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## THE USE OF IMPROVED TECHNOLOGY AND MARKET-BASED INCENTIVES TO INCREASE FOREST RESOURCE AND BIODIVERSITY CONSERVATION IN RWANDA

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THE USE OF IMPROVED TECHNOLOGY AND MARKET-BASED INCENTIVES  
TO INCREASE FOREST RESOURCE AND BIODIVERSITY CONSERVATION IN RWANDA

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THESIS

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A thesis submitted in partial fulfillment of the requirements  
for the degree of Master of Science in Forestry  
in the College of Agriculture, Food and Environment  
at the University of Kentucky

By

Kelly Marie Rayens

Lexington, Kentucky

Director: Dr. G. Andrew Stainback, Assistant Professor of Forest Policy

Lexington, Kentucky

2015

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## ABSTRACT OF THESIS

### THE USE OF IMPROVED TECHNOLOGY AND MARKET-BASED INCENTIVES TO INCREASE FOREST RESOURCE AND BIODIVERSITY CONSERVATION IN RWANDA

This study evaluated the effectiveness of two distinct approaches to ecosystem conservation in Rwanda's Nyungwe National Park: cookstove technology adoption and market-based policy instruments. A June 2014 survey of 250 households revealed that use of improved cookstove technology dramatically decreased fuelwood consumption for households in rural Rwanda, but that design, engineering and conflicting policy issues can hamper the widespread use of energy-efficient cooking technology. The second component of this research used the analytic hierarchy process (AHP) within a multi-criteria analysis (MCA) framework to explore the options for designing and implementing market-based instruments around the country's conservation targets, particularly the highly biodiverse Nyungwe National Park. A series of workshops, held in June, October and November of 2014, were conducted at the local level (with regional farmers and agricultural cooperatives) and the national level (with representatives from conservation organizations and government). Focus group participants identified criteria for evaluating MBIs, and then ranked the priority of these criteria. Finally, national-level experts ranked how well distinct MBIs could achieve conservation goals. This paper summarizes the focus group findings and provides a recommendation for the design and implementation for market-based conservation instruments in Rwanda.

**KEYWORDS:** Conservation in Rwanda, improved cookstoves, economic incentives, ecosystem services, multi-criteria analysis

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Kelly Marie Rayens

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December 11, 2015

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## TABLE OF CONTENTS

Acknowledgements.....	iii
List of Tables.....	v
List of Figures.....	vi
Chapter 1: Introduction.....	1
Rwanda and Its Economy .....	1
Land Use and Environmental Concerns .....	1
Nyungwe National Park (NNP) .....	3
Tools for Conservation in Developing Countries.....	4
Research Rationale.....	7
Chapter 2: Use of Improved Cookstoves in Households Near NNP .....	9
Introduction .....	9
Methods .....	11
Results and Discussion .....	13
Conclusions .....	23
Chapter 3: Agricultural Cooperatives’ Preferences for Market-Based Conservation Instruments (MBIs) .....	25
Introduction .....	25
Methods .....	29
Multi-Criteria Analysis and the Analytic Hierarchy Process .....	30
Results and Discussion .....	33
Conclusions.....	44
Chapter 4: National Stakeholders’ Preference for and Ex-Ante Evaluation of MBIs .....	46
Introduction .....	46
Methods .....	47
Results and Discussion .....	48
Conclusions.....	63
Appendices .....	64
Appendix A.....	64
Appendix B.....	68
Appendix C.....	72
References .....	79
Vita.....	83

## LIST OF TABLES

Table 2.1: Number of targeted households for cookstove survey.....	12
Table 2.2: Summary of major descriptive statistics across all respondent households .....	13
Table 2.3: Rates of use for <i>Darfur</i> stove recipients.....	17
Table 2.4: Rates of use for <i>canarumwe</i> stove recipients .....	17
Table 2.5: Comments from Bweyeye sector <i>Darfur</i> stove recipients regarding stove performance .....	18
Table 2.6: Measures of spread in fuelwood consumption across ICS and non-ICS households.....	20
Table 2.7: Incidence of health ailments across 142 households .....	23
Table 3.1: Results from June 2014; Criteria and indicators by which to evaluate MBIs .....	34
Table 3.2: Bugarama – Priority scores for criteria and indicators .....	38
Table 3.3: Shara Beach – Priority scores for criteria and indicators.....	43
Table 4.1: National workshop in Kigali – Priority scores for criteria and MBIs .....	61



## LIST OF FIGURES

Figure 2.1: Three stove types included in the cookstove use survey: <i>Canarumwe</i> improved stove; <i>Darfur</i> improved stove; and <i>3-stones</i> traditional stove .....	10
Figure 2.2: Household cookstove ownership across both surveyed sectors .....	14
Figure 2.3: Rates of use of improved cookstoves for all ICS-owning households surveyed .....	15
Figure 2.4: Rates of use of improved cookstoves for all ICS-owning households .....	16
Figure 2.5: Bar graph depicting median values of fuelwood consumption for households using either a 3-stones stove only, or using at least one ICS .....	20
Figure 2.6: Average values of fuelwood consumption per household, based on household size and separated by stove type .....	22
Figure 3.1: An example of the AHP scale for pairwise comparison .....	30
Figure 4.1: National workshop – The structure and hierarchy of criteria and MBI comparisons made by participants .....	47
Figure 4.2: National workshop – Aggregate priorities for criteria and MBIs .....	62

## CHAPTER 1: INTRODUCTION

### **Rwanda and Its Economy**

The nation of Rwanda, with a reported population of 12 million in 2014 and total area of 10,000 square miles, is susceptible to most of the anthropogenic pressures felt throughout other nations in East and Central Africa, such as concerns over food availability, ecological degradation of major waterways, and an overexploitation of forest resources.

Rwanda's economy has developed exponentially over the past two decades, with the World Bank reporting a 2013 GDP of US\$7.5 billion. The national economy has averaged 8% growth in GDP since 2001 (The World Bank), and overall Rwanda experiences steady reductions in rates of poverty, combined with continued improvement in life expectancy, water access, and school enrollment.

Lacking the significant mineral resources of many of its neighbors, Rwanda's primary exports are tea and coffee, and 90% of Rwanda's citizens are smallholder subsistence farmers (Stainback and Masozera, 2010). While the nation enjoys continued stability and investment in infrastructure, rapid population growth in what is already Africa's most densely populated country results in subsistence farms that are subdivided into steadily smaller parcels, and poverty – while reduced – continues to affect 47% of the national population as of 2011.

### **Land Use and Environmental Concerns**

One notable side effect of rapid economic and population growth in any part of the world is the increased scarcity of forest resources, which is especially relevant in developing economies where subsistence farming still serves the country's majority (Joon

et al., 2009; Ruiz-Mercado et al., 2012). Forest dependency is of increasing concern as conservationists, economists, and social scientists research the potential consequences of the relationships between deforestation, population growth, poverty, culture and technology. Forest dependency is an issue of tremendous global importance, and is particularly evident in regions of the developing world that exhibit extreme levels of poverty but also house ecosystems that contain high biodiversity. It is no coincidence that areas of chronic rural poverty overlap with areas of rich natural forest: this is evidence of forest dependence for which there is no substitute (Sunderlin et al., 2005).

A great problem in the matter of forest dependency and deforestation is the issue of poverty. Poverty necessitates a focus on resource collection for the immediate future, depriving a region of the chance to invest in a sufficient land management plan for the long term. This lost time results in a gap in policy evolution, which fosters instability and uncertainty surrounding the future of that region's resource base. As a consequence, that region not only has severe day-to-day subsistence pressures, but also inadequate means for estimating how long those natural resources will be able to serve the growing population or whether they will be able to provide for any livelihood improvement. The available literature on forest dependency reveal such patterns of poverty and dependency across the world, particularly in Central and South America, Southern and Southeast Asia, and Africa.

As noted by Cordova et al. (2013) in their study in the western highlands of Guatemala, poor, developing regions often experience forest resource dependency that is heavy, steady, and very unlikely to decline in the foreseeable future. In their study, the poorest households were the most heavily dependent on forest products, but the wealthiest households had the highest rates of forest use in absolute terms. This indicates a problem with equitable distribution of common pool resources.

## **Nyungwe National Park (NNP)**

This study focused on Rwanda's Nyungwe National Park, which Plumptre et al. (2006) classify as a high-priority area for conservation in the Albertine Rift. The Rift is a large and dense region for biodiversity in Africa, containing more endemic vertebrates than any other region of the mainland (ibid). The watersheds of the Albertine Rift are a water source for millions of residents of Central, East, and northern Africa.

### *NNP Biodiversity*

Nyungwe National Park is a 1000km<sup>2</sup> montane rainforest. The most recent published biodiversity survey found more than 260 tree and shrub species, 250 bird species, and 18 mammalian species, including 13 species of primate (Plumptre et al., 2002). Mammals of NNP include chimpanzee, blue monkey, l'hoesti's monkey, colobus monkey, baboon, and pest vervets. Bushpigs, duikers and Gambian rats are relatively common. Carnivores include serval, genet, mongoose and otter (Plumptre et al., 2002).

Unfortunately, the biodiversity of NNP is often threatened by illegal forest activity, such as frequent poaching for meat, harvesting timber and fuelwood, and mining. Large terrestrial species like elephant and buffalo have been very recently extirpated because of poaching activity (Plumptre et al., 2002).

NNP is particularly known for its diverse bird life, which supports much of the tourism to the park, and houses at least 22 species endemic to the Albertine Rift; however, both birds and mammals are threatened by the ever-present illicit forest activity that results in habitat degradation and fragmentation.

## **Tools for Conservation in Developing Countries**

Many intervention programs aimed at lessening forest dependence in the developing world focus on providing alternative fuel options. While it is a financially sound long-term idea (because of greater fuel efficiency), the high initial investment required for a switch to fuels like liquefied petroleum gas (LPG) makes it difficult for households to change to cleaner fuel sources (Israel, 2002; Babulo et al., 2008). Even more problematic is the widespread lack of market supply or geographic availability of alternate fuel types.

One notable theme in the literature on conservation policy is the importance placed on collaborative action: multiple approaches to poverty alleviation—not just centering on forest products – must be used in order to avoid overexploitation of forests (Fisher, 2004). A significant problem found by Walelign and Oystein (2013) in Mozambique is the lack of steady income through the year – livestock and business income were the only sources of earnings that did not fluctuate significantly, and the harvest of forest products was essential to local households looking to make up the income difference when agricultural crop production was low. Logically, this dependence would be much more severe if crops failed unexpectedly, as there is so little income buffer available. Many studies suggest facilitating alternate wage-earning local economy (such as ecotourism) and promoting agroforestry to alleviate poverty and decrease pressures on forests (Masozera and Alavalapati, 2004; Walelign, 2013).

Promotion of ecotourism is an especially viable option in regions like sub-Saharan Africa, which is home to an immense amount of tropical diversity. However, the extreme human population density often frustrates or prohibits extensive efforts at habitat conservation (Cordeiro et al., 2012). Large corridors and habitat buffers are necessary to support life for threatened migratory species, but corridor establishment is difficult because of the relatively unpredictable political relationships in this region of Africa, where

population densities are high and political regimes of nations like the Democratic Republic of the Congo are historically volatile (Cordeiro et al., 2007).

Payments for ecosystem services (PES) are increasingly popular in regions like Nyungwe to reconcile goals for conservation and poverty alleviation. In an assessment of PES programs, Gross-Camp et al. (2012) found that equity in institutional and community involvement increases perception of legitimacy and positively influences participation in PES schemes. Within Rwanda, it is ideal to integrate PES systems with other community development plans, and to reduce transaction costs associated with participation in development schemes so as to increase numbers of households involved, thereby increasing policy effectiveness (Stainback and Masozera, 2010).

In examining possible collaborative plans, one technological option for decreasing forest dependency is to make a switch to energy efficient or improved cookstoves (ICS) in areas highly dependent on woody biomass for household fuel. Many studies have found that improved cookstoves have significantly greater fuel efficiency and lower pollutant emissions than traditional cookstoves or open fire hearths (Berrueta et al., 2008; Bhattacharya et al., 2002; Granderson et al., 2008; Jetter and Kariher, 2009). Improved cookstoves can be utilized as part of a profitable carbon trading scheme (Johnson et al., 2009) and can also produce biochar for use as a soil conditioner and beneficial agricultural input (Torres-Rojas et al., 2011).

The potential benefits of improved cooking technology are not limited to decreased fuelwood dependency, decreased deforestation, or poverty alleviation; more efficient cookstoves can have serious positive consequences on human health. Ninety percent of smoke from open fire hearths is carbon monoxide, and, worldwide, half of the deaths that result from exposure to household fuel emissions are from severe pneumonia in children under 5 years of age (Adler, 2010). There are many studies that find incidence and severity

of respiratory illness is positively correlated with poor ventilation and exposure to indoor air pollution (IAP) from hearths and traditional cookstoves (Duflo et al., 2008; Ezzati and Kammen, 2001; Shen et al., 2009; Chapman et al., 2005). Women and children, because of their significant time spent in the house – particularly in traditional households most typically seen in poor, rural areas of the developing world – experience greater IAP exposure and resulting health problems. Exposure to IAP has also been linked to inhalation of dangerous toxins (An et al., 2007), high blood pressure (McCracken et al., 2007; Baumgartner et al., 2011), as well as headaches, back pain, and pain associated with the eyes (Diaz et al., 2007). More research is needed to examine the effect of IAP on fertility, cancer, heart disease, weakening of the immune system, and a myriad of other potential negative effects on human health (Fullerton et al., 2008; Rehfuess et al., 2009; Clougherty, 2010). Ezzati and Kammen (2002) outline an urgent need for research that would identify feasible and effective means of reducing exposure to IAP, now that human health scientists and medical professionals have documented its deleterious effect on human health.

Despite the many benefits, researchers have noted some social and economic factors that impede adoption of ICS. For example, within the traditional patriarchal household that is most typical of developing regions, there is a noticeable inequity between the person (generally a male head of household) who makes decisions regarding cooking technology and the persons (generally women and children) who are greatest affected by the volume of the household's energy demands or the pollution that results from inefficient hearths (El Tayeb Muneer and Mukhtar Mohamed, 2003). In addition, there are a number of economic shortcomings associated with high initial investment costs (Edwards and Langpap, 2005; Hutton et al., 2007; Jeuland and Pattanayak, 2012) and commercial manufacturing operations that fail to directly benefit the local economy (Bailis et al., 2009). For these

reasons, nearly all of the literature referenced so far in this review emphasizes a need for appropriate subsidies to accompany ICS adoption programs.

Slow or limited adoption of improved cookstoves has a great deal to do with limited education, low income and limited access to technology (Jan, 2012; Lewis and Pattanayak, 2012; Mobarak et al., 2012; Ruiz-Mercado et al., 2011), but adaptive tactics for improving cookstove adoption rates include provision of subsidies and combination with other development plans for greater overall efficacy. Identifying which variables most significantly affect households' decision on cookstove adoption is very important. The next step is to craft policy that aptly addresses any impeding factors so as to encourage ICS adoption for the benefit of forest health and human health.

### **Research Rationale**

The research presented within this thesis evaluates two distinct approaches to resource conservation: One is a survey-based evaluation of the use of technology (improved cookstoves), and another is based on the potential use of market-based instruments (MBIs) to promote environmental stewardship as well as provide local economic benefit. There are very few studies of this kind in sub-Saharan Africa, which highlights the importance of this study in southwest Rwanda's Nyungwe region.

Technology adoption is often viewed as a relatively easy, far-reaching, and minimally invasive approach to reducing dependence on natural resources such as fuelwood and forest products. Disappointingly, many adoption programs fail to perform program evaluation, whether because of a lack of funding, a lack of time, or other limiting factors. Evaluation is necessary to judge whether a conservation tool has been effective, and whether it should be continued or repeated in the future. This study on cookstove rates of use, effect on fuelwood consumption, and effect on household health is the first of its kind in



Rwanda, and is one of a minority of such studies around the world. Evaluation need not always be terminal evaluation, however, and it is also the purpose of this study to promote adaptive evaluation as part of the process of policy development and implementation.

Secondly, this research examined the potential of market-based instruments (MBIs) for use within Rwanda's environmental and economic context. Such an approach is more complex and involved, and requires a highly participatory design and implementation process. In this way, the research complemented the technology approach, exploring social and economic perspectives from individual stakeholders in order to examine adequacy and appropriateness of such policy tools.

This two-pronged approach to conservation policy research employed disparate methods and thus returned different results, based on the objectives of each study. The results give a more complete picture of the sociopolitical climate of Rwanda and how conservation policy can adapt to stakeholders as well as shape them.

## CHAPTER 2: USE OF IMPROVED COOKSTOVES IN HOUSEHOLDS NEAR NNP

### **Introduction**

This survey and analysis evaluated rates of use, levels of satisfaction, and household fuel consumption with ICS that were made available through two different distribution programs near NNP as described in the following paragraphs. The primary objectives of the survey were to identify: A) how use of an improved cookstove affects fuelwood consumption when compared to a traditional stove; B) what variables, if any, affect the rates of use and popularity of ICS; and C) how use of an ICS affects household respiratory health when compared to a traditional stove, if at all.

#### *Darfur stove type*

Beginning in 2007, a partnership between the Wildlife Conservation Society of Rwanda (WCS), Partners in Conservation (PIC), and the Rwandan government (specifically the Rwandan Defence Forces, or RDF), constructed and distributed 2300 stoves within Bweyeye sector of Rusizi district. These Darfur stoves were distributed in Rasano, Gikungu, Murwa, Nyamuzi and Kiyabo, which are all administrative cells of Bweyeye sector (Appendix A).

#### *Canarumwe stove type*

In 2012, a partnership between the Wildlife Conservation Society of Rwanda (WCS), and national NGO Rural Environment and Development Organization (REDO) distributed 100 stoves within each of the Nkungu and Bweyeye sectors of Rusizi district. One hundred *canarumwe* stoves were distributed throughout Kiyabo and Gikungu – two administrative cells in Bweyeye sector -- and another hundred stoves were distributed in the Gatare cell of Nkungu sector (Appendix A).



*Above:* A *canarumwe* wood-burning stove

*At left:* A stove of *Darfur* design

*Below:* A 3-stones stove setup, in which fuelwood is simply placed in the middle of three large stones, with a pot set on top



*Figure 2.1:* The three stove types surveyed in this cookstove evaluation. The top two are improved, energy-efficient cookstoves (ICS/EES); the bottom cooking setup is a traditional 3-stones hearth that is typical of rural Rwanda. 3-stones is considerably less fuel efficient.

The Nkungu and Bweyeye sectors were chosen for ICS distribution in part because they are directly adjacent to Nyungwe National Park (NNP) and thus could have the greatest positive effect on decreasing illicit forest product harvest and habitat disruption within NNP. The Bweyeye cells of Nyamuzi, Gikungu and Kiyabo are wedged directly between NNP and the border with Burundi. The Nkungu cells of Gatara and Mataba directly border Cyamudongo, 4km<sup>2</sup> of biodiverse forest that is part of the greater NNP region and houses Rwanda's only habituated chimpanzee population.

## **Methods**

The survey was organized into three primary sections: *Household characteristics*; *Household cooking and fuel*; and *Improved cookstove perception and satisfaction*. The survey was designed around the project objectives, using literature review to select important components for inclusion. Additionally, I examined surveys from similar studies (e.g. Yale School of Forestry) which were conducted in different geographic areas with socioeconomic features comparable with Rwanda. The finalized survey can be found in Appendix B.

Enumerator training took place on June 18, 2014 and survey administration (conducted through in-person interview) began on June 23, 2014. There were two enumerators, one for Bweyeye and one for Nkungu. Enumerators were previously known to WCS Rwanda and had worked as community liaisons on other projects in the region. Both were young men who were known to community members and had experience conducting interviews and interacting with the public. From each sector administration center, I obtained a list of households that had been part of these two ICS programs: Nkungu and Bweyeye were both part of the 2012 *canarumwe* program, and additionally Bweyeye had been part of the 2007 *Darfur* program.

From each list of ICS program participants, I selected a simple random sample of 50 primary respondents using random number generation. I then randomly selected an additional 10 respondents to function as alternates, should enumerators find that a respondent from the primary list of 50 had moved away or could not be located.

In summary, I included 150 respondents that had been part of an ICS program at some point: 50 *canarumwe* recipients in Nkungu (Gatare cell), 50 *canarumwe* recipients in Bweyeye (Nyamuzi, Gikungu and Kiyabo cells), and 50 *Darfur* stove recipients in Bweyeye (Nyamuzi, Gikungu and Kiyabo cells). To mitigate overlap and double-counting, respondents in Bweyeye who had been part of both the *canarumwe* and *Darfur* programs were listed singly and never appeared on both lists.

Lastly, each sector administrative office provided us with complete resident listings for the applicable cells within that sector. From this list, I selected a simple random sample of households that had not participated in either of these ICS programs. In Bweyeye, 50 households (plus 10 alternates) were chosen from Nyamuzi, Gikungu and Kiyabo; in Nkungu, 50 households (plus 10 alternates) were chosen from Gatare and Mataba.

*Table 2.1: Number of targeted households for survey, selected via SRS within each category*

	Bweyeye	Nkungu
Non-recipients	50	50
<i>Canarumwe</i> recipients	50	50
<i>Darfur</i> stove recipients	50	

## Results and Discussion

### *Summary of respondent household characteristics across sectors*

To begin, we look first at the averages of household characteristics across the range of respondents in both Bweyeye and Nkungu. These findings are summarized in the table below; averages are listed in bold:

*Table 2.2: Summary of major descriptive statistics across all respondent households*

	Land owned (ha)	Woodlot owned (ha)	Total livestock value (USD)	No. of household members	No. of children in household (ages 1-15)
Minimum	0.00	0.00	0.00	1	0
Maximum	5.00	5.00	2028.00	12	8
Mean	<b>1.48</b>	<b>1.98</b>	<b>271.58</b>	<b>5.72</b>	<b>2.59</b>

A large majority of households (70.4%) fall into income category 3, which lies in the middle of the 1-5 scale defined by the Rwandan government and recorded by the census. An additional 18.2% of respondents fall into income category 2, and the remaining 11.4% are distributed in the relative extremes of income classification. Within the sample only 16.1% of households have a female head of house.

Descriptive statistics are similar for both groups when divided by sector, indicating that our sample is relatively homogeneous with respect to social and economic characteristics.

### Cookstove ownership and rates of use

In examining cookstove ownership, the below graph represents types of improved cookstoves owned by households in both sectors:

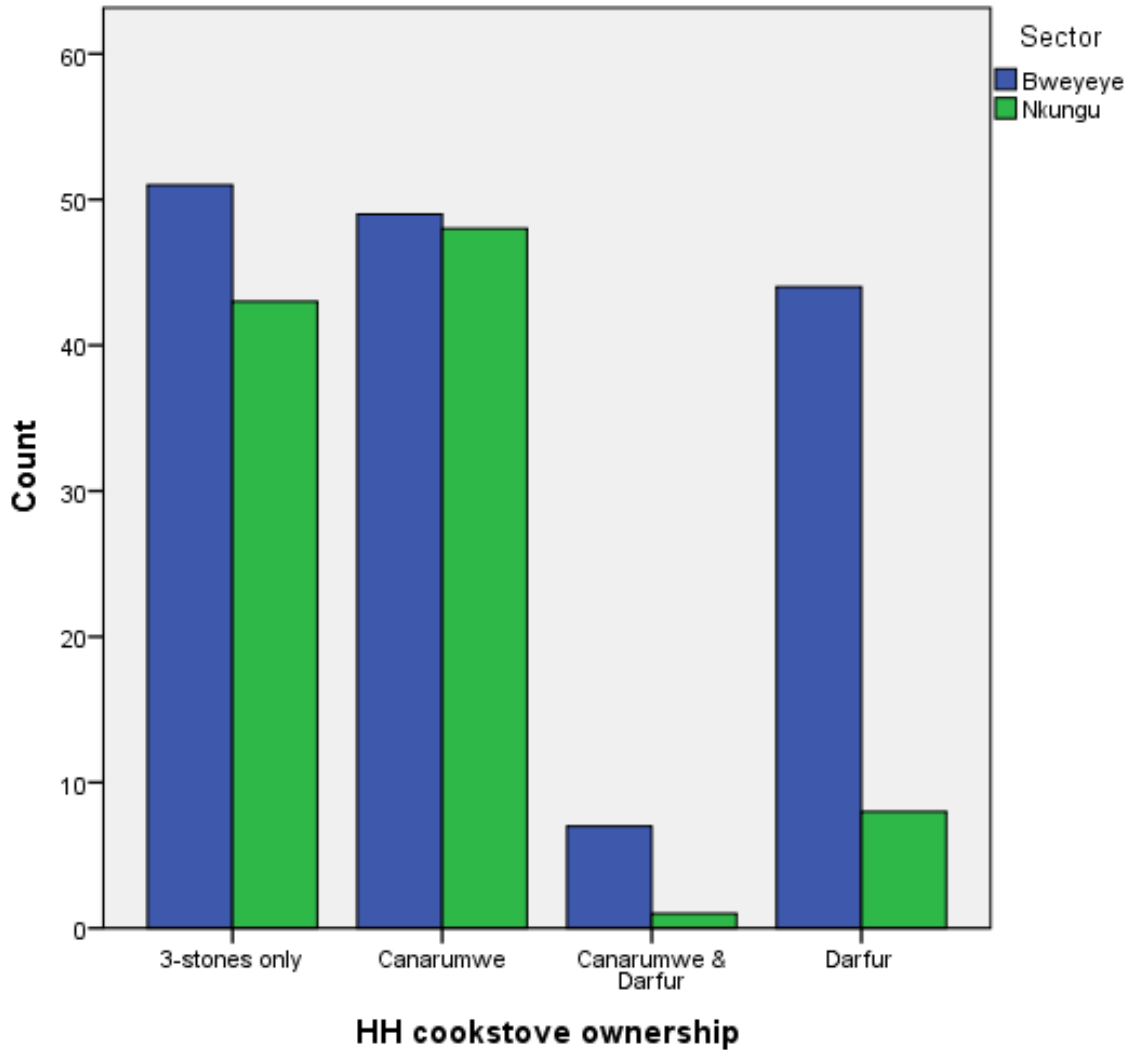


Figure 2.2: Household cookstove ownership across both surveyed sectors

Because of our sampling method, the above representations are not surprising, although Nkungu residents did apparently have some level of access to *Darfur* stoves even if the 2007 program did not take place there. Please note that, in the above graph, ownership of an ICS does not imply sole use of that ICS; in many cases, households used an ICS (or sometimes two) in conjunction with a traditional 3-stones stove. Because of this, and to

understand use frequencies, the survey inquired about how cookstove types are used. The below graph represents the frequency of stove use among those households that had ever received or purchased an ICS.

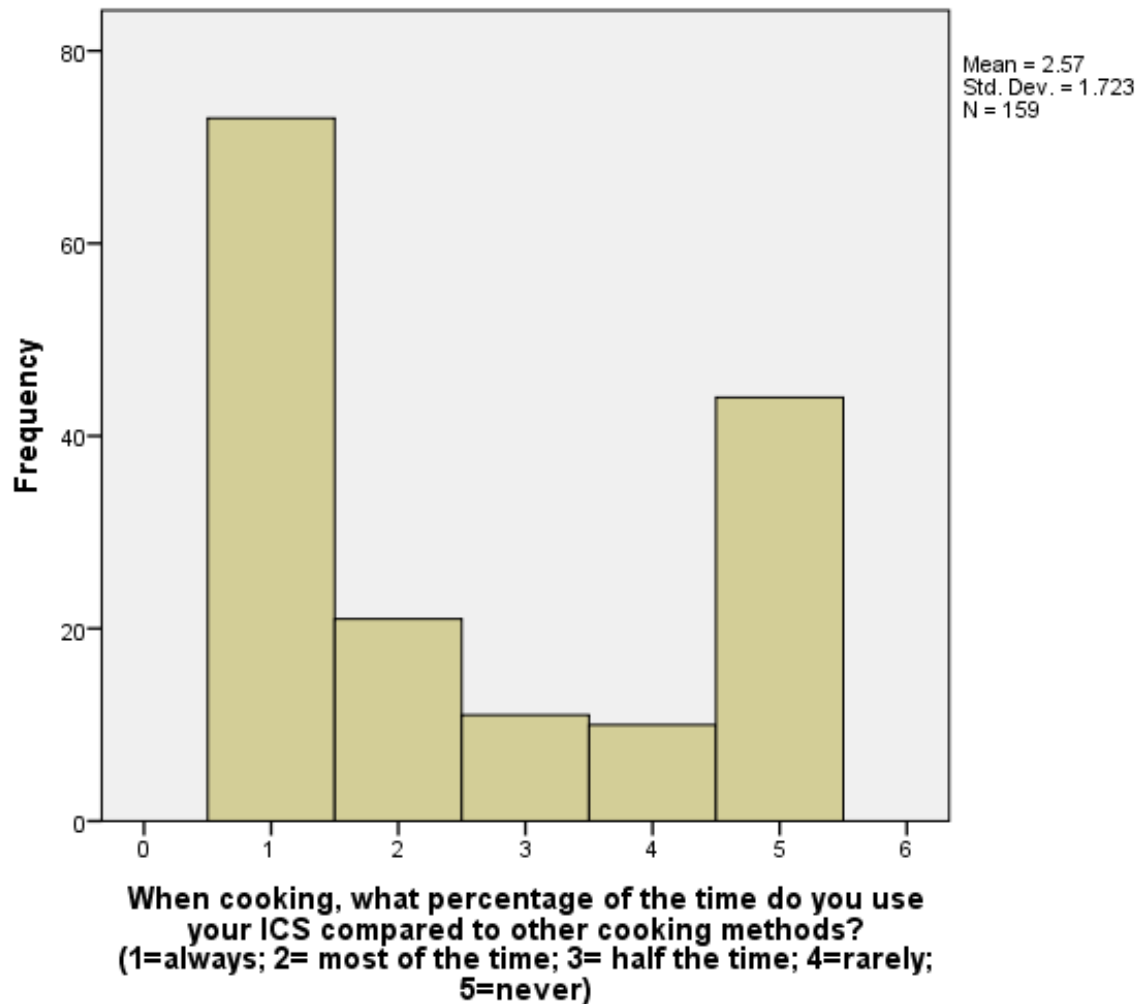


Figure 2.3: Rates of use of improved cookstoves for all ICS-owning households surveyed

Nearly half of respondents report always using their ICS compared to other cooking methods, but many also report not using it at all – and in fact, for many of these households the ICS did not show up on the map of the kitchen (drawn by our enumerators during the interviews) as even being installed in that household.



When the data are divided by sector, this is the result:

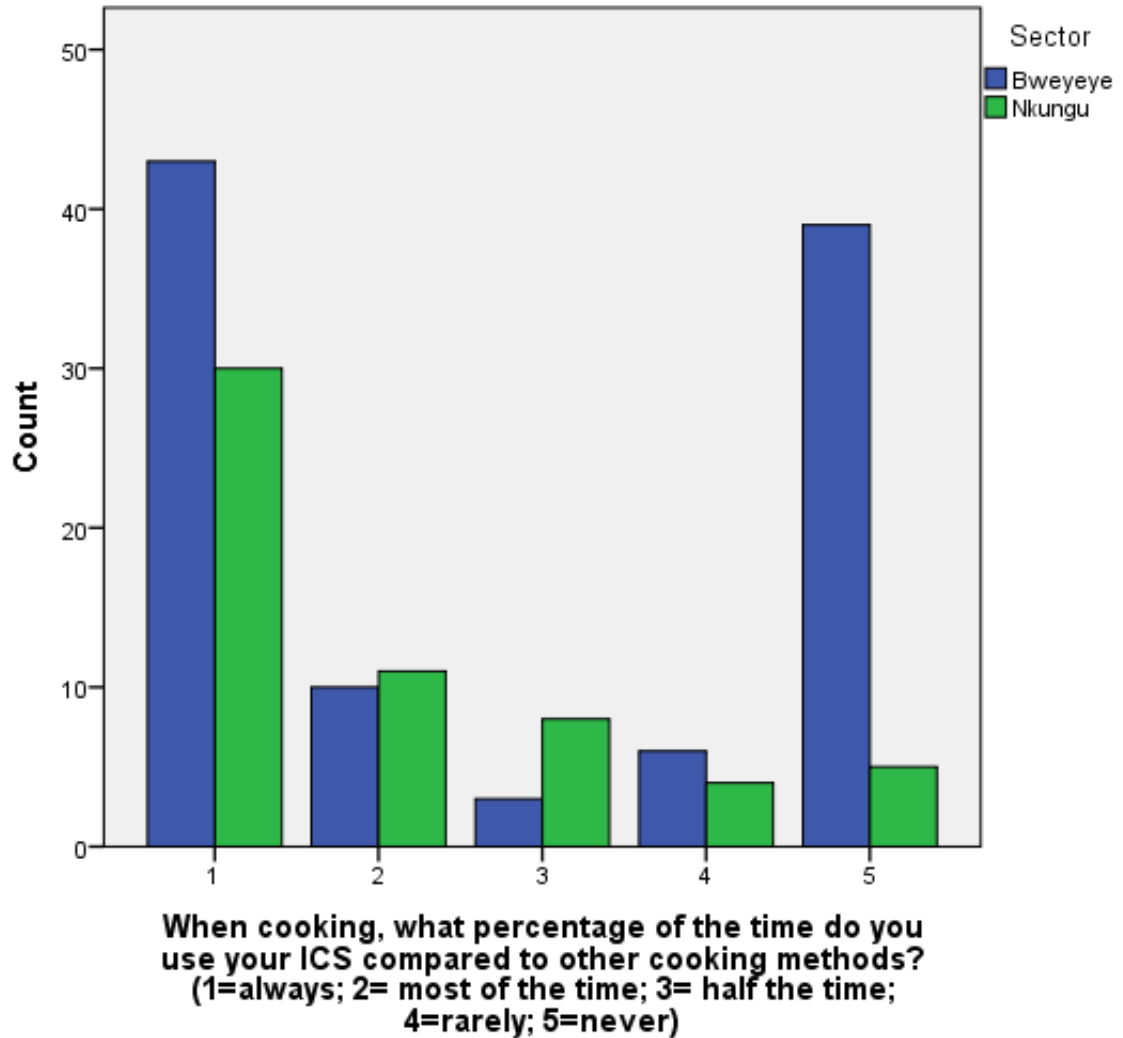


Figure 2.4: Rates of use of improved cookstoves for all ICS-owning households, by sector

When examining the difference in use between ICS types, rates of use among *Darfur* stove recipients (Bweyeye residents, as described in the methodology) are highly polarized: 32 out of 52 *Darfur* stove recipients (61.5%) report *never using it*. The complete distribution is outlined in Table 2.3, on the following page:

Table 2.3: Rates of use for *Darfur* stove recipients (n=52)

Use the stove:	Number of households	Percent of households
Always	15	28.8
Most of the time	3	5.8
Rarely	2	3.8
Never	32	<b>61.5</b>

In contrast, the average rate of use of the *canarumwe* stoves is high. Of all 96 *canarumwe* recipients, across both sectors, only 11 households (11.4%) report never using the stove. 48 out of 96 households (50.0%) report *always* using the *canarumwe*. The complete distribution is outlined below:

Table 2.4: Rates of use for *canarumwe* stove recipients (n=96)

Use the stove:	Number of households	Percent of households
Always	48	<b>50.0</b>
Most of the time	28	29.2
Rarely	9	9.4
Never	11	11.4

The difference in cookstove use frequencies between stove types is not immediately understandable from our available numerical survey data. Because the rates of use for *Darfur* recipients is so low, we examined translated portions of the open-ended responses that were included in those surveys.

Some households had not provided enough information in the open-ended answers to be included in this analysis, but in total 38 surveys of *Darfur* recipients (out of 52 total) were examined in order to create the tabulated information seen below. When respondents were asked to comment on their stove's performance, responses fell within three

categories: 1) The stove is satisfactory and still in use; 2) The stove performed well but then broke, often within a time frame viewed as excessively short by the user; and 3) ‘The stove was destroyed with the grass-thatched house.’ Results are presented in Table 2.5.

*Table 2.5: Comments from Bweyeye sector Darfur stove recipients regarding stove performance (n=38)*

	Number of households	Percent of households
<i>Darfur</i> stove still in use	8	21.0
<i>Darfur</i> stove broke	17	44.7
<i>Darfur</i> stove ‘destroyed with the grass-thatched house’	13	34.2

These results help to explain much of the anomaly seen in rates of use for the *Darfur* cohort. For the significant majority of *Darfur* recipients (in this sample, nearly 80%), the rate of use can only be “Never”, because the stove no longer exists in the home. These respondents are *Darfur recipients* but no longer *Darfur owners*.

There are two important conclusions that stem from these data. Firstly, it does appear that the design, construction or installation of the *Darfur* stoves is unsatisfactory based on its relative fragility for the user. Because this survey did not explore daily use patterns and methods for individual households, we cannot make direct assumptions about the cause of the failure of these *Darfur* stoves. It is possible that the stove design was not strong, or that recipients were not using the stoves with the ideal installation configuration or support. However, it is clear that the functionality and use of the stoves is certainly limited for Bweyeye residents.

Secondly, there appears to be a housing policy change that resulted in significant loss of these stoves for Bweyeye residents. Thirteen out of 38 valid respondents stated that their stoves were destroyed along with their grass-thatched homes. The exact policy associated with this housing change is not known, although anecdotal evidence implies that

government-mandated upgrade of grass-thatched homes is ubiquitous in this region, likely to mitigate residential fire hazards. Such policy has had significant – even if inadvertent – effect on the use rates of ICS in this sector. Consultation with RDB or other government bodies should take place in order to elucidate those policy details and improve communication between policymakers and organizations that fund and implement programs within the region – whether for the purposes of conservation, poverty alleviation, economic stimulation, or social engagement.

#### *Fuelwood use between ICS and non-ICS households*

Of particular importance in the evaluation of these ICS/EES programs is the effect that improved cookstove technology can have on decreasing fuelwood consumption. Energy efficient stoves can reduce fuel needs, which can translate into decreased pressure on private wood lots, the buffer zone, and the NNP.

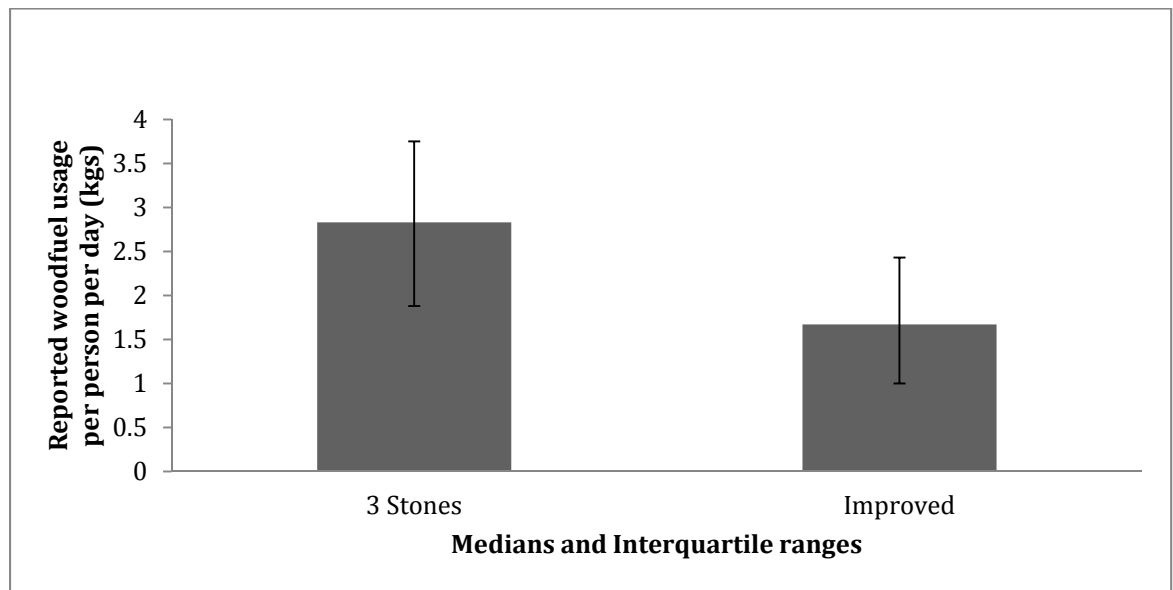
The survey asked participant households to self-report their average daily fuelwood use in kilograms. Out of the 236 households (across both sectors) that provided information on wood consumption, the average amount fuelwood consumed per person per day is 2.62 kgs. This is comparable with the finding of Gross-Camp et al. (2015), who surveyed 78 households in cells adjacent to the NNP and found that the amount of wood collected per person per day ranged from 1.05 to 7.52 kgs. Across all cells, their sample population averaged 2.78 kgs of wood collected per person per day (GC et al., 2015), a figure comparable to our 2.62 kgs. This comparison establishes continuity with previous related studies in the Nyungwe region.

Out of the 236 households that reported fuelwood consumption, 113 are ICS users and 123 households use only 3-stones stoves. Comparing fuelwood use between these groups reveals statistically significant differences. The median fuelwood consumption (per

person per day) for ICS users is 1.67 kgs. For those households using only 3-stones stoves, the median is 2.83 kgs. *NB: For this calculation, the aforementioned Darfur stove recipients who reported never using the ICS – and who had only a 3-stones stove installed in the household – were included with the other households using a 3-stones stove only.* The summary of the medians and interquartile ranges are presented in Table 2.6 and Figure 2.5:

*Table 2.6: Measures of spread in fuelwood consumption across ICS and non-ICS households (kgs per person per day)*

	Households using only 3-stones stoves (n = 123)	Households using at least one ICS (n = 113)
Median	2.83	1.67
Q1 (25%)	1.88	1.00
Q3 (75%)	3.75	2.43
Interquartile range	1.87	1.43



*Figure 2.5: Bar graph depicting median values of fuelwood consumption (per person per day) for households using either a 3-stones stove only, or using at least one ICS. Interquartile ranges (25%-75%) are superimposed.*

Median values are preferred for this comparison, as the mean value is inflated by a few single-person households with very high fuelwood consumption; it appears that these few households are operating as restaurants, but that information was not explicitly asked in the survey and so the assumption cannot be made. Rather than discard outliers, I chose to use the nonparametric Mann-Whitney U test to accommodate the skewness of the data. The distributions in the two groups differed significantly (Mann-Whitney U = 28.2450,  $p < 0.0001$ ). Use of an ICS in the household has a definitive effect on fuelwood consumption, reducing the median consumption value by more than a kilogram per person per day. I consider this reduction in fuel consumption to be a conservative estimate, as some households continued to use a 3-stones stove in conjunction with the ICS; for these households I was not able to parse the fuel consumption for the different stove types.

When examined across household size, the ICS potential to reduce fuel use appears to most positively benefit households of a medium-to-large size, as seen in Figure 2.6 on the following page.

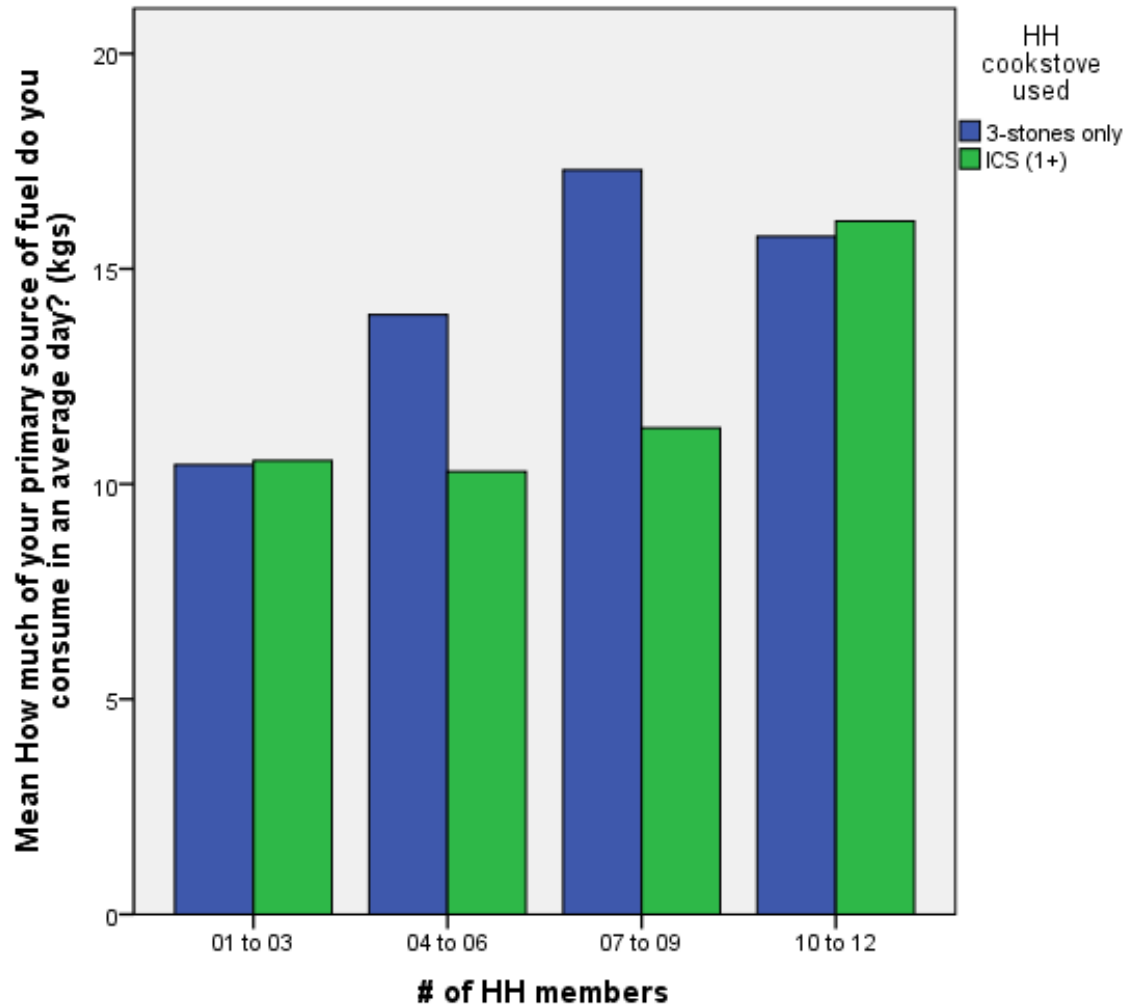


Figure 2.6: Average values of fuelwood consumption per household (*kgs per day*), based on household size and separated by stove type

The lack of positive effect on reduced fuel use for very small or very large families could be due to a variety of factors, but it should be noted that 193 of our 251 total households fell into the “4 to 6” and “7 to 9” categories of household size.

### *Cookstove ownership and health effects*

Lastly, analysis of household health information is presented as a descriptive narrative rather than as statistically significant, because many households did not report health information but it was not clear whether they did not choose to complete that section or the survey or whether they did not have any health events to report.

In total, 142 out of 252 households provided information on 1 or more health events as described in section 1.4 of the survey.

*Table 2.7: Incidence of health ailments across 142 households*

Headache	Sore eyes	Coughing	Shortness of breath	Wheezing	Dizziness
153	60	66	20	22	33

When divided between ICS users and 3-stones users, there are no observable or statistical differences in the frequency or type of health ailment experienced by household members. There are several reasons that this might be the case, including an insufficient length of time in allowing ICS use to have a positive effect on respiratory health, since these particular stoves have only been in use over the past few years. However, survey limitations resulted in incomplete and imprecise collection of individual health information from household respondents, thus I suggest a tailored, health-specific survey be conducted with both ICS and 3-stones stove users in Rwanda in 5-10 years' time.

### **Conclusions**

This survey and analysis finds that fuelwood usage for improved cookstove users in Bweyeye and Nkungu is significantly less than their counterpart 3-stones stove users: the fuelwood reduction is greater than 1kg saved per household member per day. In addition, rate of use for *Darfur* stove recipients is significantly lower than for *canarumwe* owners, and



much of this is due to the *Darfur* stoves having broken during household use or having been destroyed along with grass-thatched homes that seem to have been razed as part of a national or regional housing policy change.

This survey has been the first of its kind in Rwanda, and offers invaluable insights into the implementation and success of ICS/EES adoption programs. There is a clear reduction in wood consumption for those households using an improved stove, and if the challenges of stove design and potential conflicting policy (e.g. the timing of mandated housing upgrades) can be overcome, the overall fuelwood dependence for Rwandan households could decrease significantly. That benefit can accrue to Nyungwe National Park, Rwanda's protected areas, and to rural communities and their ecosystems.

## CHAPTER 3: AGRICULTURAL COOPERATIVES' PREFERENCES FOR MARKET-BASED CONSERVATION INSTRUMENTS (MBIs)

### **Introduction**

Over the past two decades, the broad field of conservation is increasingly concerned with threats to ecosystem services (also called environmental services) worldwide. The 2005 Millennium Ecosystem Assessment, called for by the UN in 2000, incorporated the input of almost 1500 scientists and researchers to assess human effects on ecosystem services (ES), predict future degradation, and suggest solutions to slow or mitigate threats to these ecosystems. Examples of these services include water provision and purification, carbon sequestration, provision of forest products, recreation, and many more. The Millennium Ecosystem Assessment defines four distinct types of ES: *provisioning* services such as timber and water; *regulating* services that manage and buffer events like flooding, climate change and water purification; *supporting* services such as soil formation and nutrient cycling; and *cultural* services such as the educational, spiritual and recreational value that humans may place on an ecosystem (MA, 2005). There is no single definition of 'ecosystem service', and there is a vast suite of threats that can degrade these services depending on their geographic, social, and political context. Examples of human activity that threaten ES include land conversion for agricultural or commercial development; depletion and pollution of waterways; overexploitation of natural resources, renewable as well as non-renewable; and GHG emissions that both cause and accelerate worldwide climate change.

The array of tools that have been developed to mitigate these many threats is almost as vast. Historically, conservation policy has often employed a top-down command-and-control approach to protect biodiversity and natural resources. Command-and-control policy relies on laws and management plans, often developed unilaterally, in order to

achieve success. This approach is often expensive, requiring monitoring, an extensive network of staff and many transaction costs, in addition to the social cost that can occur if local residents feel alienated.

The problems inherent in command-and-control have been part of the catalyst for employing economic perspectives in conservation. It is useful to be able to value an ecosystem service in order to factor it into an economic approach, however, valuation of ES is extraordinarily difficult: ES are often public goods, affected by nonpoint source degradation from a variety of actors; substitutions for ES are often impossible or infeasible; and ES valuation is inherently an exceptionally complicated process involving multiple actors, competing land demands, externalities, discount rates, regional infrastructure, and countless other factors. Additionally, ecosystem services can vary wildly. For these many reasons, ecosystem services have failed to inspire a traditional market system that might ensure their maintenance and provision into the future (Branca, 2011; Lopa, 2012).

Market-based instruments (MBIs) are a recent development in conservation theory; they operate on economic principles of creating and fostering a previously non-existent market for valuable yet undervalued ecosystem services. The foremost priority of MBIs is to make resource management more efficient, although additional goals may include poverty alleviation and development of regional economies and job markets. Necessary elements for effective MBI implementation include unambiguous property rights; defined, transparent structures for decision-making; sharing information; and monitoring the effects the instrument has on biodiversity conservation (Chobotova, 2013). Examples of MBIs include payments for ecosystem services (PES), subsidies, taxes, and certification or eco-labeling programs.

## PAYMENTS FOR ECOSYSTEM SERVICES (PES)

PES schemes involve the sale of a single or package set of ecosystem services from a seller to a buyer. Sellers and buyers may be public entities, such as governments, private companies, or private landowners; property rights are also important to the success of PES programs. For example, two private landowners that are neighbors on a riverfront might find themselves inadvertently affecting or affected by the other. If the upstream neighbor pollutes his water and has the legal right to do so, his downstream neighbor might wish to compensate him financially for minimizing his pollution activity. On the other hand, if the downstream neighbor has a right to unpolluted water, the upstream neighbor might pay for the privilege of polluting.

Lopa et al. (2012), who evaluated a PES scheme in the Uluguru Mountains of Tanzania, supply a highly relevant case study with a broad overview of PES. In this study, a Dar es Salaam public water utility (supplier to a local Coca-Cola bottling plant), targeted subsistence farmers living and working upriver in the Uluguru Mountains and paid participants to change agricultural practices in order to decrease erosion, waterway sedimentation, and the volume of effluent waste. While the program was a complete success in terms of exponential growth in farmer enrollments, the environmental benefit at the 2-year mark was not statistically significant. This study highlights some of the main drawbacks to PES and other similar conservation policies: results can take many years to manifest while funding can be temporary; these schemes are not always equitable (in this case, more benefits accrue to farmers with more land, who are likely already wealthier than their neighbors); and that payments may undermine good stewardship practices by providing money for what might be, to some, more a matter of conscience and sustainability for the future. (Fisher, 2012; Gross-Camp et al., 2012).

## SUBSIDIES AND TAXES

Ecosystem services protected by subsidies most often rely on government funding and intervention, which is most often directed towards private companies and individuals in possession of land that supplies valuable ES. Taxes must be similarly governed. The vital requirement for subsidy and tax-based conservation policies is that existing national and regional infrastructure must be able to cope with the administrative and transaction costs of implementing and sustaining policy. In order for subsidies and taxes to be economically and environmentally effective, the governance system should also exhibit little or no corruption.

## CERTIFICATION PROGRAMS

Successful and sustainable outfit certification – whether for agriculture, forest, or tourism industries – relies on approval from an unbiased third-party certifying body. Explicit standards for cultivation, harvest and planting (in the case of forest and agriculture) and for minimal ecosystem disruption (in the case of tourism) must be followed. Certification can increase a private company's revenue stream as it raises the value of goods and services, but this is fully dependent on the buyer demand for certified products. In order to be environmentally effective, third-party certifiers should have regular periodic evaluations of standards and rate of adherence. Like, those discussed in previous paragraphs, this conservation approach also requires management of administrative and transaction costs.

## **Methods**

Research and development of this study plan began in early 2014 with literature review on conservation MBIs and their worldwide contexts and implementation. We established that a number of criteria were necessary by which stakeholders could rank the policy priorities that a conservation instrument should target. An introductory presentation and focus group (30 participants, including both national and regional representatives) was held in June 2014 to elicit stakeholders' views on what criteria were important when evaluating conservation policy.

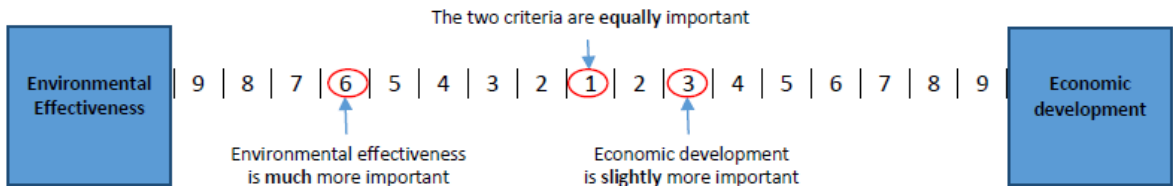
Building upon the results of the June stakeholder engagement, further workshops occurred in October and November of 2014; these focus groups took place at both the local and national level. The workshop content and ranking activities were tailored for each group's expertise and experience. Each workshop began with a concise yet thorough background on: A) The importance of Rwanda's biodiversity and ecosystem services, B) Potential threats to these environmental services, C) A description of market-based instruments for conservation, and D) How ranking individual/collective stakeholders' priorities can improve the design, implementation, and evaluation process of market-based conservation policy.

Throughout the study, we utilized a multi-criteria analysis (MCA) approach, utilizing the analytic hierarchy process (AHP) to determine criteria rankings, indicator rankings, and MBI rankings.

*Multi-Criteria Analysis and the Analytic Hierarchy Process*

The first step of multi-criteria analysis is to establish the multiple criteria and indicators to be used for comparison. When evaluating a complex problem and making comparisons, small, discrete components of the problem should be explicitly defined so that respondents can make tradeoffs between them. This step of the research was accomplished through literature review, consultation with stakeholders and results from the June 19<sup>th</sup> workshop, and subsequent refinement of indicators to eliminate overlap.

Next, respondents must conduct tradeoffs between criteria, and then between indicators within their criteria contexts. Below is pictured a simple example of the AHP scale used to rank criteria and indicators. By selecting one number on the scale to represent their opinion, respondents make tradeoffs between each of the criteria, and then also between each of the indicators within each criterion category.



*Figure 3.1:* An example of the AHP scale used to conduct tradeoffs. Respondents select one numerical answer (1 through 9, on either side) that represents their opinion on the importance of one option over another

Then, using the eigenvalue method, one determines the priority values of the criteria; these values are indicative of the criterion’s rank of importance to the respondent. These can be calculated first by establishing a reciprocal matrix that displays the relative weight of criteria, such as the example seen below. In this matrix, entries in each row are the ratios of each criterion’s AHP scale value to each other criteria scale value.

$$\begin{pmatrix} w_1 / w_1 & w_1 / w_2 & \dots & w_1 / w_n \\ w_2 / w_1 & w_2 / w_2 & \dots & w_2 / w_n \\ \vdots & \ddots & \dots & \vdots \\ w_n / w_1 & \dots & \dots & w_n / w_n \end{pmatrix}$$

Then, to calculate the eigenvector, square the matrix and sum the values across rows (in the case of our criteria comparisons, we will have had three rows – one for each criterion – and thus three row sums). Finally, calculate the ratio of each row sum to the total of all three row sums. This produces the priority value of each criterion to each other criterion.

Technically speaking, this squaring of matrices and calculation of row sum ratios should be repeated many times until the results (priority values) verge on being identical. This is impractical for calculations by hand, which is why AHP software such as Expert Choice was created. Expert Choice is the analytical software used in all AHP calculations for this research.

Once priority values are calculated in this way for criteria, they can be calculated for indicators as well. Finally, the *global priority score* of each indicator is calculated by multiplying its relative eigenvector value by the priority value of the criterion to which it applies.

An important component of AHP priority ranking is the adherence to consistency. In addition to calculating priority scores for comparison items, AHP calculates the consistency ratio for each respondent.

$$\text{Consistency Ratio (CR)} = \text{Consistency Index (CI)} / \text{Random Consistency Index (RI)}$$

Consistency Index (CI) =  $(\lambda_{\max} - n) / (n - 1)$ , where  $\lambda_{\max}$  is the largest eigenvalue of the matrix of order 'n'

$$\text{Random Consistency Index (RI)} = \text{Consistency Index of a random matrix of order 'n'}$$

Consistency ratios for respondents were tracked using AHP Expert Choice software; as long as the CR remains at 10% or below, the respondent can be considered consistent in his/her opinions. All groups' and individual's responses were monitored for internal consistency and all groups were observed to have made their tradeoffs in a consistent



fashion. Please note, however, that inconsistency of opinion is an inherently human trait and should not and cannot always be fully eliminated.

*June 19, 2014 – Gisakura, Nyungwe National Park*

Thirty individuals participated in the Gisakura workshop, the goal of which was to identify relevant indicators of environmental effectiveness, economic effectiveness, and social equity of market-based conservation policy. Participants represented the Rwandan Development Board (RDB), the Kitabi College of Conservation and Environmental Management (KCCEM), the Wildlife Conservation Society (WCS), the Rwanda Environment Management Authority (REMA), and numerous regional agricultural cooperatives.

*October 30, 2014 – Bugarama, Rusizi District*

Four rice-growers' cooperatives participated in the workshop held in Bugarama. These included COPRORIKI, KEHMU, KOJMU and KOIMUNYA. While rankings were conducted as a cooperative group, the total number of stakeholder participants was 37.

*October 31, 2014 – Shara Beach, Nyamasheke District*

Five agricultural cooperatives participated in the workshop held in Shara Beach. These included cooperatives engaged in rice, tea, and coffee production. While rankings were conducted as a cooperative group, the total number of stakeholder participants was 34.

## **Results and Discussion**

This section of Chapter 3 presents the results from each of three focus groups, held in June 2014 and October 2014. Discussion of focus group results is included at the end of each subsection. A summary of conclusions and implications is found at the end of this chapter.

*June 19, 2014 – Gisakura, Nyungwe National Park, Rwanda*

As outlined in previous sections of this chapter, the first stakeholder workshop took place on June 19, 2014, in Gisakura, Rwanda. Approximately 30 stakeholders participated in this workshop, the purpose of which was to identify indicators that should be used to evaluate conservation policy based on pre-established criteria. These criteria, identified through extensive literature review, were “Economic Effectiveness”, “Environmental Effectiveness”, and “Equitability”.

Within these existing criteria, the 30 workshop participants across both groups (see previous section, Methods, for details) identified three distinct indicators of economic effectiveness, four distinct indicators of environmental effectiveness, and three distinct indicators of equity. These indicators are as follows, listed in no particular order.

Indicators of economic effectiveness are: 1) An increase in the number and diversity of local businesses and jobs; 2) Improvement of regional infrastructure, such as roads, schools, health clinics, and provision of water and electricity; and 3) An increase in the income and/or yield from regional agricultural production.

Indicators of environmental effectiveness are: 1) An increase in the abundance of target wildlife species; 2) A decrease in incidence of threats – e.g. poaching, harvest of forest products, mining, fires – in protected areas like NNP; 3) An improvement in land management practices, to mitigate soil erosion and waterway sedimentation; and 4) An increase in overall forest cover.

Indicators of equitability are: 1) Use of a bottom-up approach in decision-making, sharing information among all affected stakeholders; 2) Consideration of vulnerable stakeholder groups, such as low-income households or those with a female head-of-house; and 3) The promotion of community empowerment and group cohesion.

Table 3.1 summarizes the results of the June 19<sup>th</sup> workshop.

*Table 3.1: Results from June 2014; Criteria and indicators by which to evaluate MBIs*

	CRITERIA		
	ECONOMY	ENVIRONMENT	EQUITY
I N D I C A T O R S	Increase the number and diversity of local businesses and jobs	Increase populations of target animal species	Use bottom-up approach in making decisions, with equal access to information among all stakeholders
	Improve infrastructure (roads, water, electricity, schools, clinics)	Decrease incidence of threats to key conservation targets (e.g. fires, poaching, and mining)	Consider vulnerable group (e.g. women, low-income households) when distributing funds or making investment contributions
	Increase income and/or yield from agricultural production	Improve land management practices to reduce soil erosion and water pollution from sedimentation	Promote cohesion and empowerment of communities through collaborative participation
		Increase forest cover	

#### Discussion of results from June 19<sup>th</sup> workshop in Gisakura

Participants were able to draw on their own experience and expertise in identifying relevant metrics of policy success within each of the three criteria categories. Additionally, it became clear during the group brainstorming component that these stakeholders were already thinking of these indicators within a hierarchy based on their personal and

professional opinions. This created a sort of narrative justification for the subsequent step of this research: ranking the criteria and indicators using MCA-AHP.

Unofficial feedback from the workshop indicated that, while the topic of market-based instruments and MCA-AHP were unfamiliar to many at the start of the workshop, the logic behind using criteria and indicators was clear. As stakeholders became more familiar with the structure and objectives of the project, they indicated that they found the workshop exercise to be appropriate and comprehensive.

*October 30, 2014 – Bugarama, Rusizi District*

Following the workshop in June 2014, conducted to establish a range of indicators by which to evaluate a conservation MBI, we then conducted the local-level workshops with regional agricultural cooperatives in October 2014. The purpose of these workshops was to establish a priority ranking of the criteria and indicators, wherein the importance of each criterion and indicator would be determined relative to the other criteria and indicators.

Participants in the October 30<sup>th</sup> workshop in Bugarama were all members of district rice cooperatives. Four cooperatives were represented. Results are presented for each group in this section; these data are summarized in Table 3.2.

#### KOIMUNYA COOPERATIVE

##### Criteria rankings (sum of scores is equal to 1.000)

As a group, the Koimunya cooperative found 'Environment' to be the most important criterion, with a priority score of 0.577. 'Equity' followed in importance, with a score of 0.342, and, lastly, 'Economy' earned a score of 0.081.

#### Indicator rankings (sum of scores is equal to 1.000)

As a group, the Koimunya cooperative ranked 'Decrease threats' as the most important indicator, with a global priority score of 0.257. Next in importance was 'Promote community cohesion', with a score of 0.181, followed by 'Improve land management' with a score of 0.149 and 'Use a bottom-up approach' with a score of 0.114. The group found 'Increase jobs & businesses' (0.013), 'Improve infrastructure' (0.024), 'Increase agricultural income' (0.044), and 'Consider vulnerable groups' (0.048) to be the least important indicators.

#### KEHMU COOPERATIVE

#### Criteria rankings (sum of scores is equal to 1.000)

The Kehmu cooperative found 'Environment' to be the most important criterion, with a priority score of 0.570. 'Economy' followed in importance, with a score of 0.333, and, lastly, 'Equity' earned a score of 0.097.

#### Indicator rankings (sum of scores is equal to 1.000)

The Kehmu cooperative found 'Decrease threats' to be the most important indicator, with a global priority score of 0.214. Next in importance was 'Increase jobs & businesses' with a score of 0.180, followed by 'Improve land management' with a score of 0.151 and 'Increase forest cover' with a score of 0.134. The group found 'Consider vulnerable groups' (0.019), 'Promote community cohesion' (0.030), 'Use a bottom-up approach' (0.048) and 'Increase agricultural income' (0.054) to be the least important indicators.

## COPRORIKI COOPERATIVE

### Criteria rankings (sum of scores is equal to 1.000)

The Coproriki cooperative found 'Environment' to be the most important criterion, with a priority score of 0.493. 'Economy' followed in importance, with a score of 0.311, and, lastly, 'Equity' earned a score of 0.196.

### Indicator rankings (sum of scores is equal to 1.000)

The Coproriki cooperative found 'Improve land management' to be the most important indicator, with a global priority score of 0.193. Next in importance was 'Increase jobs & businesses' with a score of 0.153, followed by 'Decrease threats to protected areas' with a score of 0.136. The group found 'Consider vulnerable groups' (0.038), 'Promote community cohesion' (0.061), 'Increase agricultural income' (0.061) and 'Increase target species' (0.068) to be the least important indicators.

## KOJMU COOPERATIVE

### Criteria rankings (sum of scores is equal to 1.000)

Kojmu cooperative found 'Environment' to be the most important criterion, with a priority score of 0.493. 'Equity' followed in importance, with a score of 0.311, and, lastly, 'Economy' earned a score of 0.196.

### Indicator rankings (sum of scores is equal to 1.000)

Kojmu cooperative found 'Decrease threats' to be most important, with a global priority score of 0.190. Next in importance was 'Improve land management' with a score of 0.179, followed by 'Promote community cohesion' with a score of 0.153 and 'Improve infrastructure' with a score of 0.108. The group found 'Increase jobs & businesses' (0.041), 'Increase target species' (0.043), 'Increase agricultural income' (0.047), and 'Consider vulnerable groups' (0.061) to be the least important indicators.

Table 3.2: Bugarama – priority scores for criteria and indicators, indicating the importance of each criterion or indicator relative to the others. Two priority scores are given for each indicator: the first is the **global** priority score (which is weighted in accordance with the relative importance of that indicator’s criterion category). The second priority score given for each indicator (shown in parentheses), is the **local** priority score, which shows how important it is relative to the other indicators within that criterion category only.

CRITERIA AND INDICATORS	Group 1 (Koimunya)	Group 2 (Kehmu)	Group 3 (Coprорiki)	Group 4 (Kojmu)
<b>Economic</b>	<b>0.081</b>	<b>0.333</b>	<b>0.311</b>	<b>0.196</b>
Jobs & businesses	0.013 (0.163)	0.180 (0.540)	0.153 (0.493)	0.041 (0.210)
Infrastructure	0.024 (0.297)	0.099 (0.297)	0.097 (0.311)	0.108 (0.550)
Agricultural income	0.044 (0.540)	0.054 (0.163)	0.061 (0.196)	0.047 (0.240)
<b>Environment</b>	<b>0.577</b>	<b>0.570</b>	<b>0.493</b>	<b>0.493</b>
Target species	0.062 (0.108)	0.070 (0.123)	0.068 (0.138)	0.043 (0.087)
Decrease threats	0.257 (0.445)	0.214 (0.376)	0.136 (0.276)	0.190 (0.385)
Land management	0.149 (0.258)	0.151 (0.265)	0.193 (0.391)	0.179 (0.364)
Forest cover	0.110 (0.190)	0.134 (0.235)	0.096 (0.195)	0.081 (0.164)
<b>Equity</b>	<b>0.342</b>	<b>0.097</b>	<b>0.196</b>	<b>0.311</b>
Bottom-up	0.114 (0.333)	0.048 (0.493)	0.097 (0.493)	0.097 (0.311)
Vulnerable groups	0.048 (0.140)	0.019 (0.196)	0.038 (0.196)	0.061 (0.196)
Community cohesion	0.181 (0.528)	0.030 (0.311)	0.061 (0.311)	0.153 (0.493)

#### Discussion of summary results from October 30<sup>th</sup> workshop in Bugarama

It is important to remember that participants were not asked to rank criteria and indicators based on how they perceived conservation policy to affect their own livelihoods. Rather, focus groups were asked to prioritize the objectives that conservation instruments should target in the present and in the future. However, it should be noted that the narrative surrounding the groups’ tradeoffs often referenced their own perspectives as farmers and agricultural administrators.

Many stakeholders, from all cooperatives, expressed the opinion that with good environmental stewardship, benefits would accrue to the surrounding agricultural industries as well. After the presentation (but before the groups separated into their

cooperatives to conduct the tradeoffs), one participant spoke about his unfamiliarity with the term 'ecosystem services', but his intimate familiarity with actual ecosystem services once the term had been defined and discussed, with examples given. He observed that he was exceptionally familiar with how weather patterns and water quality affect his crop yields, but that he had never until now considered how actions that he took on his own land might affect the ecosystem services of his neighbors. At this time during the workshop, many participants took time to share their own perceptions of ecosystem services. Several stakeholders, for example, mentioned that they preferred to farm in close proximity to forested land, as they perceived rainfall to be more frequent and predictable. This anecdotal evidence provides support to the findings of the AHP exercises: local farmers associate positive benefits with ecosystem service protection, even without the additional incentives offered by conservation policies that also aim for direct economic benefit.

Workshop feedback and anecdotal evidence suggests a similar phenomenon for indicators at the opposite end of the spectrum as well. Two of the most consistently bottom-ranked indicators, 'Consideration of vulnerable groups' and 'Increase agricultural yield and/or income', were considered by many workshop participants to be redundancies. One farmer remarked that, if using a bottom-up approach and promoting community cohesion, consideration of vulnerable groups would be a natural side effect and should not require particular focus. Similarly, some stakeholders indicated that an increase in agricultural yields would occur as ecosystem protection improved, and thus they had valued 'Environment' higher than other criteria; other participants did not seem very concerned with an increase in yield or income, but rather with stability and consistency of current production.



*October 31, 2014 – Shara Beach, Nyamasheke District*

As with the October 30<sup>th</sup> workshop in Bugarama, the purpose of the October 31<sup>st</sup> workshop in Shara Beach was to establish a priority ranking of the criteria and indicators, wherein the importance of each criterion and indicator would be determined relative to the others. Participants in the Shara Beach focus group were all members of district agricultural cooperatives. Five cooperatives were represented: two for rice, two for tea, and one for coffee. Results are presented for each group in this section; these data are summarized in Table 3.3.

#### GROUP 1 - RICE COOPERATIVE

##### Criteria rankings (sum of scores is equal to 1.000)

Group 1 found 'Environment' to be the most important criterion, with a priority score of 0.661. 'Equity' followed in importance, with a score of 0.208, and, lastly, 'Economy' earned a score of 0.131.

##### Indicator rankings (sum of scores is equal to 1.000)

As a group, this cooperative ranked 'Improve land management' as the most important indicator, with a global priority score of 0.364. Next in importance was 'Increase forest cover', with a score of 0.141, followed by 'Consider vulnerable groups' with a score of 0.137 and 'Decrease threats to protected areas' with a score of 0.094. The group found 'Increase jobs & businesses' (0.017), 'Improve infrastructure' (0.024), 'Use a bottom-up approach' (0.027), and 'Promote community cohesion' (0.043) to be the least important indicators.

## GROUP 2 - TEA COOPERATIVE

### Criteria rankings (sum of scores is equal to 1.000)

Group 2 found 'Environment' to be the most important criterion, with a priority score of 0.625. 'Economy' followed in importance, with a score of 0.238, and, lastly, 'Equity' earned a score of 0.136.

### Indicator rankings (sum of scores is equal to 1.000)

As a group, this cooperative ranked 'Decrease threats to protected areas' as the most important indicator, with a global priority score of 0.269. Next in importance was 'Improve land management', with a score of 0.188, followed by 'Improve infrastructure' with a score of 0.139 and 'Increase forest cover' with a score of 0.120. The group found 'Promote community cohesion' (0.018), 'Use a bottom-up approach' (0.032), 'Increase jobs & businesses' (0.044), and 'Increase target species' (0.049) to be the least important indicators.

## GROUP 3 - COFFEE COOPERATIVE

### Criteria rankings (sum of scores is equal to 1.000)

Group 3 found 'Environment' to be the most important criterion, with a priority score of 0.614. 'Economy' followed in importance, with a score of 0.268, and, lastly, 'Equity' earned a score of 0.117.

### Indicator rankings (sum of scores is equal to 1.000)

As a group, this cooperative ranked 'Increase forest cover' as the most important indicator, with a global priority score of 0.229. Next in importance was 'Decrease threats to protected areas', with a score of 0.170, followed by 'Improve infrastructure' with a score of 0.132 and 'Increase target species' with a score of 0.126. The group found 'Promote community cohesion' (0.014), 'Use a bottom-up approach' (0.031), 'Increase jobs &

businesses' (0.053), and 'Consider vulnerable groups' (0.072) to be the least important indicators.

#### GROUP 4 - TEA COOPERATIVE

##### Criteria rankings (sum of scores is equal to 1.000)

Group 4 found 'Environment' to be the most important criterion, with a priority score of 0.726. 'Economy' followed in importance, with a score of 0.172, and, lastly, 'Equity' earned a score of 0.102.

##### Indicator rankings (sum of scores is equal to 1.000)

As a group, this cooperative ranked 'Improve land management' as the most important indicator, with a global priority score of 0.339. Next in importance was 'Decrease threats', with a score of 0.201, followed by 'Increase target species' with a score of 0.116 and 'Improve infrastructure' with a score of 0.108. The group found 'Promote community cohesion' (0.010), 'Use a bottom-up approach' (0.018), 'Increase agricultural income' (0.023), and 'Increase jobs & businesses' (0.041) to be the least important indicators.

#### GROUP 5 - RICE COOPERATIVE

##### Criteria rankings (sum of scores is equal to 1.000)

Group 5 found 'Economy' to be the most important criterion, with a priority score of 0.614. 'Environment' followed in importance, with a score of 0.268, and, lastly, 'Equity' earned a score of 0.117.

##### Indicator rankings (sum of scores is equal to 1.000)

As a group, this cooperative ranked 'Increase jobs & businesses' as the most important indicator, with a global priority score of 0.337. Next in importance was 'Increase agricultural income', with a score of 0.165, followed by 'Improve land management' with a

score of 0.121 and ‘Decrease threats to protected areas’ with a score of 0.081. The group found ‘Promote community cohesion’ (0.014), ‘Increase target species’ (0.023), ‘Consider vulnerable groups’ (0.031), and ‘Increase forest cover’ (0.043) to be the least important indicators.

*Table 3.3: Shara Beach – priority scores for criteria and indicators, indicating the importance of each criterion or indicator relative to the others. Two priority scores are given for each indicator: the first is the **global** priority score (which is weighted in accordance with the relative importance of that indicator’s criterion category). The second priority score given (shown in parentheses), is the **local** priority score, which shows how important it is relative to the other indicators within that criterion category only.*

CRITERIA AND INDICATORS	Group 1 (rice)	Group 2 (tea)	Group 3 (coffee)	Group 4 (tea)	Group 5 (rice)
<b>Economic</b>	<b>0.131</b>	<b>0.238</b>	<b>0.268</b>	<b>0.172</b>	<b>0.614</b>
Jobs & businesses	0.017 (0.127)	0.044 (0.184)	0.053 (0.196)	0.041 (0.238)	0.377 (0.614)
Infrastructure	0.024 (0.186)	0.139 (0.584)	0.132 (0.493)	0.108 (0.625)	0.072 (0.117)
Agricultural income	0.090 (0.687)	0.055 (0.232)	0.083 (0.311)	0.023 (0.136)	0.165 (0.268)
<b>Environment</b>	<b>0.661</b>	<b>0.625</b>	<b>0.614</b>	<b>0.726</b>	<b>0.268</b>
Target species	0.062 (0.094)	0.049 (0.078)	0.126 (0.205)	0.116 (0.160)	0.023 (0.085)
Decrease threats	0.094 (0.142)	0.269 (0.431)	0.170 (0.277)	0.201 (0.277)	0.081 (0.304)
Land management	0.364 (0.550)	0.188 (0.300)	0.090 (0.146)	0.339 (0.467)	0.121 (0.451)
Forest cover	0.141 (0.214)	0.120 (0.192)	0.229 (0.373)	0.069 (0.095)	0.043 (0.160)
<b>Equity</b>	<b>0.208</b>	<b>0.136</b>	<b>0.117</b>	<b>0.102</b>	<b>0.117</b>
Bottom-up	0.027 (0.740)	0.032 (0.443)	0.031 (0.540)	0.018 (0.687)	0.072 (0.634)
Vulnerable groups	0.137 (0.094)	0.085 (0.169)	0.072 (0.163)	0.074 (0.186)	0.031 (0.192)
Community cohesion	0.043 (0.167)	0.018 (0.387)	0.014 (0.297)	0.010 (0.127)	0.014 (0.174)

### Discussion of summary results from October 31<sup>st</sup> workshop in Shara Beach

Feedback from the workshop in Shara Beach was similar to that of Bugarama: Many participants were wholly unfamiliar with the term ‘ecosystem services’, but were very familiar with its meaning once the terminology was explained. However, a few participants did not appear to understand how land management practices of a farming individual (or

plantation) could affect neighboring lands. Stakeholders participated in a long discussion about these issues during and after the presentation. In contrast, all stakeholders appeared familiar with environmental conservation and with regional organizations that promote environmental stewardship. As a group, we engaged in long conversation about the link between environmental stewardship, conservation policy, and the ecosystem services that affect private landowners and farmers. We also discussed, at length, the importance of stimulating economy in order to sustain individual well-being and population growth. We also discussed the importance of equitable practices in conservation policy implementation in particular.

With the exception of Group 5, which valued Economy most highly, all respondent groups placed highest priority on the Environment criterion. As a general rule, priority scores seemed to be similar to scores observed in Bugarama: 'Equity' criteria and indicators often earned the lowest priority scores. The narrative accompanying these scores reflects attitudes similar to Bugarama participants: If any of the indicators of equity is achieved, then the conservation approach will likely be equitable generally.

## **Conclusions**

Considering the nature of their livelihoods and dependence on regional agricultural economy for income, the high value placed on environmental indicators is both encouraging and mildly surprising. One explanation for this is that Rwanda enjoys considerable national stability, both economically and politically, particularly in comparison to its geographic neighbors and to its own recent history. Rwanda's economy is not large, but it is productive and efficient. This stability may offer greater opportunity for Rwandans to emphasize environmental protection and the utility of ecosystem services provided by natural and protected areas.

Lastly, the generally low priority scores earned by indicators of the equity criterion may be similarly due to nationwide stability. As members of cooperatives, perhaps participants in these workshops felt themselves (and their peers) supported and on sufficiently equal footing that equity did not seem as concerning an issue as environmental protection. For the time being, market-based conservation policy targeting environmental protection (particularly the reduction of direct threats to protected areas) has the support of regional agricultural stakeholders.

## CHAPTER 4: NATIONAL STAKEHOLDERS' PREFERENCES FOR AND EX-ANTE EVALUATION OF MBIs

### **Introduction**

On November 4<sup>th</sup>, 2014, a national-level workshop was held at the WCS national office in Kigali. Participants included representatives from Rwandan Development Board (RDB); Rwanda Environment Management Authority (REMA); International Gorilla Conservation Program (IGCP); Rwanda Energy Group Ltd. (REG); Wildlife Conservation Society Rwanda (WCS); Association for the Conservation of Nature in Rwanda (ACNR); Rwandan Ecologists' Association (ARECO); and Dian Fossey Gorilla Fund International (DFGFI).

The structure of this workshop was similar to that of the regional workshops held in the days prior, however the criteria were expanded to cater to the expertise of national representatives. Two criteria -- "Feasibility of implementation" and "Consistency and compatibility with existing laws and policy" -- were added to take advantage of the knowledge base and expertise of these national representatives. Additionally, the individual indicators were removed from the tradeoffs (though indicators were discussed during the presentation and in the context of the criteria). Instead of comparing the importance of indicators, participants were asked to rank distinct MBIs in the context of each criterion. The purpose of this comparison was to see how national-level stakeholders regarded different conservation instruments with respect to their fulfillment of the criteria. This comprises the ex ante evaluation of MBIs, which is invaluable knowledge when designing or implementing MBIs in Rwanda.

The following figure below outlines the structure of tradeoffs performed by participants in this workshop. A complete template of the national workshop survey is found in Appendix C.

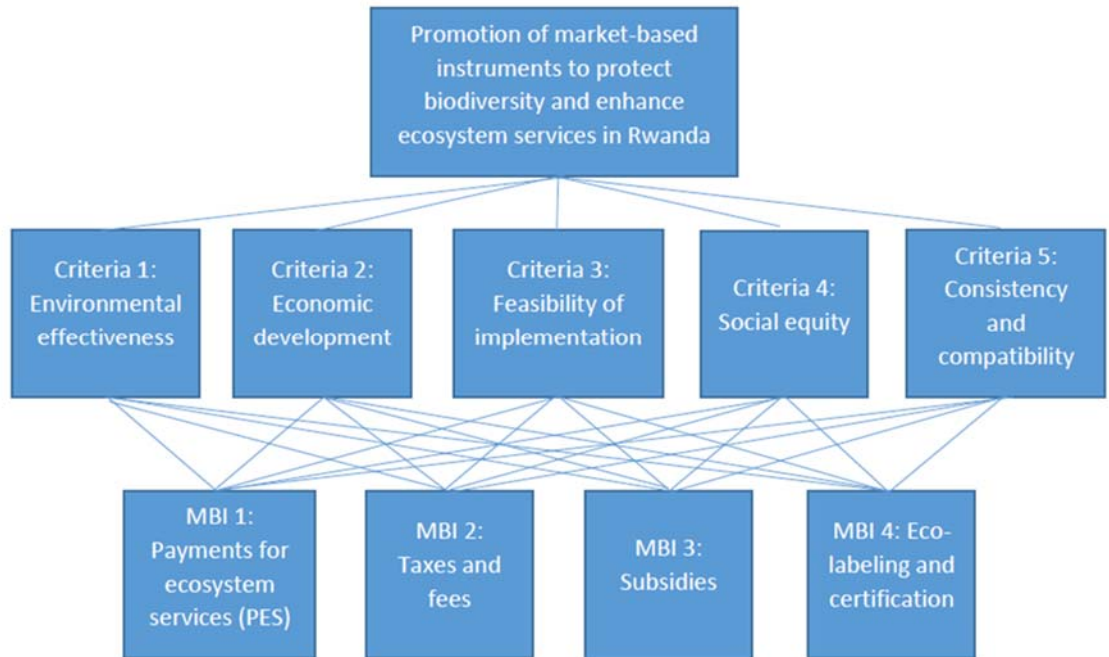


Figure 4.1: The structure of tradeoffs made by participants in the November 4<sup>th</sup> workshop in Kigali. Each participant conducted paired comparisons of all criteria, and then conducted comparisons of all four MBIs for each criterion category

## Methods

The November 4<sup>th</sup> workshop opened with a presentation discussing: A) The importance of Rwanda’s protected areas and ecosystem services, B) The diverse threats to Rwanda’s natural assets, C) The potential for MBIs to promote and improve conservation efforts, and D) The effectiveness of each MBI to be considered during designing, implementing, or evaluating the performance of that conservation instrument. Following the presentation and some questions and brief discussion, each of the 16 participants completed an individual survey using the AHP scale as detailed in Chapter 3 Methods, in which they conducted comparisons between all the five criteria, and then proceeded to make comparisons between all four MBIs within the context of each criterion.

As with the regional groups, consistency ratios were closely monitored and participants were contacted after the workshop if their responses were not consistent.



Participants were invited to amend their responses in order to reflect more consistent opinions, but were told only to make adjustments if those adjustments were truly representative of their personal opinions (i.e. not to make adjustments solely based on achieving a compatible consistency ratio). Response rates for the follow-up adjustments were not 100%, and after eliminating non-respondents or respondents whose tradeoffs remained highly inconsistent, we were left with a total of 10 valid respondents for the November 4<sup>th</sup> workshop and survey.

## **Results and Discussion**

This section of Chapter 4 presents the individual results from the national-level workshop held on November 4<sup>th</sup>, 2015. To reiterate, individual participants ranked five separate criteria based on importance. Each participant then ranked four different market-based instruments (MBIs) based on how well they would satisfy each criterion; these are presented in order of priority within each criterion category.

The individual data were aggregated to obtain a group result for this national workshop; this result is described in detail after the individual results are presented.

A summary of conclusions and implications is found at the end of this chapter.

## INDIVIDUAL #1

### Criteria rankings (sum of scores is equal to 1.000)

Participant #1 found 'Environment' to be the most important criterion, with a priority score of 0.490. Next followed 'Equity' (0.245), 'Feasibility' (0.106), and 'Compatibility' (0.099). Participant #1 ranked 'Economy' as the least important criterion, with a score of 0.060.

### MBI rankings (sum of scores is equal to 1.000)

Within the 'Environment' criterion (0.490), Participant #1 found 'Payments for Ecosystem Services' to be the most likely MBI for policy success, with a priority score of 0.226. This is followed by 'Subsidies' (0.113) and 'Eco-labeling' (0.113), and lastly 'Taxes and fees' (0.038).

For the 'Equity' criterion (0.245), Participant #1 found 'PES' to be the preferred MBI, with a score of 0.119, followed by 'Eco-labeling' (0.073), 'Subsidies' (0.037), and lastly 'Taxes and fees' (0.017).

Within the 'Feasibility' criterion (0.106), Participant #1 found 'Eco-labeling' to be the preferred MBI (0.047), followed by 'Subsidies' (0.033), 'Taxes and fees' (0.015), and finally 'PES' (0.011).

For the 'Compatibility' criterion (0.099), Participant #1 found 'Eco-labeling' to be the most apt MBI (0.059), followed by 'Taxes and fees' (0.020), 'Subsidies' (0.012), and lastly 'PES' (0.008).

Within the 'Economy' criterion (0.060), Participant #1 judged 'Subsidies' to be the most apt MBI (0.030), followed by 'Eco-labeling' (0.017), 'PES' (0.011) and then 'Taxes and fees' (0.003).

In sum, this respondent produced a variety of priority scores for different MBIs depending on criteria context.

## INDIVIDUAL #2

### Criteria rankings (sum of scores is equal to 1.000)

Participant #2 found 'Environment' to be the most important criterion, with a priority score of 0.463. Next followed 'Economy' (0.287) and 'Equity' (0.127). Participant #2 ranked 'Compatibility' (0.066) and 'Feasibility' (0.057) as the least important criteria.

### MBI rankings (sum of scores is equal to 1.000)

For the 'Environment' criterion (0.463), Participant #2 judged 'Payments for Ecosystem Services' to be the likeliest MBI (0.235), followed by 'Subsidies' (0.122), 'Taxes and fees' (0.066) and finally 'Eco-labeling' (0.040).

Within the 'Economy' criterion (0.287), Participant #2 thought that 'PES' was the most apt MBI (0.122), followed by 'Taxes and fees' and 'Subsidies' (each with 0.065) and lastly 'Eco-labeling' (0.035).

For the 'Equity' criterion (0.127), Participant #2 found 'PES' to be their preferred MBI (0.062), followed by 'Subsidies' (0.039), 'Eco-labeling' (0.016), and finally 'Taxes and fees' (0.010).

Within the 'Compatibility' criterion, Participant #2 preferred the 'Subsidies' MBI, with a score of 0.028, followed by 'Taxes and fees' (0.018), 'Eco-labeling' (0.011), and 'PES' (0.008).

For the 'Feasibility' criterion (0.057), Participant #2 preferred the 'Taxes and fees' MBI (0.027), followed by 'Subsidies' (0.015), 'PES' (0.008), and 'Eco-labeling' (0.007).

As with Participant #1, this respondent exhibited differing priority scores for each MBI, depending upon the context of the criterion.

### INDIVIDUAL #3

#### Criteria rankings (sum of scores is equal to 1.000)

Participant #3 found 'Environment' to be the most important criterion, with a priority score of 0.271. Close behind followed 'Equity' (0.252), 'Feasibility' (0.190), and 'Compatibility' (0.188). Participant #3 ranked 'Economy' as the least important criterion, with a score of 0.099.

#### MBI rankings (sum of scores is equal to 1.000)

Within the 'Environment' criterion (0.271), Participant #3 judged 'PES' to be the preferred MBI, with a global priority score of 0.138. This was followed by 'Eco-labeling' (0.053), 'Subsidies' (0.043), and 'Taxes and fees' (0.038).

For the nearly equally important 'Equity' criterion (0.252), Participant #3 thought 'PES' (0.113) to be the most apt, followed by 'Taxes and fees' (0.080), 'Subsidies' (0.039), and lastly 'Eco-labeling' (0.019).

Within the 'Feasibility' criterion (0.190), Participant #3 preferred the 'PES' instrument (0.074), followed by 'Taxes and fees' (0.060), 'Eco-labeling' (0.033), and 'Subsidies' (0.023).

For the 'Compatibility' criterion (0.188) that followed close behind, Participant #3 preferred the 'PES' MBI (0.081), followed by 'Taxes and fees' (0.061), 'Subsidies' (0.030), and 'Eco-labeling' (0.016).

For the least important criterion of 'Economy' (0.099), Participant #3 thought 'PES' (0.040) to be the most likely MBI for success, followed by 'Taxes and fees' (0.026), 'Eco-labeling' (0.022), and 'Subsidies' (0.011).

Participant #3 always found 'Payments for Ecosystem Services' to be the most apt MBI, regardless of criterion context. Other MBIs held consistent rankings across criterion categories as well.

#### INDIVIDUAL #4

##### Criteria rankings (sum of scores is equal to 1.000)

Participant #4 found 'Environment' to be the most important criterion, with a priority score of 0.489. Next followed 'Economy' (0.243) and 'Equity' (0.136). Participant #4 ranked 'Compatibility' (0.068) and 'Feasibility' (0.064) as the least important criteria.

##### MBI rankings (sum of scores is equal to 1.000)

Within the 'Environment' criterion (0.489), Participant #4 thought 'Payments for Ecosystem Services' (0.307) as the MBI with greatest success potential, followed by 'Subsidies' (0.093), 'Taxes and fees' (0.061), and 'Eco-labeling' (0.028).

For the 'Economy' criterion (0.243), Participant #4 preferred 'PES' (0.145), then 'Subsidies' (0.046), 'Taxes and fees' (0.030), and 'Eco-labeling' (0.014).

Within the 'Equity' criterion (0.136), Participant #4 preferred 'PES' (0.073), followed by 'Taxes and fees' (0.033), 'Subsidies' (0.020), and finally 'Eco-labeling' (0.010).

For the 'Compatibility' criterion (0.068), Participant #4 thought 'PES' (0.036) to be most useful, followed by 'Subsidies' (0.016), 'Taxes and fees' (0.010), and lastly 'Eco-labeling' (0.006).

Within the closely-following 'Feasibility' criterion (0.064), Participant #4 ranked 'PES' (0.030) as the most likely MBI, followed by 'Subsidies' (0.015), 'Taxes and fees' (0.013), and lastly 'Eco-labeling' (0.006).

For this respondent, the MBI rankings were practically identical in all scenarios, regardless of the criterion context. 'PES' was always the preferred market instrument, and 'Eco-labeling' was always the least preferred.

## INDIVIDUAL #5

### Criteria rankings (sum of scores is equal to 1.000)

Participant #5 found 'Environment' to be the most important criterion, with a priority score of 0.377. Next followed 'Economy' (0.311) and 'Equity' (0.191). Participant #5 ranked 'Feasibility' (0.079) and 'Compatibility' as the least important criteria.

### MBI rankings (sum of scores is equal to 1.000)

For the 'Environment' criterion (priority score of 0.377), Participant #5 preferred 'Taxes and fees' (0.178) as the best MBI, followed by 'Subsidies' (0.097), 'PES' (0.062), and then 'Eco-labeling' (0.041).

Within the 'Economy' criterion (0.311), Participant #5 preferred 'Taxes and fees' (0.147), followed by 'Subsidies' (0.080), 'PES' (0.051), and lastly 'Eco-labeling' (0.034).

For the 'Equity' criterion (0.191), Participant #5 found 'PES' (0.089) to be the most appropriate MBI, followed by 'Eco-labeling' (0.053), 'Taxes and fees' (0.031), and finally 'Subsidies' (0.018).

Within the 'Feasibility' criterion (0.079), Participant #5 thought 'Taxes and fees' (0.037) to be the most apt MBI, followed by 'Subsidies' (0.020), 'Eco-labeling' (0.013), and 'PES' (0.009).

Lastly, for the 'Compatibility' criterion (0.042), Participant #5 preferred 'Taxes and fees' (0.019), followed by 'PES' (0.013), 'Eco-labeling' (0.007), and 'Subsidies' (0.004).

Respondent #5 had some variety in MBI rankings depending on the criterion, but generally preferred 'Taxes and fees' as an MBI, regardless of context.

## INDIVIDUAL #6

### Criteria rankings (sum of scores is equal to 1.000)

Participant #6 found 'Compatibility' to be the most important criterion, with a priority score of 0.282. This was closely followed by 'Economy' (0.278), 'Environment' (0.227), and 'Equity' (0.153). Participant #6 ranked 'Feasibility' as the least important criterion, with a score of 0.061.

### MBI rankings (sum of scores is equal to 1.000)

For the 'Compatibility' criterion (0.282), Participant #6 preferred 'Taxes and fees' (0.172) over the other MBI options. Then followed 'Eco-labeling' (0.051), 'Subsidies' (0.039), and finally 'PES' (0.020).

For the nearly equally important 'Economy' criterion (0.278), Participant #6 preferred 'Eco-labeling' (0.142), followed by 'PES' (0.078), 'Subsidies' (0.037), and lastly 'Taxes and fees' (0.021).

Within the 'Environment' criterion (0.227), Participant #6 thought 'PES' (0.143) was the most satisfactory MBI by far, followed by 'Eco-labeling' (0.047), 'Subsidies' (0.022), and then 'Taxes and fees' (0.015).

For the 'Equity' criterion (0.153), Participant #6 again regarded 'PES' (0.100) as the likeliest MBI, followed by 'Taxes and fees' (0.027), 'Eco-labeling' (0.013), and 'Subsidies' (0.012).

Lastly, for the 'Feasibility' criterion (0.061), Participant #6 preferred the 'Taxes and fees' MBI (0.037), followed by 'Subsidies' (0.011), 'Eco-labeling' (0.010), and 'PES' (0.003).

The variety in this respondent's rankings of MBIs seem to indicate a belief in the appropriateness of 'Payments for Ecosystem Services' for promoting environmental protection and social equity, but at the same time the respondent indicates that approaches like 'Taxes and fees' are more feasible and compatible with existing policy approaches.

## INDIVIDUAL #7

### Criteria rankings (sum of scores is equal to 1.000)

Participant #7 found 'Environment' to be the most important criterion, with a priority score of 0.467. Next followed 'Economy' (0.238) and 'Feasibility' (0.144). Participant #7 ranked 'Equity' (0.086) and 'Compatibility' (0.066) as the least important criteria.

### MBI rankings (sum of scores is equal to 1.000)

For the 'Environment' criterion, Participant #7 rated 'PES' (0.248) as the most apt MBI, followed by 'Subsidies' (0.111), 'Taxes and fees' (0.066), and 'Eco-labeling' (0.042).

Within 'Economy', Participant #7 preferred 'Taxes and fees' (0.112), then 'Subsidies' (0.067), 'PES' (0.038), and 'Eco-labeling' (0.021).

For 'Feasibility' (0.144), Participant #7 preferred 'PES' (0.065), then 'Taxes and fees' (0.038), 'Subsidies' (0.024), and 'Eco-labeling' (0.017).

Within 'Equity' (0.086), Participant #7 found 'PES' (0.044) to be the likeliest MBI, followed by 'Taxes and fees' (0.019), 'Subsidies' (0.014), and 'Eco-labeling' (0.009).

Lastly, for 'Compatibility' (0.066), Participant #7 preferred 'PES' (0.031), 'Taxes and fees' (0.017), 'Subsidies' (0.012), and finally 'Eco-labeling' (0.006).

This respondent's results do not exhibit a great variety in MBI rankings; s/he almost always believes 'PES' to be the most apt market instrument, and always rates Eco-labeling' as the least appropriate policy tool.



## INDIVIDUAL #8

### Criteria rankings (sum of scores is equal to 1.000)

Participant #8 found 'Environment' to be the most important criterion by a very wide margin, with a priority score of 0.601. Next followed 'Compatibility' (0.121) and 'Feasibility' and 'Equity' (each with 0.100). Participant #8 ranked 'Economy' as the least important criterion, with a score of 0.078.

### MBI rankings (sum of scores is equal to 1.000)

For the criterion of extreme importance ('Environment', 0.601), Participant #8 believed 'PES' (0.349) to be the most relevant MBI by far. 'Taxes and fees' earned a score of 0.153, followed by 'Subsidies' (0.069) and 'Eco-labeling' (0.030).

Within the 'Compatibility' criterion (0.121), Participant #8 preferred 'PES' (0.068), followed by 'Eco-labeling' (0.032), 'Subsidies' (0.014), and lastly 'Taxes and fees' (0.007).

For the 'Feasibility' criterion (0.100), Participant #8 preferred 'Taxes and fees' (0.057), 'Eco-labeling' (0.026), and then 'Subsidies' (0.009) and 'PES' (0.008).

Within 'Equity' (also with a score of 0.100), Participant #8 preferred 'Eco-labeling' (0.040), followed by 'PES' (0.034), 'Subsidies' (0.015), and 'Taxes and fees' (0.011).

Lastly, for 'Economy' (0.078), Participant #8 preferred 'Taxes and fees' (0.042), followed by 'Eco-labeling' (0.021), 'PES' (0.011), and finally 'Subsidies' (0.004).

This respondent exhibited a wide variety of MBI preferences across the different criteria contexts.

## INDIVIDUAL #9

### Criteria rankings (sum of scores is equal to 1.000)

Participant #9 found 'Equity' to be the most important criterion, with a priority score of 0.273. This was closely followed by 'Environment' (0.263) and 'Economy' (0.253), and then 'Compatibility' (0.132). Participant #9 ranked 'Feasibility' as the least important criterion, with a score of 0.080.

### MBI rankings (sum of scores is equal to 1.000)

Within 'Equity' (0.273), Participant #9 found 'PES' (0.112) to be the best MBI, followed by 'Subsidies' (0.093), 'Taxes and fees' (0.037), and 'Eco-labeling' (0.031).

For the close runner-up criterion, 'Environment' (0.263), Participant #9 considered 'Taxes and fees' (0.129) to be the most appropriate MBI, followed by 'Subsidies' (0.061), 'Eco-labeling' (0.043), and finally 'PES' (0.031).

For the 'Economy' criterion (0.253), Participant #9 preferred 'Taxes and fees' (0.148) by far, followed by 'Eco-labeling' (0.057), 'PES' (0.028), and 'Subsidies' (0.020).

Within the 'Compatibility' criterion (0.132), Participant #9 found 'Taxes and fees' (0.067) to be the likeliest MBI, followed by 'Subsidies' (0.032), 'PES' (0.020), and lastly 'Eco-labeling' (0.012).

For 'Feasibility' (0.080), Participant #9 preferred 'Taxes and fees' (0.044), then 'Subsidies' (0.019), 'Eco-labeling' (0.010), and finally 'PES' (0.007).

This respondent had a notably even spread in priority scores across his/her top three criteria. This contributed to the comparable global priority scores for the MBIs in all criterion categories. This is one of only two respondents from the workshop for whom the MBI with the greatest global priority score ('Taxes and fees' under 'Economy', with a score of 0.148) does not occur within the context of the criterion with highest priority value ('Equity', with a score of 0.273).

## INDIVIDUAL #10

### Criteria rankings (sum of scores is equal to 1.000)

Participant #10 found 'Equity' to be the most important criterion, with a priority score of 0.281, followed closely by 'Compatibility' (.262) and 'Feasibility' (0.238). Participant #10 found 'Environment' (0.121) and 'Economy' (0.098) to be of least importance.

### MBI rankings (sum of scores is equal to 1.000)

Within the 'Equity' criterion (0.281), Participant #10 considered 'Subsidies' (0.093) to be the most important MBI, followed by 'PES' (0.080), 'Eco-labeling' (0.073), and lastly 'Taxes and fees' (0.034).

For the 'Compatibility' criterion (0.262), Participant #10 found 'Eco-labeling' (0.111) to be the most apt MBI, followed by 'Taxes and fees' (0.071), 'Subsidies' (0.042), and then 'PES' (0.038).

Within the 'Feasibility' criterion (0.238), Participant #10 preferred 'Taxes and fees' (0.092), followed by 'PES' (0.058), 'Eco-labeling' (0.049), and 'Subsidies' (0.040).

For the 'Environment' criterion (0.121), Participant #10 preferred 'PES' (0.044), followed by 'Taxes and fees' (0.038), 'Eco-labeling' (0.024), and 'Subsidies' (0.015).

Finally, for the 'Economy' criterion (0.098), Participant #10 found 'PES', 'Taxes and fees', and 'Eco-labeling' equally preferable (each with a score of 0.029), with 'Subsidies' earning a score of 0.010.

Similar to Respondent #9, this respondent had a fairly even spread in priority scores among the top three ranked criteria. This partly accounts for the comparable global priority scores for MBIs across all criteria categories. Additionally, the top-ranked MBI overall ('Eco-labeling' within 'Compatibility', with a global priority score of 0.111), does not occur in the context of the criterion with the highest priority value ('Equity', 0.281).

## AGGREGATE RESULTS

Combining individual results from all 10 respondents allowed for an overall summary of priority scores for the entire workshop. This was accomplished by taking the geometric mean of all individual results. The geometric mean approach is the mathematically preferred method for aggregating scores in studies using the analytic hierarchy process (Xu, 2000).

### Criteria rankings (sum of scores is equal to 1.000)

As a group, the national stakeholders found “Environment” to be the most important criterion by a wide margin, with a priority score of 0.384. ‘Equity’ and ‘Economy’ had the next highest priorities scores of 0.192 and 0.187, respectively. Finally, ‘Compatibility’ (0.124) and ‘Feasibility’ (0.113) were the lowest-ranked criteria.

### MBI rankings (sum of scores is equal to 1.000)

Within the ‘Environment’ criterion, the group considered ‘Payments for Ecosystem Services’ to be the most viable option for success, with a global priority score of 0.174. Next followed ‘Subsidies’ (0.079), ‘Taxes and fees’ (0.078), and finally ‘Eco-labeling’ (0.053).

For the ‘Equity’ criterion (0.192), the group found ‘PES’ to be the preferred MBI, with a global priority score of 0.094. ‘Subsidies’ (0.036), ‘Taxes and fees’ (0.031), and ‘Eco-labeling’ (0.031) all had similar global priority scores.

With respect to the ‘Economy’ criterion (0.187), the national group preferred ‘PES’ and ‘Taxes and fees’ (each with a score of 0.054) to either ‘Eco-labeling’ (0.042) or ‘Subsidies’ (0.037).

For ‘Compatibility’ (0.124), national stakeholders again preferred ‘Taxes and fees’ (0.039) and ‘PES’ (0.034) to either ‘Eco-labeling’ or ‘Subsidies’ (each scoring 0.026).

Lastly, for the 'Feasibility' criterion, the group found 'Taxes and fees' (0.047) to be the most apt market instrument for success, followed by 'Subsidies' (0.024), 'Eco-labeling' (0.022), and 'PES' (0.020).

On a national scale, both 'PES' and 'Taxes and fees' seem to be viable options for conservation market-based instruments. National stakeholders appear to be less optimistic about the success potential of subsidies or eco-labeling and certification schemes. However, the spread of scores for the aggregate data was not large. Only in the top two ranked criteria ('Environment' and 'Equity') was there overwhelming support for one MBI over the others; in both contexts the preferred MBI was 'PES'.

Complete individual and aggregate results are presented in Table 4.1 on the following page. These results are also graphically represented in Figure 4.2 on the subsequent page.

Table 4.1: Kigali, November 4<sup>th</sup> - Priority scores for criteria and MBIs, indicating the importance of each criterion or MBI relative to the others. Priority scores shown for the MBIs are **global** priority scores (which are weighted in accordance with the relative importance of the applicable criterion category).

CRITERIA	Ind. #1	Ind. #2	Ind. #3	Ind. #4	Ind. #5	Ind. #6	Ind. #7	Ind. #8	Ind. #9	Ind. #10	Aggregate (geo. mean)
<b>Environment</b>	<b>0.490</b>	<b>0.463</b>	<b>0.271</b>	<b>0.489</b>	<b>0.377</b>	<b>0.227</b>	<b>0.467</b>	<b>0.601</b>	<b>0.263</b>	<b>0.121</b>	<b>0.384</b>
PES	0.226	0.235	0.138	0.307	0.062	0.143	0.248	0.349	0.031	0.044	0.174
Taxes and fees	0.038	0.066	0.038	0.061	0.178	0.015	0.066	0.153	0.129	0.038	0.078
Subsidies	0.113	0.122	0.043	0.093	0.097	0.022	0.111	0.069	0.061	0.015	0.079
Eco-labeling	0.113	0.040	0.053	0.028	0.041	0.047	0.042	0.030	0.043	0.024	0.053
<b>Economic</b>	<b>0.060</b>	<b>0.287</b>	<b>0.099</b>	<b>0.243</b>	<b>0.311</b>	<b>0.278</b>	<b>0.238</b>	<b>0.078</b>	<b>0.253</b>	<b>0.098</b>	<b>0.187</b>
PES	0.011	0.122	0.040	0.145	0.051	0.078	0.038	0.011	0.028	0.029	0.054
Taxes and fees	0.003	0.065	0.026	0.030	0.147	0.021	0.112	0.042	0.148	0.029	0.054
Subsidies	0.030	0.065	0.011	0.046	0.080	0.037	0.067	0.004	0.020	0.010	0.037
Eco-labeling	0.017	0.035	0.022	0.014	0.034	0.142	0.021	0.021	0.057	0.029	0.042
<b>Feasibility</b>	<b>0.106</b>	<b>0.057</b>	<b>0.190</b>	<b>0.064</b>	<b>0.079</b>	<b>0.061</b>	<b>0.144</b>	<b>0.100</b>	<b>0.080</b>	<b>0.238</b>	<b>0.113</b>
PES	0.011	0.008	0.074	0.030	0.009	0.003	0.065	0.008	0.007	0.058	0.020
Taxes and fees	0.015	0.027	0.060	0.013	0.037	0.037	0.038	0.057	0.044	0.092	0.047
Subsidies	0.033	0.015	0.023	0.015	0.020	0.011	0.024	0.009	0.019	0.040	0.024
Eco-labeling	0.047	0.007	0.033	0.006	0.013	0.010	0.017	0.026	0.010	0.049	0.022
<b>Equity</b>	<b>0.245</b>	<b>0.127</b>	<b>0.252</b>	<b>0.136</b>	<b>0.191</b>	<b>0.153</b>	<b>0.086</b>	<b>0.100</b>	<b>0.273</b>	<b>0.281</b>	<b>0.192</b>
PES	0.119	0.062	0.113	0.073	0.089	0.100	0.044	0.034	0.112	0.080	0.094
Taxes and fees	0.017	0.010	0.080	0.033	0.031	0.027	0.019	0.011	0.037	0.034	0.031
Subsidies	0.037	0.039	0.039	0.020	0.018	0.012	0.014	0.015	0.093	0.093	0.036
Eco-labeling	0.073	0.016	0.019	0.010	0.053	0.013	0.009	0.040	0.031	0.073	0.031
<b>Compatibility</b>	<b>0.099</b>	<b>0.066</b>	<b>0.188</b>	<b>0.068</b>	<b>0.042</b>	<b>0.282</b>	<b>0.066</b>	<b>0.121</b>	<b>0.132</b>	<b>0.262</b>	<b>0.124</b>
PES	0.008	0.010	0.081	0.036	0.013	0.020	0.031	0.068	0.020	0.038	0.034
Taxes and fees	0.020	0.018	0.061	0.010	0.019	0.172	0.017	0.007	0.067	0.071	0.039
Subsidies	0.012	0.028	0.030	0.016	0.004	0.039	0.012	0.014	0.032	0.042	0.026
Eco-labeling	0.059	0.011	0.016	0.006	0.007	0.051	0.006	0.032	0.012	0.111	0.026

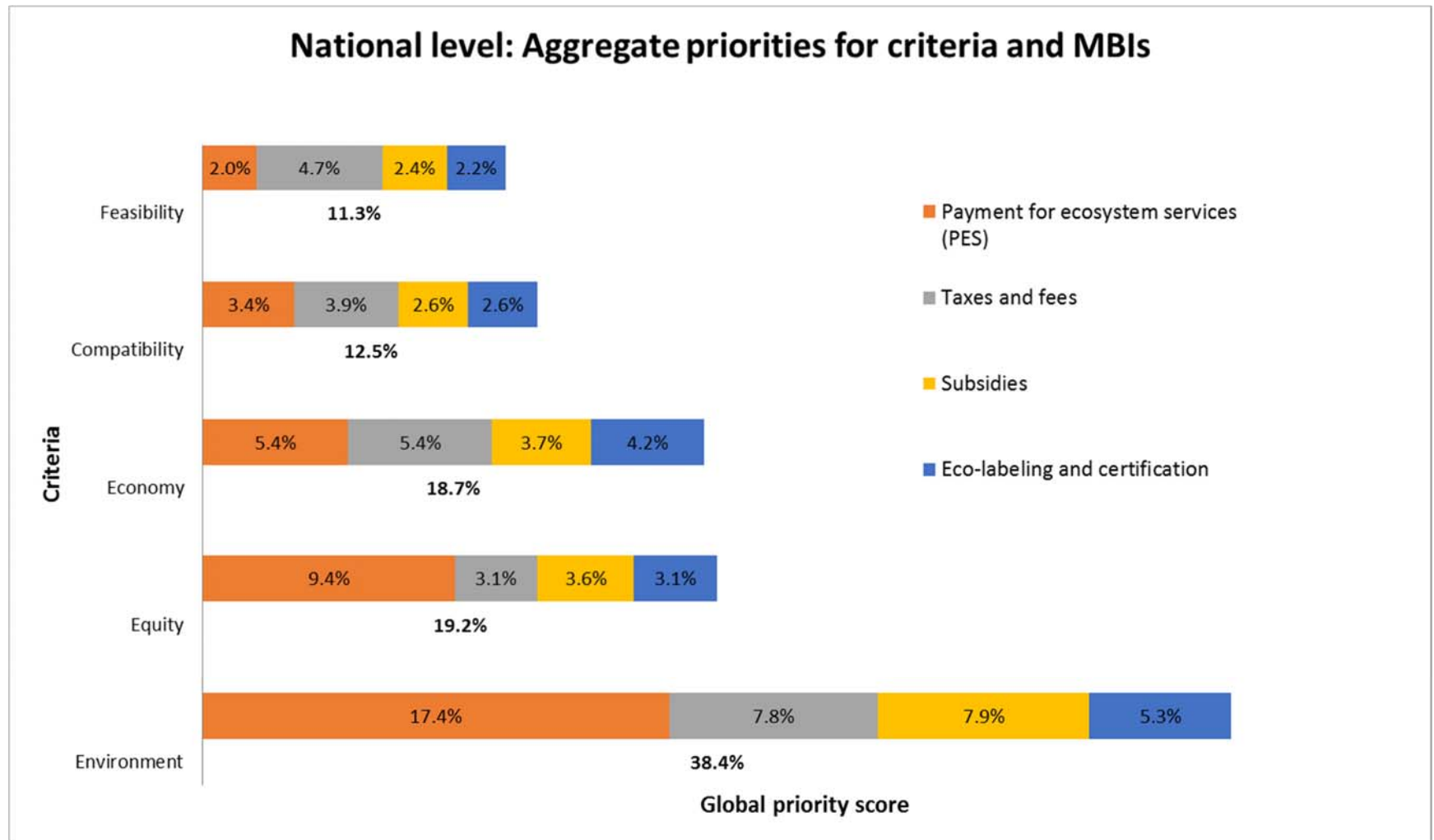


Figure 4.2: From the national workshop - global priority scores for each criterion are shown underneath the global priority scores for each MBI within the criterion category. The aggregate opinion of our national-level stakeholders is that Environment is the most important consideration for conservation MBIs, and that PES is the MBI type that is most apt to deliver positive environmental results.

## **Conclusions**

In summary, results indicate that, at the national level, stakeholders are on average more concerned about the environmental efficacy of market-based conservation instruments than any other criterion. Additionally, payments for ecosystem services is the most popular tool in this ex-ante evaluation, especially within the context of environment and equity criteria. Taxes and fees follow in popularity, which perhaps makes sense given Rwanda's developed infrastructure and capacity to absorb administrative costs.

Anecdotal evidence can help explain the low rank of the compatibility and feasibility criteria in particular. On several occasions during the presentation and group discussion, stakeholders pointed out that they did not believe a policy tool would ever be discussed formally (as if for design/implementation) if it were not already feasible (transaction costs, financing, etc) and compatible with existing laws and infrastructure. In this way, the inclusion of the feasibility and compatibility criteria was perhaps a mistake of this study, since respondents saw those criteria as prerequisites, not as optional targets.

The results from the national-level workshop mirror the results from the regional focus groups with agricultural cooperatives, pointing toward environmentally-focused PES schemes as policy instruments with great potential for participation and success within Rwanda.

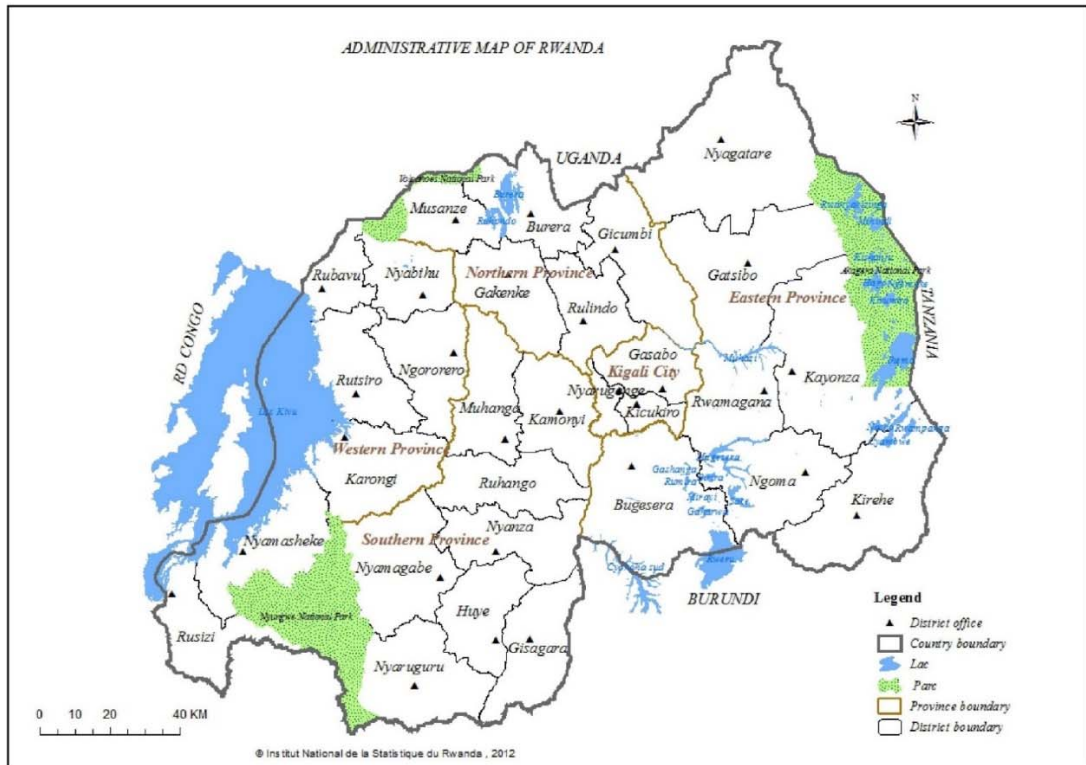


## APPENDICES

### Appendix A – The Rwandan context



Rwanda is a small country of Central East Africa located at the center of the Albertine Rift, which stretches from the Lake Albert (northern Uganda) through the Lake Tanganyika (northern Zambia) watersheds. *(Image source: University of Florida libraries)*



Rwanda has three national protected areas, designated here in green. Nyungwe National Park (southwest) is a highly biodiverse afro-montane forest situated near Lake Kivu and near Rwanda's borders with the DRC and Burundi. (Image source: National Institute of Statistics of Rwanda)



Rusizi District, in southwestern Rwanda, shares borders with both Burundi and the Democratic Republic of the Congo. Nyungwe National Park is highlighted in green on the east side of the map, and Lake Kivu is shown to the north. (Image source: National Institute of Statistics of Rwanda)



Nyamasheke District, in southwestern Rwanda, runs along Lake Kivu, which forms part of the country's western border with the Democratic Republic of the Congo. Nyungwe National Park is highlighted in green on the southeast portion of the map. (Image source: National Institute of Statistics of Rwanda)

## Appendix B – Cookstove survey (English)

Village  
Cell  
Sector  
Surveyor's name  
Interview date  
Interview start time  
Interview end time

### 1. HOUSEHOLD CHARACTERISTICS

#### 1.1 Basic household information

Income category of HH  
Total number of HH members  
How much land do you own (hectares)?

How much land do you use (hectares)? (including all the land you own and all the land you rent)

Name	Age	Gender	Education (class)	Off-farm employment?	Name of off-farm employer or industry	Average annual income from off-farm employment (RwF)
Head of HH		M/F		Y/N		
2		M/F		Y/N		
3		M/F		Y/N		
4		M/F		Y/N		
5		M/F		Y/N		
6		M/F		Y/N		
7		M/F		Y/N		
8		M/F		Y/N		
9		M/F		Y/N		
10		M/F		Y/N		
11		M/F		Y/N		
12		M/F		Y/N		
13		M/F		Y/N		
14		M/F		Y/N		
15		M/F		Y/N		

#### 1.2 Household livestock

Does your household own livestock?  
Does your household keep livestock for others?

Type of livestock	How many animals of this type do you own?	How many animals of this type are you keeping for others?
Cattle		
Goats		
Pigs		
Sheep		
Chickens		
Rabbits		
Guinea pigs		
Other (explain)		

#### 1.3 Household woodlot

Does your household own a woodlot?  
If yes, how many hectares?  
If no, where do you get fuelwood?

What types of trees grow in your woodlot?	How many trees of each type exist in the lot?	How many trees of each type are ready for harvest?	Of the trees ready for harvest, how long ago were they planted?
species			
species			
species			
species			
species			

Does your woodlot supply enough fuelwood for your HH needs?  
If your woodlot does not supply all the fuelwood that your HH needs, where do you get additional fuelwood? (For example, from your agroforestry land, or from your neighbour's woodlot, or purchased at a market)

1.4 Household health

In the past year, has any household member experienced these ailments?

	# of people	Name(s)
Headache		
Sore eyes		
Coughing		
Shortness of breath		
Wheezing		
Dizziness		

2. HOUSEHOLD COOKING AND FUEL

Enumerators, please give a general sketch of the home, including the location of the kitchen, stove(s), and external doors and windows

door =

window =

traditional 3 stones =

ICS =

charcoal stove =

Enumerators, does the kitchen have adequate space for smoke to escape? Y/N

What kind of cooking stove do you use in your household? (check all that apply):

Traditional 3 stones	<input type="checkbox"/>
ICS - canarumwe	<input type="checkbox"/>
ICS - canamake	<input type="checkbox"/>
Charcoal stove	<input type="checkbox"/>
Other (explain):	<input type="text"/>

Do you always cook in the same area of the house? Y/N

If not, please explain the variation:

Do you always use the same type of stove? Y/N

If not, please explain the variation:

Who is usually responsible for cooking in the HH?

Do other HH members help with cooking? Y/N

How many adults help? (#)

How many children help? (#)

For how many people does your HH usually cook?

During an average day, how many meals do you cook?

	Morning	Midday	Evening
During an average day, what is the main meal during these times?	<input style="width: 100%;" type="text"/>	<input style="width: 100%;" type="text"/>	<input style="width: 100%;" type="text"/>

At these times of day, what stove type do you use? (check all that apply):

Traditional 3 stones	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
ICS - canarumwe	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
ICS - canamake	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Charcoal stove	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other (explain):	<input type="text"/>	<input type="text"/>	<input type="text"/>

At these times of day, what are the approximate start and end times of cooking for each stove type?

	Morning		Midday		Evening	
	Start	End	Start	End	Start	End
Traditional 3 stones	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
ICS - canarumwe	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
ICS - canamake	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Charcoal stove	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Other (explain):	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

What is your primary source of fuel?	
What is your preferred source of fuel?	
	Why is this your primary source of fuel? (check any that apply):
	Why is this your preferred source of fuel? (check any that apply):
Cost	
Availability	
Fuel efficiency	
Clean-burning	
Tradition	
Other (explain):	
How much of your primary source of fuel do you use in an average day (approximate kgs)	
In an average week, who is mainly responsible for collecting fuelwood?	
In an average week, which other HH members assist in collecting fuelwood?	
In an average week, how many times does your HH collect fuelwood?	
On average, how much time is spent collecting wood during each trip?	
In an average week, how much is used to purchase cooking fuel for your HH?	
Branches	
Fuelwood	
Charcoal	

**3. IMPROVED COOKSTOVE PERCEPTION AND SATISFACTION**

Have you ever purchased an improved cookstove or received one through an improved cookstove promotion program? (check any that apply):

Purchased	
What type?	
When?	
From where?	
For what price?	
Received	
What type?	
When?	
From what organisation?	
Never purchased or received	

**if you check "never purchased or received", please go directly to the last question of the survey**

How did you hear about the improved cookstove promotion program? (check one):

Neighbour	
Family member	
Friend	
Park staff	
Government	
Other (please explain):	

Which of the following options most closely match your reasons for adopting an improved cookstove? (check all that apply):

The stove was free of charge	
Respiratory health of the HH	
Money saved by using less fuelwood	
Time saved by collecting less fuelwood	
Time saved from reduced cooking time	
Other (please explain):	

When cooking, what percentage of the time do you use your improved cookstove compared to other cooking methods? (check one):

Always use the improved stove	
Use the improved stove most of the time	
Use the improved stove 50% of the time	
Use the improved stove rarely	
Never use the improved stove	

Please rate your improved cookstove based on its durability:

ICS model (fill in the type)	Type A:	Type B:	Type C:	Type D:
Highly dissatisfied				
Dissatisfied				
Neither satisfied nor dissatisfied				
Satisfied				
Highly satisfied				
Please briefly explain why you are satisfied, dissatisfied, or ambivalent:				

Please rate your improved cookstove based on the amount of fuel saved in your HH:

ICS model (fill in the type)	Type A:	Type B:	Type C:	Type D:
Highly dissatisfied				
Dissatisfied				
Neither satisfied nor dissatisfied				
Satisfied				
Highly satisfied				
Please briefly explain why you are satisfied, dissatisfied, or ambivalent:				

Please rate your improved cookstove based on the amount of time saved in cooking for your HH:

ICS model (fill in the type)	Type A:	Type B:	Type C:	Type D:
Highly dissatisfied				
Dissatisfied				
Neither satisfied nor dissatisfied				
Satisfied				
Highly satisfied				
Please briefly explain why you are satisfied, dissatisfied, or ambivalent:				

Please rate how pleased or displeased you are with the amount of smoke produced by your improved cookstove:

ICS model (fill in the type)	Type A:	Type B:	Type C:	Type D:
Highly displeased				
Displeased				
Neither pleased nor displeased				
Pleased				
Highly pleased				
Please briefly explain why you are pleased, displeased, or ambivalent:				

Do you believe that your quality of life has improved, declined, or stayed the same since adopting the improved cookstove?

Please explain:

If you did not have an improved cookstove, would you purchase one?

Y/N

Would you recommend others to purchase an improved cookstove?

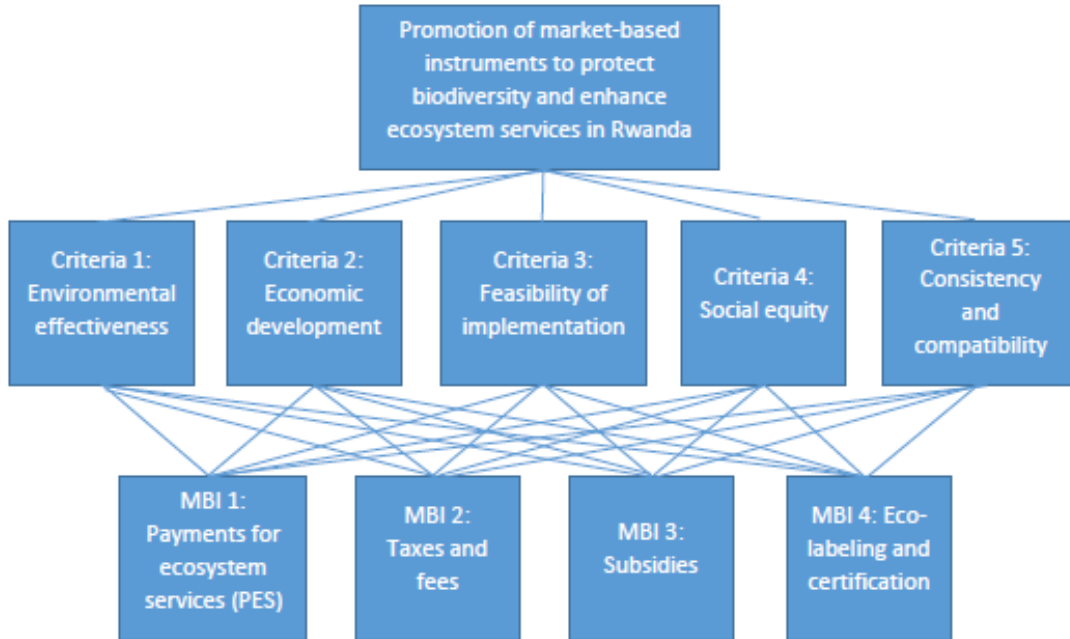
Y/N

Is there a stove type that you would like to own (for example, a stove type that your neighbour has)?

What type is it, and why would you like it?

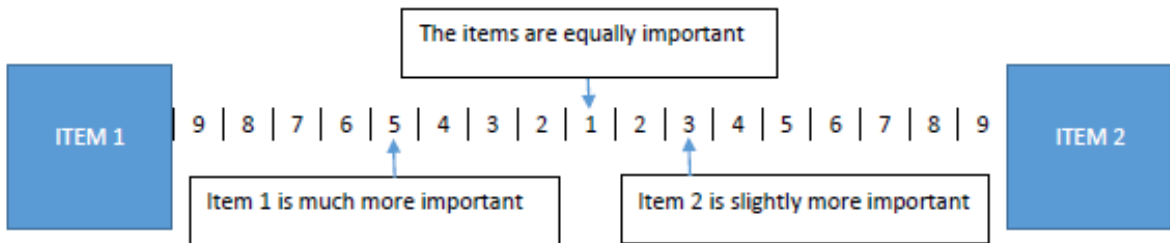


Appendix C – MCA-AHP summary and individual survey from national-level workshop



Scale for pairwise comparisons

Numerical values	Scale and meaning
1	Equal importance of both items
3	Moderate importance of one item over another
5	Strong importance of one item over another
7	Very strong importance of one item over another
9	Extreme importance of one item over another
2, 4, 6, 8	Intermediate values



### Compare criteria

For each comparison, circle the number on the scale that represents how important you feel that one criterion is over another, with respect to the overall goal:

Environmental effectiveness	9   8   7   6   5   4   3   2   1   2   3   4   5   6   7   8   9	Economic development
Environmental effectiveness	9   8   7   6   5   4   3   2   1   2   3   4   5   6   7   8   9	Feasibility of implementation
Environmental effectiveness	9   8   7   6   5   4   3   2   1   2   3   4   5   6   7   8   9	Social equity
Environmental effectiveness	9   8   7   6   5   4   3   2   1   2   3   4   5   6   7   8   9	Consistency/compatibility
Economic development	9   8   7   6   5   4   3   2   1   2   3   4   5   6   7   8   9	Feasibility of implementation
Economic development	9   8   7   6   5   4   3   2   1   2   3   4   5   6   7   8   9	Social equity
Economic development	9   8   7   6   5   4   3   2   1   2   3   4   5   6   7   8   9	Consistency/compatibility
Feasibility of implementation	9   8   7   6   5   4   3   2   1   2   3   4   5   6   7   8   9	Social equity
Feasibility of implementation	9   8   7   6   5   4   3   2   1   2   3   4   5   6   7   8   9	Consistency/compatibility
Social equity	9   8   7   6   5   4   3   2   1   2   3   4   5   6   7   8   9	Consistency/compatibility

---

Compare market-based instruments for Environmental Effectiveness

For each comparison, circle the number on the scale that represents how well you believe one MBI satisfies the criterion of Environmental Effectiveness versus the other MBI:

Payments for ecosystem services (PES) | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Taxes and fees

Payments for ecosystem services (PES) | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Subsidies

Payments for ecosystem services (PES) | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Eco-labeling and certification

Taxes and fees | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Subsidies

Taxes and fees | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Eco-labeling and certification

Subsidies | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Eco-labeling and certification

Compare market-based instruments for Economic Development

For each comparison, circle the number on the scale that represents how well you believe one MBI satisfies the criterion of Economic Development versus the other MBI:

Payments for ecosystem services (PES) | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Taxes and fees

Payments for ecosystem services (PES) | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Subsidies

Payments for ecosystem services (PES) | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Eco-labeling and certification

Taxes and fees | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Subsidies

Taxes and fees | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Eco-labeling and certification

Subsidies | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Eco-labeling and certification

Compare market-based instruments for Feasibility of Implementation

For each comparison, circle the number on the scale that represents how well you believe one MBI satisfies the criterion of Feasibility of Implementation versus the other MBI:

Payments for ecosystem services (PES) | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Taxes and fees

Payments for ecosystem services (PES) | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Subsidies

Payments for ecosystem services (PES) | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Eco-labeling and certification

Taxes and fees | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Subsidies

Taxes and fees | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Eco-labeling and certification

Subsidies | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Eco-labeling and certification

### Compare market-based instruments for Social Equity

For each comparison, circle the number on the scale that represents how well you believe one MBI satisfies the criterion of Social Equity versus the other MBI:

Payments for ecosystem services (PES) | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Taxes and fees

Payments for ecosystem services (PES) | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Subsidies

Payments for ecosystem services (PES) | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Eco-labeling and certification

Taxes and fees | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Subsidies

Taxes and fees | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Eco-labeling and certification

Subsidies | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Eco-labeling and certification

Compare market-based instruments for Consistency/Compatibility

For each comparison, circle the number on the scale that represents how well you believe one MBI satisfies the criterion of Consistency/Compatibility versus the other MBI:

Payments for ecosystem services (PES)	9   8   7   6   5   4   3   2   1   2   3   4   5   6   7   8   9	Taxes and fees
Payments for ecosystem services (PES)	9   8   7   6   5   4   3   2   1   2   3   4   5   6   7   8   9	Subsidies
Payments for ecosystem services (PES)	9   8   7   6   5   4   3   2   1   2   3   4   5   6   7   8   9	Eco-labeling and certification
Taxes and fees	9   8   7   6   5   4   3   2   1   2   3   4   5   6   7   8   9	Subsidies
Taxes and fees	9   8   7   6   5   4   3   2   1   2   3   4   5   6   7   8   9	Eco-labeling and certification
Subsidies	9   8   7   6   5   4   3   2   1   2   3   4   5   6   7   8   9	Eco-labeling and certification

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