



# Livelihood profiles and adaptive capacity to manage food insecurity in pastoral communities in the central cattle corridor of Uganda

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## ABSTRACT

Adaptive capacity is the capabilities, resources and institutions of a country or region to implement effective adaptation measures. This article aims to highlight pastoral communities' differential adaptive capacity to buffer household food insecurity. We use mixed methods including case households and key informants to provide qualitative data on determinants of adaptive capacity. Subsequently cluster analysis is applied to combine survey data from respondent households on the basis of the livelihood capitals. Three distinct, heterogeneous livelihood profiles are identified. The Minimally-endowed face uncertain access to livelihood capitals; Large-herd Landlords are endowed with physical and financial capital – ownership of land and large numbers of livestock; while the Land-rich are endowed with natural capital – access to large sizes of land. This denotes different types of adaptive capacity and underscores the need for agricultural extension, technology transfer and other interventions to be differentiated based on the variance in adaptive capacity and challenges of the existing heterogeneous livelihood clusters. We argue that if such differences are not first identified, development strategies including those of agricultural extension could fail in their attempts to ensure sustainable household food security. Rather than being a homogenous community, pastoralists in the central cattle corridor of Uganda belong to three heterogeneous livelihood profile clusters. Each cluster is differentially endowed with livelihood capitals which denote different types of adaptive capacity. As an empirical study done at household level, this work contributes insights that can be considered in designing and undertaking studies of other rural communities, prior to planning and execution of interventions.

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## Introduction

Adaptive capacity is the capabilities, resources and institutions of a country or region to implement effective adaptation measures [2]. It has also been described by Füssel and Klein [14] as “the system / society’s ability to modify characteristics or behavior to moderate potential damages, take advantage of opportunities and cope with consequences”. As with the impacts of climate change and variability, and vulnerability to them, adaptive capacity is intensely variable, within and between communities; this is one reason why the characterization of smallholder and subsistence farmers as “complex, diverse and risk-prone” Chambers et al. [9] is relevant to climate change [29]. Understanding and working with heterogeneity is important for agricultural extension, as shown by a tradition of discussion of “recommendation domains” going back to Harrington and Tripp [17]. Disaggregating information by livelihood groups allows for the partial analysis of food security conditions in otherwise heterogeneous population groups, hence leading to more appropriate and differentiated policies and actions [12]. The necessity to address such diversity is further emphasized by Klerkx et al. [22], who particularly criticize the traditional knowledge transfer approach since it fails to adequately address heterogeneity within the farming community. In a context where agricultural extension systems are expected to play a role in climate change adaptation [30], the necessity to understand and work with heterogeneity in adaptive capacity, becomes even greater.

Adaptive capacity cannot be directly measured and there is no agreement about its characteristics and determinants at national, community or household level Jones et al. [20]. This means that proxies must be used. One set of proxies are the five capitals conceptualized in the livelihood framework [41]. These comprise human capital like education and skills; natural capital like land and water; financial capital like cash or substitutes; social capital like networks and associations as well as physical capital like infrastructure [1,2,41].

In Uganda, pastoral and agropastoral communities inhabit the semi-arid ecosystems of the cattle corridor which are largely marginal for food crop production, subject to significant climate variability, and are therefore prone to food insecurity. The aim of the study was to identify the different capacities to implement coping and adaptation strategies within sub-categories or clusters of pastoral and agropastoral households. These capacities can largely, but not completely, be conceptualized in terms of the five capitals of the livelihood framework. If differences in this capacity are not first identified, development strategies, including those of agricultural extension, could fail in their support of households to ensure sustainable food security.

This article characterizes three livelihood clusters that arise from the analysis of livelihood capitals and other socio-economic variables among the sampled population, before identifying some forms of institutional support that when functioning well can enhance adaptive capacity.

## Methods

### *Theoretical framework*

This study considers adaptive capacity as an enabler to implementation of effective adaptation measures. Adaptive capacity has been described as: “the inherent ability – the set of household assets and strategies – as well as resources and institutions of a region that enable households to absorb climate shocks and to buffer their impacts thus result in livelihood resilience” [42]. The authors thus adopt a livelihoods approach with a view that indicators of livelihoods are mostly similar to those of adaptive capacity. The livelihood approach enables us to characterise distinct livelihood groups for further analysis. Landless peasants, communal land herders, agropastoral farmers on rain-fed land, small-scale livestock producers with no land are some examples of broad livelihood systems that have been used for classifying people into vulnerable groups [12]. The choice of livelihood profiling as a tool for analysis of adaptive capacity is justified for several reasons. First, livelihoods are the means by which people access resources and assets, and a livelihoods approach aims at capturing the multiple interactions between people’s resources and strategies which are dependent upon the social institutional environment [3]. Secondly clustering people sharing certain characteristics and livelihood strategies into groups, each of which can be associated with a set of measures to reduce the vulnerability based on their shared characteristics, is a powerful strategy to inform policy and programmes [25].

In looking at livelihood heterogeneity at the household level a crucial question remains about which variables are used to differentiate those groups; researchers have used income, diversity in income-generating portfolios, insights from participatory poverty assessments and a combination of a wide variety of relevant variables [4]. Addressing the issue of development of vulnerability and adaptive capacity indicators, Hinkel [18] says that a combination of deductive, inductive, and normative arguments, as well as arguments based only on the structure of the data (without reference to knowledge of vulnerability) is used. In their assessment of farm households in Ghana, Baffoe and Matsuda [6] follow a quantifiable construct by selecting livelihood asset indicators using a combination of inductive and deductive driven approaches. In doing so, they consider human, natural, social, financial and physical assets. Ansoms and McKay [4], in their study of rural livelihood profiles in Rwanda, have set out a methodology for identifying and analyzing quantifiable indicators representing the five capitals of the livelihood framework. However, the authors consider the livelihood capitals to be labels for the observable variables that determine and constrain household adaptive capacity. The human, social, financial, natural, and physical livelihood capitals considered in this paper are used as a way to write about the different sorts of assets that support livelihoods.

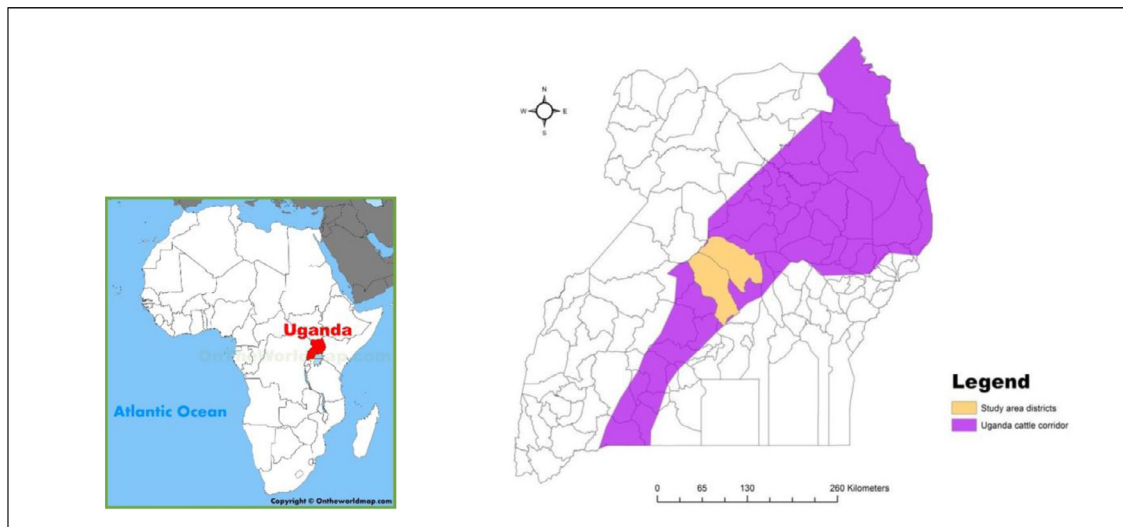


Fig. 1. Map of Uganda showing the cattle corridor and study districts. Modified from [38].

This paper's arguments therefore have a deductive core, in that the original variables are deduced from the five capitals of the Sustainable Livelihoods Approach [41], and inductive aspects in that they follow previous studies that have used this approach fruitfully. The paper then uses the data to generate livelihood clusters, and in this way could be said to be following Hinkel's [18] fourth category of argument, but only on the basis of a deductive and partially inductive argument.

#### Study area

The study was conducted in Nakasongola and Nakaseke districts in the central part of the cattle corridor of Uganda. The cattle corridor of Uganda is a strip of rangelands with an estimated area of 84,000 sq.km. It runs from the northeast – Moroto to the southwest – Mbarara district, is dominated by pastoral rangelands and has semi-arid characteristics (Fig. 1).

Pastoralists and agropastoralists along the cattle corridor constitute a significant group of small-scale family enterprises investing in the business of rearing livestock: they are Uganda's main livestock private sector [24]. After the prolonged drought of 1999/2000, the cattle corridor of Uganda experienced failed harvests, outbreaks of crop and animal diseases, and poor health conditions, leaving many vulnerable to food insecurity [36]. Nakasongola and Nakaseke districts were particularly hard hit, which inspired their consideration as the target study area on inherent ability of households to implement adaptation measures to buffer effects of hazards.

#### Sampling of respondents

First, guided by adhoc agro-ecological demarcations, each of the two districts was stratified into three farming systems - pastoral-majority areas; agropastoral areas with mixed crop-livestock-producers; and majority crop-farming areas. Subsequently two strata - the pastoral majority and agropastoral majority areas - were selected per district (2 districts x 2 strata). Registers of parishes and villages within these four parts, were obtained from parish local council chairpersons' offices. A list made from these registers was used as the sampling frame.

Initially, three parishes were randomly selected from each of the four-arrays and from each parish a group of 10–15 purposively selected individuals was mobilized for Focus Group Discussions (FGDs). This enabled a total of 12 FGDs (4 arrays x 3 parishes x 1 FGD).

Consequently, a multistage sampling process was followed, using both random and purposive techniques to select villages and households for the questionnaire survey. First, thirty villages were randomly selected from each of the four arrays of villages in the sampling frame (2 pastoral majority arrays x 2 agropastoral arrays x 30 villages) to give a total of 120 villages. In the second stage purposive selection of seven pastoral and 21 agropastoral villages, a sample roughly proportional to the population of the two strata, was done. Professional judgment was used to ensure a wide spatial and geographical spread over the study area. In the third stage, registers of households were obtained from the village local council chairperson's offices and used to get a random sample of ten households per selected village. The final sample of study units for the survey was thus 70 pastoral and 210 agropastoral households.

Further to this, based on findings from the questionnaire survey, 23 case households were purposively selected for in-depth interviews. Different inclusion criteria were used for this selection including households with large sizes and those headed by a female and / or an agricultural labourer. Other considerations were to include pastoralist households utilising borrowed farmland; those practicing communal grazing; those neither owning land nor water sources; and those who reared

cattle on their own grazing / farmland. Also included were agropastoralist households which had ownership of land; those using borrowed land or who were tenants; and those in transition from pastoralism to agropastoralism.

Finally, for key informant interviews, a purposive list including eight institutions at district and 14 at parish and village levels was made. The basis for the list was to ensure that key informants involved would include Non-governmental Organisation Organization (NGO) staff involved in food security and livelihood support; District Production Department and Community Development Officers; community-based self-help group leaders; parish chiefs as well as village local council and opinion leaders.

#### Data collection

This was a cross sectional study which employed mixed methods, including FGDs, a household survey, and in-depth qualitative interviews. Murphy et al. [34] identified actor-oriented, systems-oriented, outcome-oriented and context-oriented conceptual frameworks behind interpretation of vulnerability and adaptive capacity. These conceptual frameworks lend themselves to different assessment approaches and methodologies. In that context, the current study takes on an actor-oriented framework by focusing on specific actors and their actions. In addition, we follow a context-oriented approach in as much as we consider supportive institutions as well as social issues and the differential capacities these induce. Murphy et al. [34] recommend that where there is need to integrate local community needs into adaptation planning, more detailed assessments utilizing case study or participatory methods might be necessary. The authors used FGDs and selected case households, considered as actor and context-oriented methods, to obtain information specifically relevant to pastoral and agropastoral communities. The combination of unstructured techniques with structured interviews of similar questions was considered appropriate and necessary, because of the exploratory nature of this research, to enable triangulation of information and comparisons among respondents on those study aspects that required comparison.

Qualitative methods were used, during the community FGDs, to obtain preliminary data about the natural and man-made resources accessed; major livelihood activities; sources of income; perceived risk of changes in climate variability on food security and formal or informal rules and regulations supporting food security.

Utilizing some information from these preliminary FGDs, a questionnaire was developed. A quantitative survey method was then used to collect household level data on social status, productive assets, livelihood diversification as well as involvement in governance systems and social networks.

As recommended by Moench and Dixit [28], in using case studies, the quantitative research data was analyzed to get interesting descriptions and striking facts. The preliminary findings were then used to develop interview guides for collection of further data relevant to adaptive capacity. Subsequently, in February 2013, in-depth interviews were held with individuals from selected case study households. Key informants from selected institutions at village and district level were also interviewed. This inquiry focused on adaptation-supportive institutions, policy and investments; information flow; technical services and technology; skills and innovation; social networks; infrastructure; as well as governance & decision-making processes.

#### Data analysis

Qualitative data were analyzed both manually and with the aid of ATLAS.ti v.5.2.0 (1993–2016) software. Data was drawn from four women-only and five mixed-gender groups (i.e. 75% of targeted FGDs), in-depth semi structured interviews of all the 23 case households targeted as well as seven key informants (54% of those targeted). Household survey data were analyzed using Microsoft Excel 2010 and R Core Team, 2016. Complete questionnaires for 250 households (89% of the target), were analysed; there was a more significant rate of no-response (24%) for the pastoralists. After primary data collection, guided by the methodology of Ansoms and McKay [4], some variables were selected, from the survey data, as proxy indicators for the different livelihood capitals (see [41]): Some of these indicators are similar to the empirical data based study of household livelihood capitals by Antwi-Agyei et al. [5], in Ghana:

- Social capital: presence of any household member belonging to a formal or informal association or social network that allows access to product marketing services, financial saving and credit facilities, skills training, or social support from community members. In the present context these included: income generation support groups; women's development groups; money sharing "circles"; National Agricultural Advisory Services (NAADS) farmer groups; religious groups; charity groups; farming interest groups; adult learning support groups; village leadership; political group leadership; church leadership; Parents-Teachers Associations (PTA) leadership; drama groups; Savings & Credit Cooperatives (SACCOs); neighborhood support groups; commodity marketing groups; health support groups; youth development groups; and microfinance institution groups.
- Financial capital: major source of income and tropical livestock units (TLUs). TLUs are a standardized measure of data on the total number of different livestock species in a household. One Tropical Livestock Unit corresponds to 250 kg of animal weight. It was computed for each household as the sum of: 0.7 per head of cattle; 0.1 per sheep or goat; 0.2 per pig; and 0.01 per poultry bird.
- Natural capital: estimated land acreage accessed, irrespective of tenure system.

In contrast to Antwi-Agyei et al. [5] however, this study considers:

- Human capital: gender of household head, age and education level - with five categories ranging from not gone to school at all up to completed tertiary institution
- Physical capital: land by tenurial classification as described hereunder; and type of water source (open pond; harvested rainwater; protected spring / borehole; unprotected spring well; and tap water / gravity flow system).

With respect to land ownership, this study considered the fourfold land tenure system as recognized by article 237 of the 1995 Uganda Constitution and defined by The Land Act [44] as:

- (i) *Mailo*: a customary form of freehold confined to Buganda (central Uganda) and Bunyoro (western Uganda) regions; it came into effect when the kingdom of Buganda signed an agreement with the British-administered Uganda Protectorate. The name is derived from the fact that the basic unit is a square mile. The tenure allows holding of land in perpetuity and separation of ownership of land from that of developments on it by a bona fide or lawful occupant. However, *Mailo* owners should not use these powers against the interests of customary tenants, bona fide or lawful occupants.
- (ii) Customary: ownership and use is communal, managed by local customary regulation and parcels of land may be recognized as subdivisions belonging to an individual, family, clan or tribe.
- (iii) Leasehold: one party grants to another the right to exclusive possession of land for a specified period; for private land often with conditions of rent and / or premium payment, for public (government owned) land its conditions of use.
- (iv) Freehold: full power of ownership by either a grant of registered land in perpetuity, or for a lesser specified time period. One may use land for any lawful purpose and sell, rent, lease, subdivide and dispose of it by will. Only citizens of Uganda are entitled to own land in this category.

Beyond the official categories just described, some people occupying *mailo* do not own the land but Ugandan Law designates them “tenants by occupancy” – the land they occupy is locally termed *kibanja*. A *kibanja* holder is therefore a person who settled on land with consent of the landlord and / or by the enactment of the 1995 constitution of the Republic of Uganda, had settled on land for a minimum of 12 years without any objection from the landlord [44].

Tenants by occupancy are subject to such terms and conditions as may be prescribed, including payment to the registered owner an annual nominal ground rent. However, one’s security of tenure is not prejudiced by reason of non-possession of a certificate of occupancy. In the context of the current study, household heads may thus occupy large parcels of land without being landlords. Therefore, during data analysis land accessed was considered natural capital while land ownership was considered physical capital.

Cluster analysis, as an exploratory tool, was used to group survey data from respondent households. Cluster analysis was deemed useful in identifying household groups distinct from each other while maintaining broadly similar households within each group. Initially the survey data on characteristics of the household head including their belonging to a network, the land acreage accessed, land tenure, source of water, TLUs, source of income (alias current employment), and the human capital variables - level of education, age as well as gender of household head - were coded. Subsequently clustering was carried out based on these livelihood capitals. A Euclidean distance matrix provided input for a hierarchical clustering analysis using Ward’s agglomerative method [33,35]. This method minimizes the variability within the cluster and maximizes the variability between clusters – giving maximum intra-group homogeneity and intergroup heterogeneity [3,4]. Researcher judgement was used to select the final cluster solution. The cluster dendrogram resulting from this analysis was cut, and interpreted as guided by Kobrich, Rehman, and Khan et al. [23], to provide the optimum number of clusters.

## Results

The dendrogram in Fig. 2 gives a visual representation of household types, its interpretation suggesting the presence of three clusters. The respondent households were thus grouped into three distinct, heterogeneous livelihood profile types.

The livelihood profile types for each of the three clusters, labeled according to evident differences in livelihood capitals accessed, are as shown in Table 1.

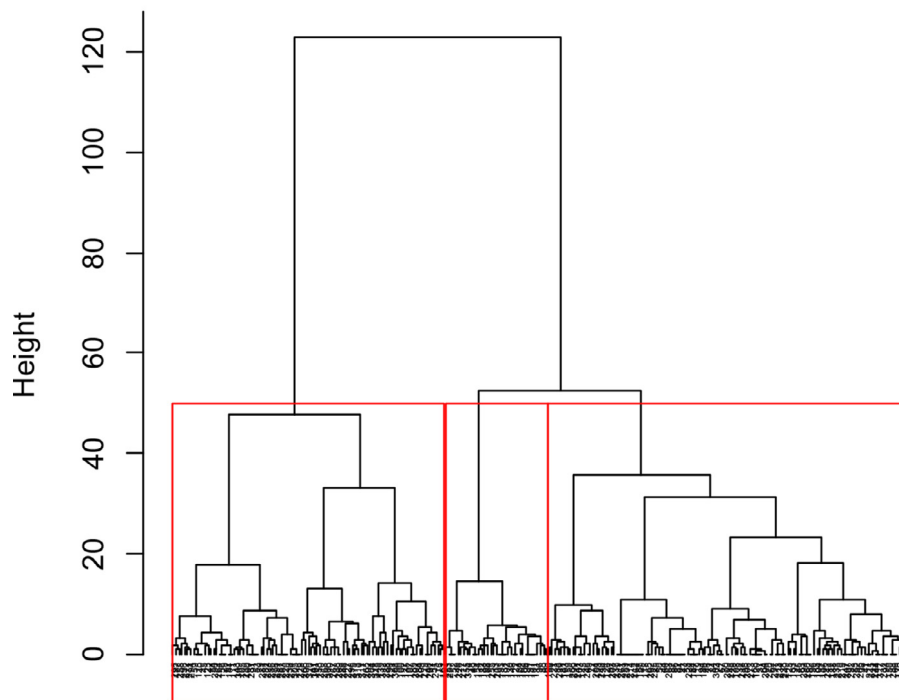
The association of these three livelihood profile groups with the human capital variables - level of education, gender and age of household head - was not statistically significant. However, the livelihood profile clusters’ association with being agropastoralists or pastoralists was highly significant,  $\chi^2 = 18.48$ ,  $df = 2$ ,  $p < 0.001$ . Agropastoralists make up a large proportion of the population of the area and thus of this study’s purposive sample. They also make up the majority of the Minimally-endowed and Land-rich clusters, as well as slightly more than half of the Large-herd Landlord cluster. It is striking that all the clusters cut across this study’s categories of pastoralism and agropastoralism. Subsequent sections present deeper insight into the cluster profiles.

### Household clusters identified

#### The Minimally-endowed

Households in Livelihood Cluster I are termed “Minimally-endowed” since they are not only peasant farmers and tenants on small sizes of land, but either have no livestock or own a meagre number. What is more they either have no access to land as natural capital or are uncertain about their future access, one respondent says:

## Cluster Dendrogram



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Fig. 2. Household cluster dendrogram based on selected variables representing livelihood capitals.

**Table 1**  
Household resource and characteristics by livelihood profile.

RESOURCE (LIVELIHOOD CAPITAL)	LIVELIHOOD PROFILE (CLUSTER)		
	Minimally-endowed (I)	Large-herd Landlords (II)	Land-rich (III)
Total Households ( $n = 250$ )	48.8	14	37.2
Pastoralist % ( $n = 53$ )	35.8	32.1	32.1
Agropastoralist % ( $n = 197$ )	52.3	9.1	38.6
Land acreage accessed ( <i>Natural</i> )	0.01–5	0.01–5	5.01–60
Land tenure ( <i>Physical</i> )	<i>Kibanja</i>	<i>Mailo</i>	<i>Kibanja</i>
Domestic Water Source ( <i>Physical</i> )	Borehole	Borehole	Borehole
Tropical Livestock Units ( <i>Financial</i> )	0–1.5	>13	3.01–13
Major Income Source ( <i>Financial</i> )	Peasant farming	Livestock keeping	Peasant farming
Belonging to an Association ( <i>Social</i> )	Yes	Yes	Yes
Age group of HH head ( <i>Human</i> )	26–45	46–65	26–45
Level of education of HH head ( <i>Human</i> )	Primary school	Primary school	Primary school
% of Female headed households, $n = 64$ ( <i>Human</i> )	45.3	10.9	43.8

"We live on a kibanja, I do not know the land size but know our boundaries. We have not been disturbed in any way by the landowner, however you never know, anytime he can tell us to pay up and buy the land - yet we do not have money - then we would have to leave, with nowhere to go." (Case 6 Agro-pastoralist elderly widow, Namikka, Nakasongola)

49% of the study households are in this cluster, and of these 52% access supportive networks. There are households that cannot access such social capital because they "...are unable to join any group, my wife and I lack enough strength to take part in networking activities." (Case 7 Agropastoralist male, Kirenge, Nakasongola)

The minimally endowed have agricultural related sources of income.

*“Money is mainly got on farm from sale of food crops - cassava, maize, ground nuts, sweet potatoes. A wife and husband may have separate gardens. Portions of cassava & sweet potato in the garden are sold fresh while other sections are left for harvesting later and drying. Pigs are either sold as soon as they are mature enough to eat or as piglets from 2 months old. Goats and some chicken are sold, although eggs are mostly eaten by household members.”* Agropastoralist Women only FGD, Kisalizi

However, it was mentioned that *“... people who migrated to provide labor only keep cattle since they do not have permanent homes.”* Pastoralist, mixed FGD Kalengedde

A prevalent notable characteristic of this cluster - relative to others - is that it contains 45.3% of the total female headed households within the larger sample, and 52.3% of the agropastoralist households.

#### *The Large-herd landlords*

The households clustered in livelihood profile II are defined, by their endowment with financial and physical capital, as *“Large-herd landlords”*. This cluster has 14% of the study households, larger livestock numbers compared to the other two clusters and is the only one where a majority of household heads are in the age range of 46–65 years. The major source of income is livestock keeping; up to 43% households in this cluster had livestock holdings of more than 13 TLUs (23% had more than 23 TLUs). The Large-herd landlords possess certificates of title to the land they occupy.

#### *The Land-rich*

Households in livelihood profile III are the *“Land-rich”* who have access to large areas of land, under *kibanja* and therefore counted here as natural capital. Compared to the other two clusters, where households access 5 acres of land or less, the Land-rich have *kibanja* sizes ranging from over 5 to 60 acres.

The Land-rich have alternative sources of income since *“...this area has crop and livestock farmers. Women mainly grow sweet potatoes, cassava, beans, bananas, coffee, vegetables, like egg plant, bitter tomato [i.e. Solanum aethiopicum], cabbage and french beans. Men mainly grow maize, rice, green pepper watermelon, tomatoes and cash crops particularly cotton. They earn money through selling and trading in these crops. Money also comes from alternative work like charcoal burning, brickmaking, building and carpentry. While the man in a household may have their own banana garden strictly for selling the crop, the woman has one both for feeding the family and some for sale. Family members may grow 1 acre for household food and 3 for sale. The highest income from food crops is at start of the dry season when they are being harvested i.e. May-June and for coffee as the cash crop it is at harvest in December-February.”* (Mixed Agropastoralist FGD\_Mijjinje, Nakasongola District).

#### *Institutional support*

Cutting across the three livelihood profiles were other, mainly institutional, issues that significantly influenced access to assets and ability to implement desired strategies, see [10,20,37].

#### *Regulations and bylaws*

During FGDs, participants cite the environment regulatory body – the National Environment Management Authority (NEMA) – as one of the institutions which enforced some regulations related to protecting the environment, in order to reduce natural resource depletion. People who burn bushes or grazing land are reported to the sub-county authorities; tree cutting, catching immature fish or hunting are also punishable offences. Respondents report traditional land use regulations like *“...kibanja holders have no permission to use the natural resources especially cut trees or excavate sand from their pieces of land.”* (Mixed FGD with Agro-pastoralist- Mijjinje, Nakaseke District)

Some area-specific bylaws directly concerned with food security are mentioned by key informants, for example:

*“There is a town council bylaw that institutes penalties to those cattle keepers whose livestock destroy food crop gardens of others.”* Female, coordinator of NAADS in pastoralist area, Ngoma Town council, Nakaseke

*“There is a bylaw where each household in the parish should have not less than half an acre of each food type like cassava, beans and sweet potatoes. The punishment is community service of 2 hrs per day for a month; or a fine of Ushs 30,000–60,000/= or imprisonment for 6 months. So far, I have not seen anyone punished - but the implementation of this law needs to be supported. Particularly because for the other bylaw related to not cutting selected species of trees - to make timber - especially fruits like jackfruit and avocado, there is a fine of Ushs 200,000/= and this has been implemented since it is enforced by government forest officers.”* (Male, district councillor, agropastoralist Kikyusa Parish, Nakaseke District)

However, enforcement of some regulations by government officers is lax, interfered with or not implemented at all. Respondents reported that implementation has been weakened mostly because the power of civil service / enforcement officers has been usurped by the elected political leadership – at subcounty and district levels – who claim they do not want their electorate reported and harassed with punishment, since this would affect their future votes.

*“Civil servants are also cautious as they could easily lose their job if a claim is made by local leaders that they are “harassing” the community.* Female, Councillor for Women Nakayonza Parish, Nakasongola District

#### *Support services*

Respondents mentioned obtaining services like training opportunities that enhanced their knowledge of agricultural production and postharvest practices, and inputs like cuttings or seeds for crop varieties and livestock breeds. They mainly

accessed these through non-governmental organisations (NGOs) and the government Agricultural Advisory Services; however some were not long lasting, for example:

*“In 2009 there was an NGO which gave a few training sessions related to food storage and households not selling off all harvested food. They promised to provide fruit trees and even mobilised us into a group to enable us to buy a generator to pump water from the valley tank to water troughs - so that cattle would not move to nor drink directly from the valley tank. However, they were short lived and left without fulfilling commitments.”* (Case 2 Agro-pastoralist household)

While some respondents had heard about government institutions giving out inputs, they had never got any support at all since they were never invited to village gatherings. They claimed local council (LC) leaders tend to invite their friends and relatives and give them items. Others reported that *“.....the organisations available in this village only support children's education; I have not seen any working on food security issues at all.”* (Case 1 Agro-pastoralist female, Kiteredde, Nakasongola).

### Decision making

There were mixed feelings about involvement of community members in decision making processes. With respect to existence of a functional system in which community members' views were sought, transmitted and considered through the different governance levels, one leader responded:

*“... I think so because, monthly, the government parish chiefs invite political leaders i.e. village chairpersons and parish councilors, to meetings and either ask them about the priority needs of their communities or inform them about government programs e.g. NAADS. The parish chiefs then come together at monthly subcounty meetings and in turn present the community views.”* (Female, Councilor for Women Nakayonza Parish, Nakasongola District).

These grass-root political leaders are expected to bring back the message to their communities so that implementation decisions are made at village and household level. However, an informant reported that unless a leader at higher level was a member of a farmers group, then there was no representation to bring feedback to households; household respondents noted that with respect to government projects, leaders do not involve them – but “think for them”. Further still, sometimes information known to district or subcounty leaders does not flow back to parishes or villages to enable implementation decisions to come from the grassroots. In other instances, at implementation time, the higher level subcounty officials do what they themselves planned and do not involve the parish or village committees in the activities. One key informant gave an example that *“.....subcounty officials procure agricultural items / inputs and select which farmers or groups to benefit without involving village committees. In the unfortunate event that the inputs are not good quality, the villagers take them, all the same, because they feel they may never get another chance to obtain better quality ones. At one time the villagers rejected restocking cattle that were not good and when these were withdrawn, none were brought again for replacement.”* (Male, Village Council Chairman, Kakonde, Nakaseke district).

### Information access

Respondents reported that information-providing bodies - particularly broadcasting houses that give information over radio – are important resources. The Uganda Broadcasting Corporation (UBC) gives weather alerts that enable them to align their agricultural activities, e.g. planting time, to the anticipated weather. Radio also provides educative programs on good agricultural practices suited for the areas in which they reside. When asked in what ways they accessed information a respondent said:

*“The chairman LC1 [i.e. of the Village Council] is the one who passes on information when he invites households for village meetings. There are no other sources of information at all and I have never heard any information on expected weather conditions.”* (Case 1 Agro-pastoralist female, Kiteredde, Nakasongola)

However, some people still do not get any information, their LC officials never make special effort to go to households to pass on news. Worse still, some aged and sickly people are unable to access information about pertinent issues. One elderly male mentioned that he could not even walk to the town center to interact with colleagues who would be a source of news.

## Discussion

### *Heterogeneity of livelihood clusters in pastoral and agropastoral communities*

This study identifies livelihood clusters with different adaptive capacities to manage food insecurity. These differences reinforce the need to vary interventions to take care of heterogeneous categories of households. The starting point for the study was our agroecological based division of the population into pastoralists and agropastoralists. However, subsequent analysis established three distinct subgroups with heterogeneous livelihood profiles, which have been termed Minimally-endowed, Large-herd Landlords and the Land-rich. These overlap in complex ways with the pastoralist or agropastoralist categories which are therefore seen as non-homogenous groups. The minimally-endowed cluster can be compared to the chronically poor households - identified by Haile, Seyoum, and Azmeraw [16] in their consideration of resilience capacity in Ethiopia - they have a much lower resource base with a low size of cultivated land and TLUs. Similar to the current study, Hyland, et. al. [19], used a cluster analysis approach to establish a typology of farmers. Their typology was based on the extent to which farmers succeed in implementing climate adaptation measures in beef farm management. That study revealed four farmer types - the environmentalist, dejected, countryside steward and productivist. This called for



dissemination methods and messages framed to resonate with each type, if the development and uptake of mitigation and adaptation measures were to be advanced [19].

#### *Enhancing adaptive capacity through livelihood capitals*

One development approach, for the current study region, could be to provide households in the identified clusters with agricultural advisory services relevant to enabling them utilise more intensely those livelihood capitals they are endowed with. This may eventually help them acquire other capitals. Livelihood dynamics may be related to the changing assets of other actors. For example, people may be migrating more because they have lost access to land, water or forests as a consequence of the acquisition of those assets by other actors – as may be promoted by certain policies [7]. In this case it would be important to invest in peoples' capability to control and defend their livelihood capitals. In other cases, the natural capital on which households depend could be depleted by extreme events and environmental processes. This may happen for clusters whose major livelihood capitals remain agriculture related - like the Minimally-endowed who depend on access to land and the Large-herd Landlords whose financial capital is livestock holdings. In such cases, extension messages promoting sustainable use of land and other natural resources should be enhanced. Field et al. [13] note the importance of knowledge and technology transfer for improving adaptive capacity. They underscore the need to engage people with different knowledge, experience and backgrounds in framing a shared approach to adaptation. Extension establishments should therefore take this as a major consideration during service delivery. Mangheni et al. [27] for Uganda, and Morton [30] for Africa more generally, have stressed the importance for agricultural adaptation to climate change of integrated knowledge management (at both national and district levels) and innovative ways of using information and communication technologies.

For those individuals belonging to community social groups, affiliations and associations, such societal networks are an important resource in increasing their households' ability to adapt in order to manage household food insecurity. Since all clusters in the current study show affiliation to societal networks, interventions including extension should provide even more opportunities for building on such social capital. A similar approach was recommended by Morton and Meadows [31], for pastoral associations based on building social capital and overall empowerment. The social capital gained by associating with others, either voluntarily or as is mandated in order to obtain support services from government or nongovernment organizations, means that one can access facilities like financial services and group marketing. Bebbington [7] notes that households' success in sustaining or increasing access to relationships including kin and ethnic networks or social organizations, as well as such institutions like intermediate state and nongovernmental organizations, has been important in securing access to different resources, opportunities and other actors. Strong organizations with networks linking them to other market actors can help open market possibilities to rural producers that otherwise they would not have and can in this way increase their ability to turn their assets into income streams. With such considerations, given that the Large-herd landlords have stable land tenure, social networks enhancing opportunities to maximise utility of their land, for example, could enable them to sustainably use that physical capital as a source of financial capital.

According to Adger et al. [2], entitlements to 'elements of adaptive capacity are socially differentiated along the lines of age, ethnicity, class, religion and gender'. The minimally endowed, among whom is a large proportion of the female headed households, are either landless, access only meagre pieces of land and / or are faced with uncertain tenure security. The latter is a stressor which particularly puts women-headed households among the categories at risk of climate related impacts on livelihood [39]. Climate variability has been shown to have gendered livelihood impacts, for example Quisumbing et al. (2011) (cited in Olsson et al. [39]) noted that in Uganda, men were able to amass land after floods while droughts reduced women's non-land assets. Field et al. [13] also note that disadvantaged groups without access to land and labor, including female-headed households, tend to benefit less from climate change response mechanisms e.g., planned agricultural adaptation projects and climate information. Further still, in their study of adaptation in the Central Rift Valley, Ethiopia, Belay et al. [8], established that being a male-headed household enhanced capacity and increased the probability of implementing various climate change adaptation strategies. Therefore, in the current study context, extension and other agricultural support services should preferably target the minimally endowed with interventions relevant to enhancing agricultural productivity of their small pieces of land, as the natural capital they access. In addition, households in this cluster should best be provided with supportive environment to build strong networks, as the social capital they can fall back onto.

#### *Institutional support to enhance adaptive capacity*

While assets and capitals are useful as indicators to help us understand the resources at the disposal of a community, according to Jones et al. [20] they typically mask the role of institutions and of intangible processes like decision-making and innovation in supporting adaptive capacity. Engle [11] underscores the importance of improving adaptive capacity assessments by examining governance and institutions – an approach attempted by the current study. According to Field et al. [13] institutions establish incentive structures that can promote adaptation, foster the development of adaptive capacity, and establish protocols for both making and acting on decisions. For example in their study of the semi-arid Tharaka subcounty of Kenya, Recha et al. [40] note that to support adaptation, institutions are engaged in support programs that are both short term like seed distribution and medium term like installation of small-scale irrigation infrastructure. Such measures contribute to enhancing community adaptive capacity. The institutional dimension of livelihoods include the tenure systems

which govern access to land for farming [10]. In the current study, the minimally endowed face unstable land tenure, which limits their ability to maximally invest in utilizing the land as part of their adaptation strategies. Plans in the Uganda land policy include establishment of communal land associations, use of communal land management schemes among pastoral and sedentary communities and protection of pastoral lands from indiscriminate appropriation by individuals or corporate institutions under the guise of investment [15]. However, uncertainty remains among those households with no land ownership.

Other institutional dimensions of livelihoods are supportive byelaws, but there are failures of enforcement and of implementation of regulations by government agencies (like NEMA), a finding very similar to those of Wright et al. [43] and Mangheni et al. [27], from studies on climate smart adaptation in Uganda. External support services like agricultural extension, and inputs provided by NGOs and semiautonomous government agencies like NAADS, were accessed by only a few of the community members. Such support - promoted through group activity - leaves out those who - for various reasons - do not or cannot belong to community groups. Not only for households left out but also for those subject to the one-off nature of some support activities, there is a risk of failure of enhancing adaptive capacity sustainably. This is especially so for households that may not have the financial, natural or physical capital to access further services - for example those in the minimally endowed cluster. These findings underscore the need to emphasize strategies such as diligent stakeholder analysis as well as contextualize interventions to situations of particular farmers [32]. There is also need to enhance institutional capacity to provide services at grass root level and interventions to strengthen cooperation of the local governments' agricultural extension office with NGOs and semiautonomous government agencies would be one way to enhance institutional capacity. This ought to be a function spearheaded and coordinated by the Ministry of Agriculture, Animal Industry and Fisheries which has the mandate for agricultural extension and food security in Uganda [26]; and has semiautonomous agencies operating at both national and local government levels.

The study observes possible suppression of participation, of community leaders who plan at lower local government levels, by political as well as government officials who make the final decision about what is implemented. Such power relations behind decision-making, which are often about whose voice is heard and whose interests count, are another intangible livelihood augmenting factor. Power imbalances exist in all societies between rich and poor, between men and women and so on, and how these imbalances are reflected will influence the capacity of individuals to adapt [20]. One of the barriers to adaptation is lack of local participation in policy formulation and the neglect of social and cultural context [37]. For Uganda, a way forward would be to implement more inclusive processes of decision-making within the framework of the Agricultural Sector Development Strategy and Implementation Plan (DSIP) - a role agricultural extension services can play.

Needless to say, Engle [11] notes that adaptive capacity is translatable to decision makers through its emphasis on governance, institutions, and management, and it plays a critical role in

Fostering sustainable adaptations. The current study enables reflection on the possible reasons for discrepancy in household adaptation strategies when faced with hazards. The profiling is not so much meant to show *levels* of adaptive capacity but contributes to knowledge on different *types* of adaptive capacity. For example, although the Minimally-endowed and the Land-rich are comparable in the human and physical capital, they differ in the land acreage accessed and the TLUs. Therefore, for the Land-rich a different type of adaptive capacity is consequent in terms of natural and financial capital. Adaptive capacity enables implementation of adaptation measures and as noted by Jones et al. [21], policy-makers should be aware that adaptation is determined by the level of livelihood capitals accessed. However as mentioned by Engle [11] in his review of adaptive capacity assessments, it is worth keeping in mind that adaptive capacity is context-specific and likely shaped by dynamic variables that are not easily generalizable and do not carry equal weight between contexts.

## Conclusion

The pastoral communities in the central cattle corridor of Uganda are not a homogenous community but rather consist of three heterogeneous livelihood profile clusters. Each of these clusters is differentially endowed with livelihood capitals. The Minimally-endowed face uncertain access to livelihood capitals; the Large-herd Landlords are endowed with physical and financial capital - ownership of land and large numbers of livestock; while the Land-rich are endowed with natural capital - access to large sizes of land. Such variances denote different types of adaptive capacity thus translate into differing adaptation potential and therefore discrepancy in household strategies to manage food insecurity. A limitation is that in assessing assets and livelihood capitals, total land holdings were considered regardless of whether it was all in use or not; what was on the land and the capacity to use that land. This could have implications to the results obtained. That notwithstanding, there are also intangible processes which are a limit to adaptive capacity across livelihood clusters. Uncertain land tenure hinders adaptation requiring investment in land; non-enforcement of byelaws enhances depletion of natural resources; while power imbalances behind decision-making mean inappropriate frameworks to support local level adaptation.

## Implications and recommendations

Communities will more likely implement adaptation measures if advisory and other interventions resonate with the adaptive capacity and challenges within heterogeneous clusters. In order to manage household food insecurity more effectively, the household types portrayed in the current study can be used as a tool to advance approaches to agricultural

extension and technology transfer that are friendly to pastoral communities. To enhance adaptive capacity, strategies should support institutions that guarantee and enhance equitable opportunities to access livelihood capitals. Agricultural advisory services, on top of transferring conventional information, could also be used to promote indigenous knowledge sharing. Policy intervention to manage food insecurity – an undesirable livelihood outcome – should be differentiated based on the variance in challenges and needs of existing heterogeneous livelihood clusters. Until actors first identify and target such disparity, development strategies including those of agricultural extension, remain unlikely to sustainably enhance the potential within communities to adapt to climatic hazards in order to manage household food insecurity.

### Ethical approval and consent to participate

This study is nested in the research on “Adaptation to the impact of climate variability on food and health security in the cattle corridor of Uganda”, which was approved by Uganda National Council for Science and Technology, Ref A456.

Participation in this study was voluntary and refusal to participate had no repercussion. Written informed consent forms were translated into local languages and signed by each participating individual before the beginning of data collection.

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### Availability of data and materials

Datasets analyzed are not publicly available due to the confidentiality and anonymity of the study population. Datasets are available from the corresponding author on reasonable request.

### Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

### References

- [1] ACF. (2010) Food security and livelihood assessments. A guide for field workers. in, ACF Food Security and Livelihoods Assessment Guideline: ACF International.
- [2] Adger, A., Mirza, S., M. M.Q., Conde, C., O'Brien, K., Pulhin, J., Takahashi, K. (2007). Assessment of adaptation practices, options, constraints and capacity. in M. L. Parry, O. Canziani, F., J. Palutikof, P., P. van der Linden, J., & C. Hanson, E. (Eds.), *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Chap 17 (pp. 717–743). Cambridge, UK: Cambridge University Press.
- [3] Alinovi, L., D'Errico, M., Mane, E., & Romano, D.. (2010). Livelihoods strategies and household resilience to food insecurity: an empirical analysis to Kenya. Paper presented at the Promoting Resilience through Social Protection in Sub-Saharan Africa, Dakar, Senegal.
- [4] A. Ansoms, A. McKay, A quantitative analysis of poverty and livelihood profiles: The case of rural Rwanda, *Food Policy* 35 (2010) 584–598, doi:10.1016/j.foodpol.2010.06.006.
- [5] Antwi-Agyei, P., Dougill, A.J., Fraser, E.D.G., & Stringer, L.C. (2012). Characterising the nature of vulnerability to climate variability: empirical evidence from two regions of Ghana. *Centre for Climate Change Economics and Policy*.
- [6] G. Baffoe, H. Matsuda, An empirical assessment of rural livelihood assets from gender perspective: evidence from Ghana, *Sustain. Sci.* 13 (2018) 815–828 Retrieved from, doi:10.1007/s11625-017-0483-8.
- [7] A. Bebbington, *Capitals and capabilities: a framework for analyzing peasant viability, rural livelihoods and poverty*, *World Dev.* 27 (12) (1999) 2021–2044 S0305-750X(99)00104-7.
- [8] A. Belay, J.W. Recha, T. Woldeamanuel, J.F. Morton, Smallholder farmers' adaptation to climate change and determinants of their adaptation decisions in the Central Rift Valley of Ethiopia, *Agric. Food Secur.* 6 (24) (2017), doi:10.1186/s40066-017-0100-1.
- [9] R. Chambers, A. Pacey, L.A. Thrupp, *Farmer First: Farmer Innovation and Agricultural Research, Intermediate Technology, London, 1989*.
- [10] F. Ellis, The determinants of rural livelihood diversification in developing countries, *J. Agric. Econ.* 51 (2) (2000) 289–302 Retrieved from, doi:10.1111/j.1477-9552.2000.tb01229.x.
- [11] N.L. Engle, Adaptive capacity and its assessment, *Glob. Environ. Chang.* 21 (2) (2011) 647–656, doi:10.1016/j.gloenvcha.2011.01.019.
- [12] FAO-CFS. (2000). Who are the food insecure? Retrieved from Committee on World Food Security, Rome:
- [13] Field, C.B., Barros, V.R., Mach, K.J., et al. (2014) Climate change 2014: impacts, adaptation, and vulnerability. Part A: global and sectoral aspects. Contribution of working group II to the fifth assessment report of the intergovernmental panel on climate change. in: Vol. 2. Technical Summary of the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (pp. 35–94). Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.
- [14] H.M. Füssel, R.J.T. Klein, *Climate change vulnerability assessments: an evolution of conceptual thinking*, *Clim. Chang.* 75 (2006) 301–329.
- [15] GOU. (2011). The Uganda national land policy. Kampala: Ministry of lands, Housing and Urban Development
- [16] D. Haile, A. Seyoum, A. Azmeraw, Does building the resilience of rural households reduce multidimensional poverty? Analysis of panel data in Ethiopia, *Sci. Afr.* (2021), doi:10.1016/j.sciaf.2021.e00788.
- [17] Harrington, L.W., & Tripp, R. (1984) Recommendation domains: a framework for on-farm research. In, CIMMYT Economics Program Working Paper 02/84. Global Environmental Change: CIMMYT.
- [18] J. Hinkel, “Indicators of vulnerability and adaptive capacity”: towards a clarification of the science–policy interface, *Glob. Environ. Chang.* 21 (2011) 198–208, doi:10.1016/j.gloenvcha.2010.08.002.
- [19] J.J. Hyland, D.L. Jones, K.A. Parkhill, A.P. Barnes, A.P. Williams, Farmer perceptions of climate change: identifying types, *Agric. Hum. Values* 33 (2) (2015) 323–339, doi:10.1007/s10460-015-9608-9.

- [20] Jones, L., Ludi, E., & Levine, S. (2010) Towards a characterisation of adaptive capacity: a framework for analysing adaptive capacity at the local level. In, ODI Background Note. London: ODI.
- [21] A.K. Jones, D.L. Jones, G. Edwards-Jones, P. Cross, Informing decision making in agricultural greenhouse gas mitigation policy: a best-worst scaling survey of expert and farmer opinion in the sheep industry, *Environ. Sci. Policy* 29 (2013) 46–56, doi:10.1016/j.envsci.2013.02.003.
- [22] L. Klerkx, M. Schut, C. Leeuwis, C. Kilelu, Advances in knowledge brokering in the agricultural sector: towards innovation system facilitation, *IDS Bull.* 43 (5) (2012) 53–60 Retrieved from, doi:10.1111/j.1759-5436.2012.00363.x.
- [23] C. Kobrich, T. Rehman, M. Khan, Typification of farming systems for constructing representative farm models: two illustrations of the application of multi-variate analyses in Chile and Pakistan, *Agric. Syst.* 76 (1) (2003) 141–157 Retrieved from, doi:10.1016/S0308-521X(02)00013-6.
- [24] S. Krätli, Karamoja with the rest of 'the Rest of Uganda, *Nomadic Peoples* 14 (2) (2010) 3–23, doi:10.3167/np.2010.140202.
- [25] Lovendal, C.R., Knowles, M., & Horii, N. (2004). Understanding vulnerability to food insecurity: lessons from vulnerable livelihood profiling. Retrieved from [www.fao.org/es/esa](http://www.fao.org/es/esa)
- [26] MAAIF. (2010). Agriculture for food and income security. Agriculture Sector Development Strategy and Investment Plan: 2010/11–2014/15. MAAIF, Republic of Uganda
- [27] Mangheni, M.N., Kisauzi, T., & Miiro, R. (2013) Climate learning and knowledge management within Uganda's agricultural research and advisory services. In. *Climate Learning for African Agriculture: Working Paper No.7: Climate and Development Knowledge Network*
- [28] M. Moench, A. Dixit, *Adaptive Capacity and Livelihood Resilience. Adaptive Strategies for Responding to Floods and Droughts in South Asia, Institute for Social and Environmental Transition, Colorado, USA, 2004.*
- [29] J. Morton, The impact of climate change on smallholder and subsistence agriculture, *PNAS* 104 (50) (2007) 19680–19685 Retrieved from, doi:10.1073/pnas.0701855104.
- [30] J. Morton, F. Nunan, *Climate change and African agriculture: unlocking the potential of research and advisory services, in: Making Climate Compatible Development Happen, Routledge, 2017, pp. 109–135.*
- [31] Morton, J., & Meadows, N. (2000) Pastoralism and sustainable livelihoods: an emerging agenda. In, *Policy Series 11: Natural Resources Institute, Chatham, UK.*
- [32] R. Moyo, A. Salawu, An appraisal of factors influencing adoption of agricultural innovations: insights from selected developing countries, *J. Int. Agric. Ext. Educ.* 24 (1) (2016) 7–9, doi:10.5191/jiaee.2016.24102.
- [33] D. Mullner, Fastcluster: fast hierarchical, agglomerative clustering routines for R and python, *J. Stat. Softw.* 53 (9) (2013) Retrieved from, doi:10.18637/jss.v053.i09.
- [34] Murphy, D.J., Wyborn, C., Yung, L., & Williams, D.R. (2015). Key concepts and methods in social vulnerability and adaptive capacity.
- [35] F. Murtagh, P. Legendre, Ward's hierarchical clustering method: clustering criterion and agglomerative algorithm, *J. Classif.* 31 (3) (2014) 274–295 Retrieved from, doi:10.1007/s00357-014-9161-z.
- [36] NAPA. (2007). Climate change Uganda national programs of action. Retrieved from Kampala: [unfccc.int/resource/docs/napa/uga01.pdf](http://unfccc.int/resource/docs/napa/uga01.pdf)
- [37] Niang, I., Ruppel, O.C., Abdrabo, M.A., Essel, A., Lennard, C., Padgham, J., & Urquhart, P. (2014) Africa. In. *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 1199–1265). Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.
- [38] A. Nimusiima, C.P.K. Basalirwa, J.G.M. Majaliwa, D. Kirya, R. Twinomuhangi, *Predicting the impacts of climate change scenarios on maize yield in the cattle corridor of Central Uganda, J. Environ. Agric. Sci.* 14 (2018) 63–78.
- [39] Olsson, L., Opondo, M., Tschaker, P., Agrawal, A., Eriksen, S.H., Ma, S., Zakieldeen, S.A. (2014). Livelihoods and poverty. In C. B. Field, V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y. O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P. R. Mastrandrea, and L.L. White (Ed.), *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (Vol. 2, pp. 793–832). Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.
- [40] C.W. Recha, G.L. Makokha, C.A. Shisanya, M.N. Mukopi, Climate variability: attributes and indicators of adaptive capacity in semi arid Tharaka Sub-County, Kenya, *Open Access Libr. J.* 4 (e3505) (2017), doi:10.4236/oalib.1103505.
- [41] Scoones, I. (1998) Sustainable rural livelihoods: a framework for analysis. In, *IDS Working Paper 72*. Brighton, UK: Institute of Development Studies.
- [42] USAID-ARCC. (2013). Uganda climate change vulnerability assessment report. Retrieved from USAID African and Latin American Resilience to Climate Change
- [43] H. Wright, S. Vermeulen, G. Laganda, M. Olupot, E. Ampaire, M.L. Jat, Farmers, food and climate change: ensuring community-based adaptation is mainstreamed into agricultural programmes, *Clim. Dev.* 6 (4) (2014) 318–328, doi:10.1080/17565529.2014.965654.
- [44] GOU, *The Land Act, 1998*, LANDWatch, Uganda, 1998. Retrieved from <https://www.landnet.ug/ladwatch/the-land-act-chapter-227>.