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# RELATIONSHIPS BETWEEN HOUSEHOLD RESOURCE DEPENDENCE, SOCIO-ECONOMIC FACTORS, AND LIVELIHOOD STRATEGIES: A CASE STUDY FROM BUSHBUCKRIDGE, SOUTH AFRICA

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4 August 2016




A dissertation submitted to the Faculty of Science, University of the Witwatersrand, Johannesburg, in fulfilment of the requirements for the degree of Masters of Science

# DECLARATION

I declare that this dissertation is my own, unaided work, unless otherwise noted within the text. It is being submitted for the Degree of Master of Science at the school of Animal, Plant and Environmental Sciences, University of the Witwatersrand, Johannesburg

This work has not been submitted for any previous degree or examination.



Fatima Hassen Ragie

Submitted to faculty on 4 August 2016

Supervisors:
Prof. Wayne Twine
Prof. Barend Erasmus

"Is it they who distribute the mercy of your *Rabb* (Lord)? It is We who have apportioned among them their livelihoods in the life of this world and have raised some of the above other in degrees (of rank) that they may employ one another in their (work). But the mercy of you Lord is better than whatever (wealth) they accumulate."

*The Noble Quraan, Chapter 43, Verse 32*

*For my mother Ayesha and my father Hassen who had the patience and courage to always support me and shoulder my troubles and work.*

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# ABSTRACT

Environmental income in rural socio-ecological systems consists of the monetary and non-monetary value derived by people from non-agricultural ecosystem goods and services that are sourced from wild or uncultivated natural systems. This environmental income forms an important part of rural households' diversified livelihood income portfolios and includes resources like fuelwood, herbs, fruits, game, medicinal plants and other materials that are used for clothing, shelter, arts and crafts. Rural households also depend on income from two other land-based income streams, crop farming and livestock husbandry, and off-farm activities income stream, which includes grants and wages, for both consumption and cash generation. While rural livelihoods are becoming increasingly reliant on off-farm income, land-based livelihood income streams (including environmental income) still play an important supplementary role, especially to satisfy subsistence needs.

Past studies in the developing world have quantified livelihood incomes and have often associated these income values to the socio-economic characteristics of households. However, neither do these studies examine the different livelihood income streams collectively as a portfolio, nor do they sufficiently account for and create understanding around the correlations within the suites of influencing factors. Livelihoods are often analysed using frameworks that are used to understand households' livelihood income portfolios, especially their environmental income dependencies, in relation to influencing factors. These frameworks can be useful tools to gain a quantitative understanding of households' livelihood income portfolios.

This study aimed to quantify and understand the contribution of environmental income to rural households as part of their diversified livelihood portfolios and relate these livelihood portfolios to household socio-economic characteristics and adopted livelihood strategies using the Sustainable Livelihoods Approach (SLA) framework. Interviews were conducted during 2010 in 590 households spread across nine villages in the Bushbuckridge region, Mpumalanga, South Africa. The interviews focussed on the quantification of four livelihood income streams — environmental, livestock, crops and off-farm. These income streams were assessed at three points of assessment (POAs) in the livelihood income chain — the initial, primary income value into the household, the value used for household consumption, and the amount of cash generated. Livelihood incomes were analysed using summary statistics, frequency distributions and ordinations. These were used to gauge the value of these incomes to individual households as well as to the system as a whole, in both absolute terms and relative to each other. Ordinations were then used to explore the relationships between variables within the suite of household socio-economic characteristics and within the suite of adopted household livelihood strategies, and finally incorporating both. Lastly, the proportional

environmental income dependencies of households were explored using global fractional logit generalised linear models (GLMs). The models first included the socio-economic characteristics as explanatory variables, and then the adopted livelihood strategies.

Almost all households used the environmental, crop and off-farm income streams for primary income and consumption, with the primary income from off-farm activities being in the form of cash generation. In contrast, less than 12% of households were involved in the primary collection and consumption of livestock income. In general, fewer households were involved in the cash generation from the land-based livelihood income streams. However, these sellers represented a larger fraction of users for the livestock income stream then when compared to the other two land-based income streams. While livestock income was used less frequently than the other two land-based income streams, it was comparatively as valuable as the off-farm income stream to its users. Overall, absolute changes in the correlated land-based income streams were not related to the off-farm income streams. Relative variation in livestock primary income was related to the relative variation in primary income values from off-farm activities. Relative variation in the crops and environmental cash generation was related to corresponding cash generation values from off-farm activities. Whether the livelihood incomes were examined for primary income, consumption or cash generation, the worth of the different livelihoods were valued differently to the socio-ecological system as a whole compared to their value to households that were involved in those activities, and their value to individuals within households.

The collective variations at all POAs of the land-based strategies were associated with different sets of household socio-economic characteristics and adopted livelihood strategies, compared to the sets that were associated with the off-farm livelihood income stream. Factors that were associated with an income stream at one POA did not necessarily have the same association at the other POAs. The choice of adopted livelihood strategies reduces the need to understand and account for all factors that influences the translation of different types of capital, which includes household socio-economic characteristics, into livelihood incomes. This simplified connection is crucial to standardising and creating models that can be put into practice at all POAs within the livelihood chain in these socio-ecological systems. Furthermore, proportional environmental income dependencies can be useful for evaluating how the worth of environmental income is related quantitatively to influencing factors. However, many of the dynamics between influencing factors and the income streams that contribute to environmental income stream are not captured.

The methodological approach used in this study in analysing the livelihoods of households in the Bushbuckridge region provides a standardised framework of analysis. The quantification of the

livelihood data in common monetary units at the three different POAs of primary income, household consumption and cash generation, allows the analysis to be expanded to different platforms of understanding. The collective understanding of the variation between the different income streams can be expanded to understand the worth of these income streams to households and individuals within these households, as well as to understand the worth of these income streams to the socio-ecological system as a whole. When combining the collective understanding of the income portfolios at the different POAs with a collective understanding of the suite of household socio-economic characteristics or with a collective understanding of the suite of adopted livelihood strategies, a platform for understanding the dynamics within livelihoods is created. This has potential for creating workable predictive models of environmental income dependency in these systems, especially using the adopted livelihood strategies. The results of this dissertation also raise caution that analyses of these socio-ecological systems needs to be interpreted at all POAs simultaneously with the collective understanding of the links between incomes and socio-economic characteristics, and with the links between incomes and adopted livelihood strategies.

There is more value during strategic planning in asking how to encourage a set of adopted livelihood strategies that are associated with the desired dependencies than asking which socio-economic household factors are likely to result in said dependencies. Policy intervention in the area that is aimed at increasing households' dependence on land-based activities needs to differentiate whether it will be encouraging the subsistence sourcing and consumption of resources, or will it encourage the cash generation from these income streams. Particular attention needs to be paid as to which households will be addressed. It will be wiser to implement some interventions across all households and rather focus other interventions on a few more involved households.

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# LIST OF DEFINITIONS

**Agricultural income** is the income derived from agro-ecosystems which are all agricultural lands including croplands, pastures, orchards and household cultivated plots (Cavendish 2000, Sjaastad et al. 2005, World Resources Institute et al. 2005). Agricultural income is divided into 'crop farming income' and 'livestock husbandry income'.

**Cash Generation POA** is the POA (Point of Assessment, see 'POAs' in this list of definitions) where cash income that was derived through the selling of land-based resources, or through grants and earnings from the off-farm livelihood income stream, is evaluated. Note: the cash-generation from the off-farm livelihood income stream is equivalent to its primary income value.

**Crop Income** is used in this dissertation to refer to the DUV of major crops (maize, bambara, groundnuts, peanuts, cowpeas, pumpkins and pumpkin leaves) harvested in household yards and agricultural plots in the surrounding lands and the cash income from selling these crops.

**Direct Use Values (DUVs)** are the monetary values given to resources that are part of households' livelihoods but have not been purchased and are calculated on the basis of how much it would cost a household to buy these land sourced resources if they were not collected, harvested or reared.

**Environmental income** is used in this dissertation to refer to the value derived — in cash sales or direct use — from non-agricultural ecosystem goods and services. This comprises of income derived from wild or uncultivated natural systems like forests, marine and inland fisheries, reefs, wetlands, grasslands and cultivated communal rangeland. Environmental income comes from the DUV and sales of **Environmental Products (EP),** which includes fuelwood, herbs, fruits, game, medicinal plants and other materials that are used for arts and crafts. EPs include non-commercially planted trees that are harvested for timber but exclude agricultural products and services. Based on: (Shackleton and Shackleton 2004, World Resources Institute et al. 2005, Babulo et al. 2008, Angelsen et al. 2014).

**Livelihoods** comprise of the capabilities, assets (including material and social resources) and activities that makeup a means of living. A livelihood is considered sustainable when, without undermining its natural resource base, it can cope with and recover from stresses and shocks, and maintain or enhance its capabilities and assets (Chambers and Conway 1992, Carney 1998, 2003, DFID 1999, Babulo et al. 2008).

**Livelihood capital** [based on the Sustainable Livelihoods Approach (SLA) framework, also referred to as **livelihood assets**] refers to all the human and non-human resources (natural, physical, human, social and financial) on which livelihoods are built. These forms of capital assets are viewed as a dynamic stock that can be stored, accumulated, exchanged or allocated to various livelihood strategies in order to achieve desired outcomes (Rakodi 1999, Babulo et al. 2008).

**Livelihood strategies** (based on the SLA framework) are the choices and combination of activities that people undertake based on the livelihood capital they have in order to achieve their goals (DFID 1999, Babulo et al. 2008).

**Livelihood outcomes** (based on the SLA framework) the achievements of these strategies and are usually expressed in terms like financial security, improved well-being, reduced vulnerability, or improved food security (Babulo et al. 2008).

**Livelihood incomes** are all the monetary and non-monetary outputs of livelihood strategies adopted that will contribute in the long term to livelihood outcomes. Used interchangeably with 'Livelihood outputs'. Either these incomes are the primary incomes of adopted strategies or the secondary income from a primary income that has been converted i.e. something is bought (cash into a resource) or sold (resources into cash).

**Livelihood income portfolio** is the set/suite of livelihood income streams that contribute to a household's livelihood.

**Livelihood income streams** are the different avenues of income that a household access in order to earn a living. The income streams encountered in this study include the three land-based livelihood income streams of environmental, crop and livestock income and the off-farm income stream.

**Livestock income (stream)** is the value of products and services received from livestock. In this dissertation, it refers to the used and sold value of products such as meat, skins, eggs, milk and services like transport and ploughing from cattle, goats, pigs and chickens. Also included is the income from the sale of live animals.

**Off-farm (non-farm) incomes are** all household incomes that are not earned from land-based activities from within household yards or from communal rangelands. In this dissertation, it refers to income earned from government grants, employment and trade not related to households' natural resource harvesting, crop cultivation and livestock husbandry.

**Points of Assessment (POAs)** is used in this dissertation to refer to the different points along the livelihood income chain where different livelihood income streams can be evaluated. The three POAs used in this study are Primary Income, Used and Cash Generation.

**Primary Income POA** is the POA where the resources that initially entered a household are evaluated. These resources could be consumed within the household or sold. Primary income is not gained through transactions of any resource, but sourced directly from the land, or directly through grants and earnings from the off-farm livelihood income stream.

**Provisioning ecosystem services** are the tangible goods or products of ecosystem services, where ecosystem services refer to the range of essential and irreplaceable benefits provided by ecosystems to people.

**Sustainable Livelihoods Approach (SLA)** is a framework for analysing livelihoods that emphasises the linkages between three separate livelihood components: Livelihood Capital, Livelihood Strategies and Livelihood Outcomes (DFID 1999). According to the SLA, the type of activity undertaken and the amount of income earned from them are a function of the assets at the disposal of the household.

**Used POA** is the POA where resources that a household consumes are evaluated. These could have been sourced from through primary income activities or through purchasing them.

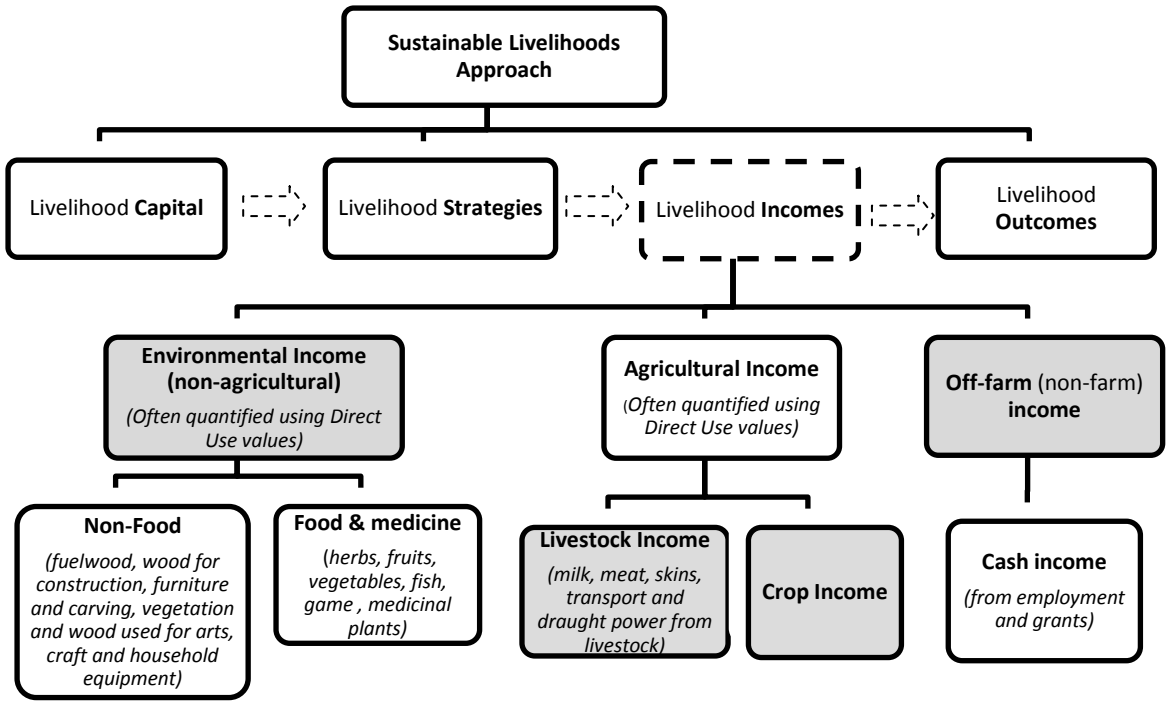



Figure (i) A breakdown of terminology used in this study where the livelihood incomes that are shaded in grey are the ones analysed in this study. The terminology used is based on the Sustainable Livelihoods Approach (DFID 1999) and what is found in literature, particularly Babulo et al. (2008).

# LIST OF ABBREVIATIONS

| | |
|---|---|
| **Agincourt HDSS** | Agincourt Health and Socio-Demographic Surveillance System |
| **Crop** | The crop livelihood income stream, also found in combination as ***CropPI,*** ***CropUsd*** and ***CropCG*** |
| **CG** | The cash generation POA |
| **EPs** | Environmental Products from the Environmental Livelihood income Stream, also found in combination as ***EPPI, EPUsd*** and ***EPCG*** |
| **Lvs** | The livestock livelihood income stream, also found in combination as ***LvsPI,*** ***LvsUsd*** and ***LvsCG*** |
| **OfFm** | The off-farm activities livelihood income stream, also found in combination as ***OfFmPI, OfFmUsd*** and ***OfFmCG*** |
| **PI** | The primary income POA |
| **POA** | Point of Assessment |
| **SLA** | Sustainable Livelihoods Approach |
| **SUCSES** | Sustainability in Communal Socio-Ecological Systems |
| **Usd** | The used/consumed POA |

*For the socio-economic strategies and adopted livelihood strategies abbreviations used in the ordination diagrams, refer to the methods section of the relevant chapters.*

# CHAPTER 1

# 1. INTRODUCTION

## 1.1. RATIONALE

The use of the natural environment by rural households forms an important part of their means of earning a livelihood, especially in supporting their consumption on a daily basis (Cavendish 2000, Angelsen and Wunder 2003, Vedeld et al. 2007, Angelsen et al. 2014). The use of these provisioning ecosystem services also serves as a safety net to overcome stresses and shocks to household income and as a pathway out of poverty by increasing total household income and providing opportunities to engage in alternative means of earning a livelihood (Angelsen and Wunder 2003, Vedeld et al. 2007, Angelsen et al. 2014). Natural resources that are extracted from the environment include fuelwood, herbs, fruit, game, medicinal plants, and non-commercial timber used for furniture, arts and craft. These resources can be referred to as *environmental products* (EPs) with the value derived from these EPs by households – in cash sales or through direct use – termed as *environmental income* (definitions are based on: Shackleton and Shackleton 2004, World Resources Institute et al. 2005, Babulo et al. 2008, Angelsen et al. 2014).

In addition to environmental income, households in rural socio-ecological systems also depend on monetary and non-monetary income from other income streams as part of their diversified livelihood income portfolio for both household consumption and cash generation. These include two other land-based livelihood income streams, crop farming and livestock husbandry, as well as the off-farm livelihood income stream. Earning income through multiple and diversified means play an important role in the resilience and sustainability of household livelihoods in these systems (Carney 1998, 2003, Babulo et al. 2008).

Analysis of rural livelihoods involves the quantification of households' use of different livelihood income streams. The values derived from the different livelihood income streams varies across households, with some households depending more on environmental income than others (Cavendish 2000, Dovie and Shackleton 2003, Twine et al. 2003, Shackleton and Shackleton 2004, 2006, Dovie et al. 2005, Mamo et al. 2007, Babulo et al. 2008, Angelsen et al. 2014, Hunter et al. 2014). Environmental resource dependency has been shown to be directly associated with household socio-economic characteristics and indirectly with the livelihood income strategies (activities) employed by these households (Cavendish 2000, Dovie and Shackleton 2003, Twine et al.

2003, Shackleton and Shackleton 2004, 2006, Dovie et al. 2005, Mamo et al. 2007, Babulo et al. 2008, Angelsen et al. 2014, Hunter et al. 2014).

An issue encountered when analysing rural livelihoods is that the sets of socio-economic characteristics, adopted livelihood strategies and household incomes from the different income streams each consist of highly correlated variables. An increase in one characteristic is often accompanied by increases and decreases in multiple other variables. This makes the identification of patterns in causation and effect within and between these sets difficult i.e. it becomes difficult which variables or combination of variables could be influencing the variable or variables of interest. Past studies have often accounted for only one or two livelihood income streams in isolation and did not account for all the income streams that make up the livelihood income portfolio. These studies were thus unable to reflect how the different income streams change as a portfolio across households, especially in relation to the measured sets of multiple and correlated household socio-economic characteristics and livelihood strategies. The potential problem of examining only some livelihood incomes is that this partial examination can easily lead to the assumption that these streams are related to each other, even though other income streams could be fluctuating in a similar manner (Dercon 2000). This partial examination can also easily conclude that a set of potential influencing factors measured by researchers are only influencing the incomes that were measured, disregarding how these factors could be influencing other incomes that were not measured similarly. Another often-overlooked aspect is that studies do not take into account that different livelihood streams contribute unequally for different aspects in the livelihood chain. For example, a particular income stream like environmental income may contribute more for household consumption than for cash generation. There is a need for studies to examine all income streams that constitute the household livelihood income portfolio collectively with associated variables, for different aspects in the livelihood chain.

The Bushbuckridge local municipality is a rural former homeland in the central Lowveld, which is situated in the Mpumalanga Province, South Africa. The area is characterised by high human densities, high levels of poverty, and high dependence on diminishing natural environmental resources, which contrasts with adjoining private and state-owned conservation areas which have low human densities and are rich in environmental resources (Pollard et al. 2008, Kahn et al. 2012). The reliance of the people on stressed environmental resource bases through consumption and trade makes it an ideal area to study drivers and consequences of both social and environmental change on ecological sustainability and human well-being.

This study aims to quantify and understand the contribution of environmental resources to rural household livelihoods in Bushbuckridge, and focuses on relating household socio-economic characteristics and adopted livelihood strategies to their use and dependency on environmental resources. The four livelihood income streams of environmental, crop, livestock and off-farm activities were quantitatively assessed. These are evaluated at three different points along the livelihood income chain: the primary income into the household, the value of resources used by the household, and the cash generated from that income stream. This study is one of many studies that fall under the *Sustainability in Communal Socio-Ecological Systems* (SUCSES) research project of the *Agincourt Health and Socio-Demographic Surveillance System (Agincourt HDSS)* (Twine 2010).

Quantification and understanding of how rural households are dependent on different livelihood incomes can help guide strategic planning aimed at household poverty alleviation and increasing households' resilience to stresses and shocks (Vetter 2013, Angelsen et al. 2014). Differentiating the relative importance of these livelihood incomes at different points in the livelihood chain is important if tradeoffs in conservation need to be made when guiding policy formation and implementation to maintain the health of these socio-ecological systems (Vetter 2013, Angelsen et al. 2014). An example could be deciding whether funding needs to be invested in a programme that is aimed at encouraging the selling of crops already grown or in increasing crop yields for household consumption. Knowing what is prevalent among households will help in advising the most efficient future path of empowering households. Additionally, the case study area of Bushbuckridge with its ongoing studies in the rural households raises a need for a standardised approach to analysing the data collected in the area for future studies.

## 1.2. ANALYSING RURAL LIVELIHOODS IN SOCIO-ECOLOGICAL SYSTEMS

### 1.2.1. Ecosystem services and sustainability in rural socio-ecological systems

Ecosystems provide a range of essential and irreplaceable benefits to people, termed as *ecosystem services*. These ecosystem services can be categorised into *provisioning services* (products obtained from ecosystems), *regulating services* (benefits from the regulation of ecosystem processes) and *cultural services* (nonmaterial aesthetic benefits), which are all underpinned by *supporting services* that are necessary for the deliverance of the former three categories of ecosystem services (Millennium Ecosystem Assessment 2003). These categorisations are not mutually exclusive and many services can be classified under more than one category. Provisioning ecosystem services, which is the category that is focussed on in this study, are the tangible products that people take from their environments (Millennium Ecosystem Assessment 2003). Food, fibre (e.g. wood, jute,

hemp, silk), fuel products (e.g. wood, dung), ornamental products, biochemicals, natural medicines and pharmaceuticals are some of the main examples of these tangible products that are derived from plants, animals and microbes.

Ecosystem services underpin human well-being and are best provided by environments that have not been compromised (Millennium Ecosystem Assessment 2003). With the rapid rate of global change from climate change and anthropogenic development, the ability of these ecosystems to continue providing these invaluable services into the future is being questioned. The concept of 'sustainability' in the environmental and developing world first gained recognition in 1987 when it was defined as "meeting the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development 1987). It emphasises that resource use and general development must not only satisfy short-term goals, but also ensure that the planet and its resources will not be adversely affected in the long term.

Management and development planning, by local authorities, regional municipalities, national government and non-profit organisations, needs to focus on the sustainability of the systems in which they work. An ecosystem cannot be sustainable if the economic and social systems that influence it are unsustainable. Likewise, the sustainability of the economic and social systems cannot be ensured if the ecosystems that they are imbedded in are unsustainable. The coupled nature of environmental, economic and social systems has led to the regarding of these systems as socio-ecological systems, which are defined as complex adaptive systems characterized by cross-scale interactions and feedback-loops between ecological and socio-economic components (Berkes and Folke 1998, Folke 2006, Walker et al. 2006). In order for the sustainability of these socio-ecological systems to be understood, an integrated approach to understanding is needed where the environment and its resources cannot be compartmentalized from anthropogenic processes.

### 1.2.2. Livelihoods and livelihood approaches

Ideas and frameworks for analysing rural socio-ecological systems include village studies, household economics and gender analyses, farming systems research, agro-ecosystem analysis, rapid and participatory appraisal, studies of socio-environmental change, political ecology and sustainability science and resilience studies (Scoones 2009). Over the last decade and a half, perspectives on livelihoods have influenced thinking and practice in rural development (Scoones 2009). A livelihood is defined as comprising the capabilities, assets (that includes both material and social resources) and activities required for a means of living (Babulo et al. 2008). While the definition of livelihoods is often simplified as 'the means of gaining a living' (Chambers 1995), in reality livelihoods are complex webs of activities and interactions that emphasise the diversity of strategies that people employ to

earn a living (Scoones 2009). The portfolios of livelihood activities or strategies that are 'chosen' by households influence the outcomes achieved which include aspects of increased monetary and non-monetary income, human well-being, food security, etc. (Babulo et al. 2008, Scoones 2009).

Livelihood approaches are methods of analysing and understanding socio-ecological systems that uses the multi-sector concept of what a livelihood is. By examining the entire, diverse livelihoods income portfolio, livelihood approaches allows for a dynamic and longitudinal analysis of socio-ecological systems that highlight concepts of coping, adaptation, improvement, diversification and transformation (Scoones 2009). Livelihood approaches comes with its own set of limitations and challenges, in particular the lack of emphasis placed on institutions, organisations, politics and powers (Scoones 2009). However, livelihood approaches have challenged more conventional, single sector approaches that are used for solving complex rural development problems by working across boundaries and not focussing on activities like agriculture, wage employment, farm labour and small-scale enterprise in isolation (Scoones 2009). Livelihood approaches do not belong to a particular discipline and have, through the development of hybrid ideas and workable frameworks, allowed for the bridging of gaps between study and practice across different fields of study, especially between the natural and social sciences (Scoones 2009).

Livelihood approaches are particularly advantageous in rural development as they focus on understanding the system from the local perspective (Scoones 2009). This is especially achieved by creating an ideal entry point for participatory approaches to inquiry through negotiating interaction between local residents and non-resident stakeholders in the learning and developing process (Scoones 2009). Analyses of livelihoods done at the level of individual people can be aggregated to quantifying and understanding livelihoods at the household, village and district level (Scoones 2009).

### 1.2.3. The Sustainable Livelihoods Approach (SLA)

The sustainable livelihoods approach (SLA) is one framework for analysing rural livelihoods that has come into common use since the 1990s (Scoones 2009). A livelihood is considered sustainable when, without undermining its natural resource base, it can cope with and recover from stresses and shocks, and maintain or enhance its capabilities and assets (Chambers and Conway 1992, Scoones 2009). To incorporate this concept of sustainability, the SLA framework is structured on three interlinked livelihood components: capital, strategies and outcomes (Figure 1.1). Livelihood capital, also referred to as livelihood assets, refers to all the human and non-human resources (natural, physical, human, social and financial) on which livelihoods are built. These capital assets are viewed as a dynamic stock that can be stored, accumulated, exchanged or allocated to various livelihood strategies in order to achieve desired outcomes (Rakodi 1999, Babulo et al. 2008). Livelihood

strategies are the choices and combinations of activities that people undertake in order to achieve their goals, and are usually based on the livelihood capital that is available to them (DFID 1999, Babulo et al. 2008). These livelihood strategies contribute to people's livelihood outcomes, with the latter usually being expressed in terms like financial security, improved well-being, reduced vulnerability, or improved food security (Babulo et al. 2008). According to SLA framework, the three livelihood components of capital, strategies and outcomes influence and are influenced by shocks, trends and seasonality in the external environment and within the household. Some examples include droughts, floods, loss of life, loss of employment, illness, etc. Furthermore, the SLA livelihood components are influenced by the anthropogenic processes and structures that exist around and within the communities (Carney 1998, 2003, DFID 1999, Rakodi 1999, Babulo et al. 2008).

Since 1992, the SLA has been used by academics, governments, NGOs and the private sector as a framework in which to study, advise and develop (Scoones 2009). However, the usage of this framework is not without shortcomings and lacks in aspects that other approaches may be better at addressing (Scoones 2009). One criticism is that the SLA does place enough emphasis on institutions and organisations as mediating livelihood strategies and their outcomes (Scoones 2009). Another criticism is that the SLA does not adequately take into account the politics and power that influence livelihoods (Scoones 2009).

Despite these shortcoming, like any other tool, the SLA needs to be used for what it was designed and be adapted to the needs of what it is used for. The SLA takes a people-centred stance toward policy advising, ensuring that the people who participate have the ability to influence the institutional structures and processes that govern their lives (DFID 1999, Scoones 2009). The SLA incorporates issues that other approaches are incapable of integrating (Scoones 2009). It is dynamic, non-sectoral and holistic in how it takes into consideration multiple influences, actors, strategies and outcomes in its application to the different dimensions of sustainability: environmental, economic, social and institutional, which is not accomplished by other livelihood approaches (DFID 1999, Scoones 2009).

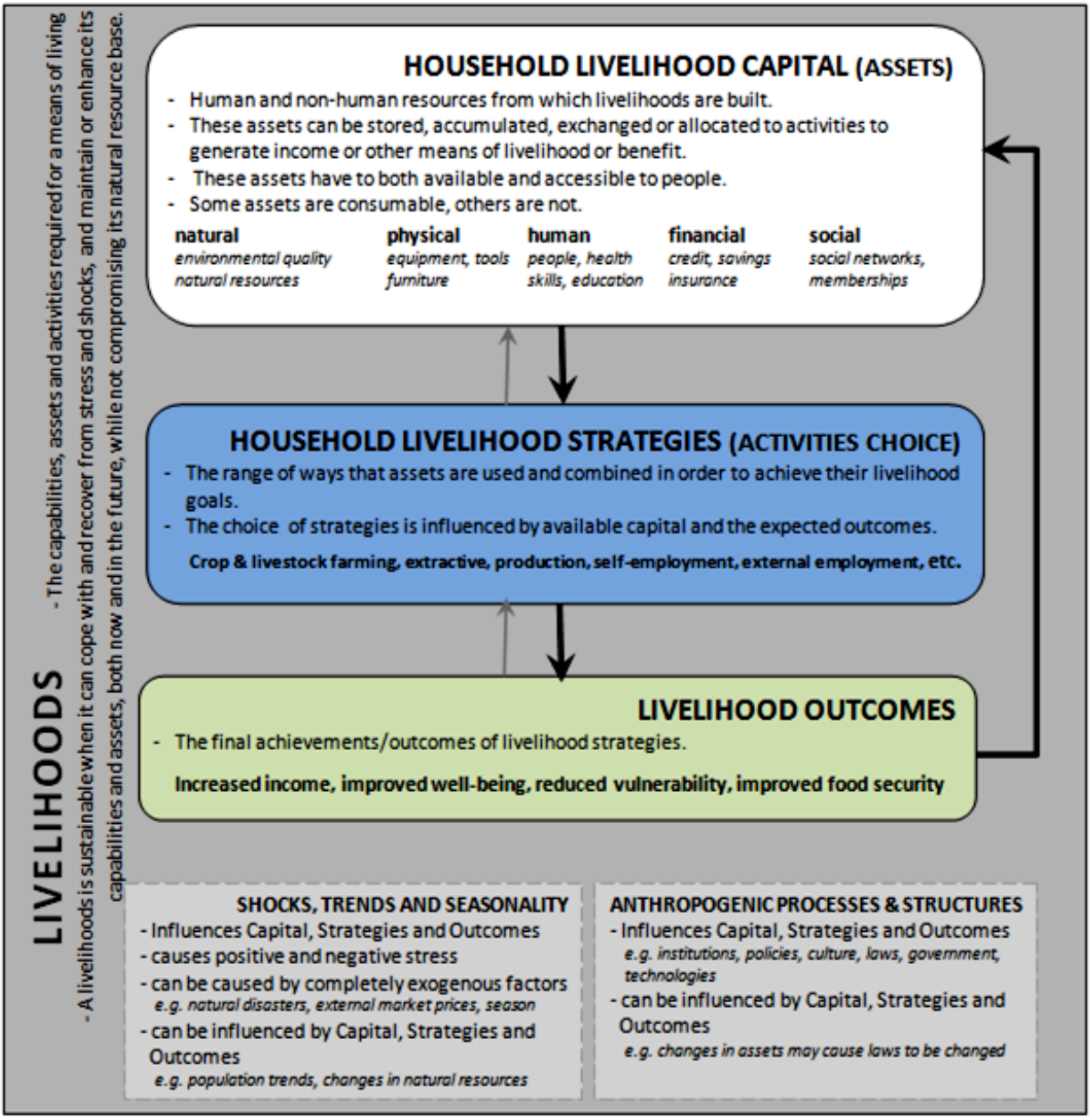



Figure 1.1 A representation of the Sustainable Livelihoods Approach (SLA) framework showing the links between Livelihood Capital, Livelihood Strategies and Livelihood Outcomes in socio-ecological systems. These three components influence and are influenced by shocks, trends and seasonality in the external environment and within the components, as well as by the anthropogenic processes and structures that exist around and within communities (based on: Carney 1998, 2003, DFID 1999, Rakodi 1999, Babulo et al. 2008).

### 1.2.4. Adapting and applying the SLA: Quantifying livelihood capital, strategies and incomes

There are various ways to understand and quantify livelihoods using the SLA framework that are based on what capital households own and the strategies that they adopt. These measurements are not exclusive to studies based on the SLA, and can be compared with other studies that use different livelihood approaches. The simplest quantifiable measures of capital and strategies within the SLA

are whether different types of capital are owned and whether particular strategies are used (Shackleton et al. 2002, Twine et al. 2003, Dovie et al. 2005). Quantification on the value of these components can also be done on a continuous scale. Livelihood capital can be quantified according to the monetary value of the physical capital owned, the numbers of people of a certain criteria that make up the household or the numbers of a type of physical capital owned by a household (Dovie et al. 2005). Physical capital owned by households can be used as indicator of the wealth status of households. Quantification of strategies adopted by livelihoods can be done in terms of the number of people performing the strategy, or the time spent on different strategies (effort) (Dovie et al. 2005). Ratios of dependency, employment, gender etc. are also used to quantify livelihood capital and strategies of households (Shackleton et al. 2002).

The SLA was adapted in this study where the "success" of a livelihood was not based on the ultimate outcomes, but rather in terms of the immediate household livelihood incomes. Livelihood incomes are all the immediate monetary and non-monetary results of the livelihood strategies adopted by households. Some examples are the environmental resources harvested like fuelwood and wild vegetables, the milk and meat derived from livestock owned, and the wages earned from working. The simplest measure of livelihood income is whether an income is received or not (Shackleton et al. 2002, Twine et al. 2003, Dovie et al. 2005). When comparing livelihood incomes of the same nature but from different livelihood strategies, the comparing of quantities of the different resources is adequate to give a more value-based measurement of livelihood incomes. For example, the number of buckets of tomatoes bought can be compared to the number of buckets of tomatoes harvested from a garden, and thus we can see whether buying tomatoes is a greater source of tomatoes to a household compared to harvesting tomatoes.

When comparing different resources, quantities of resources cannot be used because the different resources are not worth the same per a volume unit. For example, to a household, 3 kg maize meal is of different value compared to 3 kg marula fruit. Other resources are measured in completely different units, making comparisons impossible, like trying to compare one year of education to one bundle of fuelwood. To overcome this issues, household livelihood incomes are commonly converted to monetary terms and compared, where direct-use values (DUVs) are used to quantify non-financial incomes (Shackleton et al. 2002, Twine et al. 2003, Shackleton and Shackleton 2004, Dovie et al. 2005). These DUVs are given to resources that are part of households' livelihoods but have not been purchased and are calculated based on how much it would cost a household to buy these land-based resources if they were not collected, harvested or reared. This cost is usually based on local market values of the resource or a suitable alternative. Absolute monetary values of

incomes are comparable within a study or between studies that are standardised and done in close geographical proximity in a similar time period. However, relative value contributions are often more valuable at making comparisons between studies that are in different locations or are sample with large spaces of time in between them.

Livelihood incomes can be measured at different points in the livelihood income chain. In this study, points of assessment (POAs) are used to refer to the different points along the livelihood income chain where different livelihood income streams can be measured and evaluated. The three POAs at which incomes were examined in this study were primary income, used, and cash generation. The primary income value is the value of those resources that initially enters a household that could be consumed within the household or sold. Primary income is not gained through transactions of any resource, but rather sourced directly from the land, or directly through grants and earnings from the off-farm livelihood income stream. The used value is the value of resources that a household consumes which could be sourced from the primary income activities or through purchasing them. Cash generated is the cash income value that is derived through the selling of land-based resources, or through grants and earnings from the off-farm livelihood income stream. It must be noted that the cash-generation from the off-farm income livelihood income stream is equivalent to its primary income value.

## 1.3. ENVIRONMENTAL INCOME AND RURAL SOCIO-ECOLOGICAL SYSTEMS

### 1.3.1. Environmental income dependency as part of a household's diversified livelihood portfolio

As part of their diversified livelihood portfolios, rural households are typically dependent on cash income generated from off-farm activities which come from a variety of sources including migrant and non-migrant labour, self-employment, government grants and accessing sources of finance including savings and loans. Rural households are also dependent on cash and non-cash income from land-based livelihood income streams. These land-based livelihood income streams include environmental income, crop farming and livestock husbandry with the latter two often being collectively referred to as agricultural income.

Multiple, diversified means of earning income play an important role in the resilience and sustainability of rural livelihoods (Carney 1998, 2003, Babulo et al. 2008). Households that depend on fewer, uncertain livelihood income streams are considered vulnerable to the impacts of shocks and long term stresses, and the adoption of multiple, diversified tactics may help manage the risks

associated with these variable income sources (Devereux 2001, Slater 2002). However, livelihood diversification may not always be a good risk-reducing strategy as different livelihood income sources tend to fluctuate together and could simply be a strategy used to increase household income by using surplus labour resources when there are no alternatives available or conventional markets are constrained (Dercon 2000).

Global studies estimate that environmental income contributes a mean of between 22% (Vedeld et al. 2007) and 28% (Angelsen et al. 2014) of total household income in rural areas of developing countries. Regional studies have estimated contributions to be higher with some estimates including 39% in Ethiopia (Mamo et al. 2007, Babulo et al. 2009), 30% in Malawi (Fisher 2004), 35% in Zimbabwe (Cavendish 2000) and 32% in a San community in the Northern Cape Province, South Africa (Thondhlana et al. 2012). In South Africa, lower environmental income contributions of 9% (Thondhlana et al. 2012) in a Mier community in the Northern Cape Province and 19% in the Bushbuckridge local municipality in the Mpumalanga province (Dovie et al. 2005) have been estimated.

An often-overlooked aspect in many studies is that different livelihood streams contribute unequally at different points along the livelihood chain. For example, environmental income may contribute more for the primary harvesting and consumption within the household than to cash generation through selling. The importance of making this differentiation can be seen in a study in Honduras and Bolivia where land-based livelihood income streams were more important for consumption in all villages in the study, while for cash generation, some villages were more reliant on income from off-farm activities (Godoy et al. 2002).

### 1.3.2. The relationship between income streams within the portfolio

Studies rank the importance of the various livelihood streams to households differently, with estimates of environmental income varying in their absolute and relative contributions to the total household income portfolio. Environmental income could contribute less (Cavendish 2000, Fisher 2004, Dovie et al. 2005, Vedeld et al. 2007, Thondhlana et al. 2012) or more (Cavendish 2000, Mamo et al. 2007, Babulo et al. 2009, Angelsen et al. 2014) than off-farm income to the livelihood income portfolio. Agricultural income could contribute the same as EPs (Fisher 2004, Thondhlana et al. 2012) or the most (Mamo et al. 2007, Babulo et al. 2009, Angelsen et al. 2014) or the least (Thondhlana et al. 2012) or the middle amount (Dovie et al. 2005, Vedeld et al. 2007) to the livelihood income portfolio. Importantly, these studies show that the total income contributions made by land-based strategies are more than the contributions from off-farm income sources to

households' livelihood portfolios (Cavendish 2000, Godoy et al. 2002, Fisher 2004, Dovie et al. 2005, Vedeld et al. 2007, Mamo et al. 2007, Babulo et al. 2009, Angelsen et al. 2014).

Wealth status classifications that are often used in studies (Vedeld et al. 2007, Babulo et al. 2009, Thondhlana et al. 2012, Angelsen et al. 2014) limit our ability to interpret relationships between the land-based and off-farm livelihood income streams. These household wealth status classifications may be based on a household asset scale, and thus do not adequately represent the current income from off-farm activities. The alternative wealth status classification uses total household income, and is thus inherently biased towards the income stream that dominates in absolute value (Angelsen et al. 2014).

Many other studies examine only one or two livelihood streams and are thus unable to reflect how the different income streams change as a portfolio across households (Shackleton et al. 2002, Twine et al. 2003, Paumgarten and Shackleton 2011). For example, a study in the Thorndale village in Bushbuckridge, South Africa, found that all four livelihood income streams of environmental, crop, livestock and off-farm income were correlated with each other (Dovie et al. 2005). The study found that environmental, crop and livestock income streams were positively correlated with each other. However, crop income and formal cash income from off-farm activities were only weakly correlated. If only some livelihood incomes are examined, it can easily lead to the assumption that these streams are related to each other even though other income streams may be fluctuating in the similar manner (Dercon 2000).

### 1.3.3. The influence of household socio-economic characteristics

In rural socio-ecological ecosystems, both in South Africa and across the globe, the values derived from these different livelihood income streams varies across households, with some households depending more on environmental income than others (e.g. Cavendish 2000, Dovie and Shackleton 2003, Twine et al. 2003, Shackleton and Shackleton 2004, 2006, Dovie et al. 2005, Mamo et al. 2007, Babulo et al. 2008, Angelsen et al. 2014, Hunter et al. 2014). These variations in environmental resource dependency have been associated in many studies with various household socio-economic characteristics (Cavendish 2000, Dovie and Shackleton 2003, Twine et al. 2003, Shackleton and Shackleton 2004, 2006, Dovie et al. 2005, Mamo et al. 2007, Babulo et al. 2008, Angelsen et al. 2014, Hunter et al. 2014). Some examples include the increased involvement in the environmental and other land-based income streams with increases in household size (Dovie et al. 2005, Mamo et al. 2007, Babulo et al. 2008), the number of children in a household (Dovie et al. 2005, Mamo et al. 2007, Angelsen et al. 2014), and the number of females in a household (Dovie and Shackleton 2003, Shackleton and Shackleton 2004, Dovie et al. 2005, Babulo et al. 2008).

Wealthier households use more absolute amounts of environmental (Vedeld et al. 2007, Babulo et al. 2009, Thondhlana et al. 2012, Angelsen et al. 2014), livestock (Thondhlana et al. 2012) and crop (Babulo et al. 2009) income, though are relatively less dependent on these income streams. Wealth status is assigned to these households either according to the total income accessible to households (Cavendish 2000, Vedeld et al. 2007, Babulo et al. 2009, Thondhlana et al. 2012, Angelsen et al. 2014) and more rarely according to key assets found in households (Fisher 2004, Shackleton and Shackleton 2006).

## 1.4. AIMS, OBJECTIVES AND DISSERTATION STRUCTURE

### 1.4.1. Aim of this study

This study aims to quantify and understand the contribution of environmental resources to the livelihoods of households as part of their diversified livelihood portfolio, in a rural district of South Africa. Specifically this study focuses on how this dependency on environmental resources collectively relates to household socio-economic characteristics and adopted livelihood strategies. This study uses the SLA framework and examines these relationships at the household level.

### 1.4.2. Research objectives and key questions

1) Objective 1: To quantify and understand households' environmental resource dependencies based on the absolute and relative amounts that environmental income contributes to the diversified livelihood income portfolio at different points of assessment in the livelihood income chain (*addressed in chapter 3*).
   a) What are the average values contributed by the environmental, crop, livestock and off-farm income streams at the primary income, consumed and cash generation POAs?
   b) What are the relative contributions by the environmental, crop, livestock and off-farm income streams at the primary income, consumed and cash generation POAs?
   c) How do these contributions collectively vary between the different livelihood income streams as part of the livelihood portfolio across household?

2) Objective 2: To quantify and understand the influence of socio-economic characteristics on households' absolute and relative environmental income values as part of a diversified livelihood income portfolio at different points of assessment in the livelihood income chain (*addressed in chapter 4*).
   a) How do household socio-economic factors vary collectively?
   b) How do these socio-economic factors collectively relate back to the absolute and relative incomes of the portfolio at the primary income, consumed and cash generation POAs?

c) Can the proportional environmental resource dependency capture the collective variation between socio-economic characteristics and livelihood incomes?

3) Objective 3: To quantify and understand the influence of adopted livelihood strategies on households' absolute and relative environmental income values as part of a diversified livelihood income portfolio at different points of assessment in the livelihood income chain (*addressed in chapter 5*).
   a) How do households' adopted livelihood strategies vary collectively?
   b) How do these adopted livelihood strategies collectively relate back to the absolute and relative incomes of the portfolio at the primary income, consumed and cash generation POAs?
   c) Can the proportional environmental resource dependency capture the collective variation between adopted livelihood strategies and livelihood incomes?

### 1.4.3. Structure of this dissertation

The front matter of this dissertation includes the dissertation abstract, and the lists of figures, tables, definitions and abbreviations. Chapter 1, the introductory chapter, includes the rationale, the background to this study, the description of the framework of analysis and the aims and objectives of this study. This is followed by Chapter 2, which details the study area, the explanation of the larger project to which this dissertation contributes, and the methodological approach used in the following chapters. The purpose of documenting the methods used is to serve as a guide to future researchers who will approach the same dataset to answer similar questions over different timescales. It must be noted that some aspects of the methods chapter will be more accessible to researchers who are familiar with the SUCSES projects. Chapters 3, 4 and 5 are the data chapters of this dissertation, with the analyses done in Chapters 4 and 5 being independently done based on the analysis done in Chapter 3. While effort was made to reduce repetition, some material is inevitably repeated in Chapters 3, 4 and 5. These chapters have been written up in preparation for stand-alone papers that address objectives 1, 2 and 3 (see previous section) respectively. They each consist of their own introduction, results and discussions sections with their methods sections referring to the relevant sections in Chapter 2. Chapter 3 is richer in content and longer than Chapters 4 and 5. It will need to be shortened before being submitted for publication. Chapter 6 is the final, synthesis chapter.

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# CHAPTER 2

# 2. A METHODOLOGICAL APPROACH TO ANALYSING HOUSEHOLD LIVELIHOOD DATA

## 2.1. BUSHBUCKRIDGE, SOUTH AFRICA

### 2.1.1. The geography, climate and vegetation of Bushbuckridge

Our study site is the field site of the Agincourt Health and Socio-Demographic Surveillance System (Agincourt HDSS), which covers an area of 420 $km^2$ adjacent to the Kruger National Park in the Bushbuckridge local municipality, Mpumalanga Province, South Africa. The Bushbuckridge municipality is located in the Lowveld — a low-lying predominantly savanna biome landscape in north-eastern South Africa, extending between the coastal plain of Mozambique in the east to the slopes of the Drakensberg Great Escarpment in the west (Venter et al. 2003). The geology of Bushbuckridge is characterised by granite with local Timbavati gabbro intrusions (Venter et al. 2003). The topography of the area is gently undulating with the average height of hills from ground level being 450 m (Venter et al. 2003). Mean annual temperature is 22°C with frost events being uncommon (Venter et al. 2003). Rainfall varies from an average of 580 mm/year in the east to 800mm/year in the west, with most of the rain in the summer months between October and May (Venter et al. 2003). The increasing aridity in the east is accompanied with increased variability around the mean annual rainfall and drought being common (Shackleton 2000).

Vegetation is classified predominantly as granite lowveld, with gabbro grassy bushveld and legogote sour bushveld also found in the region (Mucina and Rutherford 2006). Trees that are commonly found on the granite Lowveld uplands are thorn-less, broad leafed, deciduous species that include: *Terminalia sericea*, *Combretum zeyheri* and *C. Apiculatum* (Mucina and Rutherford 2006). The bottom slopes are characterised with trees species having thorns and fine compound leaves (mainly *Mimosaceae*), and common species include *Acacia nigrescens*, *Dichrostachys cinerea* and *Grewia bicolor* (Mucina and Rutherford 2006). The woody canopy cover varies from almost 60% cover in woodlands to 5% woody cover in open lands with dispersed trees and shrubs (Venter et al. 2003). The majority of woody vegetation is in the 2-5m height category (Wessels et al. 2011).

### 2.1.2. The history of Bushbuckridge

In the early-mid 20th century, under the Apartheid government of South Africa, what is now the Bushbuckridge local municipality was divided into two homelands, *Gazankulu* and *Lebowa,* for those of African heritage (Thornton 2002). These homelands were juxtaposed with white-owned commercial farms and state lands (Thornton 2002). The forced movement of black people into the homelands of this area resulted in a large increase in human density and thus increased pressure on natural resources (Thornton 2002). Control of the homelands during Apartheid differed from today. Even though these two homelands remained part of South Africa, the land was divided into Tribal Trust Lands with the system of governance loosely based on traditional systems – overseen by Chiefs who administrated through 'Tribal Authorities' (Thornton 2002). The chief's and tribal leaders were given official recognition (Thornton 2002).

With the declaration of democracy in 1994, the social dynamics and its impacts on the environment have changed. The land continues to be strained because of prevailing high human densities, low economic growth rates and high unemployment rates (Thornton 2002). The power that pre-democracy tribal authorities had under the Apartheid era has diminished since the advent of democracy (Thornton 2002). Tensions over unsuccessful land claims and poor service delivery has allowed a mind-set to be created that makes it difficult for external agencies, including businesses and NGOs, to help (Thornton 2002). However, there has been steady improvements by both governments and lobby groups to ensure that a communal tenure system, based on the original pre-colonial system, is put in to place (Cousins and Claassens 2004). While compromised with ineffective law and policy, and poor implementation, new legislation is helping to secure the rights of both the poor and women, both as individuals and as family units (Cousins and Claassens 2004).

### 2.1.3. The people of Bushbuckridge

Bushbuckridge has high human densities for a rural area with approximately 170 persons per $km^2$ (Hunter et al. 2007). There are high levels of poverty in the area, and food security amongst poor households is precarious with environmental resources used as a buffer to shocks (Kahn et al. 2012). The development of infrastructure since 1994 has been at rates below expectation (Kahn et al. 2012). While electricity is available, it is not affordable to most households (Kahn et al. 2007). Most of the roads have not been tarred in the district, and piped water to households has not been installed even though dams have been built (Kahn et al. 2012). While all villages have primary schools and most have high schools, the quality of education is poor with few tertiary opportunities available to students (Kahn et al. 2012).

Since 1992, the population has shown a narrowing of its age pyramid base (Kahn et al. 2012). This has been reversed recently with a variety of health programmes, especially mother-to-child HIV transmission interventions (Kahn et al. 2012). There has been an increase in the risk of cardio-metabolic diseases (Kahn et al. 2012). Although women live longer than men do, the quality of their lives tends to be poorer (Kahn et al. 2012). Migratory workers, with women migrating more often than before, have higher mortality rates than those that permanently reside in the region, especially from communicable diseases such as TB and HIV (Kahn et al. 2012). These increases in illnesses and mortalities of income generators puts strain on health services and communities, with the survival of infants and children being influenced by their mother's survival (Kahn et al. 2012).

### 2.1.4. The livelihoods of the people of Bushbuckridge

The settlement pattern in the Bushbuckridge area is typical of semi-rural and rural communities of former homelands (Giannecchini et al. 2007). Villages are scattered in the landscape, each surrounded by communal rangelands used for harvesting of environmental resources, especially fuelwood (Giannecchini et al. 2007). A village consists of numerous homesteads, each consisting of the occupants' homes with associated animal pens and small-scale agricultural plots of fruit, vegetables and other crops (especially maize) (Giannecchini et al. 2007). The Bushbuckridge area is characterised by high livestock numbers, overgrazing, soil erosion, excessive wood harvesting and potentially lower productivity (Hoffman and Todd 2000, Wessels et al. 2007). This contrasts with adjoining conservation areas that have low human densities and high levels of environmental resources. Most households in the Bushbuckridge area are mainly dependent on off-farm cash income from employment (particularly migrant labour) and from government social grants (Giannecchini et al. 2007, Hunter et al. 2007). Environmental resource harvesting and agricultural activities are insufficient to support households but are a crucial supplementation to livelihoods (Giannecchini et al. 2007, Hunter et al. 2007).

Bushbuckridge households obtain a variety of direct provisioning ecosystems services from the environment, including fuelwood, wild fruits, wild vegetables, medicinal plants, insects, bush meat and fish (Dovie and Shackleton 2003, Shackleton et al. 2005, Dovie et al. 2006). These resources are harvested or purchased and subsequently used or sold (Dovie and Shackleton 2003, Shackleton et al. 2005, Dovie et al. 2006). Fuelwood is the dominant energy source and stocks around many villages are decreasing. Villagers are walking further and using vehicles or wheelbarrows to transport harvested wood, and switching to purchasing the wood when the distance to walk for fuelwood becomes too far (Twine 2005, Giannecchini et al. 2007, Madubansi and Shackleton 2007). The effects of not harvesting beyond preferred walking distances from villages are visible at a landscape

level with vegetation density increasing beyond these preferred walking distances (Wessels et al. 2013). Medicinal plants and bush meat usage are possibly underreported for fear of repercussion from legal and traditional authorities (Shackleton and Shackleton 2004). Environmental resources are harvested under authority of the local traditional leaders, but essentially these systems are open access with the occasional execution of restrictions by the local authority being weak (Shackleton and Shackleton 2004).

A variety of crops is grown within the household yard and in larger fields in the communal rangelands, and are used or sold by households (Dovie and Shackleton 2003, Shackleton et al. 2005, Dovie et al. 2006). Households that own livestock use and sell live animals, products and services, including meat, milk, and draught for transport and ploughing (Dovie and Shackleton 2003, Shackleton et al. 2005, Dovie et al. 2006). The use of these land-based resources allows households to reduce their daily costs and thus allows them to spend their limited cash resources on other needs including agricultural tools, education and capital investments (Shackleton and Shackleton 2004). Replacing the harvested resources with purchased resources, after accounting for labour spent in collection, is usually more costly (Shackleton and Shackleton 2004).

## 2.2. THE SUCSES RESEARCH PROJECT, AGINCOURT HDSS, BUSHBUCKRIDGE

This study uses data collected in the Sustainability in Communal Socio-Ecological Systems (SUCSES) research project of the Agincourt HDSS. The Agincourt HDSS was established in 1992 in Bushbuckridge to help advise the development of the area as the country moved from apartheid to a democratic governance (Kahn et al. 2012). Beginning with a baseline survey of 8 900 households (57 600 people) in 20 villages in 1992, the Agincourt HDSS programme expanded to include a total of 90 000 people living in 16 000 households in 27 villages by 2011 (Kahn et al. 2012). The expansion in Agincourt HDSS included prototyping a decentralised health system and supporting an interdisciplinary health-population initiative consisting of a variety of research groups (Kahn et al. 2012). This initiative is the research system in which the joint venture between the University of the Witwatersrand and the Rural Public Health and Health Transitions Research Unit of the Medical Research Council of South Africa (the MRC/Wits-Agincourt unit) works. The Agincourt HDSS maintains as part of its policy good ties with the communities during its consultation processes and feedback sessions (Kahn et al. 2012)

The overarching aim of SUCSES project of the Agincourt HDSS is to understand the dynamic interactions between humans and their environment in rural communities in space and over time,

and the consequences of these interactions for ecological sustainability and human well-being (Twine 2010). SUCSES seeks to address three broad themes: 1) how are socio-economic, demographic and health status of the people influencing household use and reliance on ecosystem services for their livelihoods; 2) how does the state of the environment influence ecosystem service delivery; and 3) the implications of changes in availability of ecosystem services for human well-being over time (Twine 2010).

SUCSES consists of a household livelihoods panel study linked with environmental monitoring in a subset of nine villages in the Agincourt HDSS site. SUCSES has been operational since 2010 with data collection through interviews being conducted on a yearly basis by trained field workers. The human ethics clearance for the SUCSES research project was obtained from the Human Research Ethics Committee (Non-Medical) of the University of the Witwatersrand (M10301). These household interviews are conducted by trained field workers and were analysed using the Sustainable Livelihoods Approach (SLA) framework. These interviews consist of 43 questions divided into four parts: A & B) Livelihood Capital, Activities and Outcomes (and Incomes), C) Livelihood Shocks and Stresses and D) Food and Nutrition Security

The villages were chosen for SUCSES from the 27 villages surveyed by the Agincourt HDSS to represent the socio-ecological system in the region (Table 2.1). The villages were chosen as clusters of three in each of the three rainfall zones along the west-east axis (>700 mm/year, 700-600 mm/year, <600 mm/year) with the village choice per rainfall zone representing the range of village sizes per the rainfall zone (Table 2.1). Village size was measured using the number of households per village, where the sampling unit of a household being defined as consisting those people who shared a common meal together on a regular basis (Kahn et al. 2012). The SUCSES baseline data collection in 2010 represented an 8% sample size of households randomly selected per settlement (Table 2.1). After one household declining to being interviewed and nine households that could not be interviewed despite several revisits, this baseline sample consisted of 590 households that have been annually interviewed since. Temporary migrants belonging to households were included in the survey, where they were defined as temporary migrants if they spent more than six months away from home (Kahn et al. 2012).

The SUCSES research project is a long-term research programme with multiple studies being done on the data by different researchers aimed at unpacking different components of this socio-ecological system. There is a need for research protocol and methodology to be recorded systemically in studies within SUCSES. This will allow future analysis to be simplified, progressive and compatible as

time progresses, whether building on the analysis of studies already undertaken or answering different problems.

Table 2.1 The nine villages chosen for the Sustainability in Communal Socio-Ecological Systems (SUCSES) study from the three different rainfall zones in the Agincourt Health and Socio-Demographic Surveillance System (Agincourt HDSS) area. The three clusters of villages chosen represent the village size range per rainfall zone. Village and sample sizes are for the baseline study year of 2010.

| Rainfall zone | Village | Village size (number of households) | Sample size (number of households) |
|---|---|---|---|
| Wet west | Agincourt | 1198 | 95 |
| >700mm/year | Xanthia | 760 | 61 |
| | Cunningmoor | 631 | 50 |
| Mesic mid | Kildare A, B & C | 1807 | 141 |
| 600-700mm/year | Ireagh A | 622 | 49 |
| | Ireagh B | 330 | 26 |
| Semi-arid | Justicia A & B | 1190 | 94 |
| <600mm/year | Huntington | 538 | 42 |
| | Lillydale B | 426 | 32 |
| Total | | 7502 | 590 |

## 2.3. APPROACHING SUCSES IN THIS STUDY

### 2.3.1. This study: part of the SUCSES research project

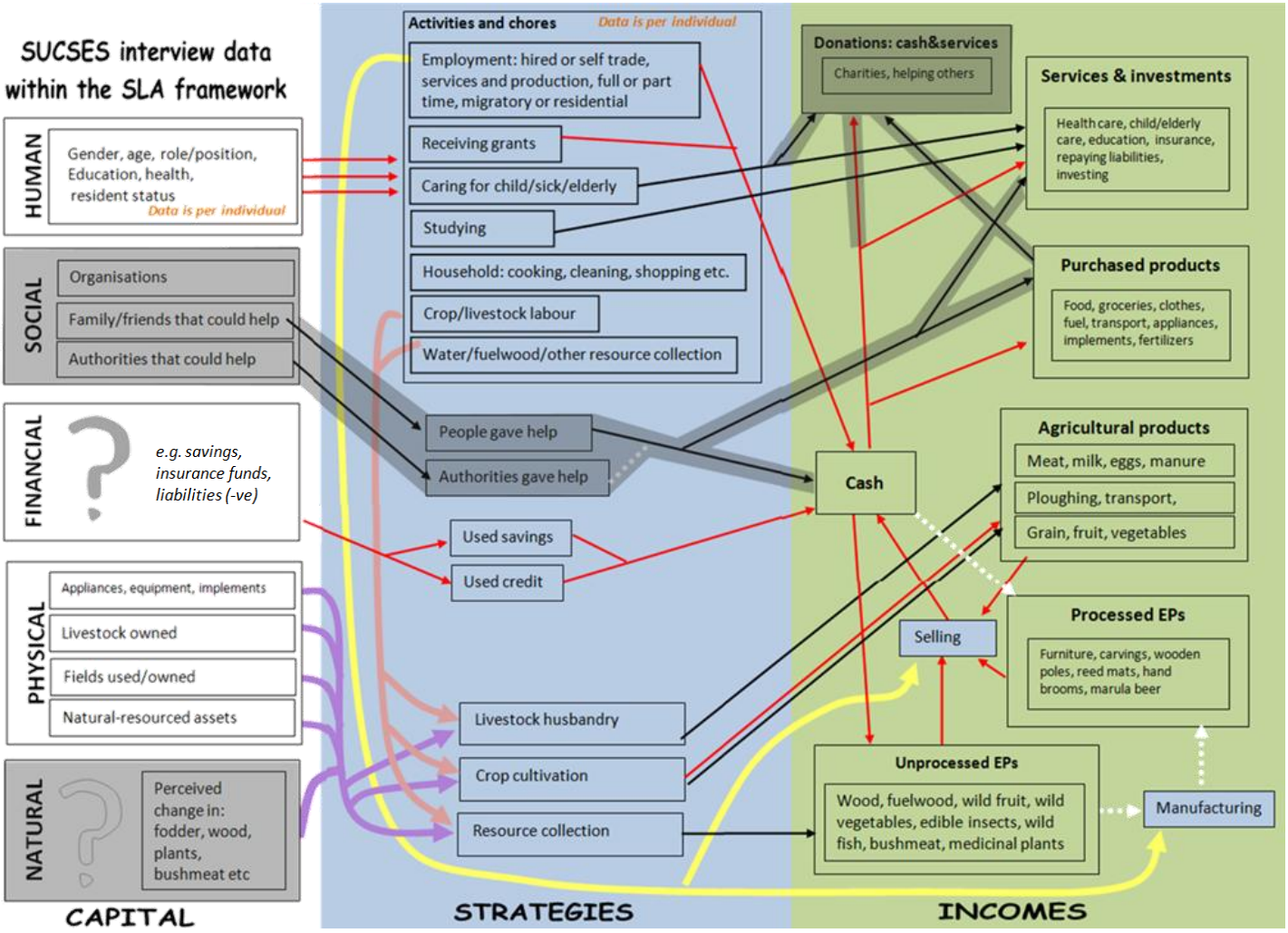
This study is one of the projects being done under the SUCSES research project and is particularly focussed on the use of natural resources by households for environmental income as part of their diversified livelihoods strategy. This study uses the SLA framework for analysis and aims to both explore the livelihood income portfolio and account for the role of household socio-economic and adopted strategies in defining it. The aims and objectives of this study have been expanded already in the previous chapter, section 1.4.

Data used in this study is from the SUCSES baseline collection of 2010 with its 590 households. Two of these households were missing income values for crop and livestock income, resulting in sample size of 588 households for those analyses that encompass the whole livelihood income portfolio. Households had a mean ± SD of 8.12 ± 4.14 individuals per household with the exclusion of temporary migrants resulting in mean ± SD of 5.78 ± 3.52 permanent residents per household. Neither total household sizes (Shapiro-Wilk, $W = 0.8972$, p-value $< 0.001$) nor numbers of permanent residents (Shapiro-Wilk, $W = 0.8431$, p- value $< 0.001$) followed a normal distribution —both distributions were skewed to the right with fewer households having many individuals in both cases (Appendix 2.1). The median and mode for total household size across all households were both

seven individuals per household, while for permanent residents per household they were both five individuals. The means, medians and modes of total household sizes (Appendix 2.2) and of the number of permanent residents per household (Appendix 2.3) were similar between villages

### 2.3.2. The interview framework of SUCSES

The interview data, which is analysed according to the SLA, forms a complex web of interactions and this study focuses on Part A and B of the interviews (Figure 2.1). The livelihood capital types that were examined in this study are the human and physical capital of households. The livelihood strategies include natural resource collection, crop cultivation, livestock husbandry, accessing financial assets, grant dependency, schooling, employment and household chores. Livelihood incomes examined include cash, natural resources and their products, agricultural products, purchased products, donations, services and investments. Human capital, and peoples' occupations and off-farm earnings were available at the individual level and subsequently aggregated to the household level.




| KEY | FLOW TYPES |
|---|---|
| → | Categorical flow available from questionnaire |
| → | Quantifiable flow available from questionnaire |
| → | Flow not available from questionnaire |
| ↘ ↗ ↘ | Implied flow, can be compared, not directly linked |

Figure 2.1 Graphical representation, according to the SLA framework, of the flow of resources within the Sustainability in Communal Socio-Ecological Systems (SUCSES) interviews that are examined at the household level in this study. The linkages between Livelihood Capital (white), Livelihood Strategies (blue) and Livelihood Income (green) are shown. Certain aspects of physical capital, the perceptions on availability of natural resources, the social capital and its associated strategies and incomes, and the donation incomes are not addressed in this study (shaded out).

The SUCSES questionnaire data are captured and stored in a relational database (Microsoft Access), with the data for each section recorded in a separate table in the database. These tables were then imported into Microsoft Excel for processing. Questions one and two had individual data recorded and had to be aggregated per household – this was achieved mainly by using pivot tables. The general rule throughout the analysis was that the missing figures that contributed to the total incomes were assigned with zero. This decision was taken in order to provide an easy, standardised

approach to this issue when analysing SUCSES data that can be easily replicated in future studies. Creating more calculations were likely to add unnecessary incompatibilities, while removing these cases would result is an extremely limited sample size, especially if studies were done over multiple years.

### 2.3.3. Quantifying livelihood incomes

#### *2.3.3.1. Sourcing livelihood income data from the SUCSES interviews*

Households were queried on four broad livelihood income streams – the three land-based activities (EP, livestock husbandry and crop cultivation) and off-farm activities (Table 2.2). These were analysed at three points of assessment (POAs) in the livelihood income chain – the primary income into a household, the value of quantities used thereof, and the cash generated from selling these resources and products (Table 2.2). The primary income value was the value of those resources that initially entered a household that could be consumed within the household or sold. Primary income is not gained through transactions of any resource, but rather sourced directly from the land, or directly through grants and earnings from the off-farm livelihood income stream. The used value was the value of resources that a household consumed which could have been sourced from the primary income activities or through purchasing them. Cash generated was the cash income value that was derived through the selling of land-based resources, or through grants and earnings from the off-farm livelihood income stream. It must be noted that the cash-generation from the off-farm livelihood income stream is equivalent to its primary income value.

Direct Use Values (DUVs) were used to evaluate the primary income and used values of the land-based income streams (Table 2.2). These DUVs are monetary values that are calculated based on how much it would cost a household to buy these resources if they were not sourced from the land. In addition to evaluating primary income and used values of the land-based income streams, households were queried if they also bought any of these land-based resources and the values thereof (Table 2.2). EPs were widely purchased and were taken into consideration in this study. The two agricultural income streams, however, were very rarely purchased and only in small quantities. They were subsequently not considered in this research. Thus, for both crop farming and livestock husbandry, households' primary income values were equivalent to their used income values. For off-farm activities, the primary income value is the same as the cash generation value in that livelihood income stream. The number of household members and the number of permanent residents were recorded per household, with the latter being used to calculate per capita values per household for all livelihood quantifications.

Table 2.2 The four livelihood income streams were analysed at the three POAs in the livelihood income chain with question numbers and codes. The question numbers of the Sustainability in Communal Socio-Ecological Systems (SUCSES) interview where the data was obtained from is listed. The codes provided are the ones that are used for the results diagrams later in this dissertation.

| Livelihood income stream* | POA** | Codes used in figures | Question number | Variable Explanation |
|---|---|---|---|---|
| 1) Environmental products | Primary Income | EPPI | Q16 | The primary income DUV in Rands from EPs harvested/collected. *(DUVs of used values were divided according to frequencies harvested vs. bought)* |
| | Used | EPUsd | Q16 | The used DUV in Rands of EPs (from purchasing and collecting). *(DUVs calculated from volumes of natural resource used per natural resource type. DUVs were approximated from average purchased prices per resource type.)* |
| | Cash Generation | EPCG, | Q18 | Cash generation Rand income from sales of EPs. |
| | Bought (additional) | – | Q16 | The DUV in Rands of EPs purchased *(DUVs of used values were divided according to frequencies harvested vs. bought)* |
| 2) Livestock agriculture | Primary Income | LvsPI | Q26 | The DUV in Rands of livestock and livestock products consumed. |
| | Used | LvsUsd | Q26 | The DUV in Rands of livestock and livestock products consumed. |
| | Cash Generation | LvsCG | Q26 | Cash generation Rand income from sales of livestock and livestock products. |
| 3) Crop agriculture | Primary Income | CropPI | Q20 | The DUV in Rands of major crops harvested. |
| | Used | CropUsd | Q20 | The DUV in Rands of major crops harvested. |
| | Cash Generation | CropCG | Q21 | Cash generation Rand income from sales of crops. |
| 4) Off-farm activities | Primary Income | OfFmPI | Q1, Q3 | Income in Rands from employment, grants, and financial assets accessed. |
| | Used | OfFmUsd | Q4, Q5 | Cash spent in Rands on off-farm activities. |
| | Cash Generation | OfFmCG | Q1, Q3 | Income in Rands from employment, grants, and financial assets accessed. |

*Livelihood Income Streams abbreviations: EPs – Environmental products, *Lvs*- livestock agriculture, *Crop* – crop agriculture, *OfFm* – Off-farm activities
**POAs abbreviations: *PI* – Primary Income, *Usd*- Used, CG – Cash Generation
***Direct Use Value (DUV) is the monetary value attributed to resources that were used by households but were not purchased.

In rural areas, where labour markets are weak and alternative employment to land-based strategies are not common, calculations of opportunity labour costs are difficult to account for (Babulo et al. 2008). Thus, net incomes for all livelihood strategies did not include own-labour costs.

#### *2.3.3.2. Household use of livelihood income streams*

Households reported on whether they received quantifiable income in a particular livelihood stream at each POA. EPs used and harvested consisted of fuelwood, wild fruits, wild vegetable, edible insects, fish caught in local dams and rivers, bushmeat and medicinal plants, with selling also including products that have been processed by households. Crop agriculture took into account 30 crop types commonly planted locally, of which the six most important crop types in the area were classified as "major" crops. These six major crops are maize (*Zea mays*), peanuts (*Arachis hypogaea*), pumpkin leaf (*Cucurbita pep*), pumpkin (*Cucurbita pep*), bambarra beans (*Voandzeia subteranea*) and cowpea (*Vigna unguiculata*). Livestock agriculture accounted for goats, pigs and cattle and excluded chickens, donkeys and sheep. Chickens were excluded because the SUCSES interviews did not quantify the ownership of them. For both donkey and sheep ownership, only one household in both cases reported owning them. Off-farm activities comprised of employment, government grants and accessing finance from savings and loans.

#### *2.3.3.3. Environmental Products: DUV and cash income calculations*

The annual cash incomes received from EPs sales were reported in Rand value by households. EPs that were harvested (primary input), that were used and additionally that which were purchased for each household were quantified using DUVs (Table 2.3). EPs that were harvested could be used by the household or sold, while the value of EPs that was consumed could have been from resources harvested or bought. These EPs consisted of five types of resources: fuelwood, wild fruits, wild vegetable, edible insects and fish caught in local dams and rivers, and excluded the bushmeat and medicinal plants that were accounted for in classifying households as EPs users (please see section 2.3.2.2 of this chapter). For each resource type, it was recorded whether the resource was consumed, the volumes consumed per month, the number of months it was used for in a year, and, if bought, the local price for the resource. Non-consumable resources that have a longer lifespan (e.g. reed mats, poles, thatching grass, woodcarvings and utensils) were excluded due to their small contribution on an annual basis to household livelihoods.

The calculations of the direct use values of EPs first involved calculating the average value per unit volume of each resource. Local metrics were used as volume units to assist households in estimating quantities used (Table 2.3). Residents who purchased these resources provided quotes for these same volume units. All of these metrics represented litre volume units for the various resources

except for the kg metrics of “bundle”, “wheelbarrow load” and “bakkie/pickup trucks” that were predominantly used to estimate fuelwood use (Table 2.3). Households gave all fuelwood amounts in the kg metrics, except for three disqualified cases given in litre metrics. For the other four resources, almost all volume estimations, for both using and pricing, were given in the litre volume metrics (Table 2.3), except for 46 cases. Of these 46 cases, three estimations were given as bakkie volumes, six as wheelbarrow loads and 37 as bundle units. Approximate litre volumes for the bakkie of 1 583.5 ℓ (load volume of Hilux commercial LDV, Toyota website) and for the wheelbarrow of 40 ℓ (from www.lasher.co.za) were used to estimate the volumes for those units. To convert the bundle units into litres, a ratio of 1kg:1.69ℓ was applied to the bundle kg unit. This was calculated by averaging the ratios of kilograms to litres for fuelwood for four metrics (the 50kg maize meal bag, the 80kg maize meal bag, the wheelbarrow load and the bakkie load).

Resources were priced at R0.63/kg for fuelwood (544 users, 104 quotes), R17.05/ℓ for wild fruit (313 users, 11 quotes), R13.50/ℓ for wild vegetables (562 users, 2 quotes), R24.66/ℓ for insects (301 users, 206 quotes) and R5.07/ℓ for fish caught (88 users, 51 quotes). While the quotes from buyers were a good representation of the users for insects (68.4%), fish (58.0%) and fuelwood (19.1%), it must be made a priority of the SUCSES project to ensure that for wild fruit (3.5%) and wild vegetables( 0.4%) more quotes are sourced. The SUCSES project needs to standardise the units used for each resource by allowing only the kg metrics to be used for fuelwood and the litre metrics to be used for the other four EPs estimations.

Table 2.3 Household metrics that were used to convert the quantities of resources that were harvested, used and bought into standard volume units per resource. Buyers provided quotes per household metric per source, which were used to estimate local prices per volume of different resources. These were than combined to give the value of environmental products (EPs) harvested, used and bought in Direct Use Value (DUV) Rands.

| Metric type | Unit description | Volume of unit | Reference |
|---|---|---|---|
| ℓ | mug | 0.4 ℓ | (Twine et al. 2003) |
| ℓ | 5 ℓ bucket | 5 ℓ | (inherent to container) |
| ℓ | 10 ℓ bucket | 10 ℓ | (inherent to container) |
| ℓ | 20 ℓ bucket | 20 ℓ | (inherent to container) |
| ℓ | 50 kg maize meal bag | 69.6 ℓ | (http://convert-to.com/504/cornmeal-amounts-converter.html) |
| ℓ | 80 kg maize meal bag | 111.3 ℓ | (http://convert-to.com/504/cornmeal-amounts-converter.html) |
| kg | bundle | 14.5 kg of fuelwood | (Matsika et al. 2013) |
| kg | wheelbarrow load | 39.6 kg of fuelwood | (Matsika et al. 2013) |
| kg | bakkie/ pickup trucks load | 532 kg of fuelwood | (Twine et al. 2003) |

Using the mean price per volume per resource and the volumes used per annum for each household per resource, the DUV of primary income EPs per household was calculated per annum. The frequency of harvesting vs. frequency of buying was used to calculate a ratio per household to divide the total EPs consumption DUV between harvesting and buying. A total of 13 outliers with reported volumes being unfeasibly large were found from fuelwood, wildfruit and edible insects. These were made zero. They consisted of examples where, for example, 24 pick-up trucks of fuelwood were said to be used in a month and no selling was reported.

#### *2.3.3.4. Livestock Husbandry: DUV and cash income calculations*

Households were asked about their ownership of cattle, donkeys, sheep, goats, pigs and chickens (please see section 2.3.2.2 of this chapter). The cash generation consisted of the sum of annual income per household from the sales of live animals, meat, milk, eggs and manure and the rent from ploughing and transport from these animals. Households were asked to provide the number of animals owned for all livestock except chickens. Only one household owned a sheep and another household owned a donkey. Thus, chickens, donkeys and sheep were not included in the DUV calculations.

Cattle had a DUV through live ownership (milk, manure, ploughing and transport) and when slaughtered for meat, while pigs and goats only have a DUV when slaughtered for their meat and hides (Dovie et al. 2006) (Table 2.4). The DUV per an animal owned/slaughtered was calculated by using ratios of DUV to live sale values per household from Dovie et al. (2006). The average live sale value per animal from the study was calculated by dividing the live sale income per household by the number of animals owned by that household and averaging this value across households. Using this average live sale value per household corrected for number of animals owned by a household in this study and the ratios from Dovie et al. (2006), it was estimated that the DUV from a single head of cattle living was R4 304 pa, while the DUV of a head of cattle slaughtered was R1 016 (Table 2.4). A slaughtered goat had a DUV of R399 and a slaughtered pig R192 (Table 2.4). These DUV were then applied per household by multiplying the appropriate values by the numbers of cattle owned and the numbers of cattle, goats and pigs slaughtered.

Table 2.4 The DUVs used in this study that were attached to a living head of cattle, a slaughtered head of cattle, a slaughtered goat and a slaughtered pig. This was calculated using the ratios of DUV to live sale values per household from Dovie et al. (2006) and the live sale values from this study adjusted per household according to different numbers of animals owned/slaughtered per household.

| | **Livestock component according to animal** | **Ratio of live sale value to DUV per household from** (Dovie et al. 2006) | **Average live sale value per household corrected by animals owned by a household in this study** | **Calculated DUV of component per animal living/slaughtered** |
|---|---|---|---|---|
| Cattle | DUV of milk, manure, ploughing and transport (for live animals) | 1:2.71 | R1 588.16 | R4 304 |
| | DUV of meat consumed (only for slaughtered animals) | 1:0.64 | R1 588.16 | R1 016 |
| Goats | DUV of meat consumed and hides (only for slaughtered animals) | 1:2.24 | R177.91 | R399 |
| Pigs | DUV of meat consumed (only for slaughtered animals) | 1:2.00 | R95.83 | R192 |

#### *2.3.3.5. Crop cultivation: DUV and cash income calculations*

For the major crops grown, the annual volumes grown and the annual volumes and Rand incomes of crops sold were queried from households. However, for the remaining 24 "minor" crops, households were only asked if they crops were grown and the annual Rand income from sales thereof. The Rand value was the sum of cash income of all crop sales. The same volume metrics used for EPs using local objects were used to assist households in estimating quantities harvested with all crops being reported using litre metrics (Table 2.3). Overall, too few households sold their crops to allow for the conversion of the volumes of major crops harvested to a DUV in Rands. Instead, the estimated price of maize per litre was inflated using CPI of 6% per annum from the 1999 prices in Dovie and Shackleton (2003) to a 2010 value of R1.89/ℓ. This price was applied to litre volume calculations of crops, of which maize made up the bulk of volumes. The values harvested were assumed to represent both the consumed and primary income value, as households in general did not buy crops from each other.

#### *2.3.3.6. Off-farm activities: cash income and expenditure calculations*

Primary income of off-farm cash income into households was recorded on an individual basis for household members and then aggregated per household. Monthly values received were recorded for grants received for child support, foster care, disabilities and pensions, which were all multiplied by 12 to estimate the annual amounts. Monthly income from work and trading was recorded with the number of months these incomes were earned also recorded and used to convert these monthly

incomes into annual figures. Annual amounts of cash from financial assets accessed were included and consisted of using money from individual lenders, loan companies, co-operatives, saving accounts and funeral plans. All of these incomes were summed up per household and represented both the primary input and the cash generation values from off-farm activities.

The cash spent per a household on off-farm purchases was interpreted as the used value of off-farm activities. The cash spent included the money spent on groceries (e.g. food, toiletries, and household cleaning products) that were purchased from the local market, spaza, general dealer and supermarket. Money spent also included what was spent on water, electricity, education, childcare, health care, donations, support to others and what was invested in savings, insurance and paying off debts. These monthly sums for households were multiplied by 12 for the yearly expenditure.

### 2.3.4. Quantifying socio-economic characteristics and adopted livelihood strategies

#### *2.3.4.1. Sourcing socio-economic characteristics data from the SUCSES interviews*

Socio-economic variables that were examined were taken mainly from question one in the SUCSES interviews and were aggregated from the individual level to that of the household (Table 2.5). The different socio-economic variables are listed in Table 2.5 with the corresponding question numbers and variable explanations. Households were first queried on a range of social characteristics consisting of the numbers and proportions of household members according to residential status, gender, age, education and health (Table 2.5). The choice of using proportions instead of ratios of characteristics eliminates the problem of having undefined values when households scored zero for some characteristics. Additionally, a proxy based on assets owned by households was used to reflect the wealth status of households.

Table 2.5 Socio-economic variables used in the analysis with the source question numbers in the Sustainability in Communal Socio-Ecological Systems (SUCSES) interviews and the codes that are used for the results diagrams later in this dissertation.

| Codes used in figures | Question number | Variable Explanation |
|---|---|---|
| HHSize | Q1 | Household (HH) size, the number of people who are associated with the household. |
| PermNum, PermProp | Q1d | Number and proportion of HH members who are permanent. |
| FemNum, MaleNum, FemProp | Q1a | Numbers of males and females per HH, and the proportion of the HH who are female. |
| AdltNum, ChildNum AdltProp | Q1b | Numbers of members per HH who are older and younger than 10 years old, and the proportion of the HH who are older than 10 years old. |
| HelthNum, SickNum, SickProp | Q1f | Numbers healthy and sick members per HH, and the proportion of the HH who are sick. |
| MrrdNum, MrrdProp | Q1i | Number and proportion of HH members who report being either formally or informally married. |
| EduNum, EduProp | Q1e | Number and proportion of HH members who have basic education i.e. completed their Grade 7 education or higher, or have an ABET qualification. |
| EduCNum, EduCProp | Q1e | Number and proportion of HH members who have some form of certified education i.e. completed their Grade 9 education or higher. |
| WlthProx | Q5 | Wealth proxy, the proportion of a total of 15 HH assets owned. |

#### *2.3.4.2. Sourcing adopted livelihood strategies data from the SUCSES interviews*

The adopted livelihood strategies -economic variables that were examined were taken from various questions from the SUCSES (Table 2.6). The adopted livelihood strategies captured the households' involvement in the three land-based livelihood income streams (EP, livestock husbandry and crop cultivation) and the off-farm livelihood income stream (Table 2.6). Livelihood strategies were quantified through households' choices to engage in the different livelihood activities as well the numbers of household members who were involved in various occupations. The different livelihood strategies are listed in Table 2.6 with the corresponding question number and variable explanation. Some of the answers were available at the individual level and were aggregated to the household level.

Table 2.6 Adopted livelihood strategies that were examined in this study with the source question numbers in the Sustainability in Communal Socio-Ecological Systems (SUCSES) interviews and the codes that are used for the results diagrams later in this dissertation.

| Codes used in figures | Question number | Variable Explanation |
|---|---|---|
| EPColctr, EPUser, EPSeller, EPBuyer | Q16g Q16a Q18a Q16i | Whether a household (HH) collected, used, sold or bought environmental products (EPs). |
| EPNinvl | Q2h | Number of HH members older than 10 years old who reported being involved in EPs collection in the preceding month. |
| LvsOwnr, LvsSellr | Q20a Q21a | Whether a HH owned livestock or sold a livestock product. |
| LvsNinvl | Q2f | Number of HH members older than 10 years old who reported being involved in livestock farming (e.g. feeding, milking, tending sick animals) in the preceding month. |
| CrpGrowr, CrpSellr | Q26a Q26e | Whether a HH grew or sold crops |
| CrpNinvl | Q2e | Number of HH members older than 10 years old who reported being involved in crop agriculture (e.g. ploughing, sowing, weeding, reaping) in the preceding month. |
| Nmplyd, Nunmplyd, Pmplyd | Q1j | Numbers employed and unemployed members per HH, and the proportion of the HH who are employed. |
| NmplydFT, PmplydFT | Q1j | Number and proportion of HH members who are employed full time. |
| NmplydPT, PmplydPT | Q1j | Number and proportion of HH members who are employed part time. |
| Nstudent | Q1j | Number of students per HH. |
| Npension | Q1j | Number of pensioners per HH. |
| Ngrants | Q1g | Number of grants received per HH. |
| AcsedFin | Q3a | Whether a HH accessed finance from either savings or credit sources. |

## 2.4. DATA ANALYSIS

### 2.4.1. Summary statistics and histogram generation

Analysing the livelihood income values compromised of both summary statistical analysis and then histogram generation. The code for both is provided in Appendix 2.4. R version 3.2.0 (2015-04-16) was used with no additional packages required (R Core Team 2015). Note that if the analyst uses the programming interface R-studio, changing the dimension of the plots when exporting the plots changes the positions of the legend and additional labels in relation to the plot. The annual average exchange rate for 2010 was that one US dollar was worth 7.638 South African Rands (IRS 2015).

### 2.4.2. Ordination analysis

Ordination analysis was used to analyse the data. Ordination methods are explanatory tools used to perform operations on a community data matrix i.e. a sample of observations where each

observation consists of a set of observed variables of interest and a set of possible explanatory variables (Ramsey and Schafer 2002). Ordinations construct linear combinations of variables from the original variables to form axes where the new combinations of variables are not correlated with each other (Ramsey and Schafer 2002). Ordinations are particularly useful in finding patterns in data sets where: observations of the different variables of interest are often zero and have redundancy; there is a large set of explanatory variables of which only a few may be important; and overall there is a lot of noise in the dataset (Palmer n.d.). Ordinations are designed to point in general directions to suggest reductions in multivariate data before formal data analysis and the detailed linear combinations , coefficients and scores are rarely used directly (Ramsey and Schafer 2002).

Data in this study were analysed using two methods of ordination. Principal Components Analysis (PCA) ordinations were first used to profile the patterns within each of the separate livelihood components of socio-economic characteristics, adopted livelihood strategies, and the livelihood incomes at all three POAs (Figure 2.2). In these PCAs, the axes of the ordinations correspond to the directions of maximum gradient variability within the observed data (Lepš and Šmilauer 2003) and thus reflect patterns in these observed values. Thereafter, Redundancy Analysis (RDA) ordinations were used to profile the livelihood incomes at all three POAs, where the axes were first constrained by the set of household characteristics and then by the set of adopted livelihood strategies (Figure 2.2). RDAs explain less variation in the explanatory data set compared to PCAs, but the variation is explained through the potential set of explanatory variables (Lepš and Šmilauer 2003). For all ordinations, any undefined value was made zero for the analysis within calculations.

Both PCA and RDA are linear ordination methods and were chosen over their weighted average counterparts on the basis that the lengths of gradients from the results of detrended ordinations were less than three i.e. the variation can be captured through linear methods (Lepš and Šmilauer 2003). Standardised ordinations were run in addition to non-standardised ordinations when livelihood incomes were the response variable for both PCAs and RDAs (Figure 2.2). These standardised ordinations reflect the relationships between relative changes in the variables (Lepš and Šmilauer 2003). The standardised ordinations can thus help understand whether there are changes within the different livelihood incomes taking into consideration that the possible absolute values differ between the different livelihood income streams. The significance of the first and of all canonical axes in the RDA ordinations was tested using Monte Carlo Tests with unrestricted permutations. All ordinations were done in CANOCO for Windows, Version 4.51 (ter Braak and Smilauer 2003).

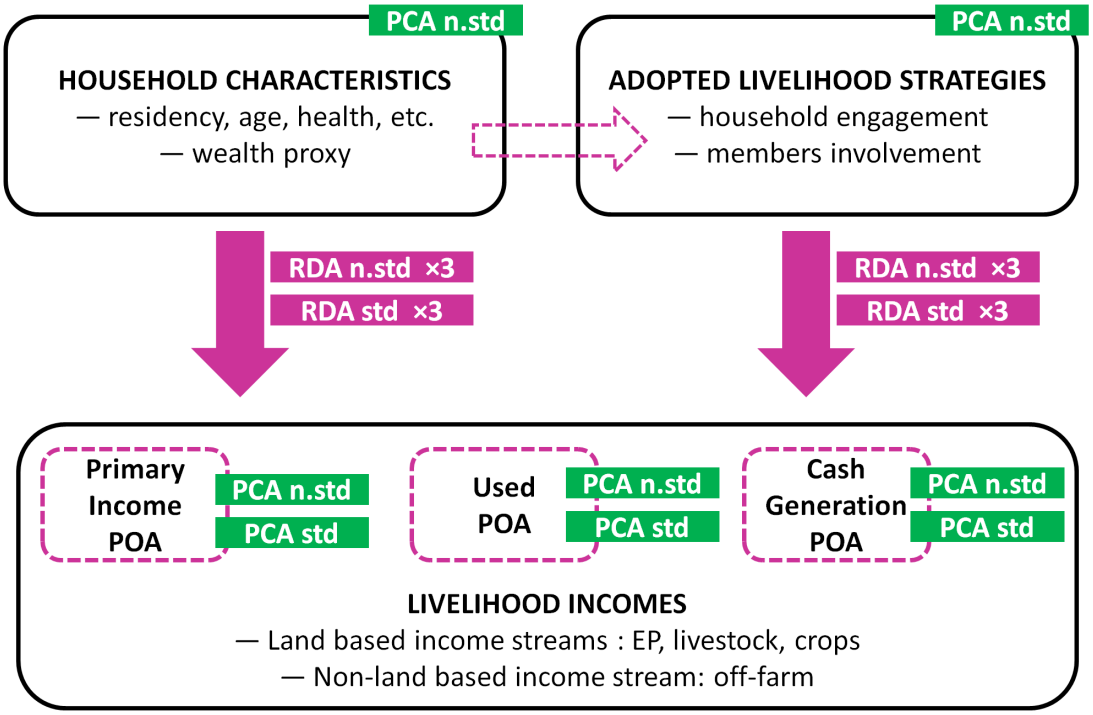



Figure 2.2 Flow diagram of the ordinations ran on the three livelihood components: household characteristics, adopted livelihood strategies and livelihood incomes. The four livelihood income streams (EP, livestock, crops and off-farm) were analysed at three POAs in the livelihood income chain. Both standardised (std) and non-standardised (n.std) PCAs were run on the livelihood incomes, while only non-standardised PCAs were run on the household characteristics and adopted livelihood strategies. Both standardised (std) and non-standardised (n.std) RDAs were used to explain livelihood incomes using first household characteristics and then adopted livelihood strategies

### 2.4.3. Interpreting the ordination analysis diagrams

The ordination analysis results are presented on ordination biplots created using CANOCO for Windows, Version 4.51 (ter Braak and Smilauer 2003). Centering by species (explanatory variables) was done with the scaling in the biplots focussing on species correlations. Schematic explanatory plots are presented in Figure 2.3 to guide the reader in understanding and interpreting these biplots. The ordination results of the first axis, which accounts for the most variation in the observed values, are plotted on the horizontal x-axis of the plots (Figure 2.3). The results of the second axis, which accounts for the second most amount of variation within the data, are plotted on the vertical y-axis of the ordination biplots (Figure 2.3).

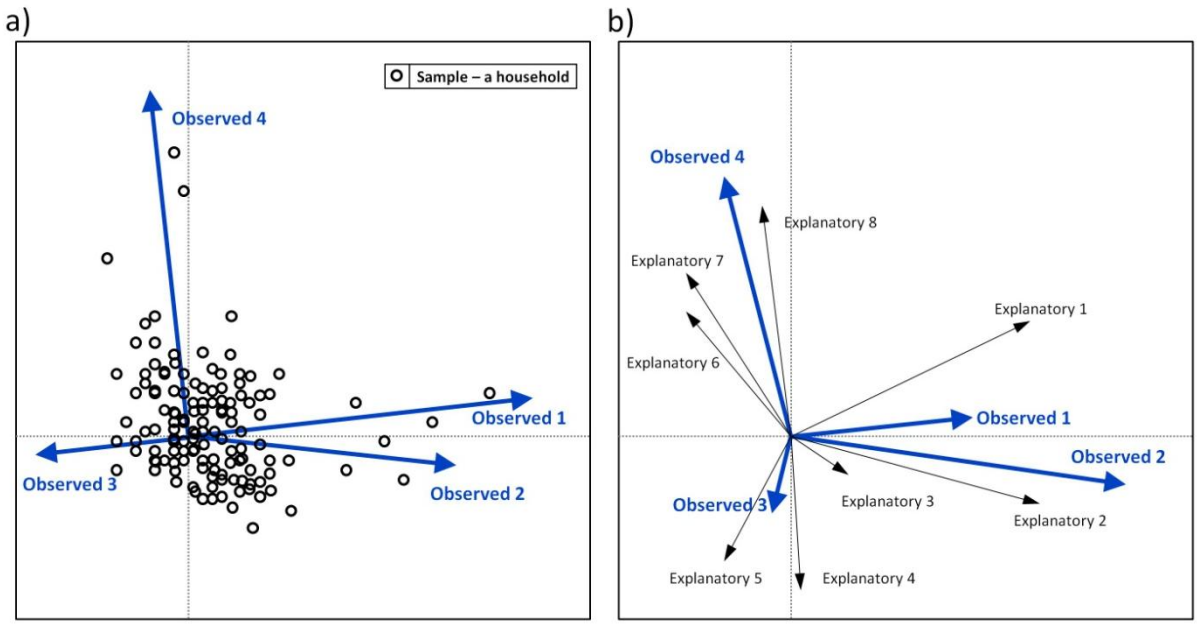



Figure 2.3 Schematic diagrams of a) PCA and b) RDA ordination biplots to aid understanding and interpretation. Circles (○) represent sampled households, while arrows represent the observed and explanatory variables.

The PCA biplots presented in this thesis (Figure 2.3a) display how the observed variables relate to each another and the distribution of the different household with regards to these variables. The directions that the arrows of the observed variables faced reflect how they were correlated. Variable arrows that were in the same direction, like Observed 1 and 2 (Figure 2.3a), are positively correlated with each other across the data. Variable arrows in opposite directions, like Observed 1 and 3 (Figure 2.3a), are negatively correlated with each other across the data. Variable arrows that are perpendicular to each other, like Observed 4 and 1 or Observed 4 and 3 (Figure 2.3a), are not related to each other. The length of a arrow reflects the size of the relative effect of that variable across the data.

The distribution of households in the PCA biplot (Figure 2.3a), reflect their values with regards to the observed variables. When projecting households perpendicular to an observed variable arrow, if the projection on to the variable is near the centre of the plot (0,0), than the household has the average value for that particular variable. If the projection lies further from the centre of the plot in the direction of the arrow, than the household has an above average value for that variable. If the projection lies further from the centre of the plot in the opposite direction of the arrow, than the household has a below average value for that variable.

The RDA biplots presented in this thesis (Figure 2.3b) display how the observed variables relate to each another when explained using the explanatory variables. The relationships between the arrows are interpreted in the same manner as for the PCA diagrams. However, the focus in the RDA interpretation is more on which explanatory variables are correlated with which observed variables, compared to the PCA diagrams where the focus was on the relationships between the observed variables.

### 2.4.4. Generalised Linear Models (GLMs)

Environmental income dependencies were calculated as the proportional contribution of the environmental income stream to the household livelihood income portfolio at all three POAs. Fractional GLMs using logit links were run in R version 3.2.0 (2015-04-16) (R Core Team 2015). Global models were run using either the entire set of socio-economic characteristics (Chapter 4) or the entire set of adopted livelihood strategies (Chapter 5). Example code is provided in Appendix 2.5.

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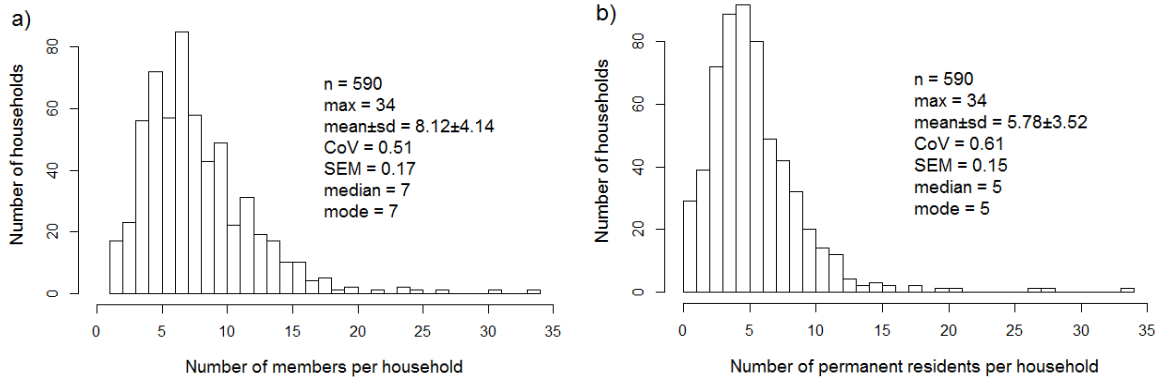
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## 2.6. APPENDICES

**Appendix 2.1 The summary statistics and frequency distributions of a) total household sizes and b) number of permanent residents. Total household size includes the number of permanent and temporary household members. Taking into consideration that both distributions were not normally distributed, the medians were more representative of the average of these components.**



**Appendix 2.2 The summary statistics of household size of the 590 households according to the nine villages that make up the sample. The number of households is provided with summary descriptive stats for each village as well across households. Household size includes the number of permanent and non-permanent members (Bushbuckridge, Mpumalanga , South Africa, 2010)**

| Village | Rainfall zone | n | Mean | Standard deviation | Co-efficient of variation | Standard error of mean | Median | Mode |
|---|---|---|---|---|---|---|---|---|
| All villages | — | 590 | 8.12 | 4.14 | 0.51 | 0.17 | 7 | 7 |
| Agincourt | Wet west | 95 | 8.82 | 3.96 | 0.45 | 0.41 | 8 | 7 |
| Cunningmore B | Wet west | 50 | 7.72 | 3.43 | 0.44 | 0.48 | 7 | 7 |
| Huntington | Semi-arid east | 42 | 7.76 | 4.21 | 0.54 | 0.66 | 7 | 5 |
| Ireagh A | Mesic-mid | 49 | 8.12 | 3.59 | 0.44 | 0.51 | 8 | 10 |
| Ireagh B | Mesic-mid | 26 | 7.42 | 4.30 | 0.58 | 0.84 | 6 | 6 |
| Justicia AB | Semi-arid east | 94 | 7.82 | 3.87 | 0.49 | 0.40 | 7 | 4;5 |
| Kildare ABC | Mesic-mid | 141 | 8.40 | 4.81 | 0.57 | 0.41 | 7 | 7 |
| Lillydale B | Semi-arid east | 32 | 7.56 | 5.60 | 0.74 | 0.99 | 6 | 5;6;7 |
| Xanthia | Wet West | 61 | 7.98 | 2.94 | 0.37 | 0.38 | 8 | 8 |

**Appendix 2.3 The summary statistics of the number of permanent members per household of 590 households according to the nine villages that make up the sample. The number of permanent members is provided with summary descriptive stats for each village as across all households (Bushbuckridge, Mpumalanga, South Africa, 2010).**

| Village name | Rainfall zone | n | Mean | Standard deviation | Co-efficient of variation | Standard error of mean | Median | Mode |
|---|---|---|---|---|---|---|---|---|
| All villages | - | 590 | 5.78 | 3.52 | 0.61 | 0.15 | 5 | 5 |
| Agincourt | Wet west | 95 | 5.67 | 3.01 | 0.53 | 0.31 | 5 | 3 |
| Cunningmore B | Wet west | 50 | 5.42 | 2.79 | 0.52 | 0.39 | 5 | 5 |
| Huntington | Semi-arid east | 42 | 5.46 | 3.32 | 0.61 | 0.52 | 5 | 6 |
| Ireagh A | Mesic-mid | 49 | 5.69 | 2.37 | 0.42 | 0.34 | 6 | 4 |
| Ireagh B | Mesic-mid | 26 | 4.81 | 2.23 | 0.46 | 0.44 | 5 | 4;6 |
| Justicia AB | Semi-arid east | 94 | 6.05 | 3.47 | 0.57 | 0.36 | 5 | 4 |
| Kildare ABC | Mesic-mid | 141 | 6.04 | 4.37 | 0.72 | 0.37 | 5 | 5 |
| Lillydale B | Semi-arid east | 32 | 6.09 | 5.23 | 0.86 | 0.92 | 5 | 5 |
| Xanthia | Wet West | 61 | 5.79 | 2.96 | 0.51 | 0.38 | 5 | 5 |

**Appendix 2.4 R code used to extract summary statistics from the income data and produce histograms:**

```
##### Summary Statistical Analysis plots #####

###Setting up

setwd("C:/File Path")

data<-read.csv("File Name.csv",header=T)

### Count,SEM, CoV, Mode functions

Count<-function(x){
  length(x[!is.na(x)])
}

SEM<-function(x){
  sd(x,na.rm=T)/sqrt(Count(x))
}

CoV<-function(x){
  sd(x,na.rm=T)/mean(x,na.rm=T)
}

Mode<-function(x){
  names(table(x))[table(x)==max(table(x))]
}

### Summary function

mysummary<-function(x,y){
 c(Count(x),max(x,na.rm=T),mean(x,na.rm=T),sd(x,na.rm=T),CoV(x)
 ,SEM(x),median(x,na.rm=T),Mode(y))
}

###Summaries for engaging HH
#To calculate income statistics across households, non-earners
must be made zero.
#To calculate income statistics for only engager, non-earners
must be made "NA".
#The "y" in the "mysummary" function is for identifying the
mode. It is recommended that the mode be calculated from income
values that are rounded-off to the nearest R100.

 SummaryStat<-
c("Count","Max","Mean","StDev","CoefVar","SeM","Median","Mode-
check","Mode2-check","Mode3-check")

income_value_used<-mysummary(data$income_value_used,
data$income_value_used_rounded)

income_value_used_percapita<-
mysummary(data$income_value_used_percapita,data$income_value_use
d_rounded_percapita)
```

```
income_value_cash_generation<-
mysummary(data$income_value_cash_generation,
data$income_value_cash_generation_rounded)

income_value_cash_generation_percapita<-
mysummary(data$income_value_cash_generation_percapita,data$incom
e_value_cash_generation_rounded_percapita)

Income_summary<-
cbind(SummaryStat,income_value_used,income_value_used_percapita,
income_value_cash_generation,income_value_cash_generation_percap
ita)

write.csv(Income_summary, "C:/File path/New Summary File
Name.csv")

###Histogram Example
#Histograms were done for engaging households, not all
households

##Making the histogram
#The number of breaks was determined by number of households,
rough guidelines: when n>100, breaks=140; when 30<n<100,
breaks=15; when n<30, breaks = 5

hist(data$
income_value_used,cex.lab=1.1,breaks=15,ylim=c(0,40),ylab=
"Number of households",xlab="Used income from income stream
(R/HH/annum)")

##Adding the legend

legend(50000,55,cex=1.2,bty="n",legend="n = 70
max = R9 999
mean±sd = R9 999±R999
CoV = 9.99
SEM = R999
median = R9 999")

##Adding the figure label

mtext("1.a) \n \n \n \n \n \n \n \n \n \n \n \n
\n",side=1,line=3,at=c(-24000),cex=1.5)
```

**Appendix 2.5 Example of R code used for the fractional logit GLMs of proportional environmental income dependencies that were explained either using the set of socio-economic characteristics or the set of adopted livelihood strategies:**

```
###Setting up

setwd("C:/File Path")

data<-read.csv("File Name.csv",header=T)

model<-glm(Proportional_env_income~ Var 1 + Var 2 + Var 3 + ...,
            family=quasibinomial(link=logit),data=data)
 summary(model)
```

# CHAPTER 3

# 3. THE CONTRIBUTION OF ENVIRONMENTAL INCOME, CROPS, LIVESTOCK AND OFF-FARM ACTIVITIES TO RURAL LIVELIHOOD PORTFOLIOS

## 3.1. ABSTRACT

Environmental income forms an important part of households' diversified livelihood portfolios for both household consumption and cash generation, in rural socio-ecological systems. In addition to environmental income, households also depend on monetary and non-monetary income from two other land-based livelihood income streams, namely crop farming and livestock husbandry, as well as from off-farm livelihood income streams. While prior studies have quantified these incomes before, they failed to differentiate between different points of assessment (POAs) within the livelihood income chain and analyse these incomes collectively as a portfolio. This study addressed these shortcomings using data collected in household interviews that were conducted in 2010 in 590 households across nine villages in the Bushbuckridge municipality of South Africa. The interviews focussed on the quantification of four livelihood income streams at three different POAs in the livelihood income chain — the primary income value into the household, the value used for household consumption, and the amount of cash generated. Incomes were compared using summary statistics, distribution plots and PCA ordinations. The majority of households used environmental, crop and off-farm income sources for primary income. In contrast, less than 12% of households made use of livestock for primary household income and consumption. Very few households relied on the land-based livelihood income streams for cash generation. While the livestock income stream was used less frequently than the other two land-based income streams, it was as valuable as the off-farm income stream to the households that used it. Absolute value changes in the land-based income streams were not related to the absolute value changes in the off-farm income streams. Relative variation in livestock primary income was related to off-farm primary income while relative variation in the crops and environmental cash generation was related to corresponding cash generation values in the off-farm income stream. Variation in the degree of reliance on different income streams highlights the need to examine collectively the different income streams that contribute to a livelihood portfolio. Furthermore, the contribution of these different streams to the livelihood portfolio needs to be differentiated at different POAs.

## 3.2. INTRODUCTION

The use of the natural environment by rural households forms an important part of their diversified livelihood portfolio, especially by supporting consumption on a daily basis (Cavendish 2000, Angelsen and Wunder 2003, Vedeld et al. 2007, Angelsen et al. 2014). This environmental income also serves as a safety net to overcome stresses and shocks to household income, and, for a small proportion of households, it serves as a pathway out of poverty by increasing total household income and providing opportunities to be involved in alternative means of livelihood income generation (Angelsen and Wunder 2003, Vedeld et al. 2007, Angelsen et al. 2014). As part of their diversified livelihood portfolios, rural households are typically dependent on cash income generated from off-farm activities as well as on cash and non-cash income from land-based livelihood income streams i.e. environmental income, crop farming and livestock husbandry, with the latter two often referred to as agricultural income.

Multiple, diversified means of income generation play an important role in the resilience and sustainability of rural livelihoods (Carney 1998, Devereux 2001, Carney 2003, Slater 2002, Babulo et al. 2008). Studies rank the importance of the various livelihood streams to households differently, with estimates of the different incomes, including environmental income, varying in their absolute and relative contributions to the total household income portfolio (Cavendish 2000, Godoy et al. 2002, Fisher 2004, Dovie et al. 2005, Vedeld et al. 2007, Mamo et al. 2007, Babulo et al. 2009, Thondhlana et al. 2012, Angelsen et al. 2014). A number of studies are focussed on examining only one or two livelihood streams and are thus unable to reflect how the different income streams change as a portfolio across households (e.g. Shackleton et al. 2002, Twine et al. 2003, Paumgarten and Shackleton 2011), which can lead to incorrect assumptions (Dercon 2000). Another often-overlooked aspect is that different livelihood streams contribute unequally at different stages or points of assessments (POAs) in the livelihood chain, especially with regards to how they use these resources within the household compared to how they generate cash income (Godoy et al. 2002).

In rural South Africa, households are mainly dependent on off-farm cash income from employment (particularly migrant labour) and from social government grants (Giannecchini et al. 2007, Hunter et al. 2007). However, they harvest or purchase, and subsequently use or sell, environmental products (EP), and farm, use and sell crops and livestock (Dovie and Shackleton 2003, Shackleton et al. 2005, Dovie et al. 2006). Many studies undertaken in South Africa, particularly in the Bushbuckridge region of Mpumalanga province, have quantified different livelihood incomes, but usually only account for some income streams and are quantified in units that are not comparable to each other (e.g. High and Shackleton 2000, Shackleton et al. 2002, 2005, Dovie et al. 2005).

The objective of this chapter is to quantify and compare the collective contributions made by four livelihood income streams (environmental, livestock, crop and off-farm activities), at three POAs to the livelihood income portfolios of households in the Bushbuckridge region of South Africa. The three POAs in the livelihood chain differentiated in this study were the primary income into a household, the value used, and the cash generated from that specific livelihood stream. Environmental income in this research was taken to specifically refer to the non-agricultural tangible value derived — in cash sales or through direct use — from products harvested or purchased from all wild or uncultivated natural ecosystems including private game reserves and communal rangelands (*sensu* Vedeld et al. 2007).

## 3.3. METHODS

All details of the methodology relevant to this work can be found in Chapter 2 of this dissertation. For a description of the study site, please refer to section '2.1. Bushbuckridge, South Africa'. Here the different sub-sections cover the geography, climate and vegetation of Bushbuckridge, and its history, people and their livelihoods. The explanation of how this study falls under the Sustainability in Communal Socio-Ecological Systems (SUCSES) research project of the Agincourt Health and Socio-Demographic Surveillance System (Agincourt HDSS) is found in section '2.2. The SUCSES research project, Agincourt HDSS, Bushbuckridge of this dissertation'.

The data that was sourced and used for this study has been explained in the section '2.3. Approaching SUCSES in this study of this dissertation. The data that this chapter is mainly based on are described under section '2.3.3. Quantifying livelihood incomes', with the details of use and value calculations of all four livelihood income streams in sub-sections 'In rural areas, where labour markets are weak and alternative employment to land-based strategies are not common, calculations of opportunity labour costs are difficult to account for (Babulo et al. 2008). Thus, net incomes for all livelihood strategies did not include own-labour costs.

2.3.3.2. Household use of livelihood income streams' to '2.3.3.6. Off-farm activities: cash income and expenditure calculations'. The statistical summary analysis protocol for analysing livelihood incomes is explained in section '2.4.1. Summary statistics and histogram generation' and the ordination protocol under the section '2.4.2. Ordination analysis'.

## 3.4. RESULTS

### 3.4.1. Household involvement in different livelihood income streams

The proportions of households that used the different income streams differed at the different POAs in the livelihood chain. Almost all household used (99.0%) and collected (97.8%) EPs, while only just

over a tenth of households reported selling these resources for cash (Figure 3.1). While 18.5% of all households owned livestock, only 11.9% of all households obtained tangible, quantifiable benefits from their livestock and even fewer households (8.0%) generated cash from the livestock income stream (Figure 3.1). Similar to EPs, crops were grown and used in almost all (96.8%) of the households but less than 5% of households reported selling these crops (Figure 3.1). Households that sold livestock products represented a larger proportion of livestock-owning households (43.1%) than when compared to the proportion of EPs primary income households that sold EPs (10.7%) or the proportion of crop growing households that sold crops (4.3%). Off-farm livelihood sources were used by 99.3% of households as a source of primary cash income, with all households reporting spending cash on off-farm products and services (Figure 3.1). Households rarely bought livestock and crop products; thus, the numbers of households using these resources also represented the number of households who were using these income streams on a primary income basis (Figure 3.1). Similarly, since the primary income from off-farm activities is in the form of cash, the number of households involved in off-farm primary income is the same as the number of households generating cash income from off-farm activities (Figure 3.1).

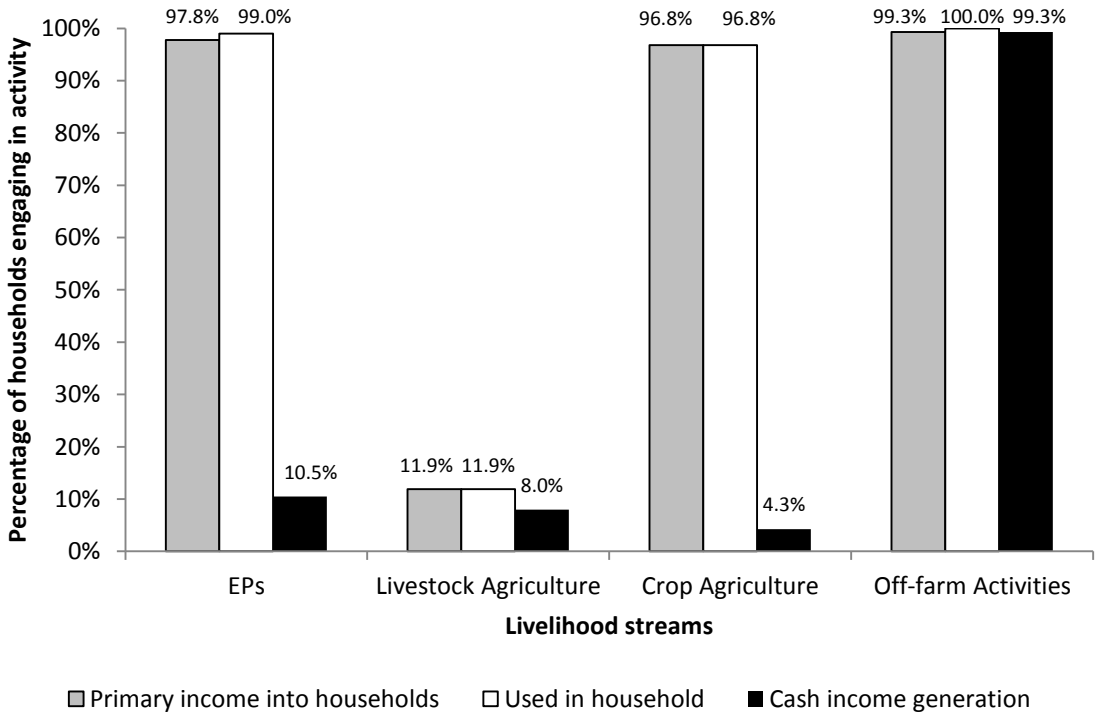



Figure 3.1 Percentages of households that were involved in the four livelihood streams at three different points of assessment (POAs) in the household livelihood chain (n=590).

### 3.4.2. Environmental Products (EPs)

Of the 590 households surveyed, 99.0% (584 households) used EPs with almost all households reporting that they collected at least one EP, and just over 50% reporting that they purchased at

least one EP (Figure 3.2). This 99.0% of user households can be further understood with just under half of all households only collecting EPs, just over half of all households collecting and purchasing EPs, and only 1% of all households relying solely on purchasing EPs (Figure 3.2). The remaining 1% of households that neither bought nor collected EPs comprised six non-user households and one user household who did not state from where they sourced their EPs.

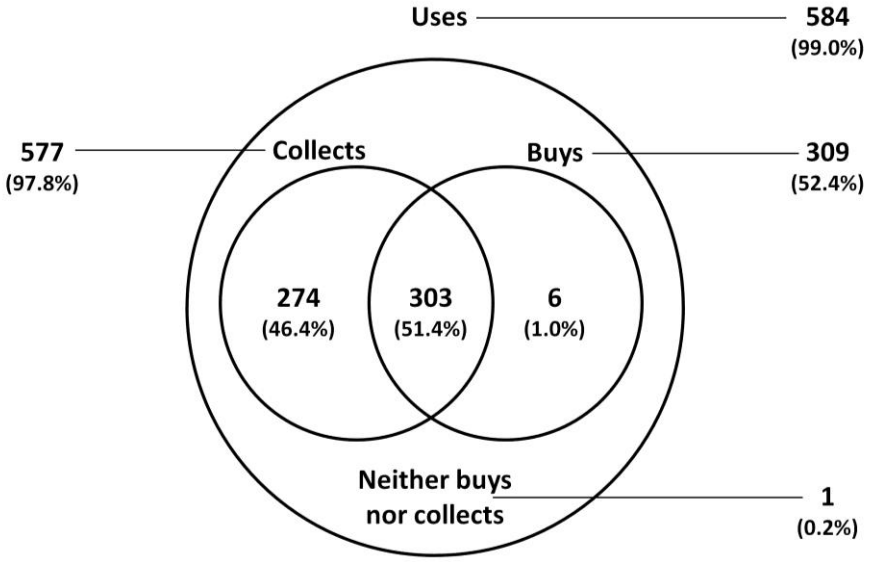



Figure 3.2 Venn diagram showing the number of EPs user households that either collected or bought or both collected and bought EPs (n=590).

The using-collecting-buying involvement varied among the different types of environmental products. While more than 90% of households used and collected wild vegetables, few of these households purchased this EP (Table 3.1). However, wild fruit and fuelwood were commonly used, but with higher proportions of households purchasing these resources (Table 3.1). Insects and fish were more commonly bought than collected by households (Table 3.1). The reported numbers of households collecting and purchasing did not add up to the number of households using as some households both collected and bought those resources and some households did not report how they sourced particular resources.

Table 3.1 The numbers and percentages of households that used, collected and bought different types of Environmental Products.

| Type of EPs | Households that used | Households that collected | Households that bought |
|---|---|---|---|
| Fuelwood | 544 (92.2%) | 464 (78.6%) | 104 (17.6%) |
| Wild fruit | 313 (53.1%) | 301 (51.0%) | 11 (1.9%) |
| Wild vegetables | 564 (95.65%) | 556 (94.2%) | 2 (0.3%) |
| Insects | 301 (51.0%) | 96 (16.3%) | 207 (35.1%) |
| Fish | 88 (14.9%) | 35 (5.9%) | 53 (9.0%) |

The direct use values for EPs were quantifiable at the primary income POA for 574 collector households and at the used POA for 580 households (Figure 3.3). The primary income had a mean ± SD of R4 383 pa ± R6 583 pa, which was less than the used value of R6 684 pa ± R9 874 pa. Similarly, the primary income median of R2 287 pa was less than the used median of R3 795 (Figure 3.3). The value of EPs bought by buyer households was estimated at R4 545 pa ± R10 056 pa with a median of R1 946 pa. Only 62 (10.5%) households reported selling at least one EP, of which 50 households provided cash income figures with a mean ± SD of R12 957 pa ± R54 483 pa and a median value of R550 pa (Figure 3.3).

The ranges in EPs household values for primary income and used were large. The majority of households fall in the lower classes (i.e. associated with medians and modes) with the frequencies of households per income class steeply decreasing as income increases (Figure 3.3). While this pattern is not as pronounced in the EPs used, it is reinforced for both primary income and used values when corrected to per capita values with the per capita values having larger coefficients of variations than their household counterparts do (Figure 3.3). For the sales of EPs, there is also a sharp decline in the number of households as income increases, with very few households occurring at the top of the range (Figure 3.3). While the per capita values had larger co-efficient of variations than household values, the distribution pattern of values did not noticeably change (Figure 3.3).

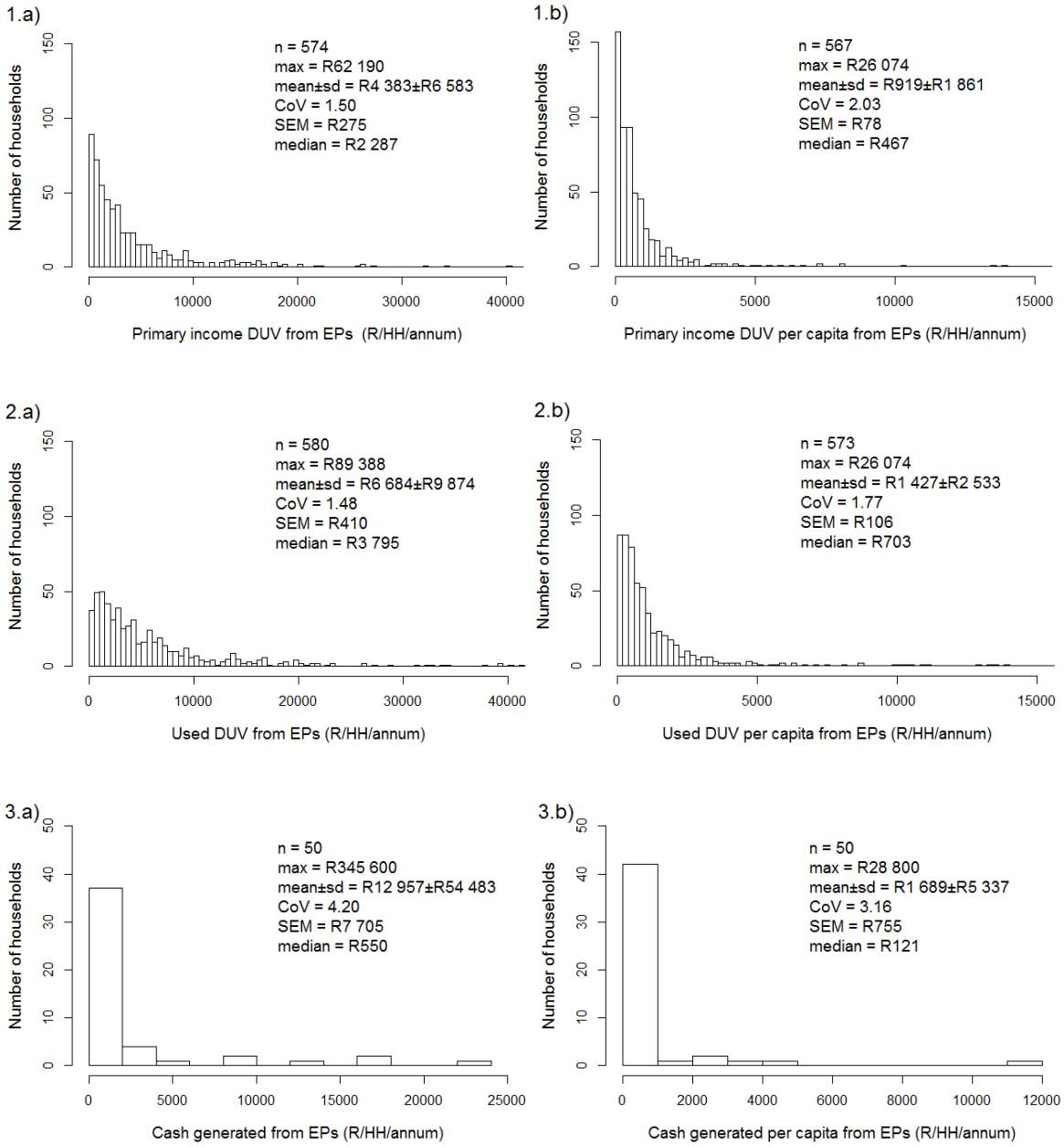



Figure 3.3 The household environmental products (EPs) values a) per household per annum and b) per capita per household per annum for 1) Direct Used Value (DUV) Used for 580 households, 2) DUV harvested for 574 households and 3) the cash income received from the sale of EPs for 50 households. Only households that were involved in these activities were used in these analyses.

The mean values of EPs bought and sold changed considerably when extended to represent all households in the area instead of only households that were involved in the buying and selling EPs. However, only a small change in the mean value was seen in primary income and used value when extended to represent all households. The mean bought value decreased by a factor of 2.44 when averaged across all households, while the mean cash generation value decreased by a factor of 11.8 (Table 3.2). The mean DUV for EPs collected and used only decreased by R119 and R114 respectively when averaged across all households (Table 3.2).

Table 3.2 Summary statistics of the values of environmental products (EPs) harvested, bought, used and sold per household that was involved in that activity and across all households per annum.

| summary statistic | Primary income EPs DUV | | Used EPs DUV | | EPs sales cash generation | | Bought EPs DUV | |
|---|---|---|---|---|---|---|---|---|
| | Collector HH | All HH | User HH | All HH | Seller HH | All HH | Buyer HH | All HH |
| **N** | 574 | 590 | 580 | 590 | 50 | 590 | 290 | 590 |
| **mean** | R4 383 | R4 264 | R6 684 | R6 570 | R12 957 | R1 098 | R4 545 | R2 234 |
| **standard deviation** | R6 583 | R6 532 | R9 874 | R9 828 | R54 483 | R16 124 | R10 056 | R7 402 |
| **coefficient of variation** | 1.5 | 1.53 | 1.48 | 1.5 | 4.2 | 14.68 | 2.21 | 3.31 |
| **standard error of mean** | R275 | R269 | R410 | R405 | R7 705 | R664 | R591 | R305 |

### 3.4.3. Livestock

Of the 590 households surveyed, 18.5% of households owned livestock. Livestock ownership can be categorised by livestock type, where 10.8% of households owned cattle, 9.5% owned goats and 2.7% owned pigs. Only 11.9% households received income through livestock benefits from living cattle or from the slaughter of goats, pigs and cattle. One household owned a sheep, another household owned a donkey, and 58.5% of households owned chickens. For livestock, the primary income value to the household and value consumed were the same i.e. a negligible number of households received or bought livestock products to be used. All 70 livestock user households had quantifiable benefits with a mean ± SD of R37 445 pa ± R37 537 pa and a median of R25 823 pa (Figure 3.4). On average, the cash income generation was lower than the used income value. From the 50 households that reported selling livestock animals or their products, the benefits of 47 households were quantifiable with a mean ± SD of R3 151 pa ± R6 675 pa and a median of R800 pa (Figure 3.4).

The ranges in household values for both the livestock used and sales were large (Figure 3.4). While the cash generated has the majority of households distinctively falling into lower classes (associated with the medians and modes), the value of livestock resources used showed a gentler decline in frequencies as the value of livestock used increases (Figure 3.4). Per capita values indicate that the majority of households earned in the lowest income categories for both the used income values and the cash generated from livestock (Figure 3.4). The per capita per household values, however, for both the used values and the cash generated from the sales of livestock and livestock products had greater variation than the total household values.

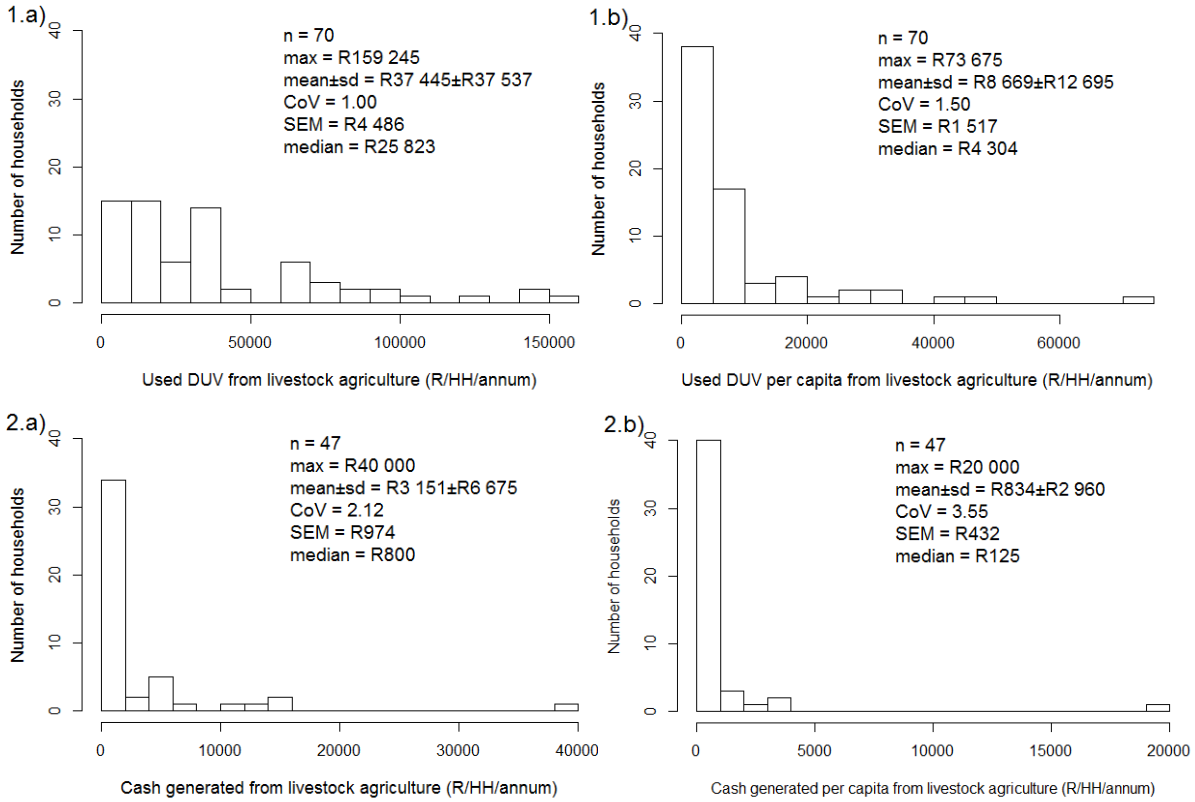



Figure 3.4 The household livestock agriculture values a) per household per annum and b) per capita per household per annum for 1) Direct Used Value (DUV) Used for 70 households and 2) the cash income received from the sale of livestock agriculture products for 47 households. Only households that were involved in these activities were used in these analyses.

Due to there being few users and sellers of livestock and livestock products, extending the average values from only involved households to across all households decreased the values substantially (Table 3.3). The consumed livestock values decreased by a factor of 8.43 from a mean ± SD of R37 445 pa ± R37 536 pa per user household to R4 443 pa ± R17 661 pa across all households. The livestock cash income decreased by a factor of 12.55 from a mean ± SD of R3 151 pa ± R6 675 pa per seller household to R251 pa ± R2 052 pa across all households.

Table 3.3 The mean summary statistics of the values of livestock and livestock products used and sold per an involved household and across all households (HH) per annum. The primary income value was assumed equivalent to the used values and measured as a Direct Used Value (DUV).

| | Used livestock DUV | | Livestock sales cash generated | |
|---|---|---|---|---|
| **summary statistic** | **User HH** | **All HH** | **Seller HH** | **All HH** |
| **n** | 70 | 590 | 47 | 590 |
| **mean** | R37 445 | R4 443 | R3 151 | R251 |
| **standard deviation** | R37 536 | R17 661 | R6 675 | R2 052 |
| **coefficient of variation** | 1 | 3.98 | 2.12 | 8.17 |
| **standard error of mean** | R4 486 | R727 | R974 | R84 |

### 3.4.4. Crops

Of the 588 households surveyed for crop use, a substantial 96.8% planted crops. The major crop types grown by households were maize (94.6%), peanuts (85.0%), pumpkin leaves (77.4%), pumpkins (66.2%), bambara groundnuts (63.4%) and cowpeas (58.2%) (Table 3.4). For the minor crops, the proportion of households growing the crops ranged from 0.2% to 59.0% of all households (Table 3.4). Only a small percentage (3.6%) of households sold at least one crop type. Spinach was the most common cash crop with 1.5% of households reporting that they sold it, though sugarcane reflected the highest seller proportion of grower households (3.33%) (Table 3.4).

Table 3.4 The number of households (HH) and percentage of HH that grew and sold crops (n=588). Crops were classified into 6 major crops (where volumes harvested were asked) and 24 minor crops (where volumes harvested were not asked).

| Crop type | Crop | Growing HH (n) | Growing HH (%) | Selling HH (n) | Selling HH (% of all HH) | Selling HH (% of growing HH) |
|---|---|---|---|---|---|---|
| major | maize | 556 | 94.6 | 0 | 0.0 | 0.0 |
| | peanuts | 500 | 85.0 | 4 | 0.7 | 0.8 |
| | pumpkin leaf | 455 | 77.4 | 0 | 0.0 | 0.0 |
| | pumpkin | 389 | 66.2 | 1 | 0.2 | 0.3 |
| | bambara | 373 | 63.4 | 4 | 0.7 | 1.1 |
| | cowpea | 342 | 58.2 | 0 | 0.0 | 0.0 |
| minor | mangoes | 347 | 59.0 | 3 | 0.5 | 0.9 |
| | spinach | 308 | 52.4 | 9 | 1.5 | 2.9 |
| | onions | 272 | 46.3 | 2 | 0.3 | 0.7 |
| | sweet potato | 270 | 45.9 | 2 | 0.3 | 0.7 |
| | African cucumber | 266 | 45.2 | 0 | 0.0 | 0.0 |
| | tomatoes | 253 | 43.0 | 7 | 1.2 | 2.8 |
| | paw paw | 241 | 41.0 | 0 | 0.0 | 0.0 |
| | cassava | 220 | 37.4 | 1 | 0.2 | 0.5 |
| | lettuce | 219 | 37.2 | 5 | 0.9 | 2.3 |
| | guava | 214 | 36.4 | 1 | 0.2 | 0.5 |
| | beetroot | 202 | 34.4 | 2 | 0.3 | 1.0 |
| | ochra | 177 | 30.1 | 1 | 0.2 | 0.6 |
| | sugar cane | 150 | 25.5 | 5 | 0.9 | 3.3 |
| | squash | 145 | 24.7 | 0 | 0.0 | 0.0 |
| | bananas | 141 | 24.0 | 0 | 0.0 | 0.0 |
| | peaches | 126 | 21.4 | 1 | 0.2 | 0.8 |
| | green peppers | 107 | 18.2 | 2 | 0.3 | 1.9 |
| | chillies | 106 | 18.0 | 1 | 0.2 | 0.9 |
| | sweet sorghum | 86 | 14.6 | 0 | 0.0 | 0.0 |
| | water melon | 78 | 13.3 | 0 | 0.0 | 0.0 |
| | carrots | 69 | 11.7 | 2 | 0.3 | 2.9 |
| | avocado | 69 | 11.7 | 0 | 0.0 | 0.0 |
| | cabbage | 62 | 10.5 | 1 | 0.2 | 1.6 |
| | sorghum | 1 | 0.2 | 0 | 0.0 | 0.0 |

Of the 569 households that reported using crops, 549 households provided quantifiable information for major crops that they harvested with a mean ± SD DUV of R615 pa ± R1 777 pa and a median of R212 pa (Figure 3.5). The twenty-one seller households earned a mean ± SD of cash income of R328 pa ± R274 pa with a median of R200 pa (Figure 3.5). Both used crop values and cash crop income had the majority of households falling into the lowest valued income brackets, and transforming these values to per capita values reinforced the pattern and increased variation in used income values (Figure 3.5). Similarly, the maximum values of major crops used far exceeded its average values while the maximum cash income was more comparable to its averages (Figure 3.5).

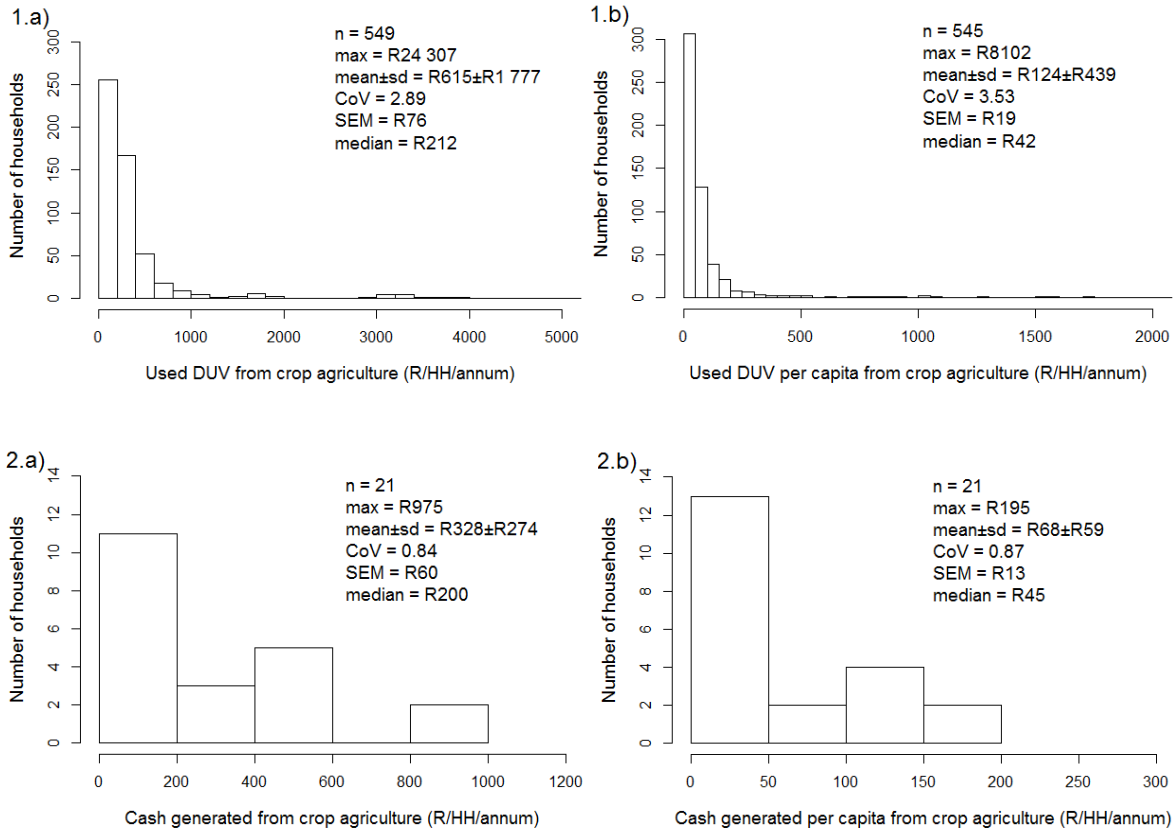



Figure 3.5 The household crop agriculture values a) per household per annum and b) per capita per household per annum for 1) Direct Used Values (DUV) Used for 549 households and 2) the cash income received from the sale of livestock agriculture products for 21 households. Only households that were involved in these activities were used in these analyses.

The average value of crops used across all households was very similar to the average value used across collector households (Table 3.5). The average value of cash sales from crops, however, decreased when extended to represent all households because of the small number of households that sold crops (4.1%) (Table 3.5). The mean value of crops used per a collector household decreased slightly from a mean ± SD of R615 ± R1 777 pa to R574 ± R1 724 pa when extending across

all households. The cash sales from selling crops changed from a mean ± SD of R328 pa ± R274 pa for seller household to R12 pa ± R79 pa per households across all households (Table 3.5).

Table 3.5 The mean summary statistics of the values of crop and crop products used and sold per an involved household and across all households (HH) per annum. The primary income value was assumed equivalent to the used value and was measured using Direct Use Value (DUV).

| | Used crops DUV | | Crop sales cash generated | |
|---|---|---|---|---|
| **summary statistic** | **Collector HH** | **All HH** | **Seller HH** | **All HH** |
| **n** | 549 | 588 | 21 | 588 |
| **mean** | R615 | R574 | R328 | R12 |
| **standard deviation** | R1 777 | R1 724 | R274 | R79 |
| **coefficient of variation** | 2.89 | 3.00 | 0.84 | 6.76 |
| **standard error of mean** | R76 | R71 | R60 | R3 |

### 3.4.5. Off-farm activities

Out of the 588 households that reported on their off-farm activities, 99.3% of households received a source of cash income from these off-farm activities. This came from grants (84.2% of households), accessing finance from credit and savings (82.0% of households) and employment (73.1% of households). The total cash income from off-farm activities had a mean ± SD of R50 515 pa ± R59 279 pa with a median of R31 520 pa (Figure 3.6). All households reported spending money on off-farm activities with a mean ± SD of R21 179 pa ± R22 046 pa and median of R15 576 pa (Figure 3.6).

Both livelihood POAs for off-farm activities had the majority of households falling into the lowest valued brackets (Figure 3.6). While the transformation to per capita value reinforced the pattern of high frequencies of low income values for the values spend, this reinforcement was only seen slightly for cash income generation from off-farm activities (Figure 3.6). The per capita values for both the cash income and cash spent on off-farm activities had more variation than the total household values (Figure 3.6).

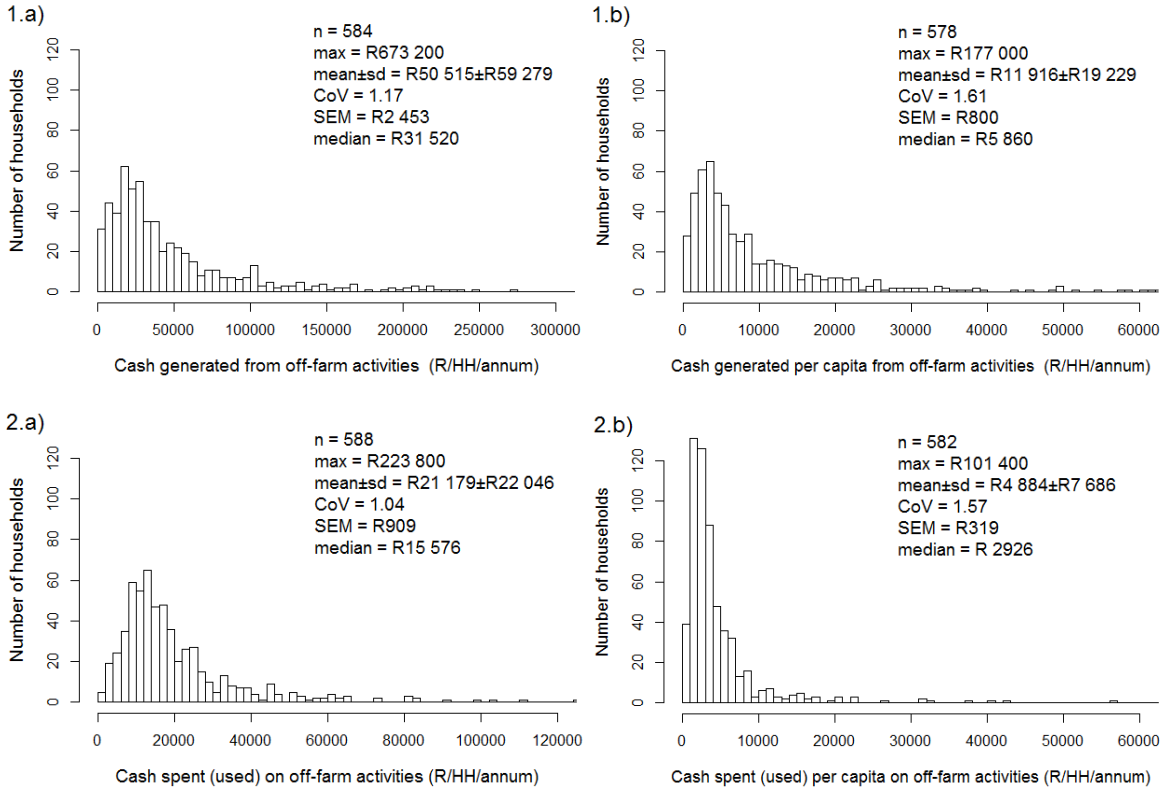



Figure 3.6 The household off-farm activities' values a) per household and b) per capita per household per annum for 1) cash generated and 2) cash spent.

Little difference was made to the off-farm cash income values when extended to include the four non-earning households (Table 3.6). Since all households used and reported the amounts spent on off-farm resources used, the summary statistics were the same when extended to include all households (Table 3.6).

Table 3.6 Cash Income per annum from off-farm activities and cash spent per household for households that were involved and across all households (HH). Per capita per household values were calculated by dividing the respective values by the number of permanent residents per household

| | **Off-farm cash income generated** | | **Cash spent on off-farm activities** | |
|---|---|---|---|---|
| **summary statistic** | **Cash generating HH** | **All HH** | **User HH** | **All HH** |
| **n** | 584 | 588 | 588 | 588 |
| **mean** | R50 515 | R50 171 | R21 179 | R21 179 |
| **standard deviation** | R59 279 | R59 223 | R22 046 | R22 046 |
| **coefficient of variation** | 1.17 | 1.18 | 1.04 | 1.04 |
| **standard error of mean** | R2 453 | R2 442 | R909 | R909 |

### 3.4.6. Relative mean EP contributions

The mean EPs income relative to the mean total household income varied at the different POAs in relation to other livelihood streams. The average contribution of EPs to the total household portfolio was 7.17% at the primary income POA (R 4264 pa), 20.05% at the used POA (R6 570 pa), and a nominal 2.13% at the cash generation POA (R1 098) (Figure 3.7). Crop income contributed the least at all three POAs, while livestock income contributed the second least at the used and cash generated POAs, but contributed 0.3% at the primary income POA (Figure 3.7). Off-farm activities contributed the most at all three POAs, with this contribution dominating the least at the used POA and the most at the cash generation POA (Figure 3.7).

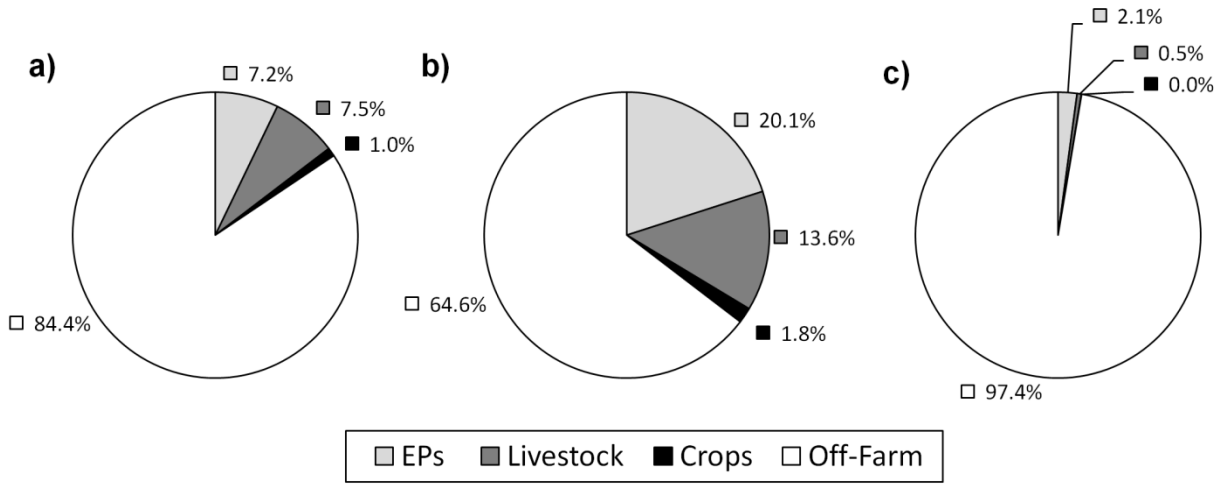



Figure 3.7 Proportion contributions of the mean benefits from the four different livelihood income streams [environmental products (EPs), livestock, crops and off-farm] at the three different points of assessment (POAs) in the livelihood income chain a) primary income value, b) used value and c) cash generated.

### 3.4.7. Collective examination of the household portfolio

The differences in the absolute income values were more distinct in characterising livelihood portfolios. This is evidenced by the fact that the first components of the non-standardised PCAs dominate at all three POAs by accounting for 54.1% to 93.5% of the variation (Table 3.7). Conversely, used relative income values in the standardised PCAs that were less distinct in characterising livelihood income portfolios though the amounts of variation accounted for by the first two ordination components were more comparable to each other than in the non-standardised PCA for all three POAs (Table 3.7).

Table 3.7 Statistical summaries of standardised and non-standardised PCA ordinations done at the three points of assessment (POAs) in the livelihood income chain: 1) primary income, 2) used and 3) cash generation. Four different streams of livelihood were analysed (environmental products income, livestock agriculture income, crop agriculture income and off-farm income) across 588 households. The eigenvalues and cumulative percentage of variation are presented for the linear combinations of variables for the first two components. As PCA is an unconstrained ordination, the sums of all eigenvalues are 1.0.

| | Components | |
|---|---|---|
| | **1** | **2** |
| 1) PRIMARY LIVELIHOOD INCOME | | |
| *Absolute values: non-standardised, centered PCA* | | |
| **Eigenvalues** | 0.908 | 0.080 |
| **Cumulative % variation of income data** | 90.8 | 98.8 |
| *Relative values: standardised, centered PCA* | | |
| **Eigenvalues** | 0.314 | 0.263 |
| **Cumulative % variation of income data** | 31.4 | 57.7 |
| 2) USED LIVELIHOOD INCOME | | |
| *Absolute values: non-standardised, centered PCA* | | |
| **Eigenvalues** | 0.541 | 0.350 |
| **Cumulative % variation of income data** | 54.1 | 89.0 |
| *Relative values: standardised, centered PCA* | | |
| **Eigenvalues** | 0.304 | 0.250 |
| **Cumulative % variation of income data** | 30.4 | 55.4 |
| 3) CASH GENERATION LIVELIHOOD INCOME | | |
| *Absolute values: non-standardised, centered PCA* | | |
| **Eigenvalues** | 0.935 | 0.064 |
| **Cumulative % variation of income data** | 93.5 | 99.9 |
| *Relative values: standardised, centered PCA* | | |
| **Eigenvalues** | 0.368 | 0.247 |
| **Cumulative % variation of income data** | 36.8 | 61.6 |

The absolute livelihood portfolios of households were mainly characterised by changes in the off-farm income stream (Figure 3.8). This held true for when the portfolio was examined at the primary income (Figure 3.8ai), the used value (Figure 3.8bi) and the cash generation (Figure 3.8ci) POAs. Interestingly, the variations in off-farm income were not related to variations within their land-based income streams (Figures 3.8ai, bi, ci). There was however, a strong co-variation between the three land-based income streams (Figures 3.8ai, bi, ci). When considering the primary income and used absolute values, household's income values were dominated by the livestock income stream over the other two land-based income streams (Figures 3.8ai, bi). However, for the cash generation POA, it was households' environmental income and then the crop income stream that varied more compared to the livestock income stream across households (Figure 3.8ci).

When the variations between the different livelihood income streams were compared on a relative scale (Figures 3.8aii,bii,cii) instead of an absolute one (Figures 3.8ai,bi,ci), the associations between the households' income streams changed. For example, for primary income, households that earned relatively more from the environmental income stream were associated with a relative increase in the crop income stream (Figures 3.8aii). At the same time, there was a strong association between households' primary income from the livestock and off-farm income streams. For the relative values used, the amounts households spent on the consumption in the off-farm income stream were not related to the amounts consumed in the strongly correlated land-based livelihood income streams (Figures 3.8bii). Furthermore, the relative variations in these land-based incomes mainly characterised the livelihood portfolio at this POA. Households that generated more relative environmental income as cash, tended to generate more relative crop and off-farm income as cash (Figure 3.8cii). The relative variations in the cash generation by households in the livelihood income stream were not related to households' relative cash generation variations from the other three income streams.

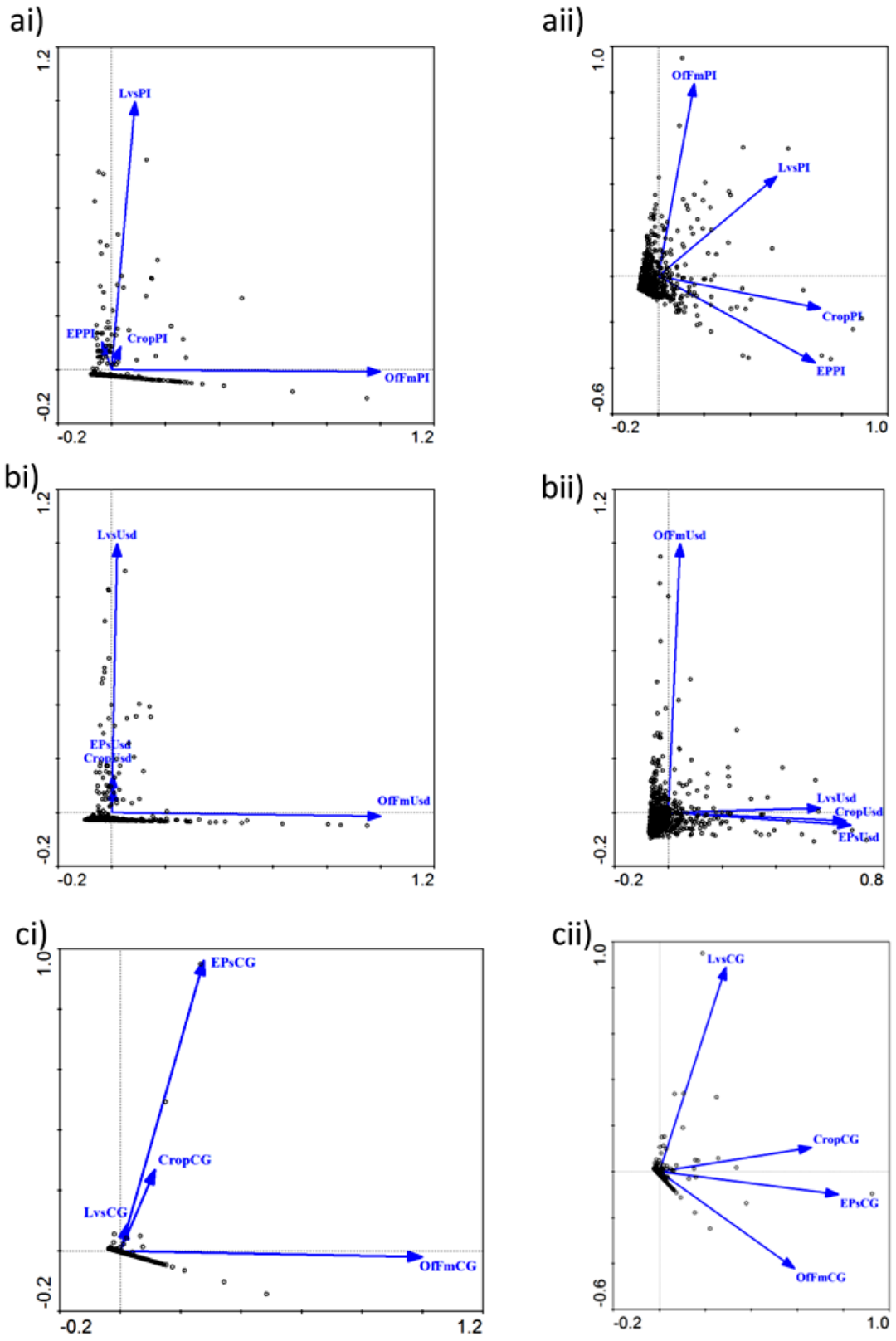



Figure 3.8 Biplots as defined by the first two components of *i)* a non-standardised PCA and *ii)* a standardised PCA of the four livelihood incomes examined at the three points of assessment (POAs). The four livelihood income streams were (Rands pa): Environmental (*EP*), livestock agriculture (*Lvs*), crops agriculture (*Crop*) and off-farm activities (*OfFm*). These were examined at three POAs: *a)* Primary Income (*PI*), *b)* Used (*Usd*) and *c)* Cash Generation (*CG*).

## 3.5. DISCUSSION

### 3.5.1. Livelihood portfolio involvement

The diversification of households' livelihood portfolios within a community needs to be understood by comparing the proportions of households that utilise particular livelihood streams at the different POAs in the livelihood income chain. This study reflected widespread involvement by households in the primary sourcing and consumption of environmental products and crop agriculture. The majority of households, between 96—100%, sourced EPs and crops directly from their environment and used for household consumption. Interestingly it was found that households were least likely to be involved in the livestock income stream with only just over a tenth of households sourcing and using livestock and livestock-based products. Previous studies reflect this widespread use of land-based livelihood streams in rural, developing households, and particularly in the South African region (High and Shackleton 2000, Godoy et al. 2002, Twine et al. 2003, Shackleton and Shackleton 2004, Babulo et al. 2009, Thondhlana et al. 2012). Some studies place emphasis on the prevalence of livestock farming, which sits in contradiction with this research (Godoy et al. 2002, Babulo et al. 2009, Thondhlana et al. 2012). Other studies however, particularly in the Bushbuckridge region, are in agreement with the results of this study and find that it is the crop and EPs livelihood income streams that are important across households (High and Shackleton 2000, Twine et al. 2003, Shackleton and Shackleton 2004). The use of EPs, in particular, is more widespread and generally more intense in households than the use of livestock and their products (Shackleton et al. 1998, 2005a, Madubansi and Shackleton 2007).

Very few households in this study earned cash though land-based livelihood streams — only 10.5% of all households sold EPs, 8.0% of households earned cash from livestock and only 4.2% of households sold crops for cash. The pattern in livestock cash generation differed from the other two land-based livelihood streams. While the percentage of all households earning cash from livestock was the lowest, these households represented a much larger proportion (43.1%) of livestock owners than the proportion of crop and EPs sellers represented their respective users. While studies speak of cash income from sales and of possibilities to stimulate local markets in the sale of these land-based products (Shackleton 1996), this low prevalence of EPs and crops as a source of cash income in the area may be problematic to programmes aimed at such intervention. While this study reflected that a just over 40% of the few livestock owners generated cash through the livestock income stream, more remote areas in Bushbuckridge that have more widespread livestock ownership could have a relatively smaller proportion of these user households generating cash from livestock (Dovie et al. 2006).

Almost every household utilized off-farm livelihood income, at both the primary income and consumption POAs. The prevalence of employment and grants across households, as well as the regular accessing of finances from savings and loans highlight the fact that Bushbuckridge has widespread reliance on the off-farm economy. This widespread use of off-farm activities is noted in previous studies and appears characteristic of the Bushbuckridge region (Dovie et al. 2005, Kahn et al. 2012).

### 3.5.2. Income value distributions across households

For all four livelihood income streams, the values of primary income, usage and cash generation followed non-normal distribution patterns with the majority of households occurring in the lower income value brackets, earning less than the mean value for those incomes. A few households earned extremely large values in all cases, with maximums that ranged from ten times to 315 times larger than the mean per livelihood income stream across all households. When household income values were transformed into per capita per household values, these distribution patterns were reinforced at all POAs for the different livelihood streams, except the cash generation values for land-based income streams. This suggests that despite increases in available human capital, earning potentials remains fixed per household. Livelihood earnings tended to be less unequal when the household is taken as the unit of influence.

An important aspect to consider is the variability among all households in these income sources. Inherently, the livelihood income values that include non-involved households will be more variable than when only considering involved households. This is especially true if only a few households were involved for that specific livelihood income. When considering the coefficients of variation of the means for all households, the lowest variability was found among the off-farm livelihood income streams at both the primary cash generation and used value POAs. Intermediate variability was found among the primary income and used values of the land-based income streams with variability increasing slightly from EPs to crops to livestock among all households. Cash generation from all land-based livelihood streams varied the most when considering all households. However, when considering only involved households, variation in cash generation from land-based income streams decreased, especially from the sales of crops as well as there being low variability in the used values from livestock agriculture i.e. the variability amongst these income was not so high when only considering households that use these resources.

### 3.5.3. The value of different livelihood income streams to households

Evaluating what a livelihood income stream represents to an individual household is important in understanding how these households perceive their choices when considering whether to start,

continue or stop pursuing a particular livelihood income stream. Due to the non-normal nature of the data the average values of the different livelihood streams to an involved household were best represented by their medians at all POAs. Overall, households that relied on the environmental income livelihood stream received median benefits for EPs at each POA that were higher than the corresponding crop values in crop-growing households and lower than corresponding livestock values for livestock-using households. The median benefits per annum, for livestock, environmental and crops, were for primary income: R25 823, R2 287, and R212 respectively; for used values: R25 823, R3 795 and R212 respectively; and for cash generated: R800, R550 and R200 respectively. The value differences amongst the land-based livelihood streams are smaller for cash generation and greater for primary income-used where livestock income values dominate over environmental and crop income values.

When compared to the median values of households that were involved in the land-based livelihood streams, median values for off-farm activities superseded the value contributions made by environmental income and crops at all three POAs in the livelihood chain. The off-farm value of R31 520 pa, which represents the primary income and cash generated value, was larger than the median livestock primary income amount of R25 823 pa and much larger than the livestock cash generation median amount of R800 pa. However, the worth of off-farm activities that were used in the household had a median of R15 576 pa — less than the median used values of livestock agriculture to a household that was involved in this income stream of R25 823 pa. Importantly, the median values for household expenditure were less than the values for cash earnings.

The mean income values follow the same orderings as the median income values for the different livelihood income streams at the different POAs. Off-farm activities contributed the most, followed by livestock agriculture, then environmental income, and lastly crop agriculture. Distinctively, all estimated means are larger than the estimated medians for all livelihood streams at all POAs. Means for the various income streams ranged from being 1.4 times to 3.9 times larger than their medians, with the extreme case of the mean of the cash generated from EPs being 23.6 times larger than the corresponding median value. These results suggest caution when interpreting the mean values commonly used in literature, as these could be grossly overestimating the worth of all livelihood income streams to individual households in these socio-ecological systems even when these studies evaluate livelihood income streams accurately.

### 3.5.4. The value of the different livelihood income streams at the community level

While the mean value contributions inaccurately represent the average worth of livelihood income streams to individual households, they are valuable at estimating the worth of these income streams

to the socio-ecological system as whole. When the mean values for livelihood income streams were extended from only households that were involved to include all households, the means of the livelihood income streams with fewer households that were involved were affected more. In other words, the mean contributions from the cash generation of all land-based income streams and the primary used income value from livestock agriculture were decreased greatly when extended to include all households.

The mean environmental income in this study across all households contributed differently to the total household income portfolio at the different POAs in relation to other livelihood streams. On average, the total household portfolio EPs contributed 7.2% at the primary income POA (R 4264 pa), 20.1% at the used POA (R6 570 pa), and 2.1% at the cash generation POA (R1 098). Global studies, that do not differentiate between the different POAs, estimate that environmental income contributes across households a mean of between 22% (Vedeld et al. 2007) and 28% (Angelsen et al. 2014) of total household income in rural areas of developing countries. Localised studies, that also do not differentiate between the different POAs, have estimated the contributions made by environmental income to be as much as 39% in Ethiopia (Mamo et al. 2007, Babulo et al. 2009), 35% in Zimbabwe (Cavendish 2000), 30% in Malawi (Fisher 2004) and 32% in a San community in the Northern Cape Province, South Africa (Thondhlana et al. 2012). The EPs contributions made in this research at the primary income and cash generation POAs were noticeably lower than in these previous studies while the relative value used was more comparable. Even with the distinction made in Honduras and Bolivia by Godoy et al. (2002) between the 38.5% contribution to consumption and the 22.7% contribution to cash generation, the contributions estimated in this study were noticeably lower. However, two studies done in South Africa had comparable contributions by environmental income to the livelihood portfolio – a 9% contribution in a Mier community in the Northern Cape Province (Thondhlana et al. 2012) and a 19% contribution in the Bushbuckridge local municipality in the Mpumalanga province (Dovie et al. 2005).

The contributions made by off-farm activities to the socio-ecological system dominated at all three POAs in relation to the three land-based livelihood income streams. Households earned a mean of R50 171 pa and spent R21 179 pa through off-farm activities, contributing to the primary income, used and cash generation POAs with 84.4%, 64.6% and 97.4%, respectively. Across all households, crop agriculture, with mean consumption values of R574 pa and cash sales of R12 pa, remained the lowest contributor to mean household primary income (1.0%), used value (1.8%) and cash generation (0.0%). The worth of livestock, while extremely valuable to households that were involved in the livestock income stream, decreased when extended to represent an average

household across all households. It was worth slightly more than EPs for primary income into households contributing 7.5% (R4 443 pa), but contributed less than EPs for used values (13.6%, R4 443 pa), and less than EPs for cash generation (0.5%, R251 pa).

Past studies rank the importance of the various livelihood streams to the household income differently to this study. While the relative contribution of environmental income has been found to be higher than off-farm income in many cases (Cavendish 2000, Mamo et al. 2007, Babulo et al. 2009, Angelsen et al. 2014), it has been found to be lower in others (Cavendish 2000, Fisher 2004, Dovie et al. 2005, Vedeld et al. 2007, Thondhlana et al. 2012). Agricultural income could contribute the same as EPs (Fisher 2004, Thondhlana et al. 2012) or the most (Mamo et al. 2007, Babulo et al. 2009, Angelsen et al. 2014) or the least (Thondhlana et al. 2012) or the middle amount (Dovie et al. 2005, Vedeld et al. 2007) to the livelihood income portfolio. Importantly, these studies show that the income contributions made by land-based strategies are more than the contributions from off-farm income sources to households' livelihood portfolios (Cavendish 2000, Godoy et al. 2002, Fisher 2004, Dovie et al. 2005, Vedeld et al. 2007, Mamo et al. 2007, Babulo et al. 2009, Angelsen et al. 2014).

### 3.5.5. Collectively examining income streams

The majority of households earned concurrently in the lower income brackets for the land-based livelihood income streams. This was especially true at the cash generation POA where most households did not earn cash from any of the land-based income streams. Characterisation of livelihood portfolios, when considering the absolute values of income, was dominated by the off-farm income streams at all POAs; although, this dominance was less pronounced in what value of the resources were consumed by households. While the value of livestock that was sourced and used was the next differentiator between households' portfolios at those POAs, it was the value of EPs sold that played the larger role in differentiating household livelihood income portfolios at the cash generation POA.

The absolute changes in the off-farm income values were not related to the changes in the land-based livelihood income streams. The strong co-variation between the three land-based income streams, at all three POAs, suggests that if households were deriving higher income values from one land-based income stream, they were more likely to be deriving higher income values from the other two land-based income streams.

Relative differences in the values of the land-based livelihood income streams played a more dominant role overall than off-farm activities at all POAs. However, this dominance was less

pronounced than when the portfolio was characterised by absolute values. The roles played by the relative differences in the off-farm income stream compared to the land-based income stream were more comparable to each other than to the differences in the absolute values. While the correlations between the land-based income streams and their dissociation from off-farm activities were strong at the primary income POA, they were strongest at the used POA. This close association between the land-based livelihood income streams and their lack of relationship with off-farm income has been shown in correlations done by Dovie et al. (2005), based in the Bushbuckridge area. However, at the cash generation POA, the cash income from the livestock income streams was not related to the other income streams.

## 3.6. CONCLUSION

Households in Bushbuckridge are predominantly dependent on the cash generation and consumption of goods and services from off-farm activities in terms of value, even though the primary sourcing and usage of the environmental and crop income streams are equally widespread among households. Differences between households' use of the land-based livelihood income streams as part of the diverse livelihood portfolio are seen more clearly when livelihood incomes are compared using the relative differences per income stream instead of absolute values. Livestock agriculture, while not as commonly sourced and used among households as EPs and crops, is worth more to households that source and use it. Variations in what households earn and use in the off-farm income stream values were not related to what they sourced, used and sold in the land-based income streams. Policy interventions that are aimed at manipulating households' dependence on land-based activities need to differentiate which households they will be addressing. For interventions aimed at subsistence sourcing and consumption in the environmental and crop income streams, it will be possible to plan and implement these interventions across all households. For interventions aimed at the use of the livestock income stream and at the cash generation from any of the land-based income streams, it is advised that these interventions be focussed on the few households that are already involved in those particular activities.

While mean income values for livelihood incomes are useful for comparing studies and for reflecting the worth of income streams to the socio-ecological system as a whole, the majority of households earn in the lower income brackets, with only a few households benefitting greatly. These system-level averages are optimistic estimations of the benefits received by individual households; the costs and benefits of a particular livelihood income activity is viewed differently from the household perspective compared to the perspective of the socio-ecological system as a whole. The response of

individual households to an intervention may be differently because of this bias in perceived benefits between the two perspectives.

The patterns of earning livelihoods tended to have more equality when the household is taken as the unit of influence compared to the per capita values within households. This emphasises that the households are the decision making units, and that individuals within some households are benefitting even less than what is usually estimated. Individuals' earning potentials are possibly restricted by the earning potential of the household unit beyond household size. This raises questions such as: (1) What factors could be influencing household income and consumption patterns that result in these values not being solely influenced by household size?, and (2) How do we structure poverty alleviation programmes aimed at individuals while ensuring that these individuals are not being limited by household factors?

This study conducted in the Bushbuckridge region of South Africa is a platform from which the analysis approaches used in other studies, especially in the Bushbuckridge region, can be scrutinised. This study needs to be validated, repeated and expanded over the years to see whether the observed patterns in livelihood incomes are maintained. There is a need for accurate validation of the DUVs of all land-based incomes and the need to standardise and simplify these evaluations.

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# CHAPTER 4

# 4. HOUSEHOLD DEPENDENCE ON ENVIRONMENTAL INCOME: THE ROLE OF SOCIO-ECONOMIC CHARACTERISTICS

## 4.1. ABSTRACT

The livelihood income portfolios of households in rural socio-ecological systems consist of the off-farm income stream and three land-based livelihood income streams: environmental, crops and livestock. These income streams contribute to the primary income, consumption and cash generation of rural households. Various studies link these contributions and derived environmental income dependencies to different household socio-economic factors, but often fail to reflect the collective, interdependent nature of both the income portfolios and associated socio-economic factors. This chapter aimed to relate the households' livelihood income portfolios to their suites of socio-economic characteristics. A total of 588 households were interviewed across nine villages in the Bushbuckridge region of South Africa by trained field workers during 2010. Interviews examined a suite of household socio-economic characteristics and quantified all four livelihood income streams at three different points of assessment (POAs) in the livelihood income chain. Households' suites of socio-economic characteristics and income portfolios were examined using ordination analysis as well as fractional logit generalized linear model (GLM) for proportional environmental income dependency. Many socio-economic characteristics were correlated with each other, and retained this correlation when used to explain livelihood incomes. Increases in education levels and overall wealth statuses are associated with decreased dependency on environmental income and increased dependency on off-farm activities. Larger households remain highly dependent on land-based income streams, particularly through the increased use of environmental income. Proportional environmental income dependency, while important to consider, tends to omit associations within the incomes portfolio and with potentially influencing socio-economic characteristics. Strategic planning needs to collectively assess livelihood portfolios and account for the co-variation between socio-economic factors and among the livelihood income streams.

## 4.2. INTRODUCTION

The livelihood income portfolio of a household consists of the different livelihood income streams that the household uses in order to earn a living. In addition to the off-farm livelihood income stream, households in rural socio-ecological systems depend on land-based livelihood income

streams that include environmental income, crop farming and livestock husbandry for both household consumption and cash generation. The potential values that can be derived and consumed from the different livelihood income streams by rural households translates into a tendency for these households to have more diversified livelihood income portfolios than their urban counterparts where they depend more on land-based livelihood income streams.

In rural socio-ecological ecosystems, both in South Africa and across the globe, values derived from these different livelihood income streams vary across households, with some households depending more on environmental income than others (Cavendish 2000, Dovie and Shackleton 2003, Twine et al. 2003, Shackleton and Shackleton 2004, 2006, Dovie et al. 2005, Mamo et al. 2007, Babulo et al. 2008, Hunter et al. 2014, Angelsen et al. 2014). These variations in natural environmental resource dependency have been associated in many studies with various household socio-economic characteristics (e.g. Cavendish 2000, Dovie and Shackleton 2003, Twine et al. 2003, Shackleton and Shackleton 2004, 2006, Dovie et al. 2005, Mamo et al. 2007, Babulo et al. 2008, Hunter et al. 2014, Angelsen et al. 2014). Household's socio-economic capital has been linked to livelihood incomes achieved by these households. Past studies have found environmental and other land-based income streams to be positively associated with household size (Dovie et al. 2005, Mamo et al. 2007, Babulo et al. 2008), the number of children in a household (Dovie et al. 2005, Mamo et al. 2007, Angelsen et al. 2014), and the number of females in a household (Dovie and Shackleton 2003, Shackleton and Shackleton 2004, Dovie et al. 2005, Babulo et al. 2008). Wealthier households often use more absolute amounts of environmental and other land-based incomes, though they are relatively less dependent on these income streams (Cavendish 2000, Fisher 2004, Shackleton and Shackleton 2006, Vedeld et al. 2007, Babulo et al. 2009, Thondhlana et al. 2012, Angelsen et al. 2014). This holds true for whether wealth status was assigned using the total income accessible to households (Cavendish 2000, Vedeld et al. 2007, Babulo et al. 2009, Thondhlana et al. 2012, Angelsen et al. 2014) or according to key assets found in households (Fisher 2004, Shackleton and Shackleton 2006). In addition to direct associations between socio-economic factors and income values, the rural livelihood literature has many examples of where socio-economic factors have been associated with the livelihood decisions made by households.

An inherent shortcoming in analysing rural livelihoods is that livelihood incomes and household characteristics are both comprised of sets of highly correlated variables. This makes the identification of patterns in causation between and within the two sets of variables difficult. Past studies usually account for only one or two livelihood income streams and are unable to reflect how the portfolio of income streams changes across households in relation to the measured set of

household characteristics. Examining only some livelihood incomes can easily lead to the assumption that these streams are related to each other even though other income streams could be fluctuating in the same manner (Dercon 2000). It could be easily concluded that the measured set of factors are only influencing these incomes, disregarding how these factors may be influencing other incomes similarly.

Another overlooked aspect is that studies do not take into account that different livelihood income streams contribute unequally in different aspects in the livelihood chain. Godoy et al. (2002) showed in their study in Honduras and Bolivia that land-based livelihood income streams were more important than the off-farm income stream for consumption, while for cash generation some villages relied more on income from off-farm activities than on the land-based income streams. Similarly, I have demonstrated in chapter 3 of this dissertation that the households under study in Bushbuckridge have a larger reliance on land-based income streams for consumption and primary sourcing than for cash generation.

This chapter aimed to relate household livelihood income portfolios, consisting of the environmental, livestock, crop and off-farm activities income streams, to household socio-economic characteristics in the Bushbuckridge region of South Africa. Livelihood income portfolios were evaluated in terms of their diversification and dependency at three different points of assessment (POAs) along the households livelihood income chain — the primary income into the household, what the household uses (values consumed that can be from primary income or from purchasing), and the amount of cash that is earned through that livelihood income stream (from off-farm activities earnings and selling of land-based resources). Quantitative comparisons between livelihood streams were made by assigning monetary Direct Use Values (DUVs) to resources that are part of households' livelihoods but have not been purchased. These DUVs are calculated based on how much it would cost a household to buy the land-based resources that they source and use.

Quantifying and understanding how rural households depend on different livelihood incomes can help guide strategic planning aimed at household poverty alleviation and increasing households' resilience to stresses and shocks (Vetter 2013, Angelsen et al. 2014). Differentiating the relative importance of livelihood incomes at different POAs is useful if tradeoffs in conservation need to be made when guiding policy formation and implementation to maintain the health of socio-ecological systems (Vetter 2013, Angelsen et al. 2014).

## 4.3. METHODS

All details of the methodology relevant to this work can be found in Chapter 2 of this dissertation. For a description of the study site, please refer to section '2.1. Bushbuckridge, South Africa'. Here the different sub-sections cover the geography, climate and vegetation of Bushbuckridge, and its history, people and their livelihoods. The explanation of how this study falls under the Sustainability in Communal Socio-Ecological Systems (SUCSES) research project of the Agincourt Health and Socio-Demographic Surveillance System (Agincourt HDSS) is found in section '2.2. The SUCSES research project, Agincourt HDSS, Bushbuckridge' of this dissertation.

The data that was sourced and used for this study has been explained in the section '2.3. Approaching SUCSES in this study of this dissertation. The data that this chapter is mainly based on are described under section '**Error! Reference source not found.**' and '2.3.4.1. Sourcing socio-economic characteristics data from the SUCSES interviews'. The ordination protocol for analysing livelihood incomes is explained in the section '**Error! Reference source not found.**' and the GLMs protocol in the section '2.4.4. Generalised Linear Models (GLMs)'.

## 4.4. RESULTS

### 4.4.1. Profiling socio-economic characteristics of households

The set of socio-economic characteristics consisted of a variety of measurements that encompassed both the actual numbers of physical assets measured as well as their relevant proportions (Figure 4.1)

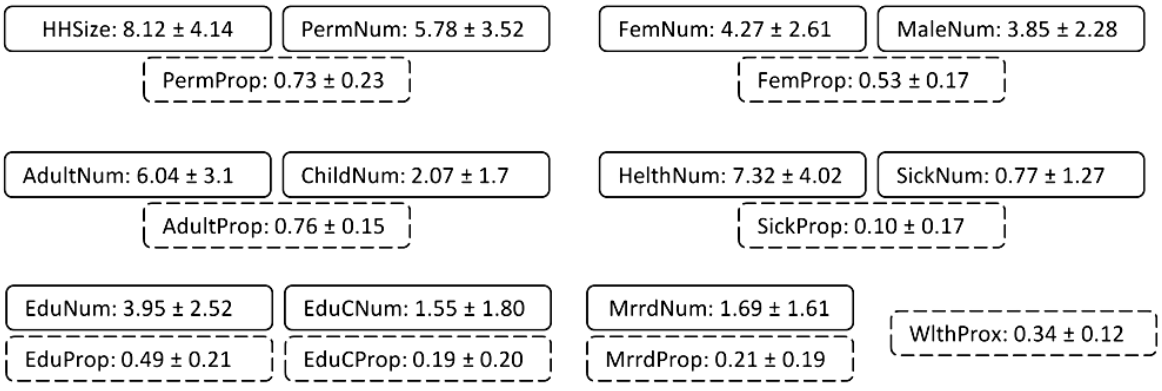



Figure 4.1 The means ± SDs of the numbers and proportions of members per household displaying socio-economic characteristics[+] (n=588). The wealth proxy is the proportion of 15 key assets that a household owned. [[+]Codes used in the labelling for household socio-economic characteristics are: *HHSize*, household size; *WlthProx*, wealth proxy; *-Num*, number; *-Prop*, proportion; *Perm-*, permanent; *Fem-*, female; *Male-*, male; *Adlt-*, adult; *Child-* , child; *Helth-*, healthy; *Sick-* , sick; *Edu-*, educated; *EduC-*, certified educated. Refer to Table 2.5 for detailed explanation on these labels.]

In the set of household socio-economic characteristics, 84.3% of all variation was captured by the first and second components of a non-standardised, centred PCA ordination (Table 4.1). The greatest amount of variation was associated with the first component of the ordination (76.8%) and comprised of variable related to the number of members in a house that displayed a certain characteristic — a household size cluster of variables. This household size cluster consisted of the strongly correlated numbers of members, healthy members, adults, females, permanent members, males, educated members children and married members per household. This household size cluster as also correlated, to a lesser degree, with the numbers of members per household that had a Grade 9 education or higher (certified) per household. Households could then be differentiated with a second set of socio-economic characteristics that was associated with the second component of the ordination (7.6%). This second ordination component was positively correlated with the numbers and proportions of educated members per household and negatively correlated with the proportion of the household that were permanent residents.

Table 4.1 Variable loadings of the first two components of a non-standardised PCA for household socio-economic factors[+] (n= 588). Bold arrows (🡅🡇) indicate variables strongly correlated with the components with variable loadings >0.5 or <-0.5, while non-bold arrows (↑↓) indicate variables that are weakly correlated with components with variable loadings lying between -0.5 and 0.5.

| **First component** | **eigenvalue** | **0.768** | **Second component** | **eigenvalue** | **0.076** |
|---|---|---|---|---|---|
| **Variable** | **Variable loading** | | **Variable** | **Variable loading** | |
| HHSize | 0.990 | 🡅 | EduProp | 0.661 | 🡅 |
| HelthNum | 0.965 | 🡅 | EduCProp | 0.639 | 🡅 |
| AdultNum | 0.938 | 🡅 | EduCNum | 0.626 | 🡅 |
| FemNum | 0.859 | 🡅 | AdultProp | 0.517 | 🡅 |
| PermNum | 0.841 | 🡅 | EduNum | 0.482 | ↑ |
| MaleNum | 0.812 | 🡅 | WlthProx | 0.244 | ↑ |
| EduNum | 0.801 | 🡅 | AdultNum | 0.207 | ↑ |
| ChildNum | 0.701 | 🡅 | MaleNum | 0.120 | ↑ |
| MrrdNum | 0.575 | 🡅 | MrrdProp | 0.113 | ↑ |
| EduCNum | 0.481 | ↑ | MrrdNum | 0.094 | ↑ |
| WlthProx | 0.268 | ↑ | HelthNum | 0.041 | ↑ |
| SickNum | 0.169 | ↑ | HHSize | -0.020 | ↓ |
| EduCProp | 0.058 | ↑ | FemNum | -0.136 | ↓ |
| EduProp | 0.038 | ↑ | SickProp | -0.161 | ↓ |
| FemProp | 0.005 | ↑ | SickNum | -0.182 | ↓ |
| MrrdProp | -0.003 | ↓ | FemProp | -0.232 | ↓ |
| PermProp | -0.068 | ↓ | ChildNum | -0.424 | ↓ |
| AdultProp | -0.127 | ↓ | PermNum | -0.435 | ↓ |
| SickProp | -0.161 | ↓ | PermProp | -0.647 | 🡇 |

[+]Codes used in the labelling for household socio-economic characteristics are: *HHSize*, household size; *WlthProx*, wealth proxy; *-Num*, number; *-Prop*, proportion; *Perm-*, permanent; *Fem-*, female; *Male-*, male; *Adlt-*, adult; *Child-* , child; *Helth-*, healthy; *Sick-* , sick; *Edu-*, educated; *EduC-*, certified educated. Refer to Table 2.5 for detailed explanation on these labels.

The correlations between the first two components are displayed in the biplot in Figure 4.2. The household size cluster of socio-economic characteristics is correlated with the first component (x-axis) while the proportions are correlated with the second component (y-axis). The education characteristics (the numbers and proportions of standard and certified education) were associated with each other. Households were less easily differentiated by their wealth proxies, by the number of sick members, and by the proportions of the households who were sick, married or female.

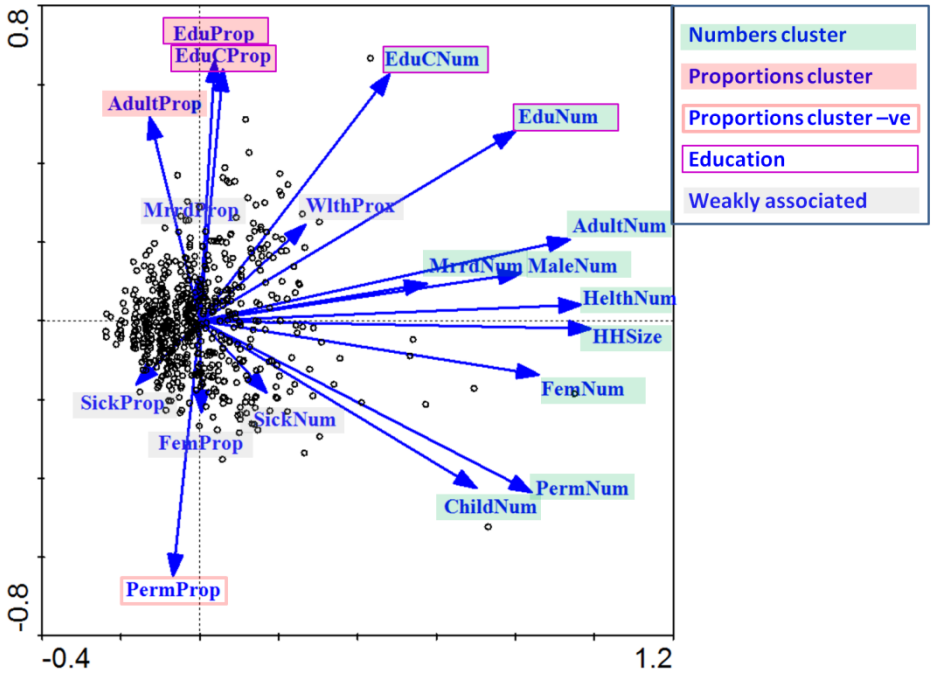



Figure 4.2 Biplot as defined by the first two components of a non-standardised PCA for household socio-economic factors⁺ (n= 588). Labels have been shifted to allow for ease of reading, and the associated arrowheads should be used to compare effects. [⁺Codes used are: *HHSize*, household size; *WlthProx*, wealth proxy; *-Num*, number; *-Prop*, proportion; *Perm-*, permanent; *Fem-*, female; *Male-*, male; *Adlt-*, adult; *Child-* , child; *Helth-*, healthy; *Sick-* , sick; *Edu-*, educated; *EduC-*, certified educated. Refer to Table 2.5 for detailed explanation on these labels.]

### 4.4.2. The use of socio-economic factors to explain livelihood income portfolios

Income variations at all three POAs were better explained through RDA ordinations using the socio-economic characteristics when incomes were measured using absolute value changes instead of relative differences (Table 4.2). The non-standardised, absolute value RDAs accounted for 28.3%, 16.0% and 28.5% of the variation in the primary income, used and cash generation livelihood income portfolios respectively while the standardised, relative value RDAs accounted for 14.0%, 11.1% and 9.5% respectively (Table 4.2). While the RDA ordinations using the set of socio-economic factors was weakest at explaining variations for the absolute income values at the used POA, these RDA ordinations for relative values were weakest at explaining the cash generation POA (Table 4.2). All RDA ordinations were significant for the first and all components (Table 4.2).

Table 4.2 Summaries of standardised and non-standardised RDA ordinations of household livelihood portfolios using socio-economic characteristics as explanatory factors done at the three POAs across 588 households. The canonical eigenvalues and cumulative percentage of variation are presented for the first two components. Monte Carlo tests were used to test the significance of the ordinations.

| | Components | |
|---|---|---|
| | **1st (x)** | **2nd (y)** |
| 1) PRIMARY INCOME vs. SOCIO-ECONOMIC | | |
| *Absolute values: non-standardised, centered RDA* | | |
| **Eigenvalues (canonical)** | 0.277 | 0.004 |
| **Cumulative % variation of income data** | 27.7 | 28.1 |
| ***Sum of all eigenvalues (canonical)*** | | *0.283* |
| ***— Monte Carlo - first canonical component: F-ratio; P-value*** | *217.831* | *0.0020* |
| ***— Monte Carlo - all canonical components: F-ratio; P-value*** | *12.457* | *0.0020* |
| *Relative values: standardised, centered RDA* | | |
| **Eigenvalues (canonical)** | 0.081 | 0.037 |
| **Cumulative % variation of income data** | 8.1 | 11.8 |
| ***Sum of all eigenvalues (canonical)*** | | *0.140* |
| ***— Monte Carlo - first canonical component: F-ratio; P-value*** | *50.276* | *0.0020* |
| ***— Monte Carlo - all canonical components: F-ratio; P-value*** | *5.160* | *0.0020* |
| 2) USED vs. SOCIO-ECONOMIC | | |
| *Absolute values: non-standardised, centered RDA* | | |
| **Eigenvalues (canonical)** | 0.135 | 0.016 |
| **Cumulative % variation of income data** | 13.5 | 15.1 |
| ***Sum of all eigenvalues (canonical)*** | | *0.160* |
| ***— Monte Carlo - first canonical component: F-ratio; P-value*** | *89.794* | *0.0020* |
| ***— Monte Carlo - all canonical components: F-ratio; P-value*** | *6.025* | *0.0020* |
| *Relative values: standardised, centered RDA* | | |
| **Eigenvalues (canonical)** | 0.066 | 0.024 |
| **Cumulative % variation of species data** | 6.6 | 8.9 |
| ***Sum of all eigenvalues (canonical)*** | | *0.111* |
| ***— Monte Carlo - first canonical component: F-ratio; P-value*** | *39.932* | *0.0020* |
| ***— Monte Carlo - all canonical components: F-ratio; P-value*** | *3.961* | *0.0020* |
| 3) CASH GENERATION vs. SOCIO-ECONOMIC | | |
| *Absolute values: non-standardised, centered RDA* | | |
| **Eigenvalues (canonical)** | 0.283 | 0.001 |
| **Cumulative % variation of income data** | 28.3 | 28.4 |
| ***Sum of all eigenvalues (canonical)*** | | *0.285* |
| ***— Monte Carlo - first canonical component: F-ratio; P-value*** | *224.798* | *0.0020* |
| ***— Monte Carlo - all canonical components: F-ratio; P-value*** | *12.570* | *0.0020* |
| *Relative values: standardised, centered RDA* | | |
| **Eigenvalues (canonical)** | 0.080 | 0.007 |
| **Cumulative % variation of income data** | 8.0 | 8.7 |
| ***Sum of all eigenvalues (canonical)*** | | *0.095* |
| ***— Monte Carlo - first canonical component: F-ratio; P-value*** | *49.275* | *0.0100* |
| ***— Monte Carlo - all canonical components: F-ratio; P-value*** | *3.319* | *0.0120* |

In general, the associations between household socio-economic characteristics and income streams were not similar between the off-farm and land-based income streams when considering these households' primary income, used values and cash generation portfolios (Figure 4.3). Households that had more members in the household size cluster variables (Figure 4.1, i.e. households that were larger and inherently had more males, females, etc.) were more likely to have higher primary income value (Figures 4.3ai, aii), have higher consumption values (Figures 4.3bi, bii) and generate more cash for their total livelihood portfolio (Figures 4.3ci, cii) income in both absolute and relative terms. While higher environmental income values tended to be associated most with these higher numbers of members, higher off-farm income values were particularly associated with households with more educated members.

Households that had a higher proportion of sick people and a lower proportion of migrant members earned less absolute and relative off-farm income at all POAs (Figure 4.3). Households with higher proportions of sick members and permanent members consumed relatively more environmental and crop income but consumed less livestock income (Figure 4.3bii).

Throughout the livelihood chain, households that were wealthier according to the asset wealth proxy had higher off-farm and livestock income values (Figure 4.3). Households that had higher proportions of adults had higher absolute and relative livestock primary income and used values (Figure 4.3a), though it had no relationship with the cash generated from the livestock income stream. Households that had higher proportions of female members had lower livestock income levels at all POAs and had higher primary income and used values of environmental income but not cash generation from environmental income (Figures 4.3aii,bii,cii).

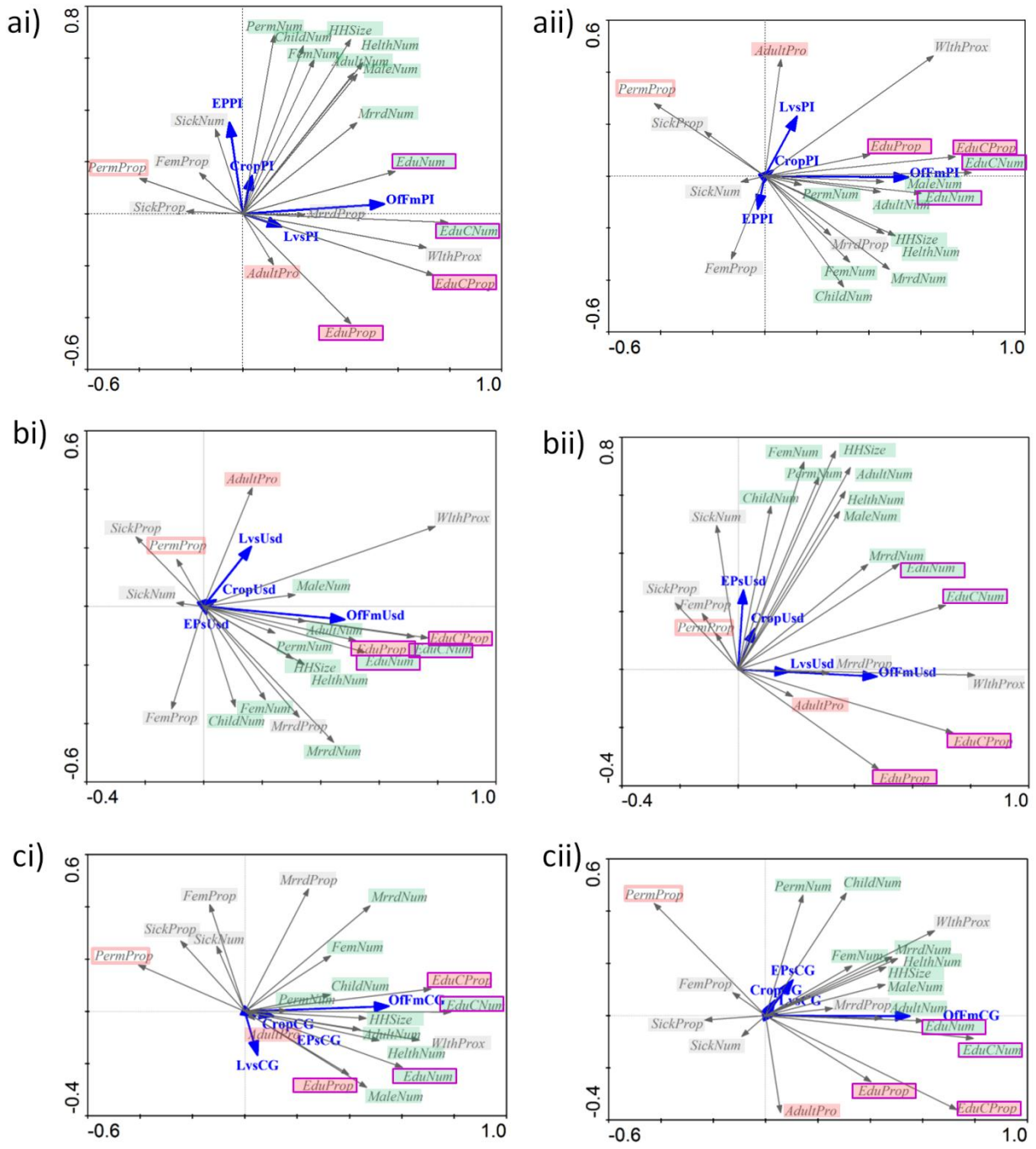



Figure 4.3 Biplots of i) non-standardised and ii) standardised RDA ordinations of household livelihood incomes with socio-economic characteristics⁺ as explanatory factors. These ordinations were done at three different POAs in the livelihood income chain: a) primary income (PI), b) used (Usd) and c) cash generation (CG). Incomes were examined from four livelihood income streams: environmental (EP), livestock agriculture (Lvs), crop agriculture (Crop) and off-farm activities (OfFm) across 588 households. Labels of variables have been shifted to allow for ease of reading and the associated arrowheads should rather be used to compare effects. [⁺Codes used in the labelling for household socio-economic characteristics are: *HHSize*, household size; *WlthProx*, wealth proxy; *-Num*, number; *-Prop*, proportion; *Perm-*, permanent; *Fem-*, female; *Male-*, male; *Adlt-*, adult; *Child-* , child; *Helth-*, healthy; *Sick-* , sick; *Edu-*, educated; *EduC-*, certified educated. Refer to Table 2.5 for detailed explanation on these labels. Refer to Figure 4.2. for colouring code of labels.]

Proportional environmental income dependence ranged from a mean ± SD of 12.29% ± 1.64% for primary income and 22.41% ± 19.18% to 0.57% ± 3.68% for cash generation. These values were both influenced by absolute changes in environmental income and other income streams. The socio-economic variables that were associated with individual income streams as part of the income portfolio (Figure 4.3) did not necessarily translate into the variables that predicted the environmental income dependence best in a global GLM model (Table 4.3).

When analysing the incomes using the GLMs, households that had higher proportions of female members had higher environmental income dependencies at all POAs (Table 4.3). While higher wealth proxy scores resulted in lower environmental income dependencies at the primary income and used POAs, it played no role in defining the environmental income dependency at the cash generation POA. While the proportion of the household that had adult members and the number of educated members were significant predictors, the confidence intervals around the results were inconclusive at the primary income POA. However, environmental income dependencies decreased with the number of educated members at the used POA, and the number of adults at the cash generation POA. While households that had a larger proportion of adults had higher environmental income dependencies for cash generation, this could be an artefact of the proportions of adults in a household being correlated to education levels within a household and inversely correlated to residential status within a household (Figure 4.2).

Table 4.3 Fractional logit model results for the null and global models of environmental income dependency at three points of assessment (POAs) using household socio-economic characteristics[+] as the explanatory variables. Environmental income dependency was the proportion contribution to the total household income portfolio.

| **POA** *(mean ± SD)* | **Null deviance** *(587 df)* | **Residual deviance of global model** *(569 df)* | **Significant socio-economic variables** | **Log-odds ratio estimate** | **Upper log-odds ratio** *(estimate+ 1.96*standard error)* | **Lower log-odds ratio** *(estimate- 1.96*standard error)* |
|---|---|---|---|---|---|---|
| **Primary income** *(12.29% ± 1.64%)* | 119.10 | 89.52 | FemProp*** | 2.32 | 1.10 | 3.55 |
| | | | AdultProp* | 1.29 | -0.23 | 2.80 |
| | | | EduNum* | -0.17 | -0.36 | 0.02 |
| | | | WlthProx*** | -3.59 | -4.60 | -2.58 |
| **Used** *(22.41% ± 19.18%)* | 126.36 | 107.71 | FemProp** | 1.13 | 0.16 | 2.10 |
| | | | EduNum** | -0.18 | -0.33 | -0.03 |
| | | | WlthProx*** | -2.36 | -3.17 | -1.56 |
| **Cash generation** *(0.57% ± 3.68%)* | 37.65 | 12.86 | FemProp*** | -7.90 | -13.58 | -2.22 |
| | | | AdultNum** | -3.80 | -7.41 | -0.19 |
| | | | AdultProp*** | 21.93 | 7.34 | 36.52 |

p<0.01***; p<0.05**; p<0.1*

[+]Codes used in the labelling for household socio-economic characteristics are: *WlthProx*, wealth proxy; *-Num*, number; *-Prop*, proportion; *Fem-*, female; *Adlt-*, adult; *Edu-*, educated. Refer to Table 2.4 for detailed explanation on these labels.

## 4.5. DISCUSSION

The analysis of livelihood income portfolios in rural socio-ecological systems often includes investigating associations between the values of different income streams to households and their socio-economic characteristics. Various studies have related parameters like household size, gender, education levels and age to the quantities of use and benefit derived from the environmental resources, crop agriculture, livestock husbandry and off-farm activities (Dovie 2003, Twine et al. 2003, Shackleton and Shackleton 2004, 2006, Dovie et al. 2005, Mamo et al. 2007, Babulo et al. 2008, Hunter et al. 2014, Angelsen et al. 2014). However, assessing the collective influence of socio-economic characteristics on environmental income relative to other incomes in the household portfolio is rare. Analysis is usually unclear on how households benefit differently from the different income streams at different POAs in the livelihood chain, and how this subsequently influences how these income streams are associated with socio-economic factors (Dovie 2003, Twine et al. 2003, Shackleton and Shackleton 2004, 2006, Dovie et al. 2005, Mamo et al. 2007, Babulo et al. 2008, Hunter et al. 2014, Angelsen et al. 2014)

The first aspect that needs to be considered when attempting to understand household livelihood income portfolios is that the potential set of household socio-economic characteristics are highly

correlated with each other. Characteristics often examined fall in the household size cluster that included the number of females, the number of adults, the number of educated member etc. are all inherently correlated with household size. If one factor from this household size cluster is strongly associated with an income stream compared to other characteristics, it may be what is driving the observed change. Alternatively, it could be the most representative of the various influencing characteristics.

The second aspect that needs to be considered is that analysing livelihood income streams for primary income into households, compared to household consumption and to what they use for cash generation has different implications. Socio-economic factors that may feature more strongly at some POAs are less important at others. Analysing only proportional environmental income dependency instead of collectively examining the different income streams can result in the omission of important relationships between individual income streams and socio-economic characteristics.

In Chapter 3 of this dissertation, I found that the households under study in the Bushbuckridge region have a widespread engagement and reliance on off-farm activities for primary cash income generation and household consumption. There was a larger engagement and reliance on land-based income streams for consumption within the household, with less dependency for primary income and even less of a land-based income stream dependency for cash generation. This was especially true for environmental and crop income streams, while the livestock income stream showed more intense use and cash generation for households involved in the income stream.

In his analysis of livelihoods in Zimbabwe, Cavendish (2000) noted, "Socio-economic variables such as sex, age, and household composition also affected resource use, sometimes leading to dramatically different patterns of resource use across different households". In this study, a clear distinction is made where the socio-economic factors that were associated with the land-based income streams were not the same as those that were associated with the off-farm income stream. While there were variations in these associations, this generally held true for whether the income streams were compared in absolute or relative terms and whether they were examined at the primary income, used or cash generation POAs. This has potential advantages and disadvantages for trying to understand and predict changes within these socio-ecological ecosystems. For example, we can expect that the changes in the land-based income streams' set of socio-economic factors to have similar effects on all the land-based income streams, at all the different POAs, in both absolute and relative terms. However, changes in these socio-economic characteristics will not influence off-

farm income — these socio-economic characteristic effects are independent of the land-based income streams and will have to be studied specifically.

In general, larger households that are represented in this study were more likely to be earning and using more income, both in absolute terms or with changes measured relatively, for all income streams. Households with higher environmental income values in particular tended to be associated with all the household size-based variables. The increased use and importance of land-based income streams in larger households, particularly environmental income, has been noted previously (Dovie et al. 2005, Mamo et al. 2007, Babulo et al. 2008, Angelsen et al. 2014). Households with higher proportions of female members had lower livestock income for primary income, consumption and cash generation. While these households also had lower cash generation values from the environmental income stream, these households with a higher proportion of females had higher primary income and use values of environmental income. Households that have more females, especially as household heads, and more children, were particularly linked to increased environmental resource use (Dovie et al. 2005, Babulo et al. 2008, Angelsen et al. 2014), while households where that had more men, especially as household heads, were more likely to have more off-farm cash income (Dovie et al. 2005, Babulo et al. 2008).

Households that had higher proportions of adults had higher absolute and relative livestock primary income and used values, though it had no relationship with the cash generated from livestock. An increase in the proportion of adults in a household is associated with increased livestock income and not with the other income streams. Households that had a larger proportion of adults had higher environmental income dependencies for cash generation. This could be an artefact of the proportions of adults in a household being positively correlated to education levels within a household and negatively correlated to proportion of permanent residents within a household. Mamo et al. (2007) in their study in Ethiopia linked higher adult proportions to less environmental resource extraction as households with more adults had higher worker-to-consumer ratios, and fewer children available for more resource extraction. Angelsen et al. (2014) states that households with younger heads may be more dependent on environmental resources.

Households that had a higher proportion of sick people and permanent residents tended to earn less absolute and relative income for their total household portfolios both in absolute and relative terms. This relationship was largely driven by the off-farm income stream where households that were healthier and had migrant members who earned and used more from the off-farm income stream. However, households with higher proportions of sick members and permanent members consumed relatively more environmental and crop income but consumed less livestock income.

Education levels are socio-economic descriptors of the human capital and development in households. Households with more educated household members were particularly associated with higher off-farm income values for both primary income and consumption, translating in to lower proportional environmental income dependencies. Increased reliance on land-based income streams in less educated households has been noted across the developing world (Angelsen et al. 2014). This probably reflects the increased engagement in off-farm income activities in more educated households (Babulo et al. 2008) which results in the lower environmental income dependencies.

Increases in total livelihood income across all livelihood income streams were associated with the wealth status of the households. Throughout the livelihood chain, households that were wealthier according to the asset wealth proxy had particularly higher off-farm and livestock income values. This translated into households that were wealthier according to the asset proxy in having lower environmental income dependencies, especially for primary income and household consumption. While households that were classified as wealthier may use more absolute values of environmental resources (Twine et al. 2003), relative dependency on natural resources decreased with increasing wealth status (Angelsen et al. 2014).

## 4.6. CONCLUSION

The shift from the use of land-based income streams to off-farm income in rural lands, particularly in South Africa (Bryceson 2002) emphasises the need to understand household livelihoods portfolio as a whole. A deeper understanding of the livelihood portfolio can be gained by analysing the interactions between the land-based income streams and the off-farm income streams within the household and, particularly, the interactions between socio-economic characteristics and the land-based and off-farm income streams. Strategic management planning is often aimed at household poverty alleviation and increasing households' resilience to stresses and shocks. Tradeoffs in conservation need to be made when guiding policies to maintain the health of these socio-ecological systems (Vetter 2013, Angelsen et al. 2014). The need for systematic quantification and understanding of rural livelihoods to guide this management planning (Vetter 2013, Angelsen et al. 2014) will benefit greatly from analyses done in the manner presented in this study. Livelihood incomes need to be examined as a portfolio with the associated suites of socio-economic characteristics. This analysis needs to differentiate between primary income, consumption and cash generation in the household income chain.

With increased socio-economic development in the Bushbuckridge area (Kahn et al. 2012), particularly increases in education levels of the people and overall wealth statuses, we can expect a

decreased dependence on environmental income. This decreased dependence is linked to increased income from off-farm activities. At the same time, larger and vulnerable households (poor, predominantly female, low education levels) remain highly dependent on land-based income streams, particularly with increased use of environmental income. This supports the claim that the environmental 'safety net' is important for the rural poor who are particularly more vulnerable to environmental degradation and climate change (Angelsen and Wunder 2003, Shackleton and Shackleton 2004).

## 4.7. REFERENCES


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# CHAPTER 5

# 5. RELATIONSHIPS BETWEEN LIVELIHOOD STRATEGIES AND ENVIRONMENTAL INCOME DEPENDENCE IN RURAL HOUSEHOLDS

## 5.1. ABSTRACT

Livelihood incomes in rural socio-ecological systems are often related back to household socio-economic characteristics. The rationale used is that these socio-economic characteristics result in the adoption of various livelihood strategies in order to achieve particular livelihood incomes. However, the links between livelihood strategies and livelihood incomes of households are not clearly made in past studies despite these links having the potential to allow for a more quantitative understanding of livelihood dynamics. The aim of this chapter was to relate collectively households' suites of adopted livelihood strategies to their livelihood income portfolios that consisted of the off-farm, environmental, crop and livestock income streams. Households were interviewed by trained field workers during 2010 in 588 households spanning nine villages in the Bushbuckridge region of South Africa. Primary, used, and sales income values were determined for all income streams and examined in relation to adopted livelihood strategies. Ordination analysis was used to allow for the collective examination of the livelihood portfolios with adopted strategies, while fractional logit generalised linear model (GLM) were used to explore proportional environmental income dependency links with these strategies. Overall, the involvement of a household in a particular income stream resulted in increased income for primary income, consumption and cash generation for that particular income stream. However, this was not always the case as strategies that were associated with increased environmental income use for household consumption, were not necessarily associated with this environmental income for households' primary income and sales values. Proportional environmental income dependency, while important in its own right, tends to omit potentially influential associations. Strategic planning needs to collectively assess livelihood portfolios, and explore the link between livelihood income streams and adopted livelihood strategies.

## 5.2. INTRODUCTION

Perspectives on livelihoods have influenced thinking and practice in rural development in recent years (Scoones 2009). A livelihood is commonly defined as comprising of the capabilities, activities,

material assets and non-material assets that make up a means of living (Babulo et al. 2008). While the definition of livelihoods is often simplified as 'the means of gaining a living' (Chambers 1995), in reality, livelihoods are complex webs of activities and interactions that emphasise the diversity of ways that people employ in order to make a living (Scoones 2009). A livelihood is considered sustainable when, without undermining its natural resource base, it can cope with and recover from stresses and shocks while maintaining or enhancing its capabilities and assets (Chambers and Conway 1992). Livelihood approaches to analysing rural socio-ecological data come with their own set of limitations and challenges, in particular the lack of emphasis placed on institutions, organisations, politics and powers (Scoones 2009). However, the concept of livelihoods has, through the development of hybrid ideas and workable frameworks, allowed for the bridging of gaps between study and practice across fields of study, especially at the local level (Scoones 2009).

The sustainable livelihoods approach (SLA) framework is a simple and structured means of analysing rural livelihoods that conceptualises the flow of resources through households (DFID 1999, Rakodi 1999, Scoones 2009). An important component of the SLA framework is the suite of livelihood strategies that are adopted by households. These are the choices and combination of activities that people undertake in order to achieve their goals and are determined by the natural, social, physical, human and financial capital available to households (DFID 1999, Babulo et al. 2008). This suite of livelihood strategies ultimately influences the household's livelihood outcomes that are achieved, that include aspects like financial security, well-being, reduced vulnerability and food security (Babulo et al. 2008).

This SLA framework can be further modified with the addition of an intermediary component, livelihood incomes, which are the direct products of livelihood strategies that help achieve the livelihood outcomes. These livelihood incomes can be evaluated at three different points of assessment (POAs) in the livelihood chain - as primary income, what is used by a household, and the cash generation from sales and employment. These livelihood incomes come from a range of livelihood income streams and can collectively be referred to as the livelihood income portfolio.

Households in rural socio-ecological systems, particularly in South Africa, mainly depend on income from the off-farm livelihood income activities with income from the environmental, crops and livestock related activities (usually referred to as the land-based livelihood activities) also playing a supplementary role (Bryceson 2002, Dovie et al. 2005, Angelsen et al. 2014). The values derived from these various income streams vary across households with different studies finding differing levels of dependence on the different income streams (Bryceson 2002, Dovie et al. 2005, Angelsen et al. 2014). Many studies examine the range of social, financial and other capitals in an attempt to

predict livelihood incomes, or relate these variables to the strategies adopted. However, the variables that can be measured are numerous and interrelated. While many studies report on the absolute and relative relationships between environmental income values and other livelihood income streams, the choice of livelihood strategies that result in these observed income patterns are not explored.

Alleviating household poverty and increasing households' resilience to stresses and shocks in these rural socio-ecological systems needs strategic planning that is guided by a quantitative understanding of households' dependency on different livelihood incomes (Vetter 2013, Angelsen et al. 2014). If tradeoffs in conservation need to be made, differentiating the relative importance of these livelihood incomes at different POAs is useful when guiding policy formation and implementation to maintain the health of these socio-ecological systems (Vetter 2013, Angelsen et al. 2014). Understanding the link between household strategies and incomes will help streamline the modelling of livelihoods in socio-ecological ecosystems. The use of particular strategies to predict which households will be high- or low-earners for different livelihood income streams, at different POAs in the livelihood income chain, is a potentially useful tool.

This chapter aimed to relate households' suites of adopted livelihood strategies to their livelihood income portfolios, which consists of the environmental, livestock, crop and off-farm income streams, in the Bushbuckridge region of South Africa. What was of interest was how do households' adopted livelihood strategies vary collectively, and how do these adopted livelihood strategies collectively relate back to the absolute and relative incomes of the portfolio at the different POAs. The proportional environmental resource dependencies were also explored to see if they could capture the collective variation between the adopted livelihood strategies and the livelihood incomes. The households in the study site area are mainly dependent on off-farm cash income from employment (particularly migrant labour) and from social government grants (Giannecchini et al. 2007, Hunter et al. 2007). A variety of environmental products (EP) such as fuelwood, wild fruits, wild vegetables, medicinal plants, insects, bush meat and fish are harvested or purchased and subsequently used or sold by households (Dovie and Shackleton 2003, Shackleton et al. 2005, Dovie et al. 2006). Various crops are grown, used and sold, and households that own livestock use and sell live animals and their products, including meat, milk, transport and ploughing (Dovie and Shackleton 2003, Shackleton et al. 2005, Dovie et al. 2006). These livelihood incomes were analysed at three POAs: primary income, used value and cash generation using monetary direct use values (DUVs). These DUVs are calculated on how much it would cost a household to buy these land-based resources or comparable alternatives if they did harvest these resources themselves.

## 5.3. METHODS

All details of the methodology relevant to this work can be found in Chapter 2 of this dissertation. For a description of the study site, please refer to section '2.1. Bushbuckridge, South Africa'. Here the different sub-sections cover the geography, climate and vegetation of Bushbuckridge, and its history, people and their livelihoods. The explanation of how this study falls under the Sustainability in Communal Socio-Ecological Systems (SUCSES) research project of the Agincourt Health and Socio-Demographic Surveillance System (Agincourt HDSS) is found in section '2.2. The SUCSES research project, Agincourt HDSS, Bushbuckridge' of this dissertation.

The data that was sourced and used for this study has been explained in the section '2.3. Approaching SUCSES in this study of this dissertation. The data that this chapter is mainly based on are described under section '**Error! Reference source not found.**' and '2.3.4.2. Sourcing adopted livelihood strategies data from the SUCSES interviews'. The ordination protocol for analysing livelihood incomes is explained in the section '**Error! Reference source not found.**' and the GLMs protocol in the section '2.4.4. Generalised Linear Models (GLMs)'.

## 5.4. RESULTS

### 5.4.1. Profiling the suite of adopted livelihood strategies

All (588) households surveyed reported spending cash on off-farm goods and services, while almost all households reported having off-farm primary cash income generation. A total of 81.5% (479) of households had at least one unemployed member and 82.3% (484) of households had at least one employed member. This employment can be further categorised into 67.9% (399) of households having at least one full-time employed member and 37.2% (219) of households having at least one part-time employed member. While only 22.5% (132) of households had at least one pensioner in the household, 79.1% (465) of households had at least one student. A total of 85.0% (500) of households received at least one grant, while 81.8% (481) of households accessed finance from credit and savings. The percentage of households that used, collected, bought and sold natural environmental resources were 99.1% (583), 98.0% (576), 52.6% (309) and 10.5% (62) respectively. A total of 53.1% (312) of households owned any kind of livestock, while 8.5% (50) households generated cash from the sales of livestock and livestock products. The majority of households 96.6% (568) grew crops while only 3.6% (21) households sold crops for cash.

For the land-based income activities, more people per household were involved in crop agriculture, than in environmental income activities or in livestock husbandry (Figure 5.1). There were more unemployed people and students than there were employed people in households, though all

reported numbers had large standard deviations (Figure 5.1). Very few people per household reported being a pensioner over other occupations (Figure 5.1). The number of grants received per household was more than the number of people who reported earning an income (Figure 5.1).

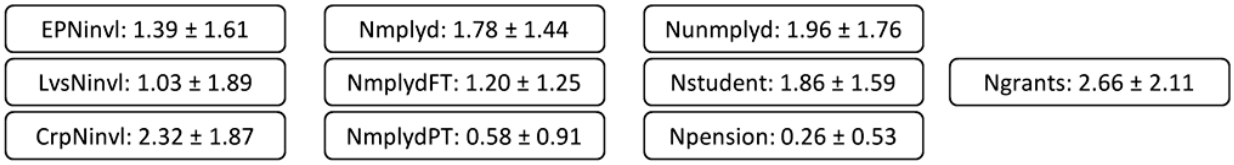



Figure 5.1 The mean ± SD of the numbers of members per household who were involved in a different livelihood strategies[+] (n=588). Households had a mean ± SD of 8.12 ± 4.14 members per household. [[+]Codes used in the labelling of adopted livelihood strategies are: *EPNinvl*, number of people involved in EPs activities; *LvsNinvl*, number of people involved in livestock activities; *CrpNinvl*, number of people involved in crop activities; *Nmplyd*, number of employed members; *Nunmplyd*, number of unemployed members; *NmplydFT*, number of full-time employed members; *NmplydPT*, number of part-time employed members; *Nstudents*, number of students; *Npension*, number of pensioners; *Ngrants*, number of grants. Refer to Table 2.6 for detailed explanation of these labels.]

In the suite of adopted livelihood strategies, 46.3% of all variation across households was captured by the first and second components of a non-standardised, centred PCA ordination (Table 5.1). The first component of the ordination accounted for 30.9% of this variation and was positively correlated strongly with the number of grants, number of members involved in crop agricultural activities per households, number of students, unemployed members, and numbers of members involved in livestock and environmental activities. The second component of the ordination accounted for the remaining 15.4% of the variation. It was moderately, positively correlated with the number of employed members and the number of members involved in crop and livestock activities.

Table 5.1 Variable loadings of the first two components of a non-standardised PCA of a variety of household strategies[+] (n= 588). Bold arrows (🡅🡇) indicate variables strongly correlated with the components with variable loadings >0.5 or <-0.5, while non-bold arrows (↑ ↓) indicate variables that are weakly correlated with components with variable loadings lying between -0.5 and 0.5.

| **First component** | **eigenvalue** | **0.309** | **Second component** | **eigenvalue** | **0.154** |
|---|---|---|---|---|---|
| **Variable** | **Variable loading** | | **Variable** | **Variable loading** | |
| Ngrants | 0.730 | 🡅 | LvsNinvl | 0.499 | ↑ |
| CrpNinvl | 0.682 | 🡅 | Nmplyd | 0.439 | ↑ |
| Nstudent | 0.596 | 🡅 | CrpNinvl | 0.437 | ↑ |
| Nunmplyd | 0.584 | 🡅 | NmplydFT | 0.348 | ↑ |
| LvsNinvl | 0.547 | 🡅 | NmplydPT | 0.217 | ↑ |
| EPNinvl | 0.534 | 🡅 | LvsOwnr | 0.204 | ↑ |
| LvsOwnr | 0.252 | ↑ | Nstudent | 0.136 | ↑ |
| Npension | 0.165 | ↑ | CrpSellr | 0.124 | ↑ |
| NmplydPT | 0.160 | ↑ | LvsSellr | 0.082 | ↑ |
| CrpGrowr | 0.145 | ↑ | EPBuyer | 0.082 | ↑ |
| EPColctr | 0.141 | ↑ | CrpGrowr | 0.081 | ↑ |
| LvsSellr | 0.141 | ↑ | EPSeller | 0.045 | ↑ |
| Nmplyd | 0.105 | ↑ | AcsedFin | 0.030 | ↑ |
| EPUser | 0.070 | ↑ | EPNinvl | 0.027 | ↑ |
| AcsedFin | 0.067 | ↑ | EPColctr | -0.050 | ↓ |
| EPSeller | 0.029 | ↑ | EPUser | -0.051 | ↓ |
| NmplydFT | 0.005 | ↑ | Npension | -0.075 | ↓ |
| CrpSellr | -0.013 | ↓ | Nunmplyd | -0.417 | ↓ |
| EPBuyer | -0.055 | ↓ | Ngrants | -0.502 | 🡇 |

[+]Codes used in the labelling of adopted livelihood strategies are: *EPColctr*, EPs collector; *EPUser*, EPs user; *EPSellr*, EPs seller; *EPBuyer*, EPs buyer; *EPNinvl*, number of people involved in EPs activities; *LvsOwnr*, livestock owner; *LvsSellr*, livestock seller; *LvsNinvl*, number of people involved in livestock activities; *CrpGrowr*, crops grower; *CrpSellr*, crops seller; *CrpNinvl*, number of people involved in crop activities; *Nmplyd*, number of employed members; *Nunmplyd*, number of unemployed members; *NmplydFT*, number of full-time employed members; *NmplydPT*, number of part-time employed members; *Nstudents*, number of students; *Npension*, number of pensioners; *Ngrants*, number of grants; *AcsedFin*, accessed finance. Refer to Table 2.6 for detailed explanation on these labels.

Households were first differentiated according to the strong correlation between the number members involved in the sourcing of environmental resources and the number of members who were students (from school and university) (Figure 5.2). The number of members involved in livestock husbandry was positively correlated with the number of members involved in crop agriculture activities. The numbers of household members who had full-time and part-time employment were not correlated completely with each other, with each inherently contributing to the total number of household members employed within the household. Households that had more unemployed members received more grants per household. Households who had more members involved in crop agriculture and livestock husbandry tended to have more employed members, but had no relationship to the number of unemployed members in those households.

Household members' involvement in the environmental income stream, while related to the number of unemployed members, was not related to the number of employed members.

Households tended to be growers of crops and owners and sellers of livestock and livestock products simultaneously (Figure 5.2). However, the selling of crops was associated more with the households that bought and sold environmental resources. Households that used and collected environmental resources were associated with households that had more pensioners and unemployed members, but were not necessarily associated with households that bought and sold these environmental resources. The accessing of financial credit and savings tended to be in households that were more active in the land-based income streams and in households with more students.

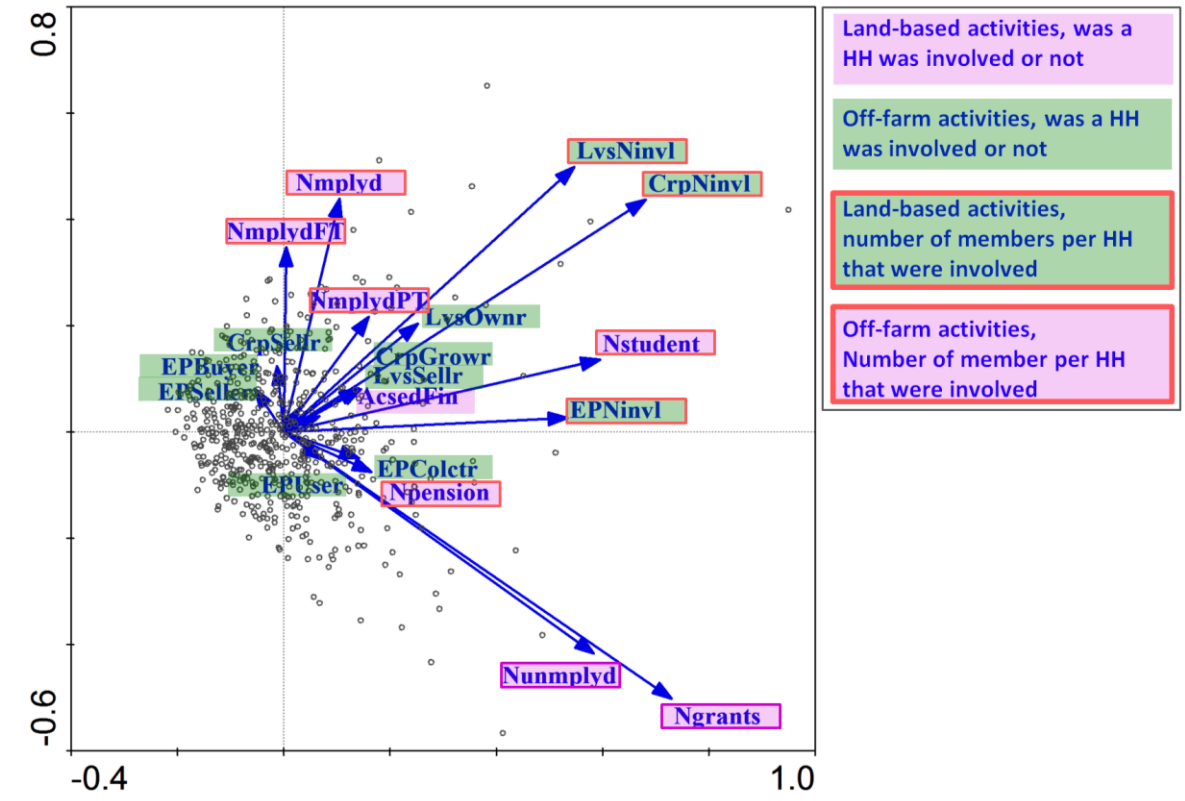



Figure 5.2 Biplot as defined by the first two axes of a non-standardised PCA of the suite of livelihood strategies* adopted by households (HH) (n=588). Labels have been shifted to allow for ease of reading and the associated arrowheads should rather be used to compare effects. [*Codes used in the labelling of adopted livelihood strategies are: *EPColctr*, EPs collector; *EPUser*, EPs user; *EPSellr*, EPs seller; *EPBuyer*, EPs buyer; *EPNinvl*, number of people involved in EPs activities; *LvsOwnr*, livestock owner; *LvsSellr*, livestock seller; *LvsNinvl*, number of people involved in livestock activities; *CrpGrowr*, crops grower; *CrpSellr*, crops seller; *CrpNinvl*, number of people involved in crop activities; *Nmplyd*, number of employed members; *Nunmplyd*, number of unemployed members; *NmplydFT*, number of full-time employed members; *NmplydPT*, number of part-time employed members; *Nstudents*, number of students; *Npension*, number of pensioners; *Ngrants*, number of grants; *AcsedFin*, accessed finance. Refer to Table 2.6 for detailed explanation on these labels.]

### 5.4.2. The use of adopted livelihood strategies to explain the livelihood income portfolio

The absolute variations in the income portfolio at all three POAs were better explained than the relative differences through the RDA ordinations using the suite of adopted livelihood strategies (Table 5.2). These RDAs were weakest at explaining the total variation at the used POA in the livelihood portfolio, accounting for 16.0% and 12.5% for the absolute and standardised values respectively. This was followed by the relative variation at the primary income POA with 16.9% being accounted for. The RDAs accounted for 28.7% in the absolute livelihood income portfolio at the primary income POA, and for 28.6% and 29.6% for the absolute and relative income values at the cash generation POA. All RDA ordinations were significant for both the first and all canonical axes.

Table 5.2. Summaries of standardised and non-standardised RDA ordinations of household livelihood portfolios using adopted livelihood strategies as explanatory factors done at the three POAs across 588 households. The canonical eigenvalues and cumulative percentage of variation are presented for the first two components. Monte Carlo tests were used to test the significance of the ordinations.

| | Components | |
|---|---|---|
| | **1st (x)** | **2nd (y)** |
| 1) PRIMARY INCOME vs. ADOPTED STRATEGIES | | |
| *Absolute values: non-standardised, centered RDA* | | |
| **Eigenvalues (canonical)** | 0.271 | 0.014 |
| **Cumulative % variation of income data** | 27.1 | 28.5 |
| ***Sum of all eigenvalues (canonical)*** | | *0.287* |
| ***— Monte Carlo - first canonical axis: F-ratio; P-value*** | *211.826* | *0.0020* |
| ***— Monte Carlo - all canonical axes: F-ratio; P-value*** | *12.700* | *0.0020* |
| *Relative values: standardised, centered RDA* | | |
| **Eigenvalues (canonical)** | 0.075 | 0.062 |
| **Cumulative % variation of income data** | 7.5 | 13.7 |
| ***Sum of all eigenvalues (canonical)*** | | *0.169* |
| ***— Monte Carlo - first canonical axis: F-ratio; P-value*** | *46.182* | *0.0020* |
| ***— Monte Carlo - all canonical axes: F-ratio; P-value*** | *6.436* | *0.0020* |
| 2) USED vs. ADOPTED STRATEGIES | | |
| *Absolute values: non-standardised, centered RDA* | | |
| **Eigenvalues (canonical)** | 0.090 | 0.061 |
| **Cumulative % variation of income data** | 9.0 | 15.1 |
| ***Sum of all eigenvalues (canonical)*** | | *0.160* |
| ***— Monte Carlo - first canonical axis: F-ratio; P-value*** | *56.326* | *0.0020* |
| ***— Monte Carlo - all canonical axes: F-ratio; P-value*** | *5.999* | *0.0020* |
| *Relative values: standardised, centered RDA* | | |
| **Eigenvalues (canonical)** | 0.061 | 0.041 |
| **Cumulative % variation of species data** | 6.1 | 10.1 |
| ***Sum of all eigenvalues (canonical)*** | | *0.125* |
| ***— Monte Carlo - first canonical axis: F-ratio; P-value*** | *36.740* | *0.0020* |
| ***— Monte Carlo - all canonical axes: F-ratio; P-value*** | *4.511* | *0.0020* |
| 3) CASH GENERATION vs. ADOPTED STRATEGIES | | |
| *Absolute values: non-standardised, centered RDA* | | |
| **Eigenvalues (canonical)** | 0.278 | 0.008 |
| **Cumulative % variation of income data** | 27.8 | 28.6 |
| ***Sum of all eigenvalues (canonical)*** | | *0.286* |
| ***— Monte Carlo - first canonical axis: F-ratio; P-value*** | *219.401* | *0.0020* |
| ***— Monte Carlo - all canonical axes: F-ratio; P-value*** | *12.671* | *0.0020* |
| *Relative values: standardised, centered RDA* | | |
| **Eigenvalues (canonical)** | 0.166 | 0.073 |
| **Cumulative % variation of income data** | 16.6 | 23.9 |
| ***Sum of all eigenvalues (canonical)*** | | *0.296* |
| ***— Monte Carlo - first canonical axis: F-ratio; P-value*** | *113.583* | *0.0020* |
| ***— Monte Carlo - all canonical axes: F-ratio; P-value*** | *13.311* | *0.0020* |

Overall, the variations within the adopted suite of livelihood strategies that were associated with variations in the land-based income streams were not associated with the off-farm income stream (Figure 5.3). This held true whether the income steams were considered as the primary income entering a household (Figure 5.3a), the value that a household used (Figure 5.3b) or the value of cash generated (Figure 5.3c). Furthermore, this dissociation between land-based income stream and off-farm income livelihood strategies also held true whether the changes in an income stream were measured in absolute rand value (Figure 5.3i) or in the change relative to the values within that particular income stream (Figure 5.3ii).

Households that had more employed members, particularly those who were employed on a full-time basis, had higher primary income and cash generation from off-farm activities (Figure 5.3a,c), and spent more money buying off-farm goods and services (Figure 5.3b). This was true whether the increases in income were measured in absolute monetary values or as relative differences. While households that had more part-time employed members were associated with higher primary income values from off-farm activities (Figure 5.3a), they were more likely to generate cash from the land-based livelihood incomes (Figure 5.3c). Households that received more grants earned higher absolute amounts of income from off-farm activities and had higher primary income and cash generation values from the land-based income streams (Figure 5.3ai, ci). Part-time employment and grants were not associated with the used livelihood income portfolio of households (Figure 5.3bi), except where households that had more grants could be using relatively more resources from the land-based income streams (Figure 5.3bii).

Households with more pensioners had higher primary incomes and used values from the land-based income streams (Figure 5.3a, b). However, they were less likely to generate cash from these activities (Figure 5.3c). Households that had more students were more likely to spend on off-farm goods and services (Figure 5.3b). Furthermore, there was tendency for these households with more students to source and use relatively more land-based incomes (Figure 5.3ai). The accessing of finance by households was only associated with households that tended to spend more on off-farm goods and services (Figure 5.3bi), even though this accessing of finance was calculated as contributing to the primary income and cash generation from off-farm income.

Households that sold environmental, crops and livestock products were more likely to be the households that sourced more primary income, used more resources and generated more cash from their respective land-based livelihood income streams (Figure 5.3). Households that grew more crops sourced and used more crop income (Figure 5.3a, b), but did not necessarily generate more cash from crop sales (Figure 5.3c). Livestock ownership meant more primary income and used value

from the livestock income stream (Figure 5.3a,b), but was associated with households that earned more cash from livestock and livestock product sales, and with households that generated more cash from off-farm activities (Figure 5.3c).

As almost all households used environmental income, this translated in it having no ability to help understand the dynamics of the livelihood portfolios (Figure 5.3). Of interest was that households that spent less on off-farm activities were households that were collecting environmental resources (Figure 5.3b). Being a buyer of environmental resources was simultaneously associated with being a household that was more involved in the primary sourcing and using of all livelihood income stream (Figure 5.3a,b), but only associated with households that generated cash from off-farm activities (Figure 5.c).

Households that had higher numbers of members involved in the land-based income streams were associated with households that primarily sourced and used more land-based incomes (Figure 5.3a, b). The number of people who were involved in environmental income sourcing in particular also showed a negative association with primary income and used values from the off-farm income stream (Figure 5.3a, b). This association was especially found at the cash generation level where the number of members involved in sourcing from the land-based income streams did not translate into generating more cash from them (Figure 5.3c). Higher numbers of members involved in the environmental income stream were associated with household that generated less cash from the off-farm income steam (Figure 5.3c).

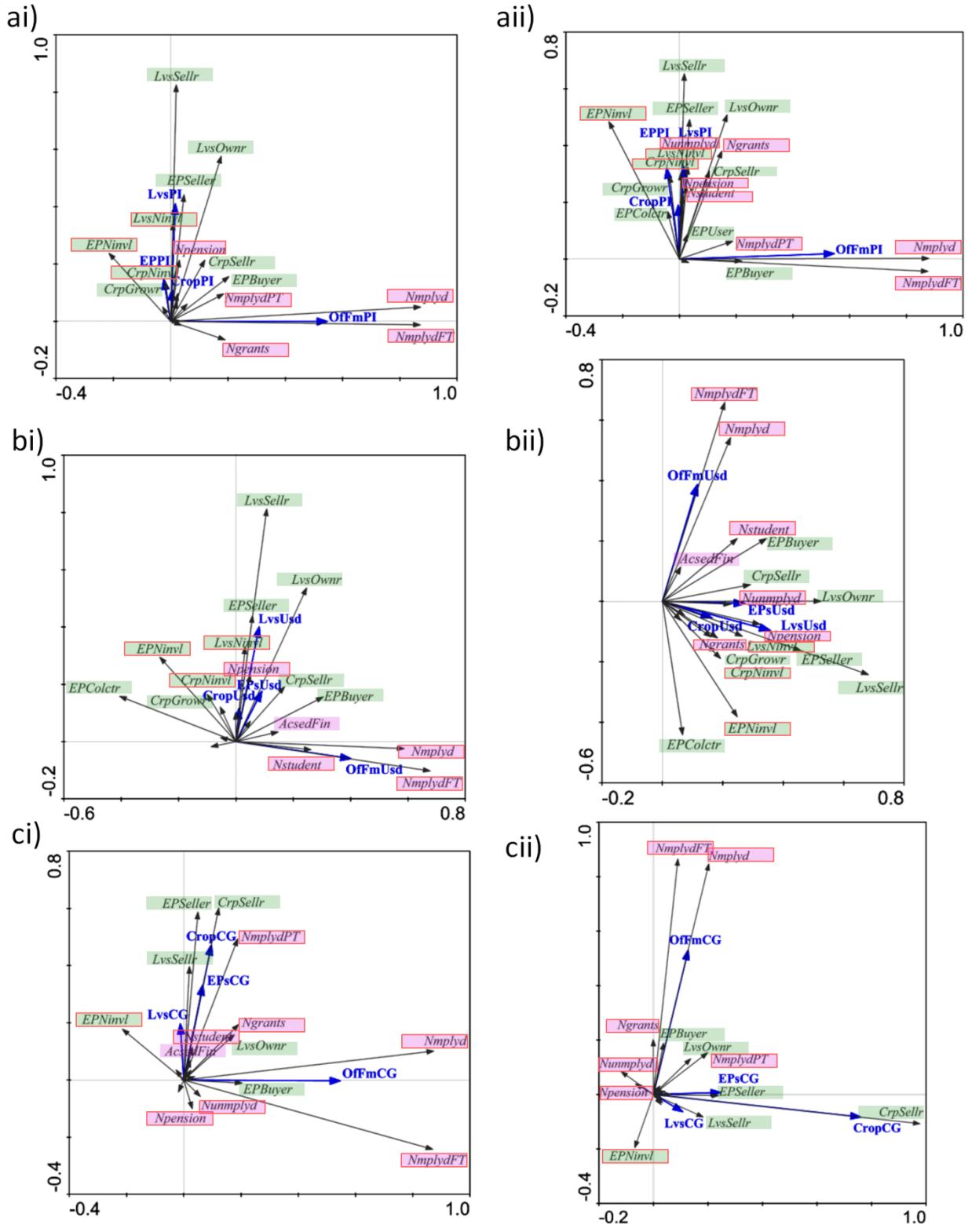



Figure 5.3 Biplots of i) non-standardised and ii) standardised RDA ordinations household livelihood incomes with adopted livelihood strategies as explanatory factors. These were done at three different POAs in the livelihood income chain: a) primary income (PI), b) used (Usd) and c) cash generation (CG). Incomes were examined from four livelihood income streams: environmental (EP), livestock agriculture (Lvs), crop agriculture (Crop) and off-farm activities (OfFm) across 588 households. Labels of variables have been shifted to allow for ease of reading and the associated

arrowheads should rather be used to compare effects. [+Codes used in the labelling of adopted livelihood strategies are: *EPColctr*, EPs collector; *EPUser*, EPs user; *EPSellr*, EPs seller; *EPBuyer*, EPs buyer; *EPNinvl*, number of people involved in EPs activities; *LvsOwnr*, livestock owner; *LvsSellr*, livestock seller; *LvsNinvl*, number of people involved in livestock activities; *CrpGrowr*, crops grower; *CrpSellr*, crops seller; *CrpNinvl*, number of people involved in crop activities; *Nmplyd*, number of employed members; *Nunmplyd*, number of unemployed members; *NmplydFT*, number of full-time employed members; *NmplydPT*, number of part-time employed members; *Nstudents*, number of students; *Npension*, number of pensioners; *Ngrants*, number of grants; *AcsedFin*, accessed finance. Refer to Table 2.6 for detailed explanation on these labels. Refer to Figure 5.2. for colouring code of labels.]

When considering the GLMs, proportional environmental income dependence in the portfolio ranged from a mean ± SD of 0.57% ± 3.68% for cash generation, 12.29% ± 1.64% for primary income into the household and 22.41% ± 19.18% for consumption. These values were both influenced by absolute changes in the environmental income stream as well as in the other income streams. While the global GLM could be used to predict the proportional environmental income dependence at the primary income and used levels, it failed to converge at the cash generation POA (Table 5.3). The variables that were associated with individual income stream as part of the income portfolio (Figure 5.3) did not necessarily translate into the variables that predicted the environmental income dependence best in a global GLM model (Table 5.3).

At the primary income level, households that were buyers of environmental resources had lower proportional environmental income dependencies, while households that had more members involved in environmental activities had higher proportional environmental income dependencies (Table 5.3). Having more members employed, especially on a full time basis, more grants per household and if a household accessed financial credit and saving resources, all resulted in lower environmental income dependencies. For the values used by households, households that reported collecting and had more members involved in environmental resource harvesting had higher environmental dependencies for what was used in the household. Furthermore, buying environmental resources is also associated with higher environmental dependencies for consumption. Households that accessed off-farm finance from credit and saving tended to have lower environmental income dependencies for what they consumed in the household.

Table 5.3 Fractional logit model results for the null and global models of environmental income dependency at three POAs using household adopted livelihood strategies as the explanatory variables. Environmental income dependency was the proportion contribution to the total household income portfolio.

| **POA** *(mean ± SD)* | **Null deviance** *(587 df)* | **Residual deviance of global model** *(569 df)* | **Significant socio-economic variables**[+] | **Log-odds ratio estimate** | **Upper log-odds ratio** *(estimate+ 1.96*standard error)* | **Lower log-odds ratio** *(estimate- 1.96*standard error)* |
|---|---|---|---|---|---|---|
| **Primary income** *(12.29% ± 1.64%)* | 119.10 | 89.30 | EPBuyer** | -0.25 | -0.47 | -0.03 |
| | | | EPNInvl*** | 0.19 | 0.12 | 0.26 |
| | | | CrpGrowr* | 0.68 | -0.09 | 1.45 |
| | | | Nmplyd*** | -0.21 | -0.35 | -0.06 |
| | | | NmpydFT*** | -0.24 | -0.42 | -0.07 |
| | | | Ngrants*** | -0.12 | -0.19 | -0.06 |
| | | | AcsedFin*** | -0.35 | -0.62 | -0.09 |
| **Used** *(22.41% ± 19.18%)* | 126.36 | 1107.22 | EPColctr** | 2.18 | 0.07 | 4.29 |
| | | | EPBuyer*** | 0.33 | 0.15 | 0.51 |
| | | | EPNInvl*** | 0.08 | 0.02 | 0.14 |
| | | | AccsdFin*** | -0.37 | -0.60 | -0.14 |
| **Cash generation** *(0.57% ± 3.68%)* | Model failed to converge. Attributed to variables unable to differentiate between the very low, small range of environmental income dependencies, with the possibility that these dependencies being predicted perfectly by one or more variables. | | | | | |

p<0.01***; p<0.05**; p<0.1*

[+]Codes used in the labelling of adopted livelihood strategies are: *EPColctr*, EPs collector; *EPBuyer*, EPs buyer; *EPNinvl*, number of people involved in EPs activities; *CrpGrowr*, crops grower; *Nmplyd*, number of employed members; *NmplydFT*, number of full-time employed members; *Ngrants*, number of grants; *AcsedFin*, accessed finance. Refer to Table 2.6 for detailed explanation on these labels.

## 5.5. DISCUSSION

Quantitative understanding of livelihoods in rural socio-ecological systems is needed to guide strategic planning aimed at alleviating poverty and increasing the resilience of livelihoods (Vetter 2013, Angelsen et al. 2014). The adoption of different livelihood strategies by households, in addition to considering the values derived from the various income streams, is important in understanding livelihood dynamics in the Bushbuckridge region. This understanding is deepened by considering the numbers of household members that are involved in these livelihood strategies. The link between adopted livelihood strategies and their resulting incomes serves as a basis on which to quantify and understand livelihoods. General and focussed economic upliftment interventions are often promoted in development plans for the area (Bushbuckridge Local Municipality 2014). By taking the understanding of how households' adopted livelihood strategies influence livelihood

incomes, authorities in charge of planning and implementing economic upliftment interventions can guide their efforts to encourage or discourage certain strategies in order to influence the resulting incomes.

Sourcing and using income from the environmental, crop and off-farm income streams were widespread among households in the Bushbuckridge region. In contrast, the use and cash generation from the livestock income stream and cash generation from the environmental and crop income streams were not common; these could be easily used to differentiate households' livelihood strategy portfolios. When taking into consideration the number of members involved in the livelihood strategies, the positive correlation between livestock and crop activities was not shared with environmental activities. This suggests that programmes that are aimed at increasing individual participation in different livelihood strategies can be designed to encourage both agricultural streams simultaneously, while a different focus will be needed for environmental activities participation. Households' environmental and crop income streams economic activities were associated with each other, even though the farming of crops was more associated with households that farmed and sold livestock. This has significance in that the household circumstances and market opportunities that determine whether households sell crops and environmental resources are related to each other, even though the circumstances that contribute to adopting the agricultural income streams are unrelated to that of the environmental income stream. There are low levels of trade of environmental resources even though this trade has the potential to be a viable source of income, especially for the poor (Shackleton et al. 2000, 2005, Dovie et al. 2002, Botha and Shackleton 2004, Shackleton and Shackleton 2004). This trade is limited by a variety of factors including lack of formal markets, limited knowledge on trade skills, underdeveloped processing methods that add value to resources, and unreliable supplies to resources due to environmental conditions and different levels of authority applied by landowners and authorities (Dovie et al. 2002, Shackleton 2005)

Whether household members are unemployed is not determined by whether there is already employment in the household but rather by factors external to the household, with one likely external factor being the lack of employment opportunities in this rural area (Kahn et al. 1999, Hunter et al. 2014). Having more unemployed members per household had no bearing on whether the household had more members involved in the land-based income strategies, while households with more students tended to have more members involved in environmental activities. This suggests that involvement in the land-based income streams may be determined by the individual, cultural roles of people within the household (Shackleton 2005, de Sherbinin et al. 2008) and not

simply by having available labour. Additionally, there may be the added co-variate of age related duties, where increased numbers of children, who are most likely students, were more closely associated with environmental resource collection compared to the numbers of adults (see section '4.4.2. The use of socio-economic factors to explain livelihood income portfolios'). Furthermore, the limited use of these land-based resources reflects that available labour is not capitalised on to increase income from these streams beyond subsistence needs. Households that had more pensioners were also more likely to be collectors of environmental resources, reflecting the cultural or needs-based tendency for the elderly to use these available resources (Shackleton et al. 2006, Hunter et al. 2014). If Bushbuckridge experiences a longer life expectancy and an aging population with the introduction of health programmes (Kahn et al. 2012), it is possible that this use of the environment will persist in the region.

From chapter 3 of this dissertation, we see that the off-farm income stream contributes the most to household livelihoods for primary income and cash generation. The livestock income stream, while comparatively as valuable as the off-farm income stream to user households, is not worth much more than the other two land-based income streams when evaluated across all households in the region. In this chapter, we see that the variations in the primary income, used values, and cash generation values of the land-based strategies were associated with a different set of adopted livelihood strategies than the set of strategies that were associated with the off-farm income stream. Additionally, strategies that were associated with an income stream at one POA did not necessarily have the same association at the other POAs. The observed income values obtained by a household from the land-based income streams compared to the off-farm income stream seems not to be as a result of choices between alternative strategies and their expected outputs. While many studies report on the absolute and relative relationships between environmental income values and other livelihood income streams, especially off-farm and total income values, (Cavendish 2000, Fisher 2004, Shackleton and Shackleton 2006, Babulo et al. 2009, Thondhlana et al. 2012), the choice of livelihood strategies behind these observed patterns are different and may be unrelated.

An important feature of the livelihoods approach used in this study is that it draws attention to the links between the assets people have, the options presented to them in practice to pursue alternative activities, and the subsequent choices that that they make in order to generate different the different incomes that they need for survival (Ellis 2000). This study shows that increasing the numbers of employed members per household, especially full-time employment, is associated with higher off-farm income and expenditure values in households. Receiving more grants was only associated with increased off-farm primary cash income, while using credit and savings that was

associated with spending more on off-farm activities. This suggests that while grant money is used to meet the basic needs of a household, the use of credit and savings is usually for when there could be increased needs and stress on the expenditure of the household when purchasing items and services in excess of the norm. Part-time employment, receiving more grants and owning livestock was associated with households that are dependent on cash from both the land-based and off-farm livelihood income streams. This reflects a tendency for households who can access alternative, lucrative cash income streams (i.e. livestock) or who need more income (i.e. lack of steady, formal employment), to shift away from depending only on cash generation from the off-farm income stream. They are also likely to depend on cash income from the land-based income streams including environmental income.

Households with more pensioners and students had higher primary income values from the land-based income streams. However, having more pensioners meant only more consumption from the land-based income streams and having more students only meant consuming more from the off-farm income stream. While the number of students did not influence the cash generation from the land-based income streams, having more pensioners decreased the likelihood of earning cash from these land-based income streams. The cultural- and needs- based tendency, that was noted in household members involvement in different livelihood strategies, further influences the values obtained from these income stream at different POA in the livelihoods income chain.

Households with lower off-farm expenditure were more likely to be collectors of environmental resources, while households with higher incomes from off-farm activities were more likely to be buyers of environmental resources. This implies environmental resource consumption could be serving in Bushbuckridge as an alternative to consuming goods and services from the off-farm activities market. In order to shift from being a collector of environmental resources to a buyer, households need higher amounts of off-farm income. When households had more members involved in environmental income sourcing, they had lower values in off-farm income stream especially at the cash generation level. For cash generation, while the number of members involved in the land-based income streams translates in to higher primary income and used values, it did not mean generating more cash from them. Observing increased involvement in land-based livelihood income streams does not mean increased cash generation from these income streams.

Proportional environmental income dependencies are useful for evaluating how the worth of environmental income changes between the primary income, used and cash generation points of assessment. However, many of the dynamics between adopted livelihood strategies and all the income streams that contribute to environmental income stream are not captured. This limits our

ability of extending such findings to make predictions in time and space or in suggesting practical solutions to uplifting communities or changing livelihood patterns.

Generalisations about the causes and effects of livelihood diversification, as made in this study, are useful for policy (Ellis 1998). These generalisations allow for policies to be made to tackle the causes of diversification (if diversification is considered bad) or to stimulate it further (if diversity is considered good), or to channel it in particular directions to see to the interests of a particular group of people (Ellis 1998). At the same time, it must be kept in mind that livelihood diversification is a heterogeneous process, that is subject to various different pressures and possibilities (Ellis 1998). The generalisations made in this study must not be interpreted in isolation. Researchers and policy makers need to work with the understanding of the entire diversified livelihoods portfolio and socio-ecological system.

## 5.6. CONCLUSION

The various factors that influence the translation of household capital into livelihood income are often too numerous and intricate to measure and model (Scoones 2009). However, the relatively straightforward relationship between the adoption of livelihood strategies and the resulting incomes may present a more efficient solution to modelling livelihoods. The findings in this chapters stress that a collective examination of both the strategies involved and the resultant incomes is needed to understand the dynamics within these socio-ecological systems. This will help create the quantitative understanding of these socio-ecological systems that is being called for to guide strategic planning (Vetter 2013, Angelsen et al. 2014). Analysing only a few income streams or analysing proportional dependence is insufficient. Furthermore, understanding these dynamics at different points of assessment in the livelihood chain will be useful if tradeoffs in conservation need to be made when guiding policy formation and implementation to maintain the health of these socio-ecological systems (Vetter 2013, Angelsen et al. 2014). While associating household capital with livelihood income values is valuable, the quantification and understanding of the link between livelihoods strategies and incomes as demonstrated in this chapter is a more streamlined approach for making implementable recommendations to policy makers.

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# CHAPTER 6

# 6. SYNTHESIS

## 6.1. BACKGROUND

Conservation is a human activity that takes places among many other human activities; researchers and policy makers need to take into account human well-being orientated activities in order to contribute to feasible and practical conservation solutions (Lienert and Burger 2015). Ecosystem services theory and research has until recently focussed mainly on ecological processes (Scoones 2009, Cumming et al. 2014). However, with the recognition that the underlying drivers of ecosystem change and degradation are socio-economic, there has been a shift to more holistic research in socio-ecological systems (Scoones 2009, Cumming et al. 2014). Livelihood approaches offer an important and comprehensive research lens for looking at complex rural development and associated conservation questions (Ellis 1998, 2000, Scoones 2009). The focus in these livelihood approaches is on locally embedded, integrative, cross-discipline analysis, rather than on the more typical, macro-analysis, single-sector analysis in disciplines like economics, agriculture or ecology (Ellis 1998, 2000, Scoones 2009).

Using the Sustainable Livelihoods Approach (SLA), this study set out to quantify and understand the contribution of environmental resources to the diversified livelihood portfolios of households in a rural district of South Africa as part of the Sustainability in Communal Socio-Ecological Systems (SUCSES) research project. Households' livelihood portfolios consisted of four livelihood income streams: environmental, livestock, crops and off-farm (Figure 6.1). The analysis of these incomes and the associated roles of household socio-economic and adopted strategies in defining these incomes were examined at three points of assessment (POAs): primary income, used value and cash generation.

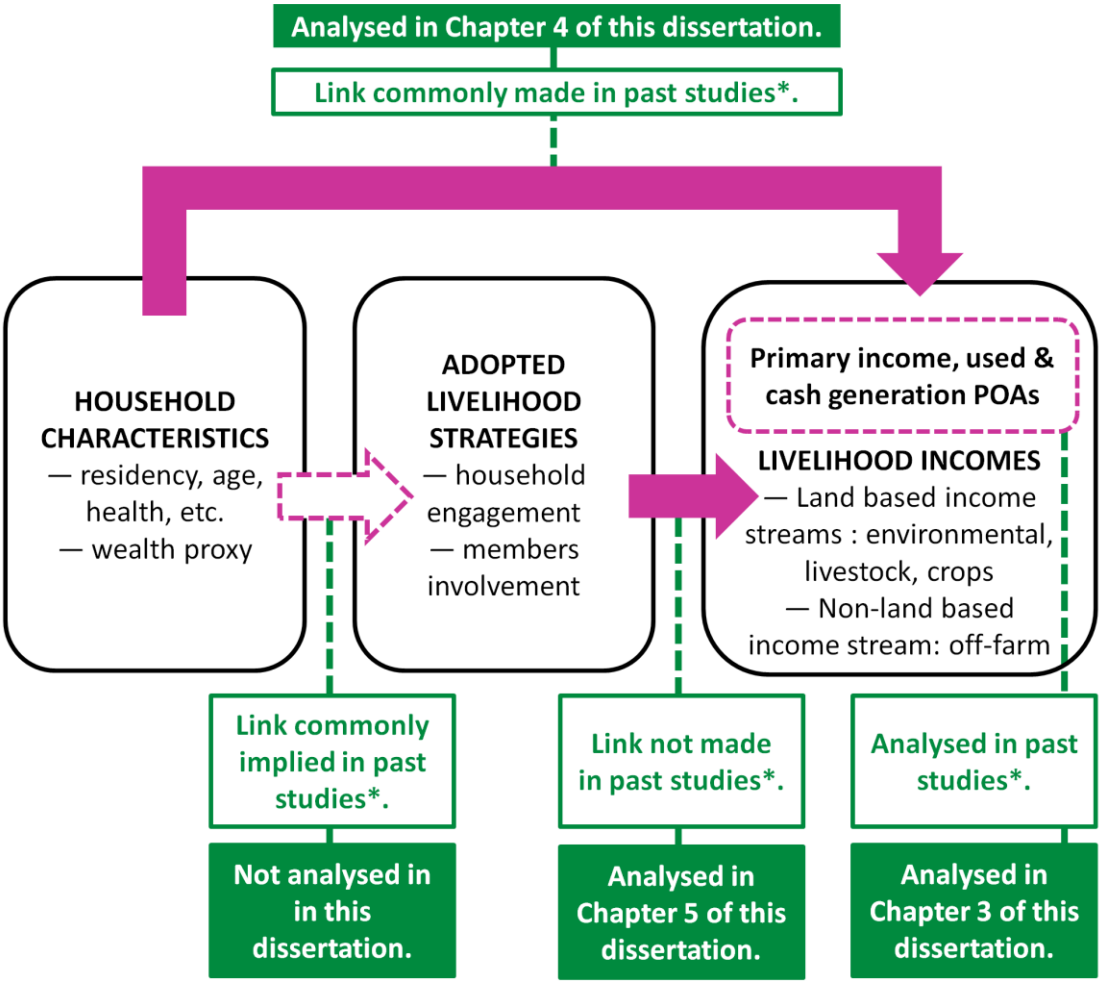



Figure 6.1 Analysis structure that was used in this dissertation that was applied to the baseline 2010 Sustainability in Communal Socio-Ecological Systems (SUCSES) dataset. The diagram shows the livelihood components that were examined and the links made between these components. This framework of analysis is based on the Sustainable Livelihoods Approach (DFID 1999) and has been adapted to address the objectives of this dissertation.

## 6.2. RECOMMENDATIONS TO STAKEHOLDERS IN SOCIO-ECOLOGICAL SYSTEMS

### 6.2.1. A systematic methodology of analysing household livelihood data

Systematic quantification and understanding of rural livelihoods is needed to guide strategic planning and development that is often aimed at poverty alleviation among households and at increasing their resilience to stresses and shocks (Ellis 1998, Vetter 2013, Angelsen et al. 2014). Large-scale surveys that focus only on generating masses of off-farm income and expenditure data have failed to record, let alone generate an understanding of, the groundswell of livelihood

diversification that takes places (Ellis 2000). Livelihood approaches, particularly the SLA framework, have helped standardise research but often lead to recommendations that are too localised and are not generalised enough (Scoones 2009). These recommendations are usually pushed aside by governing bodies in favour of more mainstream globalised economical recommendations that are easier to understand and implement (Scoones 2009). With a more systematic livelihoods approach to analysis, researchers will be able to design and conduct research more effectively and efficiently, as well as make recommendations that are more accessible and practical to stakeholders.

The systematic methodology used in this study in analysing households' livelihoods provides a practical, standardised framework for future research that can be used to advise policy more effectively. The initial quantification of the livelihood data in common monetary units at the three different POAs of primary income, household consumption and cash generation allows for the analysis to be expanded to different platforms of understanding (Figure 6.2). The collective understanding of the variation between the different income streams can be extended to understanding the worth of these income streams to households and corresponding per capita values (Figure 6.2b), as well as understanding the worth of these income streams to the socio-ecological system as a whole (Figure 6.2c). Combining the collective understanding of the income portfolios at the different POAs with a collective understanding of either the household socio-economic characteristics or the adopted livelihood strategies creates a platform for understanding the dynamics that influence the different income streams within households' livelihood portfolios (Figure 6.2a,d-i). This platform of understanding has potential for creating workable, predictive models in these systems, especially when a suite of adopted livelihood strategies is used. However, the creation of these workable and predictive model needs to be done cautiously, as resultant models need to be interpreted at all POAs simultaneously, with the collective understanding of the links between incomes and socio-economic characteristics and between incomes and adopted livelihood strategies.

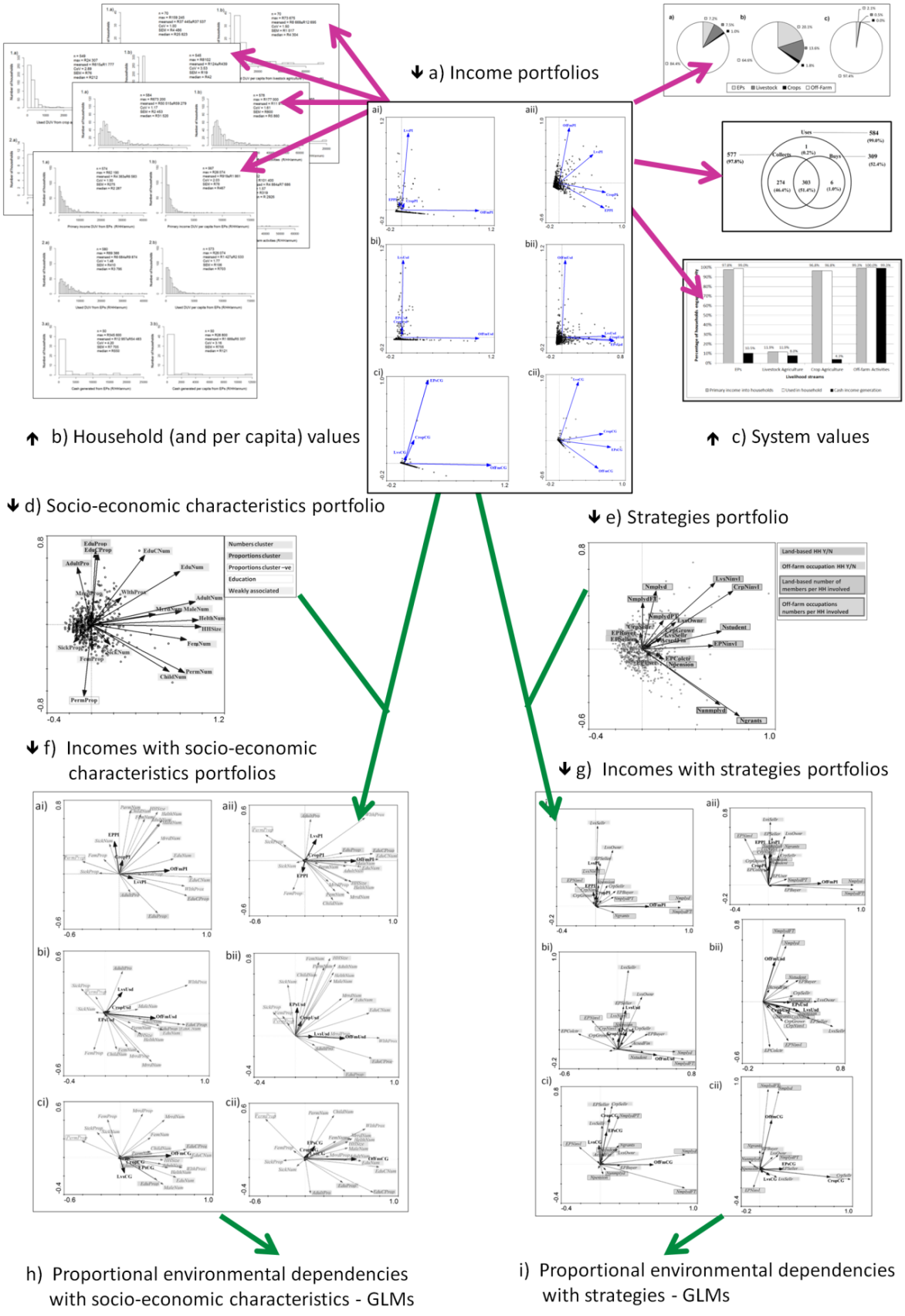



Figure 6.2 Graphical synthesis of the results of this dissertation with a), b) and c) being addressed in chapter 3; d), f) and h) being addressed in chapter 4; and e), g) and i) being addressed in chapter 5.

### 6.2.2. Differentiating the value of income streams to the system, to households and to individuals

Households are frequently used as the unit of analysis in livelihood studies in rural socio-ecological systems. An important stance that needs to be taken is that the worth of the different livelihood income streams at different POAs is of different value to the socio-ecological system as a whole compared to its average value to individual households; households view the value of a particular livelihood income stream different to what value of the livelihood income stream is to the whole socio-ecological system. While the mean values for households is a valuable tool in estimating the value of a particular livelihood stream to the socio-ecological system as a whole, it overestimates the values of these livelihood streams to individual households where the median is a more accurate representation. Stakeholders need to understand this perspective bias from the point of view of the household, and adjust their projects and the target of their projects appropriately.

Extending household income values to per capita values emphasises the inequality of earnings, with more households earning in the lower income brackets. The realised earnings and consumption potentials of households seems not to be determined by household size but is limited by other household factors that include education, gender, age and employment. Livelihood approaches are focussed on realising the capacities and capabilities of the people instead of only focussing on their needs (Scoones 2009). Poverty alleviation and empowerment programmes in rural socio-ecological should not determine the scope to household units or according to household size. These programmes should rather focus on realising or increasing the potential of the individuals within the household based on their individual socio-economic characteristics.

### 6.2.3. The collective examination of livelihood portfolios at all points of assessment in the livelihood chain

The results from this study reflect that a collective analysis of income streams at all the different POAs creates a more comprehensive understanding of households' livelihood portfolios. If the absolute values of income streams are analysed in isolation, it can easily disregard the relationships between income streams and the corresponding changes in relative income dependencies. Furthermore, stakeholders need to do collective examinations, at all POAs, of the livelihood income portfolio with either the suite of socio-economic characteristics or the suite of adopted livelihood strategies or both. Socio-economic factors and livelihood strategies that feature more strongly at some POAs are less important at others. While an individual factor that is more associated with an income stream compared to other characteristics may be what is driving the observed income

values, it also could simply be better at representing the influence of a combination of a few other household characteristics.

Policy intervention aimed at manipulating households' dependence on land-based activities needs to differentiate whether it will be influencing the subsistence sourcing and consumption of resources, or will intervention influence the cash generation from these income streams. Particular attention needs to be paid as to which households will be addressed in policy interventions. It will be wiser to focus interventions that concern the sourcing and consumption of environmental and crop resources across all households. Some examples of these interventions would be altering the harvesting access of all households to fuelwood and other natural resources in private and public nature reserves for household consumption, or programmes that educate and assist households to grow crops to meet their own needs. It is advised that decision makers need to encourage and maintain current environmental resource use and crop agriculture that is supporting household consumption across all households, along with taking environmental sustainability into account. Other educational and infrastructural interventions that focus on the sourcing and primary consumption of livestock resources and the sale of all land-based resources will be better aimed at those fewer households that are already involved and on how to maximise their benefits for production, consumption and sales.

### 6.2.4. Capital, strategies and incomes: moving from understanding to modelling

Programmes aimed at poverty alleviation and increasing rural households' resilience to stresses and shocks need strategic planning that is guided by quantitative understanding of households' dependencies on the different livelihood incomes (Vetter 2013, Angelsen et al. 2014). Using proportional environmental income dependency, instead of the different income streams values, omits important aspects that are valuable in understanding household livelihoods, especially the relationships among livelihood incomes and the relationships between incomes, socio-economic characteristics and adopted livelihood strategies.

The SLA (DFID 1999) links the various types of capital available to households to the livelihood strategies that these households adopt in order to earn income. This needs to be strategically considered when analysing livelihoods. The various factors that influence the translation of household capital into livelihood income are often too numerous and intricate to measure and model (Scoones 2009). However, the relatively straightforward relationship between the adoption of strategies and the resulting incomes may present a more efficient solution to modelling livelihoods. From this study, we can see that the suite of adopted livelihood strategies is as valuable to understanding livelihood incomes as the suite of household socio-economic characteristics. This

suite of adopted livelihood strategies has particular potential for creating workable predictive models in these systems. The choice of adopted livelihood strategies reduces the need to understand and account for all factors that influences the translation of all livelihood capital, including household socio-economic characteristics, into livelihood incomes. This simplified connection is crucial to standardising and creating models that can be put into practice at all POAs within the livelihood chain in these socio-ecological systems.

Lastly, when trying to understand and encourage increased or decreased dependence on the environmental and other income streams, there is more value in asking how to encourage a set of adopted livelihood strategies that is associated with a certain set of dependencies on the different income streams rather than asking which socio-economic household factors are likely to result in said dependencies.

## 6.3. INTO THE FUTURE

Livelihood diversification in rural areas of developing countries is not a new trend; what is new is the recognition of livelihood diversification as a concept in socio-ecological system research and practice through the increased use of livelihood approaches (Ellis 2000). The use and, in limited cases, sale of environmental and other land-based resources as part of a diversified livelihoods incomes portfolio can move rural households out of poverty, while acting as a safety net for those most deeply impoverished (Bryceson 2002, Angelsen and Wunder 2003, Shackleton and Shackleton 2004, Dovie et al. 2005, Shackleton et al. 2008, Paumgarten and Shackleton 2011, Hunter et al. 2014). Even though we often consider livelihood diversification as only a starting point, or a transitional phase to something better (Scoones 2009), the capacity to diversify income sources is generally associated with improvements in livelihood security and income-increasing capabilities of rural households (Ellis 1998). The unchallenged shift from the use of land-based income streams to off-farm income in rural lands, particularly in South Africa (Bryceson 2002), emphasises the need to understand the livelihood interactions within the rural household. This is especially true when tradeoffs between the immediate interests of the people and longer-term sustainability decisions in conservation need to be made when guiding policies to maintain the health of these socio-ecological systems.

We often consider rural areas like Bushbuckridge to be in ‘green loop’ systems where there is clear, direct feedback between the state of the environment and human well-being , and that human population numbers are stable and highly dependent on local, healthy ecosystems (Cumming et al. 2014, Hamann et al. 2015). Alternatively, these rural areas are caught in green trap, especially in places with growing human populations, inadequate local production of food and other environmental products, ongoing poverty and unsustainable local degradation of the local

ecosystem (Cumming et al. 2014, Hamann et al. 2015). These rural areas, however, are more of a transition from a green loop system into a 'red loop' system where the population is dependent on off-farm income, goods and services and is disconnected from their local environment (Cumming et al. 2014). The people's use of natural resources in Bushbuckridge is not limited to the feedback they would receive from the ecosystem services, resulting in potential negative consequences for biodiversity and ecosystem services. This presents an interesting perspective for conservation and development in the region.

Past, present and future governmental policy plays a huge role in regulating households' dependencies on environmental income as part of their diversified portfolio (Bryceson 2002). Livelihood analysis is a malleable concept that can be used to serve multiple purposes and ends, and is often incorrectly and easily narrowed down to fit within a particular planning concept (Scoones 2009). We need to be careful when giving recommendations based on analysis using livelihood approach frameworks. Poverty reduction requires longer term, more strategic undertakings than snapshots usually given using the SLA in particular (Scoones 2009). Poverty reduction undertakings need to encompass social and political realities of powers in areas as well as confront ethical choices and trade-offs made by researchers and policy makers (Scoones 2009). Generalisations, while accessible and useful to policy makers, often are not needed to create policy based on the holistic understanding that livelihood diversification is based on (Scoones 2009). We need to query: which interest group's livelihoods are valued over others, and why, what we regard as a positive or negative livelihood, and why we deem certain livelihood typologies as inappropriate and thus in need of rescue, discipline and transformation (Scoones 2009).

The Bushbuckridge Integrated Development Plan (IDP) of 2014-2016 states that local government has the duty to "exercise the municipality's executive and legislative authority and use the resources of the municipality in the best interest of the local communities", and any credible IDP should "be reflective of the accurate developmental needs of the local communities", (Bushbuckridge Local Municipality 2014). The Bushbuckridge Local Municipality has subsequently adopted a holistic approach in addressing the inter-related socio-economic factors that can contribute to the quality of life for those living in the area (Bushbuckridge Local Municipality 2014). With these correct mindsets in place, it can be seen from this IDP that it is difficult to account for agricultural and environmental resource use alongside off-farm income. Livelihood approaches do offer one of the best solutions to rural development understanding, but a lot needs to be done to ensure that methods and recommendations are accessible to political and powerful stakeholders (Scoones 2009).

The framework of analysis applied in this study to the baseline SUCSES data is a platform that past, current and future frameworks of analysis, both in the Bushbuckridge region and in other in areas, can be based on and scrutinised with. Livelihood incomes need to be collectively examined as a portfolio, with the suites of household socio-economic characteristics and livelihood strategies, and differentiating between household primary incomes, consumption and cash generation in the livelihood income chain. There is a need for validation of the direct use values (DUVs) of the land-based incomes that were used in this study. There is scope for many of the interactions between livelihood incomes, capital and strategies that have been highlighted in this study to be further explored in more focussed studies. This study needs to be repeated and expanded over the years to see whether the observed patterns in livelihood income portfolios are maintained. The choice of household socio-economic and livelihood strategies measurements and proxies used in this study will benefit from a revision. Lastly, a study into how these socio-economic characteristics and other forms of capital translate into the adopted livelihood strategies will deepen our understanding of the dynamics at play.

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"And We have certainly established you upon the earth and made for you therein ways of livelihood. Little are you thankful."

*The Noble Quraan, Chapter 7, Verse 10*