reallocate these resources to (or find additional resources for) SLM.

Farmers in both Lushoto and Ntcheu describe a situation where these problems are being compounded as time goes on. As farm yields and productivity decline still further and the returns to agriculture continue to be eroded, farmers are forced to seek more and more non-farm sources of income, and are able to invest less and less in maintaining their land. As land degradation worsens, farmers become increasingly impoverished, perpetuating the whole cycle. Farmers are thus becoming trapped in an ever-worsening downward spiral of low agricultural productivity, poverty and land degradation. Even those farmers who can still afford to invest cash and labour in SLM and sustainable intensification are often unable to reverse these trends. In Lushoto, for example, it was reported that the many of the gains from improved crop breeds and farming practices, higher input use and more participation in SLM have been offset by the decreases in productivity arising from land degradation.

The study findings thus confirm the "vicious economic cycle" of low agricultural productivity, poverty and land degradation that is already noted in Lushoto and Ntcheu and is mentioned so frequently in the literature on SLM in Malawi and Tanzania (Figure 37; see for example Emerton 2014b; Pender et al. 2006; Sauer and Tchale 2006, Munthali and Murayama 2013). They also reinforce the conclusion that, without finding concrete solutions to the joint problems of poverty, food insecurity and cash shortages, any effort to persuade farmers to engage in sustainable land management or to enable them to break out into so-called "virtuous cycles" or "upward spirals" is likely to be futile (Emerton 2014a; Kassie et al. 2009; Mangisoni 2009).

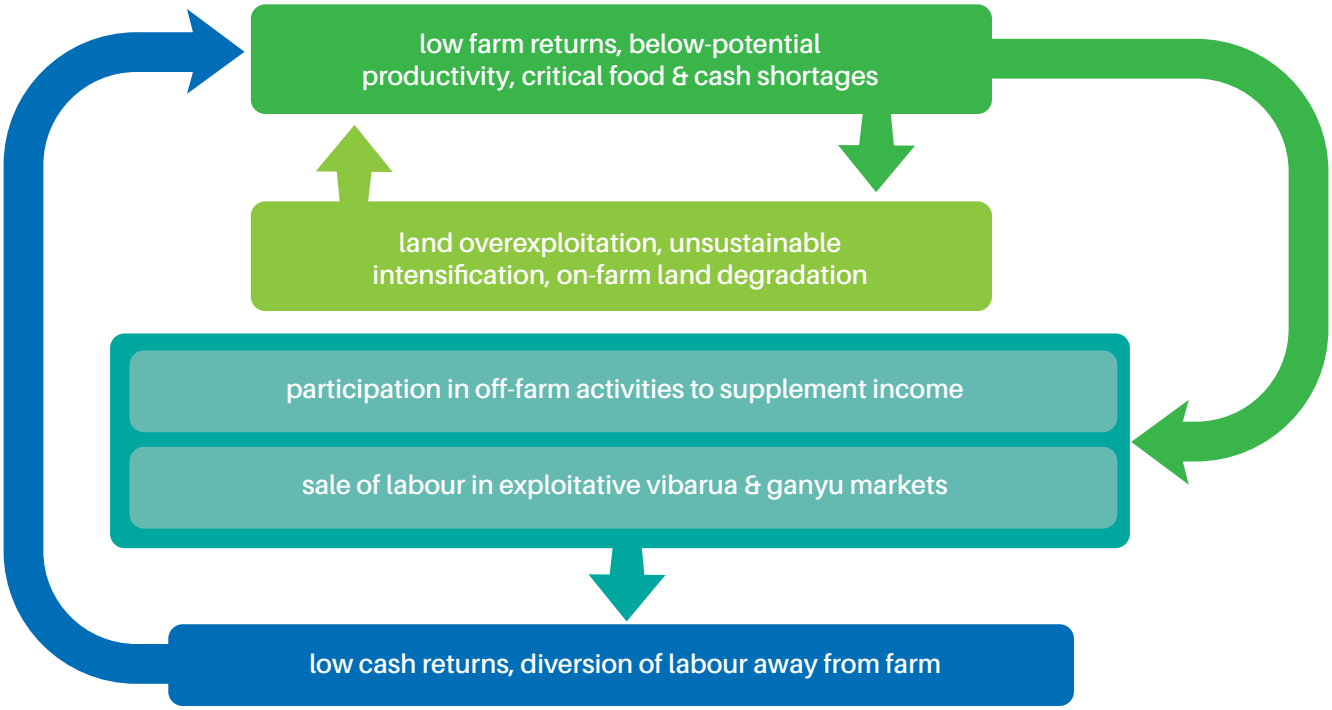


Figure 37. Vicious economic cycle of low agricultural productivity, poverty and land degradation

Adapted from Emerton 2014b.

Livelihood trade-offs & synergies: what farmers need and have available to them at different times

Farmers' economic circumstances exert a strong influence over their ability and willingness to engage in SLM. On the one hand, they determine whether (and in what forms) there are opportunities to capture value-added and profit from SLM activities. Market and price conditions (and in particular the vicious cycles or downward spirals of low agricultural productivity, poverty and land degradation that they give rise to) also determine what it is feasible for farmers to invest in SLM in terms of land, labour and other inputs, and what, in turn, they require SLM to deliver to them in terms of costs, benefits and other economic attributes.

Opportunity costs

The focus group discussions held in the study sites reinforce the observations made elsewhere in the literature that effective cost is a decisive factor in farmers' land management decisions, with labour and input requirements exerting especially powerful influences (Tchale and Wobst 2004, Chinangwa 2006). Farmers in Lushoto and Ntcheu frequently stated that they cannot afford to bear these costs. It is however important to note that it does not seem to be absolute cost that acts as the primary determinant of whether farmers are willing and able to take up a particular SLM technique, but rather how its requirements match up to farmers resource endowments and with the alternative use of those inputs elsewhere within the household

economy. In most cases there is a high opportunity cost to allocating land, labour, cash, farm inputs and other materials to SLM rather than to other productive ventures or income-generating activities.

High opportunity costs are seen as a major barrier to uptake, as most households need to allocate their labour to a multiplicity of tasks and a diversity of income-generating activities in order to survive. This is especially the case for poor households: the lower a farmer's resource endowment is and the more varied his or her livelihood activities are, the higher the opportunity cost. Again, the situation in the two sites reflects that described in other studies in rural Malawi and Tanzania which describe the difficulties that resource-poor farmers face in reallocating inputs and assets away from other productive (and potentially land/resource-degrading) uses towards SLM (FAO 2001; Iiyama et al. 2010; LTSI 2014a).

In both study sites, labour and capital were highlighted as the most binding constraints to SLM, and as the inputs which had the highest opportunity costs in terms of broader demands and potential uses elsewhere, a finding that is also reinforced in the literature (see Asfaw et al. 2014; Barungi and Maonga 2011; Chinangwa 2006; Peterson et al. 2014; Tenge 2005; Wickama and Nyanga 2009). The fact that several SLM techniques which might otherwise be considered to be both effective and attractive (for example terraces, cut-off drains and agroforestry) have high demands for cash and/or labour can put them beyond the reach of many farmers.

Even when sufficient labour and cash are available, SLM may not be considered a priority if the activities that it competes with for these resources are considered to have the potential to yield higher returns elsewhere (for example trade and business), are deemed essential life support services (for example water and fuelwood collection), or are just generally thought have a higher importance in terms of the monetary or non-monetary payoffs they can generate. In Lushoto, for example, involvement in off-farm activities has been found to negatively influences the adoption of SWC measures due to competition for labour (Tenge et al. 2004). The timing of SLM input demands also influences their opportunity costs, and the relative likelihood of their being able to be met. For example, in Ntcheu, it was stated that many SLM techniques require attention just at the time when labour is also needed for other farm activities (such as planting, weeding and fertiliser application), or during the hungry season when most households need to sell their labour as ganyu and allocate such cash resources as are available to buying food.

Maize crops in Malawi

Additionality & co-benefits

It is perhaps self-evident that without higher yields, greater production or improved income possibilities, incentives for investing in SLM technologies remain limited (Orr and Ritchie 2004). Yet the question of which particular benefits farmers need or seek from SLM varies – as, indeed, does the level or type of benefits that are considered necessary and sufficient conditions to take up SLM. The study found that, especially for poorer or more vulnerable households, a single stream of benefits is not enough to make SLM an economically appealing (or viable) option. The ability to "stack" benefits was repeatedly highlighted by farmers in Lushoto and Ntcheu as a key factor influencing their choice between different SLM techniques.

There was broad consensus in both study sites that it is the combination of different benefits (not necessarily their absolute value) which together make the SLM techniques worthwhile. Several examples were given of the ways in which this kind of additionality can shape farmers' decisions to take up SLM. In Ntcheu, for example, intercropping and crop rotation were emphasised as being desirable because – as well as being low cost to implement – they provided a way of simultaneously improving harvests, spreading risk, intensifying land use, optimising fertiliser use and, ultimately, maximising farm income. In Lushoto, farmers emphasised that although crop yield gains are important, by itself they are not usually sufficient to persuade people to invest in SLM. Additional benefits are needed – for example improved water availability, a supply of livestock feed, or other outputs which can be sold for cash or used within the household. Thus one of the reasons for the popularity of terracing and, to a lesser extent, grass strips – despite their relatively high costs and minor yield impacts – is that grass can be used to feed livestock, manure can then ploughed back into the land to improve soil fertility, and the additional crops and income would improve both food and cashflow.

Risk and uncertainty

The literature generally characterises smallholder farmers as being risk averse as regards their response to the expected returns from the adoption of new land management practices (Zeller et al. 1997; Simtowe 2006), including SLM (Kassie et al. 2008; Marenya et al. 2012; Ngirwa et al. 2013). In a similar vein, the need to manage (and where possible minimise or mitigate) risk and uncertainty was also found to exert an important influence on land management decisions in Lushoto and Ntcheu. Many farmers in the study sites explained that they simply cannot afford to bear the risk (and fairly high likelihood) of crop failure. There is also a general preference for SLM techniques that can help to even out the flow of food, income and other benefits over the course of the year, especially those that generate

Demonstration plot

Bean power in Tanzania

products or income at times when food and cash are otherwise scarce. Many of the SLM techniques that are most preferred display these characteristics, even when the overall yield and income effects are low. In some cases, these characteristics might even serve to make financially unprofitable SLM techniques both attractive and viable for farmers.

Thus, for example, farmers in Lushoto mentioned that although terracing has little or no impact on crop yields, it is perceived to reduce substantially the incidence of crop failure because it helps to retain moisture in the soil. Even when there is only very little rainfall it is likely that farmers with terraces will be able to obtain some crop production, whereas without terraces it is likely that there would be no harvest at all. Similarly, in Ntcheu, farmers explained that they treated some SLM techniques as a form of insurance. Practices such as box ridges and crop rotation were seen as a way of decreasing the likelihood of crop failure, while agroforestry is favoured due to its ability to generate a stream of products over the course of the year that can be used for food or sold in order to generate cash income. This means that, to some extent, access to a less risky and more diversified production base can act as a perverse incentive as far as SLM is concerned. For example, in Ntcheu, it was stated that richer farmers and households who have access a wider array of livelihood opportunities were less likely to invest in SLM, because they felt less need to take action to reduce risk and manage uncertainty. This has also been noted in Lushoto, where a recent study found that the availability of valley-bottom plots tends to decrease significantly the level of SLM investments in less productive (and more risky/uncertain) upland fields (Nyanga et al. 2016).

The converse may, however, also hold true: perceptions of risk and uncertainty can in some cases act as a constraint to SLM uptake. It is interesting to note that in both study sites, farmers more frequently emphasised the potential risk associated with SLM uptake than the possible effects on risk reduction. They explained that SLM practices were often seen as involving risks, especially during the set up and establishment phase: for example the risk of crop yields being reduced (or failing altogether). Reluctance to engage in potentially risky activities is often compounded by weak knowledge (and thus high levels of uncertainty) about the eventual effects or efficacy of some SLM practices, especially those which are newly introduced from outside, or

which farmers are not already familiar with. These risks were sometimes seen as being untenable. In Lushoto, this was especially highlighted as an issue among farmers who lack access to valley bottom farms (and who therefore rely on a relatively narrow, undiversified crop production base),while in Ntcheu it was mentioned to be a particular constraint to the poor and female-headed households who have few sources of fallback in times of stress or emergency.

Cashflow & liquidity

Issues of cashflow and liquidity are closely related to risk reduction, and were highlighted repeatedly in Lushoto and (especially) Ntcheu as a key factor influencing SLM uptake. Farmers stated that it is not just overall output effects that are of interest to them, but the form in which they accrue and the time at which they become available. The preference is for products and outputs that can be readily transformed into cash, so as to offset household expenditure needs. Other studies in the survey areas have also noted that there often a premium attached to cash earnings as compared to non-marketed output and products (Chirwa 2008; LTSI 2014a; Marenya et al. 2012). For this reason, in Ntcheu activities such as timber harvesting, charcoal or brick production were stated to be particularly attractive (and in many cases the only option available) at times of severe cash shortage, especially in the hungry season when there are no crops available for sale or home consumption, and food supplies have dwindled or run out. In Lushoto too, farmers emphasised that SLM techniques that can generate saleable products and income (such as agroforestry, woodlots and grass planting) would for most farmers be preferable to those which only generate indirect benefits (such as maintaining soil fertility) or non-marketed outputs.

Time preference

It is not only the absolute or relative amount of benefits or costs generated by a SLM technique that is of importance, or even their timing over the course of the year in relation to needs and availability, but the rate at which they accrue. Many SLM techniques have high initial investment costs, while the benefits take a relatively long-time to mount up. Many farmers (especially poor ones) cannot afford to wait a long time for this return. Thus, for example, in Lushoto, farmers stated that the high upfront investments and initial construction costs of rainwater harvesting mean that few people have taken it up. It has also been noted by other authors that negative returns over the first few years of operation serves as a disincentive to SLM adoption, even if over the longer term it is profitable (Matata et al. 2010; Tenge et al. 2004).

Likewise, in Ntcheu, farmers indicated that they can only carry out SLM technologies that give benefits within two to three years. Residue incorporation was highlighted as being a particularly favoured technique due to its quick effects on crop yields. This is confirmed by various other studies of in the middle and lower Shire Basin, which identify time preference as a key factor determining uptake, both with respect to the immediate costs of shifting to SLM practices and the rate at which its benefits accrue, as well as in relation to how far into the future the costs associated with land degradation are perceived to lie (LTSI 2014b; Nakhumwa and Hassan 2012). Current time preference has been found to be a particular feature for the poorest households, who are least able to wait for income to accrue, to bear short-term losses, or to finance the upfront cash investments that are required to start up new activities (Giordano 2003; Nkonya et al. 2011).

Malawi Roadside Market

CONCLUSIONS: towards understanding and addressing SLM costs, benefits & economic drivers

The study was motivated by the apparent contradictions that exist between what research recommends, projects promote and donors invest in as being the most effective SLM options, and those which farmers actually choose to carry out. Focusing on economic aspects, it sought to investigate the costs, benefits and drivers that shape farmer's willingness and ability to invest in SLM (or, conversely, encourage or even force them into situations which result in land degradation), and which, ultimately, determine how its success should be judged in economic terms.

The research findings underline the fact that simple benefit/cost-based measures of SLM profitability do not serve as adequate indicators of what farmers themselves perceive to be the positive and negative economic attributes associated with different land management choices. At best they provide only a weak predictor of whether (and to what extent) SLM will be adopted. Farmers' needs, aspirations and preferences extend far beyond efforts to maximise short-term income and production gains or to minimise direct outlays and cash expenditures. In Lushoto and Ntcheu Districts, a broad range of economic indicators are used by local households to determine the desirability and viability of SLM options, measure their desired effects, and weigh up their advantages and disadvantages. Unless these broader factors are identified, and addressed in the land management "solutions" that are presented, SLM interventions are unlikely to be acceptable, effective or sustainable in practice.

A second important conclusion is, however, that substantial gaps often exist between the SLM decisions that farmers would like make, and those that they are actually able to undertake, given their economic circumstances, endowments and the resources available to them. Households are not necessarily able to choose the land management options that they consider to be most effective for SLM or most desirable in economic terms, but undertake those that they are able to accomplish. The SLM techniques that are actually practised are often only second best solutions.

A wide array of economic circumstances and conditions in the two study sites shape local needs and preferences as regards SLM, and determine people's ability and willingness to invest in it. Weak and exploitative agricultural input, output and labour markets, combined with unfavourable terms of trade and weak bargaining power, act as barriers to SLM, and have driven many rural households into a vicious cycle of low agricultural productivity, poverty and land degradation. Without addressing these underlying economic causes of land degradation, or unlocking the

constraints that they pose in terms of preventing people from being able to capture sufficient value-added and improve their livelihoods, many of the SLM options that are recommended to (or even demanded of) farmers are likely to remain beyond their reach.

While the recognition that land degradation is not solely a technical or technological problem, but is fundamentally economic in its causes, effects and potential solutions, would hardly seem to be a novel insight, it still often remains absent from SLM research and practice (Emerton 2014a). At the worst, SLM techniques are still being promoted which do not even make direct financial sense to farmers (see, for example, Kassie et al. 2009). Yet, while simple farm budgets and cost-benefit analysis are, thankfully, now for the most part considered a routine part of SLM research and planning, there still remains only a limited number of studies that acknowledge that land management choices are essentially socio-economic decisions (Mascarenhas, 2000; Tenge et al. 2007), or that provide evidence and examples of the wide variety of non-monetary economic factors that shape SLM profitability and uptake (Emerton 2014b; Halbrendt et al. 2014; Reyes et al. 2005; Tenge et al. 2005; Tennant et al. 2014; Tisdell 1996).

If these broader economic factors and drivers of farmers' land management decisions are not considered as a routine part of SLM research, planning and implementation, there remains a real risk that the interventions and responses which are proposed will do little either to address the root causes of land degradation, promote appropriate and effective sustainable land management options, or result in solutions that are economically viable, equitable and sustainable for land managers (Pretty and Shah 1997; Giordano 2003). To do this there is a need to adopt a much more holistic research approach. The study highlights the need to employ integrated research methods which do not look only at numerical measures of SLM uptake and financial profitability, but also seek to determine farmers' economic preferences and perceptions, as well as to identify and explain the underlying economic drivers and structural conditions which variously enable, constrain, encourage, discourage or even force them to make certain land use decisions.

Forages in Tanzania

Lushoto, Tanzania

ANNEX

Table 9. Glossary of SLM techniques investigated in the research

SLM technique	Description
Agroforestry	Land use systems and practices in which woody perennials are deliberately integrated with crops and/or animals on the same land management unit, either in a spatial mixture (e.g. crops with trees) or in a temporal sequence (e.g. improved fallows, rotation).
Basins	Circular holes which harvest runoff water, in which manure may be added and crops may be planted.
Box ridges	Partitions are made between ridges which allow rainwater to be retained and prevent soil loss.
Burying weeds	Weeds are uprooted (and sometimes torn up and/or allowed to dry out) and then buried in the soil, so as to improve soil fertility and reduce weeds.
Chain boxes	???
Composting	the controlled biological and chemical decomposition and conversion of animal and plant wastes with the aim of producing humus to be incorporated into the soil.
Conservation agriculture	A farming system that conserves, improves, and makes more efficient use of natural resources through integrated management of soil, water and biological resources. The three fundamental principles behind the conservation agriculture concept are usually taken to be: minimum soil disturbance, permanent soil cover and crop rotation.
Contour marker ridges	Usually larger than ordinary ridges made across the slope along which other ridges are aligned, which serve to trap and curtail surface water runoff thereby reduce soil erosion and encourage infiltration. Crops are planted in between the markers, in alignment with the contour..
Contour planting	Ploughing, planting and weeding along the contour (i.e. across the slope, rather than up and down it).
Crop residue incorporation	Sound handling and utilisation of plant and crop residues which typically combines mulching, composting and manure management, which ideally leaves 30% or more of the soil covered with crop residues after harvest.
Crop rotation	Planting suitable crops (such as legumes and grasses) in rotation with other crops in order to maintain the fertility of the soil.
Cut-off drains	Drainage ditches dug across a slope to intercept surface runoff, drain it off sloping agricultural land, and carry it safely to an outlet (e.g. a canal or stream).
Enclosures/set asides	Closure or fencing of farm areas on which no form of cultivation, grazing or other land use is then permitted, which is allowed to return to natural vegetation.
Fallowing	Resting period between two cropping cycles, permitting the restoration of soil fertility, weed control and the interruption of pest and disease cycles.
Fanya juu terraces	Terraces created by digging a trench and throwing the soil upslope to form a ridge or embankment. To stabilise the soil, the risers may be planted with grasses.
Farmyard manure	Collection of livestock dung and urine and application to croplands.
Grain-legume intercropping	Cultivation of grain/cereal crop in association with legumes (e.g. maize-beans), with the leguminous crops serving to transfer nitrogen, and leading to soil improvements due to the increased amount of humus and organic matter and better soil cover.
Grass strips	Planting of strips of grass, often along terraces, which serve to slow down runoff, increase infiltration and retain sediment, as well as yielding a source of grass for home use or sale.
Green manure	Cover crops (e.g. fast-growing legumes, forage crops, tree crops) that are ploughed back into the soil or otherwise incorporated while they are green or soon after they flower, so as to provide nutrients, add nutrients and organic matters, and improve soil structure.
Lime	Application of lime to raise soil pH, in order to restore fertility.
Matengo pits	*Matengo* pits are characterised by a two-year rotation with a short fallow period in the first year. After the fallow, lines of cut grass or weeds are laid out in a grid, which is then covered in topsoil formed into ridges, The ridges produce a series of pits across the whole field which function as buffers, and control run-off by allowing rainwater to stand. Later harvest residues are buried under new ridges where there have been pits in the previous season and vice versa..
Mulching	Covering the soil surface with organic matter (plant residues or other materials) to enable surface composting, create an optimal micro-climate and protect the soil from erosion.
Rainwater harvesting	The collection (and possibly storage) of rainwater to make it available for agricultural production or domestic purposes.
Ripping	A means of reduced tillage which utilises the use of ploughs which are modified to creates only small furrows without turning the soil over, leaving crop residues on the surface. Both shallow and deep ripping (subsoiling) can be undertaken, to different depths. Ripping increases water infiltration and reduces runoff, as well as leaving the soil less exposed and not so vulnerable to erosion.
Sasakawa	Based on recommendations from the *Sasakawa* Global 2000 agricultural programme, this system involves 75 cm row spacing and 25 cm spacing of single seeds in the row.
Stone bunds	Stone lines are used to create bunds which slow runoff and trap fertile soil sediment, either as a soil conservation measure (on slopes), or for rainwater harvesting (on flatlands). Stones are arranged in lines across the slope to form walls. Where these are used for rainwater harvesting, the permeable walls slow down the runoff, filter it, and spread the water over the field,
Terraces	Terraces are levelled soil structures which may be used for a variety of purposes, including modifying steep slopes to allow cultivation, reducing surface run-off, trapping moisture, promoting infiltration.
Woodlots	Areas of farmland planted to trees (or with natural trees) which are set aside specifically for wood production.

Source: Compiled from Linger et al. 2011; Recha et al. 2014; WOCAT 2016

Table 10. : Basic household economic and livelihood indicators in the survey villages by gender

		Lushoto		Ntcheu	
		Female-headed)	Male-headed	Female-headed)	Male-headed
Lushoto					
Household size	(no. persons)	3.9	6.1	4.1	5.8
Dependency ratio	(non-workers : workers)	2.3	1.3	1.8	1.2
Land					
Farm size	(ha)	0.8	1.0	1.3	1.8
Land area/capita	(no.)	0.24	0.18	0.40	0.33
Plots of land	(ha)	2.6	2.8	1.8	2.2
Farmers with hillside plots	(% farmers)	100%	97%	73%	72%
Farmers with valley plots	(% farmers)	53%	68%	52%	56%
Farmers practicing irrigation	(% farmers)	45%	62%	25%	35%
Livestock					
Farmers with livestock	(% farmers)	79%	90%	60%	82%
Herd size	(TLU)	0.6	1.3	1.13	1.48
Non-land fixed assets					
Equipment, machinery, vehicles & electronic items	Index of ownership	0.18	0.29	0.12	0.15
Income					
Total income* per household	(2014 market USD/year)	1,217	1,725	1,071	1,856
Total income* per capita	(2014 market USD/year)	231	332	326	305
	(2014 intl PPP USD/year)	642	925	1,084	1,014
% total income* contributed by**:					
Non-marketed crops	(% income)	55%	27%	62%	49%
Crop sales	(% income)	11%	35%	7%	18%
Livestock sales	(% income)	2%	13%	3%	8%
Casual labour sales	(% income)	22%	10%	7%	5%
Other off-farm income	(% income)	11%	15%	21%	20%
% households earning cash from:					
Crop sales	(% households)	61%	73%	64%	78%
Livestock sales	(% households)	27%	50%	21%	43%
Casual labour sales	(% households)	55%	41%	29%	27%
Other off-farm income	(% households)	48%	44%	64%	29%

* Cash earnings plus value of home-consumed production; ** averaged across all households, not just those engaged in activity.

Table 11. Basic household economic and livelihood indicators in the survey villages by wealth

		Lushoto			Ntcheu		
		Richer	Middle	Poorer	Richer	Middle	Poorer
Labour							
Household size	(no. persons)	5.5	6.1	5.4	5.9	5.5	4.3
Dependency ratio	(non-workers : workers)	1.3	1.7	1.6	1.2	1.1	1.4
Land							
Farm size	(ha)	1.4	0.9	0.5	2.5	1.43	1.00
Land area/capita	(no.)	0.30	0.17	0.11	0.47	0.29	0.29
Plots of land	(ha)	2.8	3.3	2.2	2.4	2.2	1.7
Farmers with hillside plots	(% farmers)	96%	98%	98%	72%	75%	69%
Farmers with valley plots	(% farmers)	68%	64%	47%	59%	55%	54%
Farmers practicing irrigation	(% farmers)	77%	60%	38%	30%	42%	28%
Livestock							
Farmers with livestock	(% farmers)	91%	96%	77%	89%	82%	56%
Herd size	(TLU)	1.5	1.3	0.6	2.26	0.69	0.33
Non-land fixed assets							
Equipment, machinery, vehicles & electronic items	Index of ownership	0.41	0.25	0.13	0.26	0.13	0.05
Income							
Total income* per household	(2014 market USD/year)	3,715	621	435	3,795	897	367
Total income* per capita	(2014 market USD/year)	798	122	88	723	192	99
	(2014 intl PPP USD/year)	2,222	341	244	2,405	640	329
% total income* contributed by**:							
Non-marketed crops	(% income)	18%	36%	45%	46%	47%	67%
Crop sales	(% income)	39%	30%	20%	17%	19%	10%
Livestock sales	(% income)	12%	16%	4%	7%	8%	3%
Casual labour sales	(% income)	6%	9%	23%	2%	4%	10%
Other off-farm income	(% income)	25%	9%	8%	29%	22%	11%
% households earning cash from:							
Crop sales	(% households)	89%	75%	47%	69%	87%	65%
Livestock sales	(% households)	55%	49%	32%	50%	42%	19%
Casual labour sales	(% households)	26%	55%	51%	15%	26%	39%
Other off-farm income	(% households)	62%	49%	25%	77%	65%	45%

* Cash earnings plus value of home-consumed production; ** averaged across all households, not just those engaged in activity.

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