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LIVELIHOODS STRATEGIES AND HOUSEHOLD RESILIENCE TO FOOD INSECURITY: AN EMPIRICAL ANALYSIS TO KENYA

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ABSTRACT

The way a household copes with and withstands economic shocks depends on the options available, in terms of capabilities, assets (including both material and social resources) and activities. A livelihood strategy is the way those options are arranged and selected. Comprehending the driving factors of each livelihood strategy is crucial to improve the response mechanisms related to poverty and food security in developing countries. This paper aims to measure empirically the outcomes of different livelihoods strategies in terms of household resilience to food insecurity in the specific context of Kenyan households.

Kenyan households are classified according to their own livelihood strategies by using the Ward's cluster analysis technique on data from the Kenya Integrated Household Budget Survey 2005-06. The information on shares of income sources, productive assets and occupational activities have been used to allow the data to identify the most meaningful and homogeneous groupings of Kenyan households in terms of livelihood strategies: pastoralist, agro-pastoralist, smallholder farmers, large-holder farmers, entrepreneurs and wage-employees.

In order to understand the key determinants of each livelihood strategy and compare different livelihood strategies, we used and updated the resilience analysis framework developed by Alinovi et al. (2008). Comparing resilience by livelihood clusters in the eight provinces of Kenya shows there are significant differences across provinces and among clusters. Nairobi is by far the most resilient province and Eastern province the least one. Moreover, the large-holder farmers' cluster is the most resilient, whilst the pastoralist is the least resilient.

However, the determinants of resilience are different for each livelihood group. Those differences are relevant in terms of policy implications, considering the differences between the ultimate determinants of each component. In terms of access to basic services, for example, access to credit is much more relevant to pastoralists and large-holders than it is to others. Access to water is more relevant to both farmer groups and agro-pastoralists, while access to electricity and telephone networks is relevant to entrepreneurs and wage-employees. The social safety-nets (transfers per capita) for wage-employees are twice those of other groups: this is related to urban poverty, where the lack of other assets (land, livestock, etc.) dramatically reduces the urban poor coping capacity.

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1 Introduction

The way a household copes with and withstands economic shocks depends on the options available in terms of capabilities, assets (including both material and social resources) and activities, i.e., on the household livelihood strategy (Dercon and Krishnan, 1996; Ellis, 1998). This is important both from a positive and normative viewpoint. In fact, households belonging to different socio-economic groups have different strategies to earn their own living which, in turn, may ensure different levels of resilience to food insecurity. As a result, households belonging to different socio-economic groups (for example, a farmer's household vs. a household whose main income source is public sector employment) require different interventions. Policy-makers should tailor their national food security strategies in order to account for the different needs of the population. Comprehending the driving factors of each livelihood strategy is therefore crucial for improving the response mechanisms related to food insecurity and poverty in developing countries.

Traditionally, most research in the field of food security has focused on the development and refining of the methods of analysis chosen to predict more accurately the likelihood of experiencing future loss of adequate food, i.e., vulnerability to food security (Løvendahl et al., 2004). However, more recently a new concept has been proposed, i.e., resilience to food insecurity (Alinovi et al., 2008), that is the ability of the household to maintain a certain level of well-being (for example, food security) withstanding shocks and stresses, depending on the options available to the household to make a living and its ability to handle risks. Resilience is a related, but different, concept from vulnerability. Both share a common set of parameters such as the shocks and stresses to which a social-economic system is exposed, and the response and adaptive capacity of the system. Nevertheless, vulnerability analysis often tends to measure only the susceptibility of an individual/household to harm and the immediate coping mechanisms adopted. Resilience analysis tries to identify the different responses adopted by a household and capture the "dynamic" components of the adopted strategies. A resilience approach investigates not only how disturbances and change might influence the structure of a system (for example, a household or a community), but also how its functionality in meeting these needs might change.

There is a potentially fruitful ground of common research in merging livelihood and resilience analyses. One of the innovations of this paper is its focus on the analysis of livelihood strategies as a tool to understand the structure of the Kenyan households resilience to food security better. Thus, this paper aims to empirically measure the outcomes of different livelihoods strategies in terms of household resilience to food insecurity in a specific context, that of Kenya. Specifically, the paper's objectives are the following: to identify the distribution of different livelihood groups across Kenyan provinces, to assess resilience levels per province and per livelihood group, to identify the key determinants of resilience according to livelihood grouping, to compare different livelihood strategies across groups in order to achieve a given level of resilience, and to discuss the policy implications for food security.

In pursuing these objectives, the paper is organised as follows. Section 2 briefly recalls the theoretical frameworks of the livelihood and resilience approaches as applied to food security. Section 3 reports the results of the livelihood classification and resilience assessment as applied to Kenya. Finally, Section 4 discusses the main findings of the study in the light of past experiences of food security shocks in the country and the policy implications of the study results.

2 Theoretical Framework

2.1 Food Systems as Complex Systems

A very general definition of the term "food system" might be that of a system made up by all the interacting social and ecological components that affect the food security of a given group of people. Therefore, a food system involves all the various phases from the production to the consumption of food, through distribution and processing. Such a definition of the term "food system" is quite general and conceptually very broad since it entails many dimensions – economic, social, institutional, technological, cultural – and different scales – global, national or local depending on the purpose of the analysis. The multi-dimensionality of the food system concept derives from the fact that, whatever the chosen scale of analysis, a food system is always made up of at least two components: the resource base that ensures the food supply, and the socio-economic component that depends on this resource base.

Notwithstanding the multi-dimensionality of food systems, different disciplines have traditionally analysed these systems adopting merely sectoral approaches that reflect principles, categories and methods of analysis that are discipline-specific. This is true in general, and it is especially true for each of the two above-mentioned components of food systems that were usually analysed separately in the fields of ecology and economics, respectively. However, one of the more significant recent achievements in the study of ecological and economic systems is that the economy and its environment are jointly-determined systems and the economic activity scale is such that it matters.[1] In other words they "co-evolve" (Norgaard, 1994) and cannot be analysed separately by each other. This applies specifically to food systems that are genuinely jointly-determined "socio-economic-ecological systems".

The consequences of this acknowledgement are important both from the viewpoint of the contents of the analysis (which is the subject under scrutiny) and from the methodological point of view (how we should analyse it), since they imply that food systems should be thought of as "complex adaptive systems" which must be analysed by adopting a non-reductionist, systemic approach. More precisely, the recent research on jointly-determined socio-economic-ecological systems has reached the conclusion that they are stochastic evolutionary systems (Perrings, 1998) characterised by the following features:

- path-dependency: history matters and the current status of a system is largely determined by the sequence of the states that the systems went through in the past;
- discontinuous changes: observed changes tend not to be continuous or gradual, but involve more or less sudden alterations around critical threshold values;
- multiple equilibria: the functionally-different states of a system involve different equilibria, i.e., systems tend to evolve by switching between system equilibria;
- non-linearity: the system dynamics and stability tend to vary non-linearly with the scale of the systems.

An implication of this characterisation is that the stability of the jointly-determined system depends less on the stability of the individual components of the system, than on the ability of the system to maintain its self-organisation in the face of stress and shock, that is to say, on its "resilience". This essentially means that the focus

[1] Different scales of analysis imply different emphasis on specific dimensions that characterize a food system. For instance, if the scale of analysis is the household or community level (for example, a village or a tribe), we expect that the implications of actors' actions on the system's natural resource base should be analytically more relevant than in the case of a national scale analysis.

of the analysis of complex adaptive systems should be less on the study of the steady-state or near-equilibrium states, and more on the conditions that ensure the maintenance of system functions in the face of stress and shock, which ultimately means moving from a static, deterministic analysis towards a dynamic, stochastic analysis. These conclusions have profound implications for the analysis of food systems as well as of food security (see Section 2.3).

2.2 Livelihood Approaches

2.2.1 The Rise and Fall of Livelihood Approaches

"Livelihoods thinking" is mainly an offspring of British development think tanks and organisations (IDS, ODI and DFID, among others), which was enthusiastically embraced by several important NGOs (for example, CARE, Oxfam) and development agencies (for example, UNDP, FAO). Nowadays, it is no longer as fashionable as it use to be, but its legacy is still here to stay and for good reasons.

The livelihood approach dates back to the contributions of several scholars between the mid-1980s and the early 1990s as a new way of thinking about the objectives, scope and priorities for development. Its emergence had all the qualities of a classic "paradigm shift" (Solesbury, 2003). A midwifery role was played by the influential Chambers and Conway (1992) IDS discussion paper that changed perceptions of the nature of rural development and the priorities for policy and practice. This change came at a time when the previous dominant theories and practices – particularly those associated with integrated rural development – were losing their intellectual and political appeal.

"Sustainable livelihoods" offered a fresh approach. Part of its attraction was that it captured and synthesised diverse strands of evolving thought and action. It has been seen as having conceptual, practical and organisational roots (Ashley and Carney, 1999). Conceptually, it drew on changing views of poverty, recognising the diversity of aspirations, the importance of assets and communities, and the constraints and opportunities provided by institutional structures and processes. Practically, it placed people – rather than resources, facilities or organisations – as the focus of concern and action, emphasising that development must be participatory and improvements must be sustainable. Organisationally, it had evolved within research institutes, NGOs and donor agencies, and was not exclusive to one or the other.

For the researchers, the sustainable livelihoods concept provided a rich new agenda. It quickly became an international focus for both empirical and theoretical work. The UK Government endorsed it in its 1997 White Paper on International Development and between 1998 and 2002 the Department for International Development (DFID) placed considerable emphasis on the development and rolling out of the approach (DFID, 1999). ELDIS,[2] DFID,[3] IDS,[4] Oxfam,[5] Save the children,[6] Tango[7] and FAO[8] are among those who implemented and further developed the sustainable livelihoods approach over the years.

However, around 2002-03, the emphasis of international development changed. The focus shifted to securing transformation at a national scale and providing greater

[2] Cf. http://www.eldis.org/go/topics/dossiers/livelihoods-connect and http://www.eldis.org/go/topics/resource-guides/poverty/rural-poverty-and-livelihoods.
[3] Cf. http://www.eldis.org/go/topics/dossiers/livelihoods-connect/livelihoods-in-dfid.
[4] Cf. http://www.ids.ac.uk/go/knowledge-services/focus-topics/livelihoods.
[5] Cf. http://www.oxfam.org.uk/resources/learning/livelihoods/index.html.
[6] Cf. http://www.savethechildren.org/programs/livelihoods/.
[7] Cf. http://www.tangointernational.com/index.php?mh=2&mi=20.
[8] Cf. http://www.fao.org/es/esw/lsp/.

support for domestic budgetary processes. Sustainable livelihoods, which was closely associated with a smaller-scale project approach, fell out of favour.[9] Nowadays, sustainable livelihoods is less important than it used to be a decade ago, but it has not completely died, though it is notable that the "sustainable" side of the picture – especially environmental sustainability – has largely fallen from view. Variants of sustainable livelihoods thinking are still employed by some development agencies and NGOs especially at project level.[10]

Today, livelihoods approaches are most useful as an analytical or heuristic tool (Clark and Carney, 2008). They provide a way to order information and understand not only the nature of poverty, but also the links between different aspects of people's livelihoods. In this way, they help users to understand complex and changing situations. They broaden the policy dialogue and assist in identifying the relevance of programmes as well as where key constraints and opportunities lie. Furthermore, livelihoods approaches are still essential within social and economic research on poverty and food security, both as embedded in research strategies or as a research tool (Carter and May, 1997; Orr and Mwale, 2001; Barrett et al., 2001; Brown et al., 2006; Devereux, 2006; Ellis and Freeman, 2007; Babulo et al., 2008).

2.2.2 Sustainable Livelihoods Framework

> "A livelihood comprises the capabilities, assets (stores, resources, claims and access) and activities required for a means of living. A livelihood is sustainable which can cope with and recover from stress and shocks, maintain and enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation; and which contributes net benefits to other livelihoods at the local and global levels and in short and long term." (Chambers and Conway, 1992: 7)

According to this view, poverty reduction interventions should focus on empowering the poor to build on their own opportunities, supporting their access to assets, and developing an enabling policy and institutional environment. It is easy to see that livelihoods approaches place people and their priorities at the centre of development, trying to understand the differences between groups of people and working with them in a way that is appropriate to their current livelihood strategies, social environment and ability to adapt. Therefore, livelihoods approaches are basically participatory. Moreover, they try to balance economic, institutional, social and environmental sustainability. Last, but not least, livelihoods approaches recognise the dynamic nature of livelihood strategies and people's flexible responses to changing situations.

In addition to these principles, livelihoods approaches are based upon a conceptual framework[11] to aid analysis of the factors affecting peoples' livelihoods (Figure 1), including their priorities (i.e., livelihood outcomes), their access to assets and

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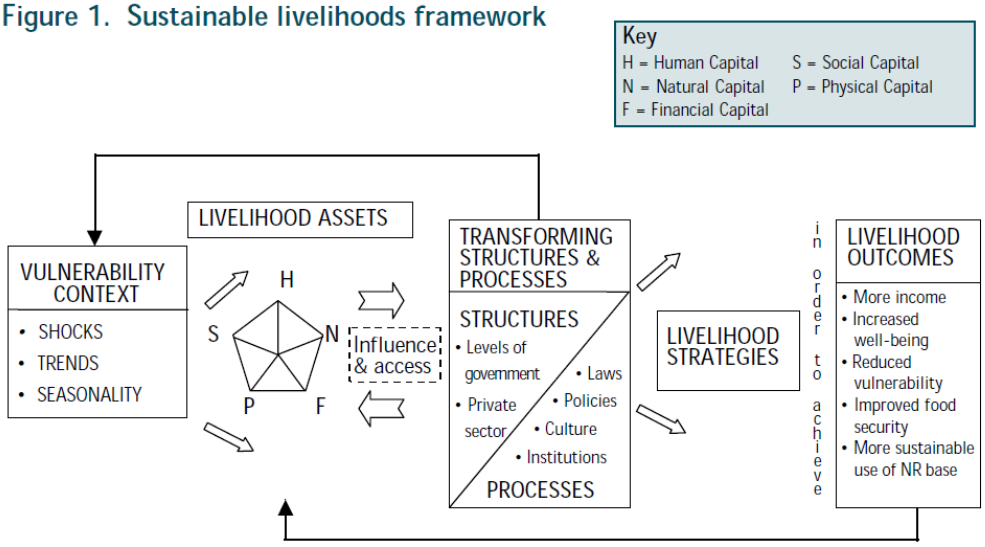
[9] There are several reasons for the fading out of sustainable livelihood as a development paradigm, some internal to organizations, some other external, reflecting the shift of emphasis in the development discourse. For instance, the fact that it was too closely associated with rural development which was a sector in retreat at the time, or its difficulty in matching theory with practice (e.g. sustainable livelihood's non-sectoral viewpoint does not marry with the reality of sector line ministries) and eventually its inadequacy in focusing on the underlying causes of poverty such as exclusion, entitlement failures, and the lack of power.

[10] The strong association between livelihoods approaches and projects – as opposed to programme or budgetary support – can be explained observing that projects are viewed as a second best option to be employed only where more transformative work is not an option (because of the nature of the state, too fragile, too much conflict).

[11] This is the original DFID's sustainable livelihoods framework (see DFID, 1999). Other authors and organisations have proposed slightly different frameworks whose building-blocks are more or less the same.

their ability to put these to productive use, the different strategies they adopt, the policies, institutions and processes that shape their access to assets and opportunities, the context in which they live, and factors affecting vulnerability to shocks and stresses.

Figure 1. Sustainable livelihoods framework



Livelihood outcomes are the goals to which people aspire, the results of pursuing their livelihood strategies, such as increased income, reduced vulnerability, increased well-being, improved food security, and more sustainable use of natural resources. Livelihoods outcomes are important because they help the analyst to understand the results of peoples' livelihoods strategies in a particular context, why people pursue particular strategies and what their priorities are, and how people are likely to respond to new opportunities or constraints.

Assets which people can rely upon play a crucial role in the livelihoods framework. Those with more assets are more likely to have greater livelihood options with which to pursue their goals and reduce poverty. Traditionally, five categories of assets or capitals (i.e., human, social, natural, physical, and financial) are identified, although subsequent adaptations have added others.

Livelihood strategies are the combination of activities that people choose to undertake in order to achieve their livelihood goals. They include productive activities, investment strategies and reproductive choices.[12] A major influence on people's choice of livelihood strategies is their access to assets and the policies, institutions and processes that affect their ability to use these assets in order to achieve positive livelihood outcomes. Livelihoods approaches try to understand the strategies pursued and the factors behind people's decisions, to re-enforce the positive aspects of these strategies and mitigate against constraints.

Policies, institutions and processes refer to the complex social, economic and political context within which people pursue their livelihood strategies. They can have a

[12] The choice of strategies is a dynamic process in which people combine activities to meet their changing needs. For example, in farming households, activities are not necessarily confined to agriculture but often include non-farm activities in order to diversify income and meet household needs. Migration, whether seasonal or permanent, is one common livelihood strategy. Social protection programmes can support the extreme poor to achieve their own positive livelihoods outcomes in cases where they are unable to compete with those with greater access to assets.

great influence on access to assets – creating them, determining access, and influencing rates of asset accumulation. Those elements in the sustainable livelihoods framework cover the inter-related issues of social relations, social and political organisation, governance, service delivery, social norms, policy and policy processes.[13] These operate at global, national, regional, district and local levels. Key to understanding their impact on local livelihoods is an analysis of the operation, or absence, of links between micro, meso and macro levels.

The vulnerability context within which people pursue their livelihoods includes trends (for example, economic or resource trends), shocks (for example, conflict, economic shocks, natural shocks, etc.), seasonal fluctuations in prices, production, health, employment opportunities.[14] These factors can have a direct impact on people's assets and on the options available to them to pursue beneficial livelihood strategies. The vulnerability context of poor people's livelihoods is usually influenced by external factors outside their direct control and is dependent on wider policies, institutions and processes. To support people in order for them to be more resilient to the negative effects of trends, shocks and seasonality, development policy-makers and practitioners can support people's access to assets and help ensure that critical policies, institutions and processes are responsive to their needs.

Particularly, livelihood approaches have proved to be valuable in the following specific areas (Clark and Carney, 2008):

- understanding the dynamics of the trajectory out of social protection to the production and promotion of more viable livelihoods, even for those with very few assets;
- analysing complex trends such as climate change and conflict situations – i.e., situations in which a key objective is to strengthen people's overall resilience as the future becomes more uncertain – and linking these to practical action;
- providing a framework for understanding food crises and how and why they affect different groups in different ways.

In conclusion, livelihood approaches can help identify the key differences between different socio-economic groups (for example, the poorest and other groups) as well as being used to track changes over time. This will prove crucial for resilience analysis (see Section 2.4).

2.3 Resilience Approach

2.3.1 The Concept of Resilience

The concept of resilience, originally proposed in the ecological literature (Holling, 1973) was successively proposed to explore the relative persistence of different states of nature in complex dynamic systems such as socio-economic systems (Levin et al. 1998). The concept of resilience has two main variants (Holling, 1996). One, called "engineering" resilience by Gunderson et al. (1997), is the ability of the system to return to the steady-state after a perturbation (Pimm, 1984; O'Neill et al., 1986; Tilman et al., 1994). It focuses on efficiency, constancy, and predictability, and it is the concept which engineers turn to in their attempt to develop optimal designs ("fail-safe" designs). The

[13] Given the complexity of these issues, different organisations have found their own ways to understand the policies, institutions and processes and apply that understanding to their policy and programmes: some include political capital as an additional asset; some put gender at the centre of the framework; others argue that an in-depth understanding of market systems is key to successful livelihoods support.

[14] Clearly, not all trends are negative or cause increased vulnerability – for example, new technologies, medical advances or positive economic trends can help improve people's livelihoods.

other definition, we can refer to as "ecological" resilience, is the magnitude of disturbance that can be absorbed before the system re-defines its structure by changing the variables and processes that control behaviour (Walker et al., 1969; Holling, 1973). It focuses on conditions away from any stable steady-state, where instabilities can flip the system into another regime of behaviour (i.e., to another stability domain).

Both variants deal with aspects of the stability of system equilibria, offering alternative measures of the capacity of a system to retain their functions following disturbance. However, each definition emphasises different aspects of stability that "can become alternative paradigms whose devotees reflect traditions of a discipline or of an attitude more than of a reality of nature" (Gunderson et al., 1997: 3).[15] In conclusion, the two definitions reflect two different views of the world: engineers want to make things work, while ecologists acknowledge that things can break down and change their behaviour. Now, what about economists? Traditionally, economists have primarily tended to consider conditions close to a single stable state.[16] However, the issue of ecological resilience has also begun to emerge in economics with the identification of multi-stable states due to path-dependency (Arthur, 1987), "chreodic" development (Clark and Juma, 1987) and production non-convexities such as increasing return to scale (David, 1985).

Levin et al., (1998) argue that resilience offers a helpful way of thinking about the evolution of social systems, partly because it provides a means of analysing, measuring and implementing the sustainability of such systems. This is largely because resilience shifts attention away from long-term equilibria and towards the system's capacity to respond to short-term shocks and stresses in a constructive and creative way.

But what are the sources of resilience within a system? Key sources of resilience lie in the requisite variety within functional groups. Examples include biodiversity in critical ecosystem functions, flexible options for management, norms and rules in human organisations, cultural and political diversity in social groups.[17] Resilience also comes from accumulated capital that provides sources for renewal. In ecological systems, these include mechanisms for regeneration, such as seeds and spatial recolonisation, or in soil properties. In social systems, it is the social capital of trust, networks, memory, and developed relationships, or, in the cultural capital of ethics, values, and systems of knowledge.

Moreover, the kindred discipline of system ecology acknowledges that critical ecosystem organising processes, or "keystone" (Paine, 1974) processes, create feedback that re-enforces the persistence of system temporal and spatial patterns over specific scale domains. These processes interact across a range of spatial and temporal bounds. In social-ecological systems, there are many factors which contribute to this, including institutions, property rights, and the completeness and effectiveness of markets.[18] This makes critical organising processes robust in their functions.

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[15] For instance, the engineering resilience focuses on maintaining efficiency of functions rather than maintaining existence of functions, as it is the case in ecological resilience. This means that the former explores system behavior in the neighborhood of the steady-state while the latter explores the properties of other stable states, with a focus on the boundaries between states. These attitudes reflect different traditions, being the former developed in the vein of deductive mathematics theory, while the latter stems out from inductive disciplines like applied mathematics and applied resource ecology.

[16] For instance, in partial equilibrium analysis, multiple equilibria are excluded by constructing convex production and utility sets or, when multiple equilibria theoretically exist, then their number is reduced by means of individuals' strategic expectations and predetermined normative and social institutions.

[17] Diversity does not support stability yet it does support resilience and system functioning (Holling, 1973 and 1986), while rigid control mechanisms that seek stability usually tend to erode resilience and facilitate the breakdown of the system.

[18] From the operational point of view, it is important: (a) to establish the role of different actors in supporting key processes over the relevant range of natural and economic conditions; and (b) to

2.3.2 Households as (sub-) Systems of a Broader Food System and Household Resilience

Households are components of food systems and can be conceived as (sub-) systems themselves. The household definition is, in fact, consistent with the Spedding (1988: 18) definition of system as "a group of interacting components, operating together for a common purpose, capable of reacting as a whole to external stimuli: it is affected directly by its own outputs and has a specified boundary based on the inclusion of all significant feedback". Moreover, as decision-making unit, it is the unit within which the most important decisions to manage uncertain events, both ex ante and ex post, including the ones affecting food security, are made: for example, what income-generating activities to engage in, how to allocate food and non-food consumption among household members, what strategies to implement in order to manage and cope with risks, etc.

It is therefore straightforward to think of households as the most suitable entry point for the analysis of food security. This does not mean that the importance of the relationships between the household and the broader food system they belong to (e.g. the community, the market chain, etc.), which contribute indeed to determine the household performances in terms of food security, including its resilience to food insecurity, are disregarded. Instead, this means acknowledging that systems are comprised of hierarchies, each level of which involves a different temporal and spatial scale, and that their behaviour appears to be dominated by some key structuring processes (see Section 2.2) which are often beyond the reach of single system components (for example, households) and are therefore assumed as given by those components at a given scale (for example, households) and time-frame (for example short-term). In other words, household strategies to manage and cope with risks prove to be more effective in a given neighbourhood (the household livelihood space) and over a finite time-span. We will therefore use the household as the most suitable level of analysis.

The multi-dimensionality of the food security (and poverty) concept(s), and the complexity of the conduit mechanisms to food insecurity, qualifies the household as a system which faces largely unpredictable exogenous shocks. This also implies that it is necessary to consider a household as a complex adaptive system. The survival of a household as a system depends less on the stability of its individual components than on the household's ability to maintain its self-organisation in the face of stress and shock; in other words, on its resilience. In a resilient household, change has the potential to create opportunity for development, novelty and innovation. As resilience declines, it takes a progressively smaller external event to cause a catastrophe. A household with low resilience may still maintain its functions and generate resources and services – i.e., may seem to be in good shape – but when subject to disturbances and stochastic events, it may exceed a critical threshold and change to a less desirable state.

For all these reasons, the concept of resilience as applied to household food security seems to be promising: it aims to measure the capability of households to absorb the negative effects of unpredictable shocks, rather than to predict the occurrence of a crisis (as in the case of most vulnerability literature).

2.4 Combining Livelihood and Resilience Analyses

The two crucial features of resilience analysis are the acknowledgement of the dynamic nature of food systems (path dependency, discontinuous changes) and the heterogeneity in the mechanisms that allow people to earn their own living (the existence of multiple

identify the institutional conditions, the regulatory framework, and the structure of incentives required to assure their conservation.

equilibria, non-linearity). These two features call for an analytical framework that explicitly incorporates them. In terms of estimation strategy, the natural candidate to this analysis is the use of panel data at household level that allow the econometric estimation of fixed-effects estimators and dynamic estimators.

Let yit be an index of the i-th household resilience to food insecurity at time t. Ideally, this index should indicate attainments of households outcomes such as nutritional status, health status, etc. This index is a function of a vector of observed time-varying covariates xit including the household income level, asset endowments, access to basic services, social safety nets, etc., and depends also on a vector zi of observed time-unvarying household or group-specific variables, such as ethnic group, sex composition, age structure, location, or unobserved household specific characteristics, such as heterogeneity in skills and preferences, while λt represents the time effect:

$$y_{it} = \alpha + \lambda_t + \mathbf{z}_i'\gamma + \mathbf{x}_{it}'\beta + \varepsilon_{it}. \qquad (1)$$

If zi can be observed for all households, the entire model can be treated as an ordinary linear model and fit by least squares. If zi is unobserved, the model will be a fixed effect or a random effect model according to the different hypotheses on its correlation with xit.

Unfortunately, in most of developing countries, it is very difficult to have a suitable dataset that allows for this estimation strategy. The major limitations are the number of periods over which the cross-sections are observed and the comparability of the values assumed by the resilience index yit over time.[19]

Without overcoming these two problems, the issue of estimating the household resilience and its determinants can only be approximated using techniques that "mimic" what the availability of a suitable panel dataset would allow. This is where the livelihood approaches can come into the picture. In fact, although livelihood approaches have been criticised on different grounds, particularly on their qualitative nature, which does not allow a quantitative assessment of the analyses, there is quite a wide consensus on using them as an analytical tool to single out the different livelihood strategies of different socio-economic groups. Identifying the different livelihood strategies makes it possible to analyse the different level of resilience to food insecurity achieved by each livelihood group as well as the different strategies pursued by such groups in order to gain resilience to food insecurity. However, while this strategy is able to analyse the heterogeneity within the sampled population, it does not capture the dynamic nature of household resilience, as would otherwise be the case if a panel dataset were available. This is the major limitation of this study to Kenya, which can be thought only as a first approximation to the issue of resilience estimation.

3 An Empirical Application to Kenya

3.1 A short Introduction to Kenya

Kenya is a low-income country (World Bank, 2010) whose 38.8 million population had, on average, an annual income of 1,560 US$ PPP (Table 1). The prevailing macro-economic conditions between 2003 and 2008 have helped to improve the welfare of Kenyans. The economy grew at a sustained rate (between 5% and 7%) and only in

[19] In fact, the dependent variable y_{it} is an index estimated over a multi-dimensional set of variables, different from the ones included in the two vectors **x** and **z**, whose specific values need to be normalized to be summed up into a single index.

2008, due to the effects of the financial and economic crisis, did the economic growth rate drop to 1.7%.[20]

The national absolute poverty declined from 52.3% in 1997 to 46.1% in 2005/06 (KNBS, 2007a and 2007b). In rural areas, overall poverty declined from 52.9% to 49.1%, while, in urban areas, poverty declined from 49.2% in 1997 to 38.8% over the same period.[21] Despite the impressive gains in economic growth prior to the 2008 crisis, poverty remains a major challenge. Most of the poor (84%) are living in rural areas. The Kenyan poverty profile also reveals strong regional disparities in the distribution of poverty. According to the 2005/2006 survey, the lowest incidence of rural poverty was in Central province (30.3%), followed by Nyanza (47.9%), Rift Valley (49.7%), Eastern (51.1%), Western (53.2%), Coast (69.7%), and North Eastern province (74.0%).

Table 1: Kenya selected indicators, 2008

Population, total (millions)	38,77
Population growth (annual %)	2.6
Surface area (sq. km) (thousands)	580.4
GNI, Atlas method (current US$) (billions)	28.42
GNI per capita, Atlas method (current US$)	730
GNI, PPP (current international $) (billions)	60.32
GNI *per capita*, PPP (current international $)	1.560
Life expectancy at birth, total (years)	54
Fertility rate, total (births per woman)	4.9
Primary completion rate, total (% of relevant age group)	80
GDP (current US$) (billions)	30.35
GDP growth (annual %)	1.7
Inflation, GDP deflator (annual %)	13.1
Agriculture, value added (% of GDP)	27
Source: World Development Indicators 2010	

Inequality in Kenya remains high. The distribution of income measured by the Gini co-efficient was estimated at 39% in rural areas and 49% for urban areas (pre-crisis). Income disparities in the rural areas have gone down since 1997, while the disparities in the urban areas have increased slightly.

There has been additional progress with regard to other dimensions of social development over the past years. For example, net primary education enrolment was only 80% in 2003, but increased to about 90% in 2008 (with an equal enrolment ratio between boys and girls). In 2004, only about 60% of primary students completed their education compared with about 80% in 2008.

According to last Country Briefs of the FAO (2010),[22] an estimated 3.8 million people in rural areas are between highly-to-extremely food insecure. FAO/GIEWS and FEWSNET agree that, in the short term, Kenya is a hunger-prone country, while WFP and IFPRI assess the long-term situation as alarming and hunger as moderately high. There is a long history of periodic shortfalls in food supply in Kenya. Shortfalls occur in all the country or in parts of the country, and sometimes for two years in a row. In times of unfavourable weather, even the provinces normally characterised by a maize surplus (such as the Rift Valley) or marginally self-sufficient provinces (such as Western and Nyanza) may enter a maize deficit situation. In addition, in areas characterised by

[20] However, Kenya is one of the few countries in the world that grew faster in 2009 compared to 2008 (World Bank, 2010).

[21] However, it is feared that the political crisis of early 2008 is bound to reverse the achievements thus far in poverty reduction.

[22] http://www.foodsec.org/countrybrief/Feb10/Kenya_February%202010.pdf.

chronic deficits (such as the Coast and Eastern and North Eastern provinces) the situation becomes acute. In many districts in these areas, emergency relief becomes necessary.[23]

3.2 The Data

The dataset is drawn from the Kenya Integrated Household Budget Survey 2005-06 (KIHBS), conducted by the Central Bureau of Statistics over the twelve months running from mid-May 2005 to mid-May 2006. The Survey was conducted in 1,343 randomly selected clusters across all Kenya districts and comprised 861 rural and 482 urban clusters. Following a listing exercise, 10 households were randomly selected with equal probability in each cluster, resulting in a total sample size of 13,430 households.

The year-long survey was organised into 17 cycles of 21 days each, during which enumerators conducted household interviews in the clusters. Furthermore, the districts were grouped into 22 zones that were logistically convenient for field teams to operate. Seasonal variation was captured by randomising visits to the selected clusters so that, in each cycle, at least one cluster was visited in each zone. The survey instrument was organised in four questionnaires:

1. a household questionnaire;
4. a 14-day household expenditure diary to record consumption and purchases;
5. a market price questionnaire; and,
6. a community questionnaire.

The sample we used contains a total of 13,212 households, accounting for 66,725 household members, with a share of 49.3% of the male population. The average age is of 22.17 years (21.9 years for males and 22.3 years for females). Rural households account for 63.9% of the total sample. The religion shares in the sample are in line with the shares at Census level, that is, Protestants are by far the most represented (45.64%), followed by Muslims (14.8%), Catholic (11.5%), and other Christians (10.0%).

3.3 Livelihood Classification

3.3.1 Methodology

This paper aims to analyse the livelihood strategies of different socio-economic groups in order to understanding the structure of the Kenyan household economy better. In most of the previous studies, household livelihoods have been classified either according to the income shares from different sources, or according to the main income activity as stated by the household. Both options have some limitations. In fact, the classification based upon income shares requires income to be measured properly, which is very difficult for some activities such as farming, especially in developing countries.[24] Alternatively, the classification based upon the stated main income activity is problematical because it forces a household with different sources of income to select the main source from a pre-determined arbitrary list.

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[23] Data from food relief operations of the Office of the President shows that some relief may be necessary in as many as 8 out of 10 years (World Bank, 1995).

[24] Moreover, income is an unstable indicator. Suppose that a farming household has lost its production and has zero or negative income. Its livelihood is still agriculture even if the income is non-positive.

In this study, a different approach is adopted. Each household is classified according to their own livelihood strategies as resulting from the cluster analysis, which is a multivariate statistical technique that encompasses algorithms and methods for grouping different observations into categories. The information on shares of income sources, productive assets and occupational activities have been used to allow the data to identify the most meaningful and homogeneous groupings of the Kenyan households.[25]

There are many cluster analysis methods according to the adopted definition of the distance between clusters, which is how the similarities/differences between clusters are measured. Running a cluster analysis requires to make three decisions. First, a specific definition of distance between clusters (i.e., measure of diversity) has to be chosen. The most widespread distance definition is the Euclidean distance, although other definitions (i.e., Manhattan, Chebychev, Mahalanobis and so on) have been proposed as well. We chose the Euclidean distance as the most reliable.

A second step is the choice of the aggregation algorithm. There are two main options: hierarchical and non-hierarchical. In hierarchical clustering (Johnson, 1967; Everitt 1979), the procedure begins with as many clusters as observations. Then, step by step, the observations are grouped according to the minimum distance between them, up to the point where only one cluster exists. The process can be represented by a dendrogram, which visually shows the clustering rationale across the sample population. Alternatively, in the case of non-hierarchical techniques (Andemberg, 1973; Matthews, 1979), the clustering procedure leads to a unique partition of the n observations in the (ex ante established) g groups: therefore, the clustering is not inferred by how the data aggregates, but it is decided ex ante by the analyst upon the basis of some priors.

Finally, the analyst has to choose which linkage method should be used. In the case of hierarchical techniques, there are many options, namely, single-linkage, complete-linkage, average-linkage and Ward method, among others. The difference between them depends on how the distance (between the groups) is measured. Ultimately, the choice depends on the type of data, and on what analysis is needed to be performed. In terms of performances, according to Punj and Stewart (1983), Ward's method appears to outperform the average linkage method, except in the presence of outliers; K-means appears to outperform both Ward's and average linkage methods if a non-random starting-point is chosen; if a random starting-point is used, the K-means method may be notably inferior to others.[26] Vice versa, in the case of non-hierarchical techniques the decision is restricted to either K-mean or K-median, in which the observation is assigned to the cluster with the nearest mean or the nearest median, respectively.

We decided to use a hierarchical cluster analysis, using Euclidean distance and Ward's method as the linkage method, because this method minimises the variability within the cluster and maximises the variability between clusters (Orr and Jere, 1999).[27]

The following variables have been used to run the cluster analysis:

- *sector of employment*: we have categorised the employment sectors as agriculture, mining, food processing, textile, chemical, heavy industry, manufacture, commerce, transport, professional services, and services (according to the four digit ISIC Rev. 2 of UN);

[25] Unlike other statistical methods for classification, such as discriminant analysis, cluster analysis makes no prior assumption about important differences within a population. Cluster analysis is a purely empiric method of classification and as such is primarily an inductive approach (Punj and Stewart, 1983).

[26] For an exhaustive comparative analysis of different methods, see Punj and Stewart, 1983.

[27] We run several kinds of cluster analysis, both hierarchical and non hierarchical. We report only the results of chosen technique *i.e.*, hierarchical cluster using Euclidean distance and the Ward's method.

- *job classification*: army, employee, administrator, professional, technician, clerk, service provider, farm entrepreneur, farm worker, craftsman, operator, and other low level job;
- *income shares*: shares from each income-generating activity in total household income;
- *income generating activities*: this is a discrete variable accounting for how many (if any) income generating activities a household is involved in;
- *owned land*: hectares owned by household;
- *owned livestock*: livestock units owned by the household, calculated as tropical livestock units (TLU) a measure used in the tropics equivalent to an animal of 250 kilograms;
- *transfers*: this is a dummy variable indicating whether a household has received any kind of transfers irrespective of the transfer source.

3.3.2 Results

The cluster analysis described above produced a dendrogram (Figure 2), which shows a clear grouping in six different clusters.[28] Annex 1 reports the most relevant and significant variables for the cluster analysis: we have listed all variables of identified clusters to evaluate which was the livelihood strategy adopted.

The final clustering is reported in Table 2. The Kenyan population can be broken down in six different livelihood strategy groups: pastoralist (6%), agro-pastoralist (14%), small-holder farmers (34%), large-holder farmers (3%), entrepreneurs (19%) and wage-employees (24%). Some descriptive characteristics of the resulting clusters are as follows:

- *agro-pastoralists* (1,398 households): households belonging to this group largely depend on both crop and livestock; as expected, urban households are relatively little represented (9.09%) within this cluster; the mean TLU is 5.62 and the mean owned land is 3.20 ha; the share of people whose income from livestock exceeds 50% of total income is 12.8%;
- *small-holder farmers* (3,790 households): households gaining their own livelihood mainly from farming, owing farming land less than 2 ha each (mean equal to 1.03 ha); mean TLU is equal to 1.23; more than 87% the cluster is made by rural households;
- *large-holder farmers* (273 households): households gaining their own livelihood mostly from farming, owing not less than 2 ha each of farming land (mean equal to 10.02 ha); mean TLU is equal to 3.34; more than 91% the cluster is made by of rural households;
- *entrepreneurs* (2,699 households): households that gain almost 60% of their total income from self-employment activities, mainly commerce; owned TLU and land are negligible and the amount of received transfers are on average smaller than in other clusters; their average income is the highest across the surveyed population (119,454 Khs);
- *wage employees* (4,255 households): mostly urban households employed in the service sector, second-highest income (109,612 Khs); they show the lowest mean livestock and land per household (0.39 TLU and 0.11 ha, respectively);

[28] In order to ensure a minimum size to all clusters so that they would be statistically significant, we decided to assign *ex ante* all households whose livestock income share exceeded 75% of total income to the sixth cluster, *i.e.*, the pastoralist.

- *pastoralists* (797 households): households whose livelihood is mainly from livestock (on average, 89% of total income and 8.33 TLU per household); 89% of them live in rural area.

Figure 2: Dendrogram of Livelihood Strategy Clusters in Kenya

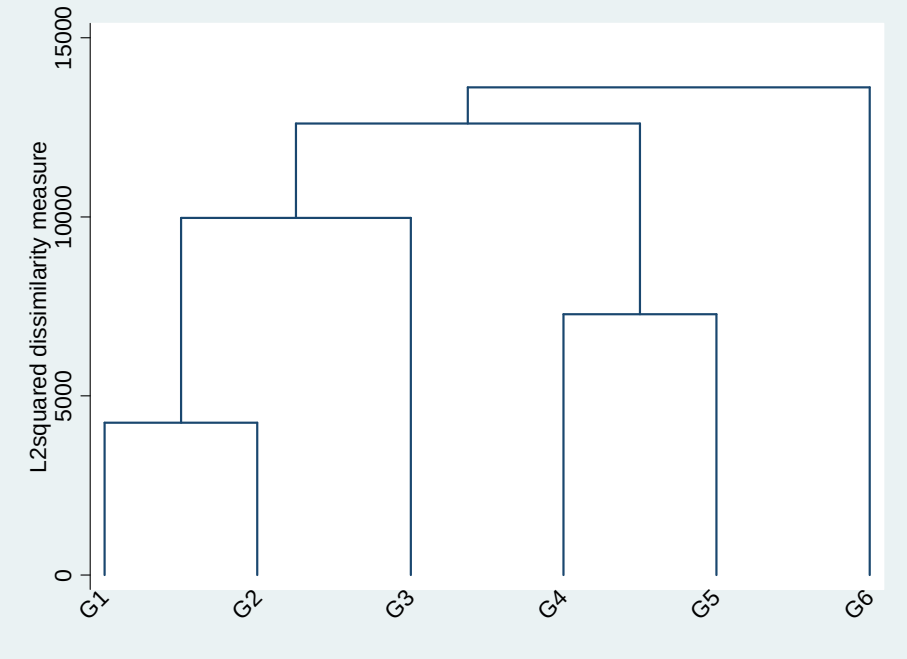


Table 2: Livelihood Strategy Groups in Kenya

Livelihood Strategy	Frequency	Percent
Agro-pastoralists	1,398	10.58%
Small-holder farmers	3,790	28.68%
Large-holder farmers	273	2.07%
Entrepreneurs	2,699	20.43%
Wage employees	4,255	32.21%
Pastoralists	797	6.03%
Total	13,212	100.00%

The distribution of the livelihood group differs across the eight Kenyan provinces (Table 3). For example, large-holder farmers are mostly concentrated in Eastern province (42%), while pastoralists are mostly represented in the Rift Valley and North Eastern provinces. Entrepreneurs are the livelihood group most evenly distributed across provinces while large-holder farmers are the most concentrated ones. In terms of distribution within a given province (Table 4) the largest share of small-holders can be found in the Central province (53%), while the share of wage-employees is highest in Nairobi (67%). Coast province shows the most diversified distribution, while Nairobi shows the highest concentration on only a few livelihood groups.

Table 3: Distribution of Livelihood Strategy Groups across Kenyan Provinces

Livelihood Strategy Groups	Nairobi	Central	Coast	Eastern	North Eastern	Nyanza	Rift Valley	Western	Total
Shares per livelihood groups									
Agro-pastoralists	0.06	7.28	11.33	32.05	1.69	9.70	25.68	12.21	100
Small-holder farmers	0.04	19.11	5.59	18.43	0.27	17.76	23.67	15.13	100
Large-holder	0.00	5.34	10.78	41.86	0.00	3.89	24.44	13.69	100

farmers									
Entrepreneurs	13.17	8.37	13.42	11.90	0.87	18.61	16.99	16.68	100
Wage employees	22.25	10.71	10.54	6.49	5.81	11.69	27.70	4.82	100
Pastoralists	0.22	6.51	7.17	12.34	19.76	9.52	35.36	9.13	100

Table 4: Distribution of Livelihood Strategy Groups within Kenyan Provinces

Livelihood Strategy Groups	Nairobi	Central	Coast	Eastern	North Eastern	Nyanza	Rift Valley	Western
Shares per province								
Agro-pastoralists	0.1	8.1	16.6	26.6	7.4	9.2	14.4	13.7
Small-holder farmers	0.2	52.8	20.2	37.9	3.0	41.5	32.8	42.1
Large-holder farmers	0.0	1.2	3.3	7.2	0.0	0.8	2.8	3.2
Entrepreneurs	32.2	13.3	27.9	14.1	5.4	25.0	13.5	26.7
Wage employees	67.4	21.1	27.2	9.5	44.6	19.5	27.4	9.6
Pastoralists	0.2	3.4	4.8	4.7	39.7	4.2	9.1	4.7
Total	100	100	100	100	100	100	100	100

3.4 Resilience Assessment

3.4.1 Methodology

In order to understand the key determinants of each livelihood strategy and to make a comparison between them, we used an updated version of the resilience framework developed by Alinovi et al., (2008) using data from Palestinian households. The resilience to food insecurity of a given household at a given point in time is assumed to depend primarily on the options available to that household to make a living, such as its access to assets, income-generating activities, basic services and social safety-nets. These options represent a pre-condition for the household response mechanisms to a given risk, that is, its ability to handle it. In the original framework, Alinovi et al., proposed to assess the resilience to food insecurity for the i-th household as a latent variable defined according to the following components: income and food access (IFA), assets (A), access to public services (APS), social safety-nets (SSN), stability (S), and adaptive capacity (AC):

$$R_i = f\left(IFA_i, A_i, APS_i, SSN_i, S_i, AC_i\right). \quad (2)$$

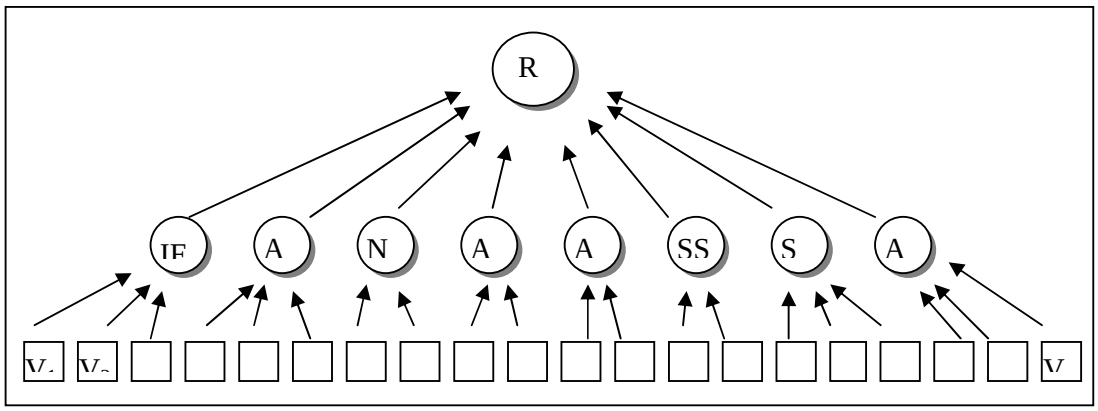
In this study, given the importance of farming for the livelihoods of Kenyan households, we have broken down the assets into agricultural production assets (AA) and non-agricultural assets (NAA), and we have included an additional component called agricultural practice and technology (APT) to capture the different technological levels in farming activities:

$$R_i = f\left(IFA_i, AA_i, NAA_i, APT_i, ABS_i, SSN_i, S_i, AC_i\right). \quad (3)$$

In this framework, resilience is not observable per se and is considered a latent variable depending on the terms on the right-hand side of equation (3). To estimate R, it is therefore necessary to estimate separately IFA, AA, NAA, APT, ABS, SSN, S, and AC, which are themselves latent variables because they cannot be directly observed in a given survey, although it is possible to estimate them through multivariate techniques.[29]

[29] As pointed out by Alinovi *et al.*, (2008), two alternative estimation strategies could be adopted for the estimation of household resilience: structural equation modelling and multi-stage modelling. There are two main reasons for adopting the latter estimation strategy: (i) usually, the available variables are not all normally distributed, so their estimation requires the use of different multivariate techniques; and (ii) measuring the different components separately makes the model

Figure 3: Path diagram of the household resilience model



Thus, the resilience index is estimated using a two-stage factor analysis strategy (Figure 3). In the first stage, an index for each component is estimated separately using an iterated principal factor method over a set of observed variables.[30] In the second stage, the resilience index is derived using a factor analysis on the interacting components estimated in the first stage:

$$R = \sum_j w_j F_j \qquad (4)$$

in which the resilience index is a weighted sum of the factors generated using Bartlett's (1937) scoring method and the weights are the proportions of variance explained by each factor.

3.4.2 Results

A detailed description of the estimates obtained applying the framework above is reported in Annex 2. In this section, we summarise only the most important results on how the observed variables contribute to assessing the value of the latent variables representing the resilience components (first stage), as well as the results of the resilience index estimation (second stage).

Income and Food Access (*IFA*)

This indicator is directly related to household's capacity to access food. Traditionally, food access is measured by income; however, to better estimate the overall aspect of access to food, we included two more variables, namely, per capita expenditure and per capita caloric intake:

- *per capita income* (INC): this is the total household income computed adding up all sources of income that contribute to the household livelihood;
- *per capita expenditure* (EXP): this is an aggregated value computed adding up any household expenditure for consumption;
- *per capita caloric intake* (CAL): this is the household's average food calories intake per person per day estimated using the FAO methodology (see Sibrian et al., 2006).

more flexible, allowing the inclusion of prior information and thus reducing parameter identification problems.

[30] Whenever an observation showed a missing value for a given variable, the missing value has been imputed estimating it through regression techniques. In general, the number of missing values has been very small, varying from 0 to a maximum of 4% in each observed variable.

All these variables are indicators for measuring food access, so the high correlation among them can produce a latent variable that fits the common pattern in the data. To estimate the IFA latent indicator, a factor analysis has been run using the principal factor method and the scoring method suggested by Bartlett (1937):

$$\hat{f}_B = \Gamma^{-1}\Lambda\Psi^{-1}x, \qquad (5)$$

in which $\Gamma = \Lambda'\Psi^{-1}\Lambda$, □ is the unrotated loading matrix, Ψ is the diagonal matrix of uniquenesses, and x is the vector of observed variables.[31]

The first factor is significant in all clusters and can be considered the latent variable for food access. Table 5 reports the factor loadings between each variable and the IFA for the entire population as well as the six clusters.[32] The estimates are similar across all clusters except in the case of pastoralists, for whom the contribution of per capita income to food access is negligible.[33]

Table 5: Factor loadings for the observed variable used to estimate the IFA component

Variables	Kenya	Agro-pastoralists	Small-holder farmers	Large-holder farmers	Entre-preneurs	Wage employees	Pastoralists
INC	0.5073	0.5332	0.4698	0.5362	0.5302	0.6021	-0.0317
EXP	0.7412	0.7483	0.7178	0.7017	0.7469	0.7375	0.6978
CAL	0.4577	0.4293	0.6192	0.4584	0.4402	0.5467	0.6915

Access to Basic Services (*ABS*)

Access to basic services endows the households with several important key factors for enhancing their resilience, for example, by improving the effectiveness of household's access to assets. As a result, access to basic services affects a household's capacity to manage risks and respond to shocks. The following basic services have been considered in the analysis:

- *telecommunication* (TEL): this is a dummy variable for having access to a telephone (fixed or mobile), equal to 1 if the household shows any telephone expenditure and 0 otherwise;
- *electric power* (ELE): this is a dummy variable indicating whether a household has electric power at home or not;
- *distance to water* (WAT): this is a continuous variable measuring the time that it takes to walk to the closest water source plus the time spent queuing once there;
- *distance to work* (DTW): it is a continuous variable measuring the time that it takes to household members to travel to work; it is calculated as the average time among household members who have been effectively working;
- *school drop-out* (SDO): this is a dummy variable indicating whether the household's children drop-out from school because of conflicts, poor quality of the school or excessive distance from the school;

[31] The estimates produced by this method are unbiased, but may be less efficient than those produced by the regression method suggested by Thompson (1951). The formula for Thompson's regression method is: $\hat{f}_T = \Lambda'\Sigma^{-1}x$, where Σ = the correlation matrix of x.

[32] Annex 2 includes also the correlation between each observed variable and the latent variable representing the resilience component, for example, in this specific case, the IFA.

[33] This result may reflect that income is less important for pastoralist than for other livelihood groups. However, it may also partially reflect the difficulty of recording livestock outputs and inputs that are difficult to be properly captured in household surveys.

- *credit* (CRE): this is a dummy variable measuring whether any household member has borrowed credit over the observation period irrespective of the credit source (formal or informal) and nature (in cash or in kind).

The variables show a common pattern, which demonstrates the positive impact of access to telephone networks, electric power and credit on the latent variable access to basic services, while the distance to the closest water source and to work, and the dropping-out from school negatively affect the latent variable ABS (Table 6). The estimates show also the relative importance across livelihood groups of each observed variable: for example, access to telephone and electric power are much more important for entrepreneurs and wage employees than for other clusters, while access to credit is more important for large-holder farmers and pastoralists.

Table 6: Factor loadings for the observed variable used to estimate the ABS component

Variables	Kenya	Agro-pastoralists	Small-holder farmers	Large-holder farmers	Entre-preneurs	Wage employees	Pastoralists
TEL	0.5941	0.0362	0.3122	0.2504	0.6231	0.6091	0.3912
ELE	0.6581	0.2185	0.3187	0.2346	0.6316	0.6500	0.2951
WAT	-0.2753	-0.4893	-0.3701	-0.5676	-0.2838	-0.4790	-0.1398
DTW	-0.0281	-0.4300	-0.2247	-0.1236	-0.0432	-0.1596	-0.3635
SDO	-0.1847	-0.0995	-0.2182	-0.0317	-0.1677	-0.3405	-0.2446
CRE	0.0435	0.0187	0.1064	0.4128	0.1348	0.1080	0.3576

Agricultural Assets (*AA*)

This component measures the impact on resilience of assets important for agricultural production. It has been computed as agricultural assets per capita, that is, the sum of the monetary value of land and animals owned by each household divided by the household size. Table 7 clearly shows that agricultural assets are more important for large-holder farmers, followed by agro-pastoralists and pastoralists.

Table 7: Factor loadings for the observed variable used to estimate the AA component

Variables	Kenya	Agro-pastoralists	Small-holder farmers	Large-holder farmers	Entrepre-neurs	Wage employees	Pastoralists
AA	27,397.2	59,529.3	26,700.1	103,958.4	13,245.2	6,078.5	48,127.4

Non Agricultural Assets (*NAA*)

Assets play a crucial role in determining the household's risk-coping mechanisms. They include both individual assets and "technical" assets (those needed to work, cook and so on), namely:

- *house value* (HOU): the value of the house in which the interviewed household lives;
- *durables value* (DUR): expenditures for all durable assets bought by the household.

Given that NAA is composed by only two observed variables, this variable has been generated simply by summing-up the values of the two observed variables. As expected, NAA are more relevant for entrepreneurs, large-holder farmers and wage-employees, while it shows the lowest value among pastoralists and small-holders (Table 8).

Table 8: Average total value of the NAA component

Variables	Kenya	Agro-pastoralists	Small-holder farmers	Large-holder farmers	Entrepre-neurs	Wage employees	Pastoralists
NAA	210,805	192,563	101,761	353,042	310,542	300,236	131,605

Agricultural Practice and Technologies (*APT*)

This component is supposed to capture the level of agricultural production technology adopted by a given household. The variables used to generate this latent variable are the following:

- *organic fertilisers* (ORG): this is a dummy variable equal to 1 if the household used organic fertiliser over the survey period, 0 otherwise;
- *inorganic fertilisers* (INO): this is a dummy variable equal to 1 if the household used inorganic fertilisers over the survey period, 0 otherwise;
- *veterinary* (VET): this is a dummy variable equal to 1 if the household needed any veterinary service over the survey period, 0 otherwise;
- *pesticides* (PES): this is a dummy variable equal to 1 if the household used pesticides over the survey period, 0 otherwise;
- *artificial insemination* (INS): this is a dummy variable equal to 1 if the household needed artificial insemination services over the survey period, 0 otherwise.
- *agricultural inputs* (INP): this continuous variable indicates the cost per acre of agricultural inputs, that is, the sum of the expenses for agricultural inputs (fuel, lubricants, machine and equipment repair, tractor, small farm implements, etc.) divided by cultivated land.

Again, Table 9 shows that entrepreneurs and wage-employees used more advanced agricultural techniques as compared to other livelihood groups.[34]

Table 9: Factor loadings for the observed variable used to estimate the APT component

Variables	Kenya	Agro-pastoralists	Small-holder farmers	Large-holder farmers	Entrepre-neurs	Wage employees	Pastoralists
INO	0.5721	0.4639	0.3494	0.4831	0.6669	0.7928	0.5961
ORG	0.5617	0.3956	0.4558	0.0935	0.5976	0.6537	0.5362
VET	0.6705	0.4203	0.6044	0.6386	0.7298	0.6629	0.2034
PES	0.4377	0.3414	0.3291	0.0871	0.4378	0.4998	0.5449
INS	0.6431	0.6486	0.6895	0.5737	0.6370	0.6634	0.4149
INP	0.2240	0.2329	0.1641	0.4222	0.2038	0.3158	0.4646

Social Safety-Nets (*SSN*)

Social safety-nets are crucial for all households, especially for the poor. We built a single variable that includes transfers received by individual, non-profit organisations,

[34] The lower value of veterinary services for pastoralists as compared to other groups sounds counterintuitive: this can be explained taking into account that Table 8 reports only the values of the first factor; indeed, factor analysis for pastoralists shows that in the case of veterinary services are important also factors other than the first one, while this is not the case for other livelihood groups.

government, firms, and remittances. Then, we standardised it, in order to have a latent variable with zero mean and variance equal to 1, before running the second stage factor analysis to estimate resilience. In this case, wage-employees show the highest level of SSN while pastoralists and small-holder farmers the lowest level (Table 10).

Table 10: Average values of the SSN component

Variables	Kenya	Agro-pastoralists	Small-holder farmers	Large-holder farmers	Entrepr e-neurs	Wage employees	Pastoralists
SSN	1,117.6	985.0	660.1	944.2	1,197.9	2,055.4	242.6

Stability (*S*)

Stability is an important dimension of household's resilience that captures the degree to which household's options vary over time. To estimate the value of this latent variable, we used the value of losses due to shocks, namely:

- *animal shock* (ANS): the value-loss due to stolen or dead livestock;
- *crop shock* (CRS): this is the crop loss caused by droughts, floods, crop diseases, pest outbreaks, fall in output prices, increase in input prices, and water shortages;
- *other shocks* (OTS): this variable summarises the value loss due to shocks other than those considered in the previous two variables (for example, the illness, death, job loss of a household member);
- *shocks* (SHK): this is a count variable constructed as the sum of the dummy variables which indicate whether a household was hit or not by each shock typology during the five years before the survey.

Clearly, a given monetary loss does not have the same meaning for all households. Thus, we decided to normalise the first three variables by dividing each of them for household per capita expenditure. Each observed shock variable is, indeed, an indicator of instability. Thus, we multiplied each of them times -1 in order to make them consistent with the meaning of the latent variable S.

Table 11 shows that the most stable livelihood groups are wage-employees and large-holder farmers, while small-holder farmers are those who are relatively the least stable.

Table 11: Factor loadings for the observed variable used to estimate the S component

Variables	Kenya	Agro-pastoralists	Small-holder farmers	Large-holder farmers	Entrepre-neurs	Wage employees	Pastoralists
SHK	0.4009	0.7122	0.5641	0.3621	0.2500	0.4822	0.2540
ANS	0.6796	0.7134	0.2329	0.6662	0.1865	0.8528	0.8026
OTS	1.0069	0.9904	0.9337	1.0088	0.9706	1.0123	1.0102
CRS	0.7726	0.7588	0.9548	0.9117	0.9046	0.7913	0.8406

Adaptive Capacity (*AC*)

This is another important dimension of resilience, which measures the household's ability to adapt and react to shocks. The following observed variables are meant as the determinants of the household adaptive capacity:

- *diversity* (DIV): this is a count variable that accounts for the number of household sources of income; the idea is that the more diversified the sources of income, the higher the ability of the household to adapt to a given shock;

- *employment ratio* (EMP): this variable measures the ratio between the number of household members currently employed and the household size;
- *education average* (EDU): this is the mean of the years of education completed by the household's members;
- *food ratio* (FRA): this is a variable which reports the ratio (ranging from 0 to 1) of food expenditure on total household expenditure; as a cost, this variable negatively affects the household adaptive capacity.

Table 12 shows that wage-employees are those who are most capable of adapting to shocks, while smallholder farmers are the least adaptable livelihood group.

Table 12: Factor loadings for the observed variable used to estimate the AC component

Variables	Kenya	Agro-pastoralists	Small-holder Farmers	Large-holder farmers	Entrepre-neurs	Wage employees	Pastoralists
EMP	0.4522	0.3390	0.4705	0.3436	0.5622	0.6075	0.5219
DIV	0.4151	0.4213	0.3234	0.2316	0.3108	0.5768	0.4570
EDU	0.7461	0.7032	0.6899	0.7636	0.7663	0.7664	0.6191
FRA	-0.6375	-0.6681	-0.4652	-0.6672	-0.5477	-0.6565	-0.5345

Resilience (*R*)

The variables estimated in the previous sub-sections become co-variates in the estimation of the resilience index. Considering that all the estimated components are normally distributed with zero mean and variance equal to 1, a factor analysis was run using the iterated principal factor method, which re-estimates communalities iteratively.[35]

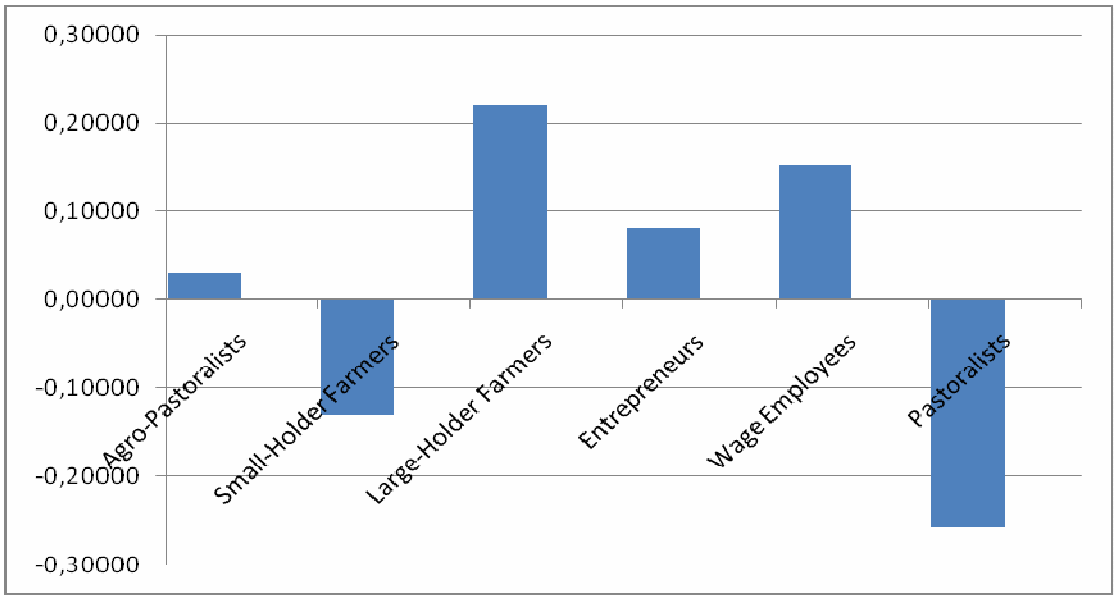
The analysis of resilience and its components by livelihood cluster has generated insightful results. If we compute the difference between each livelihood group index and the overall resilience index for Kenya (Figure 4), we can see that large-holder farmers are the most resilient (0.22), followed by wage-employees (0.15), entrepreneurs (0.08) and agro-pastoralists (0.03). The worst-off are pastoralists (-0.26) and smallholder farmers (-0.13).

Table 13: Resilience Index per Livelihood Group

Livelihood Strategy Groups	R index
Agro-Pastoralists	0,03027
Small-holder Farmers	-0,13001
Large-holder Farmers	0,22007
Entrepreneurs	0,08171
Wage Employees	0,15228
Pastoralists	-0,25765
Kenya	0.0000

[35] Communality is the proportion of the variance of a particular item that is due to common factors (in other words, that it is shared among several items).

Figure 4: Resilience by Livelihood Strategy Group in Kenya



Moreover, the resilience analysis conducted separately for each livelihood cluster shows that the determinants of resilience are different per each livelihood group. Table 14 shows that there are large differences in terms social safety-nets, stability, productive assets and agricultural practices and technology. For example, entrepreneurs show the highest contribution to the resilience index in terms of income (IFA), adaptive capacity (AC) and non agricultural assets (NAA), an indicator wealth; as expected, the latent variables related to farming, (i.e., the proxy for agricultural techniques, APT, and agricultural assets, AA) are more important in determining the household resilience of the socio-economic groups which earn their own living primarily from farming, to wit, farmers, agro-pastoralists and pastoralist; finally, social safety-nets are much more important for the wage-employees livelihood group than for other groups.

Table 14: Correlation matrix for resilience components

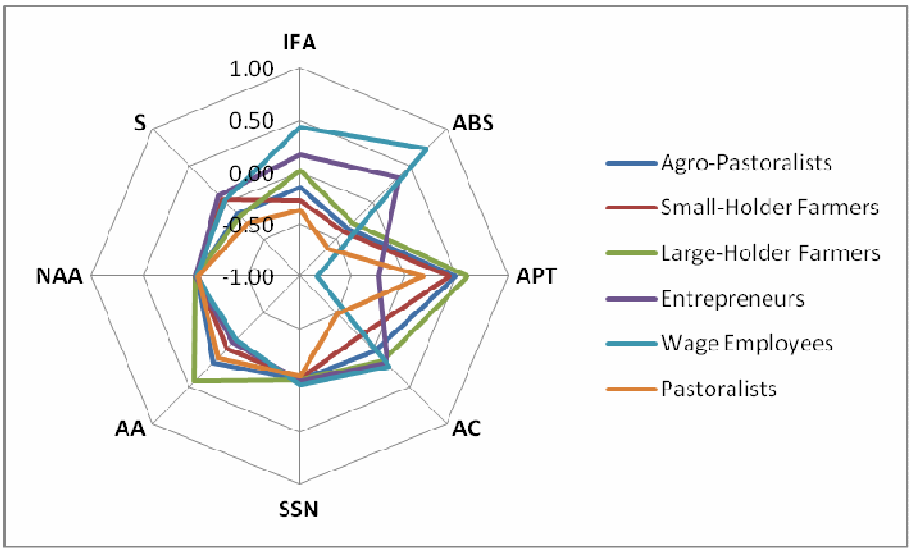
Components	Kenya	Agro-Pastoralists	Small-holder Farmers	Large-holder Farmers	Entrepreneurs	Wage Employees	Pastoralists
IFA	0.6702	0.8657	0.7440	0.6879	0.7687	0.7357	0.8429
ABS	0.4103	0.1125	0.1950	0.3934	0.6310	0.5019	0.5976
APT	0.0515	0.3924	0.2582	0.7119	0.0885	0.4730	0.5102
AC	0.4497	0.4127	0.2989	0.5580	0.7164	0.6689	0.5703
SSN	0.2643	0.0894	0.3360	0.1206	0.2431	0.3489	0.0484
AA	0.2492	0.3595	0.7854	0.4796	0.2612	0.4060	0.2484
NAA	0.7539	0.8671	0.5666	0.1617	0.5643	0.5341	0.3542
S	0.0526	0.0153	0.0191	0.4368	0.0761	0.0579	0.3226

These differences are very relevant in terms of policy implications if we consider the differences between the ultimate determinants of each component. In terms of access to basic services, for example, access to credit is much more relevant to pastoralists and large-holders than to others. Access to water is more relevant to both farm-holders groups and agro-pastoralists, while electricity and telephone networks are relevant to entrepreneurs and wage-employees. The social safety-nets (transfers per capita) for wage-employees are twice that of other groups: this seems to be related to

urban poverty, where the lack of other assets (land, livestock, etc.) dramatically reduces the urban poor coping capacity.

However, resilience levels do not tell the whole story. Resilience component analysis is even more relevant in terms of policy implications (Figure 5). In fact, the results show that, even if large-holders have the highest level of resilience, their access to basic services (electricity, water, etc.) is much lower than for wage-employees or entrepreneurs. Another concerning issue is the situation of pastoralists: they generally show low levels of all components, and especially dramatically low levels of adaptive capacity (education, income diversification, etc.) and of access to basic services.

Figure 5: Resilience Components by Livelihood Strategy Group in Kenya



The results of resilience by provinces (Figure 6) show that Nairobi province is by far the most resilient province (0.83) and North Eastern province the least resilient (-0.64). The high levels of access to basic services and income generation capacity are the most important determinants of the high level of resilience in the case of Nairobi (Figure 7). A particular concern is the low adaptive capacity in the North Eastern province.

Figure 6: Resilience by Provinces in Kenya

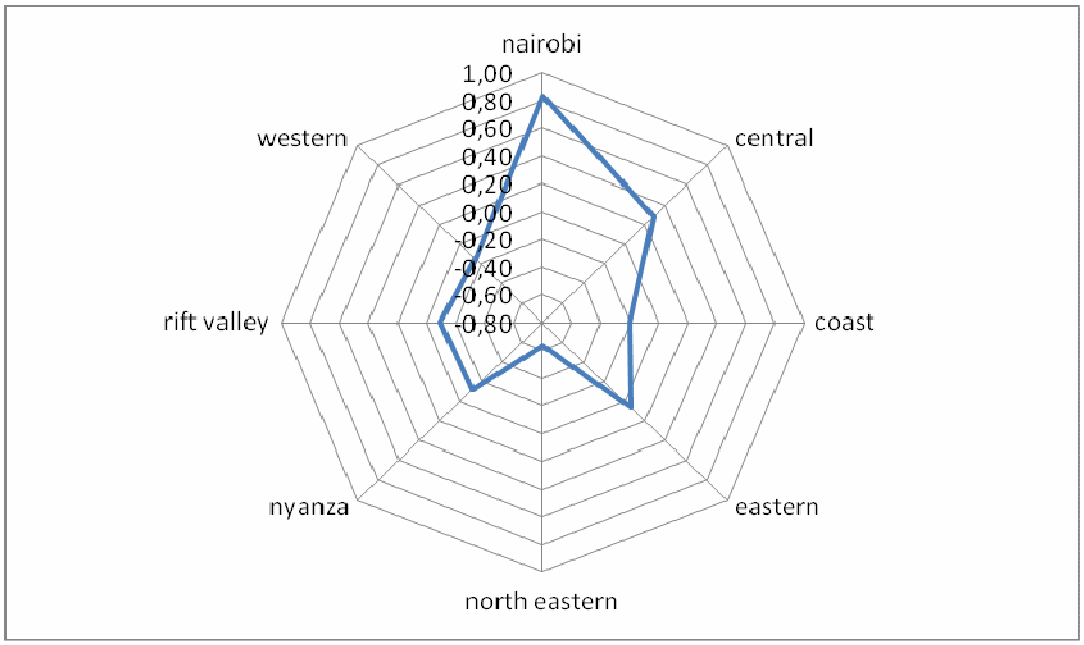
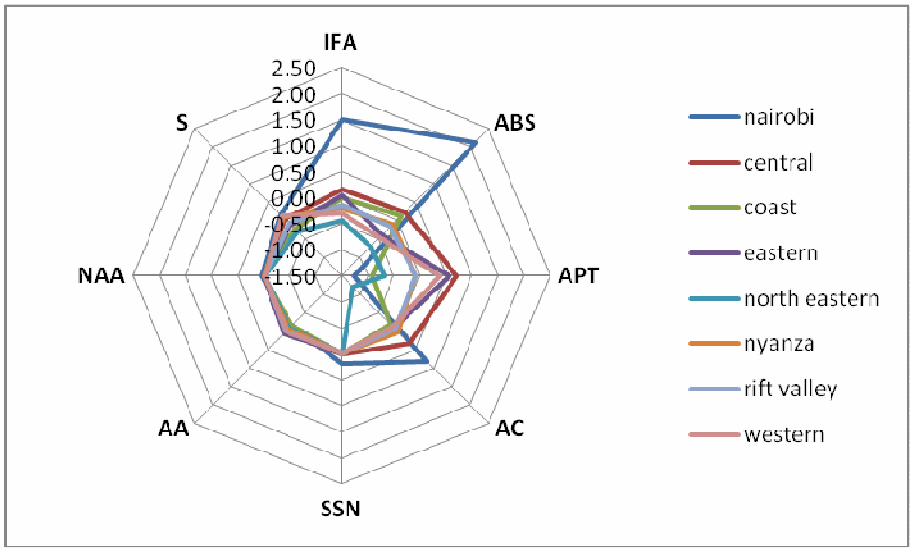
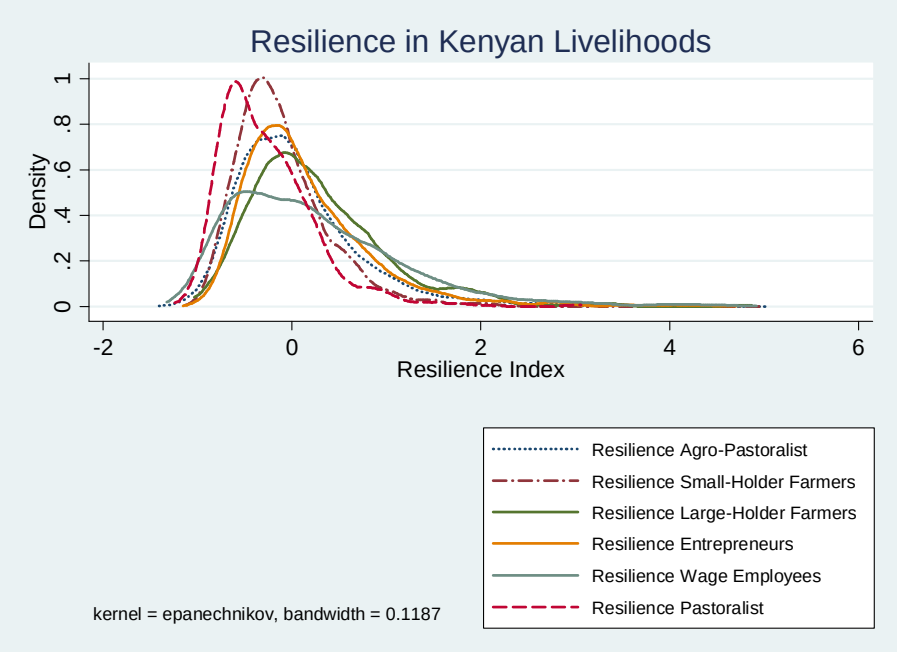


Figure 7: Resilience by Provinces and Livelihood Components in Kenya



All results and comments presented up to now have referred to the average levels of resilience. This may lead to misleading conclusions if we do not consider the fact that, even within the most resilient livelihood groups, there are households with low levels of resilience. Moreover, from the social policy point of view, it is worth looking at inequality among the different groups. Figure 8 shows the distribution of resilience for each livelihood strategy group. The graph shows that wage employees are the livelihood strategy group with the most inequality, while pastoralists and small-holders are the groups which show a more equally-distributed resilience, though on average low level of resilience. The main implication from these results is that specific attention should be given to pastoralists and small-holder framers as a whole as well as to the lowest quintile of wage employees, which generally refers to the urban poor.

Figure 8: Distribution of Resilience for Each Livelihood Strategy Group



What about gender issues?

Gender disparities are an important issue in Africa and are generally driven by the different access that men and women have to economic opportunities, assets, education, decision-making process and social protection schemes. The resilience approach presented in this paper can also shed some light on the determinants of gender disparity in Kenya.

An accurate gender analysis would require individual data on socio-economic indicators while most of the indicators used in the resilience analysis are at household-

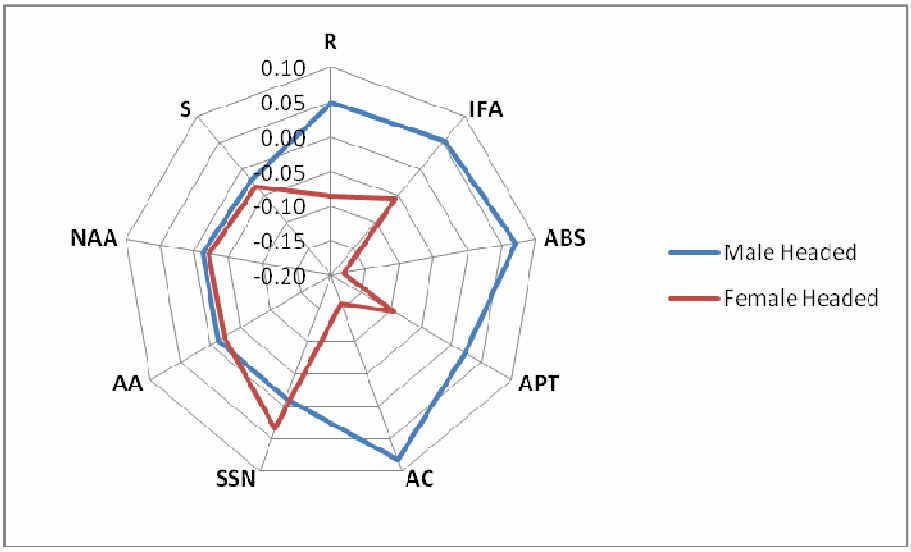
level. However, important insights can also be derived by analysing the differences between male- and female-headed households.[36]

Figure 9 shows that male-headed households are much more resilient than female-headed households. The difference between male and female is enormous in terms of access to basic services, adaptive capacity (mainly due to the large difference in terms of education), income and food access and agricultural practice and technologies. The only component where a female-headed household performs better is social safety-net, which is clearly the simplest way that the female-headed households have to cope with shocks. The differences in terms of assets (both agricultural and non-agricultural) and stability appear less important.

T-tests have been conducted to assess the statistical significance of the differences between the means of male- versus female-headed households (Annex 3). The t-test confirms that the difference for AA, NAA and S are not statistically significant. Annex 3 includes also the t-tests on mean differences between genders for each livelihood group and the results are quite surprising. They show that the difference in resilience is not significant for large-holder farmers, agro-pastoralists and pastoralists.[37] The results also vary for the components of resilience. For example, IFA is higher for females in small-holder farmers; S for males is higher in large-holder farmers and wage-employees, while it is higher for females in the small-holder farmer cluster.

The magnitude of the t-statistic is also important since the larger it is, the higher the gender disparity. By and large, urban-based groups (i.e., wage-employees and entrepreneurs) show the largest gender disparities in resilience, mainly due to access to income and food, access to basic services and adaptive capacity. In the case of agrarian livelihoods, gender disparities are generally less pronounced (with the exception of smallholders) due to the less important role played by access to income and food as well as to basic services as a determinant of gender bias.

Figure 9: Resilience by Household Head Sex in Kenya. (blu line: male; red line: female)



[36] This approach, although not very accurate, is commonly used to conduct gender analysis using household surveys. The shares of households that are headed by a female is quite large in Kenya, around 30%, which make possible to carry out the analysis also by livelihood groups.

[37] The difference for pastoralists is quite consistent but not significant due to the small sample size. In fact, the differences for pastoralists and large-holder farmers, which are the smallest groups are rarely significant.

4 Discussion

4.1 Food Insecurity among the Less Resilient Livelihood Groups

Unpredictable shocks and crises are among the major causes of food insecurity in sub-Saharan Africa. Kenya has a long record of shocks and crises that can be traced back to four main causes – droughts, floods, diseases, and political crises – which are often intertwined compounding the impact of each shock.[38] Among these determinants, droughts are the most relevant shocks in Kenya. The country is, indeed, a drought-prone country, with arid and semi-arid lands (i.e., areas where the annual rainfall range is between 200 and 500 mm) covering 80% of the territory. In the twenty years before the KIHBS 2005, there were at least seven shortfalls in food supply directly linked to droughts.[39]

The way in which droughts impact upon people's lives is highly differentiated across Kenyan households. The most vulnerable are:

- pure food consumers households (who buy, but do not produce, food), including most of the urban poor and the landless, as well as the urban non-poor;
- farming households that are net buyers of maize;[40] and
- farming households that are net sellers.

The most vulnerable are the rural poor who depend on agriculture and livestock for their livelihood. Considering that most rural poor are net buyers of food, the typical poor rural Kenyan was negatively impacted by the food price spikes resulting by the food availability decline caused by the drought. One clear consequence of the recurrent droughts is the escalation of poverty and food insecurity among dryland communities. This has set in motion a range of social problems, for example, the dismantling of family ties, child abandonment and dropping out of school (especially for girls), which have far reaching implications for the country's development.[41]

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[38] For example, this has been the case of the 1992-93 drought when, despite the alert launched by the early warning systems about the inadequacy of long rains (April-May 1992), the Government response was at best very slow (because busy with the electoral campaign) and went with an appeal to donors only late in the year, *i.e.*, October/November 1992. The figures of the shortfall were finalised only at the beginning of 1994 and the Department of Drought Management was set up in the Office of the President to coordinate relief activities. The situation came under control only after two years of rising food prices and hardship. But, in March 1994, the National Cereals and Produce Board was still holding more than 3 million bags of grain, when it should have just unloaded stocks onto the market to stabilise the rising open market prices (World Bank, 1995).
A similar dynamics has been operating in the case of the 2009 drought: a series of three failed rain seasons deteriorated the situation with tension on the maize market. Unfortunately, the maize tariffs reduction and the liberalisation of maize imports come too late and price rose.

[39] Namely, the 1984-85, 1988-89, 1992-93, 1996-97, 1999-2000, 2004, and 2005 food crises.

[40] Currently, approximately 60% of all farming households in Kenya - and an even higher percentage among poor farming households - are net buyers, meaning that they buy more maize than they sell. In contrast, the current maize production structure is skewed in favour of the 2% of maize farmers, who account for over 50% of the sales and their average maize sales income is over 20 times that of the bottom 70% of households (World Bank, 2009).

[41] Generally, pastoralists are more vulnerable than other groups to the different types of crisis, especially climatic hazards, starting a vicious circle that gets them stuck in a poverty trap: vegetation is reduced to minimum quantities, due to droughts, and this induce pastoralist to move their livestock to Ethiopia and Somalia; this leads to overgrazing of water-endowed areas deteriorating the environments; impinging upon those territories leads to conflicts with other pastoralist communities; the overcrowding of cattle eases the diffusion of livestock's diseases; herd raids become more common; and so on.

Communities that live in risky environments such as drylands possess a rich repertoire of responses against climatic hazards.[42] These can range from reducing food intake, to gathering forest products (fruit, firewood, medicine, and honey), to burning charcoal and selling assets. Adaptation, on the other hand, is a long-term process that entails socio-economic and institutional adjustments to sustain livelihoods in a changing environment. For instance, pastoralist communities use some form of demographic control by delaying marriage (many women remain unmarried into their thirties) and by subjecting women to several years of post-partum sexual taboo in order to maintain a sustainable balance between human and livestock and natural resources. Pastoralists have traditionally relied on transhumance (strategic movement of livestock to manage pasture and water resources) and the splitting of stock among relatives and friends in various places. They also introduce new animal species (for example, goats or cows) and practice opportunistic cultivation to adapt to changes. Other options include small trade, handicraft and migration to more favourable areas and urban settlements. These individual initiatives, when backed by strong social networks of solidarity, have enabled dryland communities to absorb significant amount of shocks.

The northwestern districts are the main areas of concern. In Ukambani, Mbeere and Tharaka, farmers have adopted innovations and new production techniques to cope with long dry spells that kill subsistence farming. The Arid Land Resources Management Project II (ALRMP) and the Ministry of Northern Kenya and Other Arid Lands are spearheading this onslaught against obsolete technology and giving farming a new chance of life by providing them with adequate food and financial resources to beat famine. [43]

Strategies adopted by pastoralists are more complex and usually do not depend on government interventions. The "Livestock Loan System" is one of these strategies (Nunow, 1994).[44] The establishment of livestock networks allows pastoralists to meet their subsistence needs even in the event of huge animal losses as they can quickly re-build the herd. Furthermore, they practice breeding selection to improve the adaptive capacity of the animals. Another coping strategy used during droughts is to reduce pressure on the animals: household members are split up and some move to live temporally with richer relatives or they engage in other activities as farming.[45] Cross-ethnic ties are quite common in Northern Kenya, with clans often involved in one or two societies (Schlee 1989): those relationships (re-inforced by marriage) can be reactivated in times of crisis, thereby gaining access to resources.[46]

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[42] As emphasised by Campbell (1999) "The outcome is a complex mosaic of societal processes and land use patterns. As these alter, so do the options available to rural people for coping with food insecurity. Not all options are available to all people or groups. Differentiation by age, gender, and socio-economic status exists in the availability of such options, as with most aspects of livelihood systems."

[43] For instance, a hybrid poultry production has been introduced by ALRMP in Mbeere district. This breed weighs twice as much as the former; fetches KSh500 at the marketplace compared to the paltry KSh150 for the traditional breeds and its eggs are also much bigger than its predecessors' one (cf. http://www.aridland.go.ke/index.php).

[44] Livestock is transferred to relatives or stock associates for self-insurance. The Livestock Loan System is used to balance economic risks, establish social bond and redistribute and reallocate labor (Schlee, 1989).

[45] Cultivation has been used by pastoralist as a fall back activity supposed to help poor herder to re-building their herd and turn back to pastoralism (Toulmin and Fulton, 1982). But, remunerative cultivable areas are scarce and concurrence is hard; this means reduction in coping strategies for pastoralist.

[46] Pastoralist communities have never been isolated. They have always maintained relationships with pastoralist and farmer communities ensuring access to inputs while under drought. Historically, in Africa, even enemies were allowed to survival resources (Saina, 1995).

Recently adopted strategies include the expansion of horticulture, increased income from tourism,[47] and greater effective demand provided by population growth, which has increased the economic opportunities in the area. The ability of people to participate in this economic expansion depends on their production system and location. People living close to main roads and farming centres have an advantage, and herders are less well-positioned than those who farm. Those who remain in the livestock-based economy appear to be less able to take advantage of these changes than those who farm, and, indeed, the re-distribution to crop production of resources formerly in the herding domain has weakened the herding economy. In contrast, farmers see increased income to purchase food as important to their food security. This income is derived from the sale of crops (particularly from horticulture), participation in trade and off-farm labour (Campbell, 1999).

Pastoralist and small farmers in food insecure areas are the most disadvantaged in terms of levels of consumption and access to basic services (World Bank, 2009),[48] while agro-pastoralists are relatively more resilient given the geographical and infrastructural conditions. Those evidences are robust with our findings (Figure 4). Agro-pastoralist are relatively better endowed with IFA, ABS, PA and APT and this allows them to be more resilient than pastoralists and smallholder farmers: the communities that are able to diversify their production and which are given access to services are better off in terms of resilience.

4.2 Policy Implications

The adoption of ex ante risk reduction mechanisms is essential to strengthen household resilience to food insecurity. The resilience analysis allows us to identify the geographic areas where interventions are most needed as well as the specific issue that should be addressed.

The most resilient province is Nairobi, due to its greater access to basic services, income generating activities and adaptive capacity. This is largely due to the large share of entrepreneurs and wage-employees living in this province, who show significantly higher values of ABS and IFA vis-à-vis other livelihood groups. Conversely, the Eastern province shows the lowest resilience index because of much lower levels of ABS, IFA, AC and APT.

Focusing on less resilient livelihood groups, we know that pastoralists are located mainly in Rift Valley (35.36%), North-Eastern (19.76%) and Eastern (12.34%); the small-holder farmers are located mainly in the Rift Valley (23.67%) and Eastern (18.43%) as well as agro-pastoralists (respectively 25.68% and 32.05%). All those livelihood groups are dramatically deficient in IFA and ABS.

As shown in the factor loading tables, pastoralists are mainly concerned about the distance to work and the access to credit.[49] This seems to be related to the remoteness of pastoralists groups from markets that do not make effective coping mechanisms possible, such as de-stocking, i.e., the early off-take when the terms of trade for livestock are still favourable, in the event of drought. The lack of adequate transport infrastructure, which would make the off-take of large numbers of animals from drought-stricken areas to markets possible, is one of the major constraints faced by pastoralists in times of drought (HPG, 2006). When this option is prevented, credit may play a

[47] Income from tourism is obtained from a variety of activities, but none of them are available to pastoralist.

[48] One of the main problem is the endemic lack of infrastructure in the north of Kenya: providing basic services is difficult since villages are far from each other, the need for water forces people to move away from villages creating problems for health and schools.

[49] The data referring to the importance of telecommunication ought not to be considered as the survey frequency of this variable for pastoralists does not guarantees significance.

crucial role in ensuring the household livelihood, and this explains the emphasis that pastoralists put on the access to credit. Conversely, agro-pastoralists and smallholders seem to be more concerned about the distance to water sources.

These considerations turn immediately into policy implications. In contexts such as the Northern Kenya districts, livelihood interventions are called for to contribute both to saving lives and building resilience. The Regional Resilience Enhancement Against Drought (RREAD) initiative aims precisely at this through livestock interventions (for example, de-stocking, supplementary livestock feedings, emergency veterinary programmes, transport subsidies to support de-stocking, and re-stocking of those who have not abandoned the pastoral system) and enhancing water access (for example, creating and re-habilitating wells and boreholes, establishing strategic water sources, subsidised provision of fuel and pumps). These results are consistent with the literature evidence on effective interventions in drought-prone areas of the Horn of Africa (see Pantuliano and Pavanello, 2009).

Another interesting implication can be drawn looking at adaptive capacity. This component is very important for pastoralists (higher than for anyone else). AC is composed of years of education, the employment ratio, the food ratio and diversity (which is an indicator for the diversification of household livelihood activities). This, once again, is strongly robust with the literature evidence on response mechanism to drought (see Section 4.1), which shows that those who are able to diversify their activities, for example, by starting to do both herding and farming, are among those who cope with the drought shock better, whilst those whom remained anchored to pastoralism were forced to migrate and suffered most.

Households in the pastoral regions of Northern Kenya are the ones most exposed to shocks caused by climatic hazard (primarily droughts) and pastoralist households are those who are mainly hit by shocks (as proven by the S component in resilient analysis).[50] Thus, an overall policy indication is to build risk-management mechanisms and insurance schemes for pastoralists in these areas. This is, indeed, what has been recently proposed by the so-called index-based livestock insurance (IBLI) scheme (ILRI, 2010). [51] IBLI is a product that is designed to protect against drought-related livestock mortality. Because index insurance is based upon the realisation of an outcome that cannot be influenced by insurers or policy-holders (such as the amount and distribution of rainfall over a season), it has a structure relatively simple and transparent. This makes such product easier to administer, and, consequently, more cost-effective to develop and trade.

More generally, the resilience analysis supports the findings of extensive research on drought response carried out in the region over the last decade (see, among others, Pavanello, 2009) that demonstrates that the disastrous consequences of droughts can be averted by strengthening and protecting pastoral livelihoods systems, building their resilience and capacity to survive the inevitable occurrence of drought. Livelihood interventions, such as livestock-related initiatives (for example, de-stocking) and water-related interventions (including creating and re-habilitating wells and boreholes), contribute both to saving lives and to strengthening the resilience of pastoralists. By equipping communities with the ability to manage and to respond to shocks in the early stages of a crisis, strategic livelihood interventions allow for more timely and appropriate

[50] It is worth noting that pastoralists are not only hit by animal shocks (which is indeed straightforward), but they show very high level of crop shock and other shocks as well (cf. Table 10).

[51] This is an initiative financed by Financial Sector Deepening (FSD) Kenya / DFID, USAID and the World Bank which is being currently piloted in the Marsabit District. The index in IBLI is predicted livestock mortality calculated by using a satellite-recorded measure of pasture availability which is fed into a response function that relates pasture availability with drought related livestock mortality. The index threshold above which payouts must be made is 15% that is IBLI will compensate if predicted livestock mortality is above 15%.

responses to disasters than is possible with typical emergency relief assistance. In addition, the early protection and promotion of people's livelihoods significantly reduces the need for massive food aid operations when malnutrition and disease reach acute levels.

This calls for a more flexible approach that goes beyond the traditional dichotomy between development and relief interventions. In fact, livelihood support is often considered to be distinct from relief aid, in that it is more "developmental" and usually implemented over a longer period. Such an either-or distinction between the "development" and "relief" modes of assistance is particularly misleading in the Horn of Africa region: the form of urgent, large-scale livelihood support fits neither paradigm well, and requires new ways of thinking about the problems that people are actually facing. If building the resilience of pastoralists' communities is the ultimate goal of donor-sponsored interventions, a long-term approach is imperative and resources need to be made available with a long-term perspective (Pantuliano and Wekesa, 2008).

5 Conclusions

This study has focused on household resilience to food insecurity, which is defined as a household's ability to maintain a certain level of well-being (food security) in the face of risks, depending on that household's available options to make a living and its ability to handle risks. The study has tested a conceptual framework developed to analyse the resilience of different livelihood groups as a second best of the "ideal" analytical framework for the analysis of resilience, which would, indeed, require the adoption of methods able to capture the dynamic nature of resilience as well as the heterogeneity in the mechanisms that allows people to earn their own living. However, the lack of a suitable panel dataset has prevented us from fully exploring the potential of resilience analysis. Coupling livelihood analysis with a "static" resilience analysis has made it possible to explore only the second feature (i.e., heterogeneity), but not dynamics: this is the major limitation of this application to Kenya, which can be thought only as a first approximation to the issue of resilience estimation.

Nevertheless, the results are meaningful and the resilience index estimates across Kenyan provinces and livelihood groups show significant differences. Specifically, the resilience structure of each group is very different, and depends on how the different components contribute to household resilience according to the household livelihood. The most resilient group is that of large-holder farmers, followed by wage employees, agro-pastoralist and entrepreneurs. Vice versa the worst off are the small-holder farmers and the pastoralists, who show dramatically low levels of income and access to basic services especially in the northern drought-prone districts. Moreover, the analysis emphasises how gender bias plays a role in determining resilience to food security: by and large, urban-based groups (i.e., wage-employees and entrepreneurs) show the largest gender disparities in resilience, while the difference is less pronounced for agrarian livelihoods (with the exception of smallholders) mainly due to the different role played by access to income and food, access to basic services and adaptive capacity as determinants of resilience in each livelihood group.

The fundamental question is how to design policies to maintain system resilience and avoid the system sliding into undesirable domains. Adopting resilience as a criterion for policy design shifts the focus of policies from controlling change in systems assumed to be stable, to managing the capacity of social-ecological systems to cope with, adapt to and shape change. This means, in the specific case of pastoralists and small farmers in the Kenyan drylands, that "livelihoods interventions" need to be made, such as livestock-related initiatives (for example, de-stocking) and water-related interventions (including creating and rehabilitating wells and boreholes).

More generally, this calls for a more flexible approach that goes beyond the traditional dichotomy between development and relief interventions. If building the resilience of communities is the ultimate goal of interventions, a longer-term approach is

imperative. By equipping communities with the ability to manage and respond to shocks in the early stages of a crisis, strategic livelihoods interventions allow for more timely and appropriate responses to disasters than is possible with typical emergency relief assistance. In addition, the early protection and promotion of people's livelihoods significantly reduces the need for massive food aid operations when malnutrition and disease reach acute levels.

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Annex 1. Livelihood Analysis: Descriptive Statistics of the Variables Used for the Cluster Analysis

cluster 1	Agro Pastoralists (n=1,803)												
	Income	Shares of Income					Farming activities details				TLU	Owned land	Urban
	89,943	Crop	Livestock	Non Agr Act	Self-Empl.	Transfers	Farmer activities	Own production	Workers	Other	5.623	3.207 (ha)	9.09%
		27.1%	19.4%	15.2%	10.6%	23.2%	89.6%	49.5%	21.4%	43.5%			
cluster 2	Small-holder Farmers (n=4,474)												
	Income	Shares of Income					Farming activities details				TLU	Owned land	Urban
	43,390	Crop	Livestock	Non Agr Act	Self-Empl.	Transfers	Farmer activities	Own production	Workers	Other	1.23	1.033 (ha)	8.71%
		45.1%	16.6%	10.0%	0.4%	20.0%	98.9%	41.2%	39.9%	22.3%			
cluster 3	Large-holder Farmers (n=380)												
	Income	Shares of Income					Farming activities details				TLU	Owned land	Urban
	114,385	Crop	Livestock	Non Agr Act	Self-Empl.	Transfers	Farmer activities	Own production	Workers	Other	3.34	10.02 (ha)	9.15%
		31.0%	15.7%	14.7%	11.0%	17.1%	100.0%	37.4%	36.6%	33.7%			
cluster 4	Entrepreneurs (n=2,558)												
	Income	Shares of Income					Farming activities details				TLU	Owned land	Urban
	119,454	Crop	Livestock	Non Agr Act	Self-Empl.	Transfers	Farmer activities	Own production	Workers	Other	0.4307	0.430 (ha)	54.64%
		10.4%	5.7%	10.2%	57.9%	11.1%	47.6%	14.0%	15.2%	51.9%			
cluster 5	Wage Employees (n=3,130)												
	Income	Shares of Income					Farming activities details				TLU	Owned land	Urban
	109,612	Crop	Livestock	Non Agr Act	Self-Empl.	Transfers	Farmer activities	Own production	Workers	Other	0.392	0.115 (ha)	62.92%
		7.8%	3.5%	52.2%	0.5%	16.7%	14.4%	11.7%	5.2%	28.9%			
cluster 6	Pastoralists (n=812)												
	Income	Shares of Income					Farming activities details				TLU	Owned land	Urban
	12,700	Crop	Livestock	Non Agr Act	Self-Empl.	Transfers	Farmer activities	Own production	Workers	Other	8.34	1.13 (ha)	11.40%
		7.2%	89.4%	0.8%	1.4%	4.4%	59.9%	51.9%	21.2%	21.7%			

Annex 2. Resilience Analysis: Factor Loadings and Correlation Matrixes

Income and Food Access

Factor Loadings

Kenya			
Variable	*Factor1*	*Factor2*	*Uniqueness*
INC	0.5073	-0.2628	0.6736
EXP	0.7412	0.0093	0.4505
CAL	0.4577	0.2763	0.7142
Agro Pastoralists			
Variable	*Factor1*	*Factor2*	*Uniqueness*
INC	0.5332	-0.2617	0.6472
EXP	0.7483	0.0201	0.4396
CAL	0.4293	0.2900	0.7316
Small Holder Farmers			
Variable	*Factor1*	*Factor2*	*Uniqueness*
INC	0.4698	0.1653	0.7520
EXP	0.7178	0.0077	0.4847
CAL	0.6192	-0.1343	0.5986
Large Holder Farmers			
Variable	*Factor1*	*Factor2*	*Uniqueness*
INC	0.5362	-0.1908	0.6761
EXP	0.7017	0.0090	0.5076
CAL	0.4584	0.2095	0.7460
Entrepreneurs			
Variable	*Factor1*	*Factor2*	*Uniqueness*
INC	0.5302	-0.2578	0.6525
EXP	0.7469	0.0168	0.4419
CAL	0.4402	0.2820	0.7267
Wage Employees			
Variable	*Factor1*	*Factor2*	*Uniqueness*
INC	0.6021	-0.1467	0.6160
EXP	0.7375	0.0023	0.4561
CAL	0.5467	0.1584	0.6760
Pastoralists			
Variable	*Factor1*	*Factor2*	*Uniqueness*
INC	-0.0317	0.2005	0.9588
EXP	0.6978	-0.0838	0.5060
CAL	0.6915	0.0937	0.5131

Correlation Matrix (Kenya)

	IFA	INC	EXP	CAL
IFA	1.0000			
INC	0.6640	1.0000		
EXP	0.8902	0.3104	1.0000	
CAL	0.5288	0.1478	0.3656	1.0000

Access to Basic Services

Factor Loadings

Kenya						
Variable	*Factor1*	*Factor2*	*Factor3*	*Factor4*	*Factor5*	*Uniqueness*
TEL	0.5941	0.1491	0.0702	0.0951	-0.0058	0.6109
ELE	0.6581	0.0809	-0.0740	-0.0584	-0.0054	0.5515
WAT	-0.2753	0.3394	0.1349	0.0140	-0.0423	0.7888
DTW	-0.0281	0.3993	-0.0311	-0.0796	0.0251	0.8318
SDO	-0.1847	0.1976	-0.1722	0.0889	0.0319	0.8882
CRE	0.0435	-0.0144	0.2641	-0.0002	0.0454	0.9261
Agro Pastoralists						
Variable	*Factor1*	*Factor2*	*Factor3*	*Factor4*	*Factor5*	*Uniqueness*
TEL	0.0362	0.4323	0.0363	0.0312	0.0561	0.8064
ELE	0.2185	0.2202	0.3022	0.0258	0.0134	0.8116
WAT	-0.4893	-0.0918	-0.0093	-0.1333	-0.0281	0.7335
DTW	-0.4300	-0.0663	-0.1782	-0.1089	-0.0429	0.7653
SDO	-0.0995	-0.1433	-0.0241	-0.2382	-0.0489	0.9099
CRE	0.0187	0.2457	0.2655	0.0813	0.0571	0.8589
Small Holder Farmers						
Variable	*Factor1*	*Factor2*	*Factor3*	*Factor4*	*Factor5*	*Uniqueness*
TEL	0.3122	0.3122	0.0069	0.0091	0.0708	0.7999
ELE	0.3187	0.2130	0.1285	0.0434	0.0834	0.8277
WAT	-0.3701	-0.2291	-0.0647	-0.0933	-0.0488	0.7952
DTW	-0.2247	-0.3220	-0.0625	-0.1247	-0.0106	0.8263
SDO	-0.2182	-0.0470	-0.2325	-0.0982	-0.0635	0.8824
CRE	0.1064	0.0193	0.2851	0.1061	0.0246	0.8952
Large Holder Farmers						
Variable	*Factor1*	*Factor2*	*Factor3*	*Factor4*	*Factor5*	*Uniqueness*
TEL	0.2504	0.4363	0.0072	0.0260	0.0098	0.7462
ELE	0.2346	0.0239	0.1927	0.2024	0.0586	0.8629
WAT	-0.5676	-0.0116	-0.1700	-0.0294	-0.0362	0.6466
DTW	-0.1236	-0.1696	-0.0519	-0.2586	-0.0440	0.8844
SDO	-0.0317	-0.0619	-0.3577	-0.0229	-0.0568	0.8635
CRE	0.4128	0.3083	0.1318	0.0955	0.0048	0.7080
Entrepreneurs						
Variable	*Factor1*	*Factor2*	*Factor3*	*Factor4*	*Factor5*	*Uniqueness*
TEL	0.6231	0.1594	0.0686	0.0092	0.0619	0.5777
ELE	0.6316	0.0393	0.0147	0.0529	0.0797	0.5902
WAT	-0.2838	-0.2669	-0.2101	-0.0286	-0.0526	0.8005
DTW	-0.0432	-0.4702	-0.0642	-0.0471	-0.0244	0.7701
SDO	-0.1677	-0.1889	-0.1730	-0.1619	-0.0169	0.8798
CRE	0.1348	0.0263	0.1799	0.1645	0.0367	0.9204
Wage Employees						
Variable	*Factor1*	*Factor2*	*Factor3*	*Factor4*	*Factor5*	*Uniqueness*
TEL	0.6091	0.2800	0.0325	0.0558	0.0001	0.5464
ELE	0.6500	0.2119	0.0925	0.0447	0.0047	0.5220
WAT	-0.4790	-0.3477	-0.0180	-0.0208	-0.0172	0.6486
DTW	-0.1596	-0.3895	-0.1389	-0.0594	-0.0071	0.8000
SDO	-0.3405	-0.2627	-0.2276	-0.0246	-0.0138	0.7625
CRE	0.1080	0.0914	0.3075	0.0363	0.0066	0.8840
Pastoralists						

Variable	*Factor1*	*Factor2*	*Factor3*	*Factor4*	*Factor5*	*Uniqueness*
TEL	0.3912	0.2589	0.0050	0.1312	0.0516	0.7600
ELE	0.2951	0.3657	0.0657	0.0825	0.0458	0.7659
WAT	-0.1398	-0.0180	-0.3605	-0.0628	-0.0337	0.8451
DTW	-0.3635	-0.2074	-0.0718	-0.1800	-0.0466	0.7851
SDO	-0.2446	-0.2012	-0.1124	-0.2267	-0.0227	0.8352
CRE	0.3576	0.2437	0.2311	0.0230	0.0373	0.7574

Correlation Matrix (Kenya)

	ABS	*TEL*	*ELE*	*WAT*	*DTW*	*SDO*	*CRE*
ABS	1.0000						
TEL	0.7582	1.0000					
ELE	0.8628	0.4244	1.0000				
WAT	-0.3917	-0.1359	-0.1795	1.0000			
DTW	-0.0955	-0.0029	-0.0224	0.1121	1.0000		
SDO	-0.2732	-0.0983	-0.1118	0.1081	0.0879	1.0000	
CRE	0.0982	0.0537	0.0264	0.0051	0.0040	-0.0607	1.0000

Agricultural Assets

Variables	*Kenya*	*Agro-Pastoralists*	*Small-Holder Farmers*	*Large-Holder Farmers*	*Entrepreneurs*	*Wage Employees*	*Pastoralists*
AA	27,397.2	59,529.33	26,700.12	103,958.4	13,245.23	6,078.497	48,127.36

Non Agricultural Assets

Mean

Variables	*Kenya*	*Agro-Pastoralists*	*Small-Holder Farmers*	*Large-Holder Farmers*	*Entrepreneurs*	*Wage Employees*	*Pastoralists*
NAA	210,805	192,563	101,761	353,042	310,542	300,236	131,605

Agricultural Practice and Technologies

Factor Loadings

Kenya						
Variable	*Factor1*	*Factor2*	*Factor3*	*Factor4*	*Factor5*	*Uniqueness*
INO	0.5721	0.0979	0.2325	-0.0510	-0.0221	0.6060
ORG	0.5617	0.0342	-0.2900	0.0377	-0.0085	0.5977
VET	0.6705	-0.1823	-0.0185	-0.0354	0.0557	0.5125
PES	0.4377	0.3405	-0.1112	-0.0298	-0.0063	0.6791
INS	0.6431	-0.2295	0.0748	0.0409	-0.0373	0.5251
TIN	0.2240	0.2032	0.1910	0.0825	0.0304	0.8643
Agro Pastoralists						
Variable	*Factor1*	*Factor2*	*Factor3*	*Factor4*	*Factor5*	*Uniqueness*
INO	0.4639	-0.3545	0.1221	-0.0882	-0.0098	0.6363
ORG	0.3956	0.4124	0.0723	-0.0083	0.0628	0.6642
VET	0.4203	-0.0127	-0.2069	0.1534	-0.0688	0.7521
PES	0.3414	0.1479	0.3321	-0.0042	-0.0873	0.7437
INS	0.6486	0.0013	-0.2432	-0.0762	0.0268	0.5136
TIN	0.2329	-0.1918	0.1980	0.1312	0.0906	0.8443
Small Holder Farmers						
Variable	*Factor1*	*Factor2*	*Factor3*	*Factor4*	*Factor5*	*Uniqueness*
INO	0.3494	0.1508	0.2755	-0.1501	0.0247	0.7561
ORG	0.4558	0.0583	-0.3611	-0.0066	0.0625	0.6545
VET	0.6044	-0.1756	-0.0110	0.0125	-0.1309	0.5864
PES	0.3291	0.4321	-0.0761	-0.0042	-0.0412	0.6975
INS	0.6895	-0.2069	0.1004	0.0253	0.0760	0.4652
TIN	0.1641	0.1667	0.1874	0.1935	0.0189	0.8724
Large Holder Farmers						
Variable	*Factor1*	*Factor2*	*Factor3*	*Factor4*	*Factor5*	*Uniqueness*
INO	0.4831	-0.3698	0.1602	0.2148	-0.0912	0.5498
ORG	0.0935	0.5919	0.2258	-0.1208	-0.0606	0.5717
VET	0.6386	0.3900	-0.1248	0.1703	-0.0208	0.3950
PES	0.0871	0.1162	0.1254	0.1769	0.2011	0.8914
INS	0.5737	-0.0840	-0.2766	-0.2150	0.0469	0.5389
TIN	0.4222	-0.2078	0.3055	-0.2210	0.0440	0.6345
Entrepreneurs						
Variable	*Factor1*	*Factor2*	*Factor3*	*Factor4*	*Factor5*	*Uniqueness*
INO	0.6669	0.2718	-0.2292	-0.0439	-0.0186	0.4266
ORG	0.5976	-0.1077	0.3088	0.0720	0.0285	0.5299
VET	0.7298	-0.2257	-0.0298	0.0209	-0.1189	0.4010
PES	0.4378	0.2368	0.2111	-0.1574	0.0134	0.6828
INS	0.6370	-0.2024	-0.1655	0.0065	0.1180	0.5120
TIN	0.2038	0.3585	0.0149	0.1756	0.0055	0.7988
Wage Employees						
Variable	*Factor1*	*Factor2*	*Factor3*	*Factor4*	*Factor5*	*Uniqueness*
INO	0.7928	0.1639	0.0496	-0.1672	-0.0144	0.3139
ORG	0.6537	0.0568	-0.2997	-0.0160	0.0266	0.4787
VET	0.6629	-0.2862	0.1529	0.0055	-0.0923	0.4468
PES	0.4998	0.2427	-0.0495	0.1566	-0.0791	0.6581
INS	0.6634	-0.3034	0.0179	0.0720	0.1053	0.4512
TIN	0.3158	0.3249	0.2158	0.0422	0.0788	0.7402
Pastoralists						

Variable	*Factor1*	*Factor2*	*Factor3*	*Factor4*	*Factor5*	*Uniqueness*
INO	0.5961	0.1465	-0.2092	-0.0242	-0.0841	0.5718
ORG	0.5362	-0.1403	0.0287	0.2453	-0.0493	0.6294
VET	0.2034	0.1928	0.3029	0.0703	-0.0151	0.8245
PES	0.5449	-0.3034	0.0125	-0.0383	0.1031	0.5988
INS	0.4149	0.3163	-0.0477	0.0113	0.1186	0.7113
TIN	0.4646	-0.0371	0.1306	-0.2479	-0.0554	0.7011

Correlation Matrix (Kenya)

	APT	*INO*	*ORG*	*VET*	*PES*	*INS*	*INP*
APT	1.0000						
INO	0.6765	1.0000					
ORG	0.6533	0.2946	1.0000				
VET	0.7600	0.3498	0.3648	1.0000			
PES	0.5269	0.2770	0.2935	0.2409	1.0000		
INS	0.7154	0.3654	0.3245	0.4661	0.1854	1.0000	
INP	0.2996	0.2025	0.1159	0.1120	0.1373	0.1132	1.0000

Social Safety Nets

Mean

Variables	Kenya	Agro-Pastoralists	Small-Holder Farmers	Large-Holder Farmers	Entrepreneurs	Wage Employees	Pastoralists
SSN	1,117.6	985.0	660.1	944.2	1,197.9	2,055.4	242.6

Stability

Factor Loadings

Kenya				
Variable	*Factor1*	*Factor2*	*Factor3*	*Uniqueness*
SHK	0.4009	0.1574	0.1576	0.7896
ANS	0.6796	0.5191	-0.0072	0.2686
OTS	1.0069	-0.0331	-0.0954	-0.0239
CRS	0.7726	-0.4952	0.0489	0.1555
Agro Pastoralists				
Variable	*Factor1*	*Factor2*	*Factor3*	*Uniqueness*
SHK	0.7122	0.2570	0.0546	0.4237
ANS	0.7134	0.6501	-0.0278	0.0677
OTS	0.9904	-0.1627	-0.0179	-0.0077
CRS	0.7588	-0.6401	-0.0017	0.0145
Small Holder Farmers				
Variable	*Factor1*	*Factor2*	*Factor3*	*Uniqueness*
SHK	0.5641	0.2092	0.2546	0.5732
ANS	0.2329	0.5416	-0.0451	0.6504
OTS	0.9337	0.0328	-0.2195	0.0790
CRS	0.9548	-0.2878	0.0752	-0.0001
Large Holder Farmers				
Variable	*Factor1*	*Factor2*	*Factor3*	*Uniqueness*
SHK	0.3621	0.2263	0.1105	0.8054
ANS	0.6662	0.1938	-0.1184	0.5045
OTS	1.0088	0.0272	0.0287	-0.0192
CRS	0.9117	-0.2616	0.0109	0.1002
Entrepreneurs				
Variable	*Factor1*	*Factor2*	*Factor3*	*Uniqueness*
SHK	0.2500	0.1483	0.1164	0.9020
ANS	0.1865	0.4089	-0.0507	0.7954
OTS	0.9706	0.1238	-0.0054	0.0425
CRS	0.9046	-0.2582	-0.0160	0.1149
Wage Employees				
Variable	*Factor1*	*Factor2*	*Factor3*	*Uniqueness*
SHK	0.4822	-0.0411	0.0893	0.7579
ANS	0.8528	-0.4219	-0.0220	0.0942
OTS	1.0123	0.0023	-0.0149	-0.0250
CRS	0.7913	0.4767	-0.0117	0.1464
Pastoralists				
Variable	*Factor1*	*Factor2*	*Factor3*	*Uniqueness*
SHK	0.2540	0.0023	0.0564	0.9323
ANS	0.8026	0.4919	0.0087	0.1137

OTS	1.0102	-0.0068	-0.0294	-0.0213
CRS	0.8406	-0.4622	0.0100	0.0797

Correlation Matrix (Kenya)

	S	*SHK*	*ANS*	*OTS*	*SHK*
S	1.0000				
SHK	-0.3979	1,0000			
ANS	-0.6744	0.3531	1,0000		
OTS	-0.9992	0.3834	0.6678	1,0000	
SHK	-0.7667	0.2396	0.2676	0.7897	1,0000

Adaptive Capacity

Factor Loadings

Kenya				
Variable	*Factor1*	*Factor2*	*Factor3*	*Uniqueness*
EMP	0.4522	0.5303	0.1327	0.4967
DIV	0.4151	0.3333	-0.3081	0.6217
EDU	0.7461	-0.1645	0.2464	0.3556
FRA	-0.6375	0.4006	0.1819	0.4000
Agro Pastoralists				
Variable	*Factor1*	*Factor2*	*Factor3*	*Uniqueness*
EMP	0.3390	0.4734	0.1135	0.6480
DIV	0.4213	0.2863	-0.2509	0.6776
EDU	0.7032	-0.1040	0.2212	0.4457
FRA	-0.6681	0.3112	0.1321	0.4393
Small Holder Farmers				
Variable	*Factor1*	*Factor2*	*Factor3*	*Uniqueness*
EMP	0.4705	0.4689	0.0790	0.5525
DIV	0.3234	0.2723	-0.2760	0.7451
EDU	0.6899	-0.1552	0.1778	0.4683
FRA	-0.4652	0.4333	0.1516	0.5728
Large Holder Farmers				
Variable	*Factor1*	*Factor2*	*Factor3*	*Uniqueness*
EMP	0.3436	0.4365	0.1254	0.6756
DIV	0.2316	-0.0466	0.3934	0.7895
EDU	0.7636	0.1155	-0.2076	0.3605
FRA	-0.6672	0.3409	-0.0365	0.4373
Entrepreneurs				
Variable	*Factor1*	*Factor2*	*Factor3*	*Uniqueness*
EMP	0.5622	0.4577	0.1767	0.4433
DIV	0.3108	0.4033	-0.3265	0.6341
EDU	0.7663	-0.2459	0.2086	0.3089
FRA	-0.5477	0.3547	0.2879	0.4914
Wage Employees				
Variable	*Factor1*	*Factor2*	*Factor3*	*Uniqueness*
EMP	0.6075	0.4870	0.1620	0.3676
DIV	0.5768	0.3454	-0.2815	0.4688
EDU	0.7664	-0.2674	0.2471	0.2801
FRA	-0.6565	0.4420	0.1911	0.3372
Pastoralists				
Variable	*Factor1*	*Factor2*	*Factor3*	*Uniqueness*
EMP	0.5219	0.4584	0.2051	0.4755
DIV	0.4570	0.4132	-0.2735	0.5456
EDU	0.6191	-0.3367	0.2361	0.4476
FRA	-0.5345	0.4108	0.2398	0.4881

Correlation Matrix (Kenya)

	AC	*EMP*	*DIV*	*EDU*	*FRA*
AC	1.0000				
EMP	0.5177	1.0000			
DIV	0.4752	0.3236	1.0000		
EDU	0.8541	0.2829	0.1789	1.0000	
FRA	-0.7298	-0.0517	-0.1872	-0.4968	1.0000

Resilience

Factor Loadings

Kenya								
Variable	*Factor1*	*Factor2*	*Factor3*	*Factor4*	*Factor5*	*Factor6*	*Factor7*	*Uniqueness*
IFA	0.7454	0.0135	0.3239	0.0270	-0.0520	0.0242	-0.0949	0.3262
ABS	0.7240	-0.1773	-0.2412	0.0331	0.1456	0.0138	0.0755	0.3580
APT	-0.1343	0.5965	0.0099	-0.0693	0.0090	0.0486	0.0676	0.6142
AC	0.7207	0.2482	-0.2575	-0.0857	-0.1098	-0.0625	-0.0163	0.3291
SSN	0.2289	-0.0481	0.3446	-0.2206	0.0843	-0.0336	0.0707	0.7647
AA	0.0444	0.3125	0.0626	0.1484	0.1752	-0.0766	-0.0733	0.8325
NAA	0.2393	0.0531	0.1830	0.2342	-0.0769	0.0389	0.1204	0.8297
S	0.1064	0.0374	-0.0498	-0.0347	0.0472	0.2376	-0.0462	0.9228
Agro Pastoralists								
Variable	*Factor1*	*Factor2*	*Factor3*	*Factor4*	*Factor5*	*Factor6*	*Factor7*	*Uniqueness*
IFA	0.8263	0.2516	-0.0168	-0.0609	0.1351	0.0345	-0.0655	0.2262
ABS	-0.2621	0.2260	0.3004	-0.0786	0.1395	0.0589	-0.0009	0.7609
APT	0.4088	-0.3654	0.1688	0.0910	0.0334	0.0954	0.0704	0.6474
AC	0.6056	-0.3578	0.0327	-0.2048	-0.0108	-0.0652	-0.0233	0.4573
SSN	0.1575	0.1048	-0.1890	-0.1169	-0.0862	0.1702	0.0355	0.8772
AA	0.2211	-0.0500	0.0808	0.2132	-0.1514	0.0593	-0.0972	0.8607
NAA	0.6792	0.3266	0.0472	0.1052	-0.0876	-0.0774	0.0803	0.3987
S	0.0939	-0.1048	-0.1732	0.1753	0.2588	0.0004	0.0068	0.8524
Small Holder Farmers								
Variable	*Factor1*	*Factor2*	*Factor3*	*Factor4*	*Factor5*	*Factor6*	*Factor7*	*Uniqueness*
IFA	0.7167	-0.1129	0.2556	0.0585	0.0005	-0.1257	-0.0041	0.3890
ABS	-0.3751	0.1426	0.1303	0.1488	-0.1126	-0.0312	0.0998	0.7762
APT	0.3558	-0.1519	-0.2726	0.2130	0.0293	0.1105	0.0225	0.7171
AC	0.5563	-0.2328	-0.2384	-0.1071	-0.1289	-0.0409	0.0374	0.5484
SSN	0.2655	-0.2361	0.3735	-0.0040	0.0072	0.1435	0.0165	0.7134
AA	0.4885	0.4701	0.0008	0.1681	-0.0159	0.0040	-0.0337	0.5107
NAA	0.3894	0.3955	-0.0027	-0.2179	0.0252	0.0670	0.0505	0.6368
S	0.0662	-0.0462	-0.0484	0.0218	0.2228	-0.0656	0.0605	0.9331
Large Holder Farmers								
Variable	*Factor1*	*Factor2*	*Factor3*	*Factor4*	*Factor5*	*Factor6*	*Factor7*	*Uniqueness*
IFA	0.7566	-0.2319	0.0947	0.2539	-0.1463	0.0186	0.0014	0.2786
ABS	-0.3495	-0.0451	-0.2311	0.3113	-0.0048	0.0195	0.0992	0.7152
APT	0.5072	0.3443	0.1046	-0.0827	0.1990	-0.0139	0.0719	0.5614
AC	0.6955	0.1909	-0.3718	0.0022	-0.0662	-0.0998	-0.0147	0.3271
SSN	0.2599	-0.4533	0.1686	0.0814	0.2205	-0.0723	-0.0033	0.6381
AA	0.2968	0.1878	-0.0454	0.1888	0.1314	0.1554	-0.0519	0.7948
NAA	0.4115	-0.2311	0.0153	-0.3015	-0.0917	0.1044	0.0562	0.6637
S	0.0339	0.2787	0.4845	0.1174	-0.1290	-0.0315	0.0148	0.6549
Entrepreneurs								
Variable	*Factor1*	*Factor2*	*Factor3*	*Factor4*	*Factor5*	*Factor6*	*Factor7*	*Uniqueness*
IFA	0.7874	0.2614	-0.1543	-0.1260	-0.1003	-0.0093	0.0310	0.2608
ABS	0.6614	-0.3273	0.1596	0.2109	0.0251	0.0218	-0.0053	0.3843
APT	-0.2967	0.4929	0.2607	0.0322	0.0877	0.0474	0.0090	0.5900
AC	0.6490	0.0104	0.3793	-0.1531	0.0570	-0.0317	-0.0198	0.4068
SSN	0.2497	0.0360	-0.0692	-0.0109	-0.0210	0.1858	-0.0241	0.8959
AA	-0.0327	0.2356	0.2179	0.1700	-0.1732	-0.0241	-0.0098	0.8364

NAA	0.4751	0.3175	-0.2760	0.1553	0.1037	-0.0440	-0.0210	0.5600
S	0.0709	-0.0290	0.0378	0.0440	0.0246	0.0185	0.1448	0.9689
Wage Employees								
Variable	*Factor1*	*Factor2*	*Factor3*	*Factor4*	*Factor5*	*Factor6*	*Factor7*	*Uniqueness*
IFA	0.8242	-0.1002	0.2910	-0.0932	-0.0513	-0.0785	0.0687	0.2038
ABS	0.6733	-0.1011	-0.2575	-0.0590	0.0985	0.1491	-0.0582	0.4314
APT	0.0108	0.7207	0.0225	0.1622	0.0654	-0.0113	0.0144	0.4491
AC	0.7850	0.1306	-0.2888	0.0822	-0.0535	-0.1240	-0.0417	0.2565
SSN	0.2244	-0.0898	0.3817	0.0507	0.1811	-0.0292	-0.0961	0.7504
AA	0.1008	0.6081	0.0983	-0.2266	-0.0326	0.0484	-0.0212	0.5551
NAA	0.3930	-0.0030	0.2035	0.1629	-0.1157	0.1598	0.0413	0.7369
S	0.1441	0.0025	-0.1081	-0.0165	0.1758	0.0043	0.1569	0.9117
Pastoralists								
Variable	*Factor1*	*Factor2*	*Factor3*	*Factor4*	*Factor5*	*Factor6*	*Factor7*	*Uniqueness*
IFA	0.5553	0.3952	0.1932	-0.0075	-0.0535	-0.0362	-0.0193	0.4935
ABS	0.5647	-0.0915	0.0483	0.0907	-0.0446	0.1619	-0.0659	0.6296
APT	0.6138	-0.1813	-0.0839	0.0343	-0.0955	-0.1559	-0.0139	0.5486
AC	0.6978	-0.1743	-0.1912	-0.0204	0.0955	0.0366	0.0666	0.4308
SSN	0.0290	0.1787	-0.0750	-0.0705	-0.1620	0.0665	0.1000	0.9160
AA	0.1888	0.3900	-0.2460	-0.0897	0.0971	-0.0035	-0.0412	0.7326
NAA	0.0840	0.1761	0.0988	0.2493	0.0883	-0.0200	0.0671	0.8773
S	0.3009	-0.0947	0.3012	-0.1857	0.0855	-0.0026	0.0306	0.7670

Correlation Matrix

Kenya									
	R	*IFA*	*ABS*	*APT*	*AC*	*SSN*	*AA*	*NAA*	*S*
R	1.000								
IFA	0.670	1.000							
ABS	0.410	0.427	1.000						
APT	0.052	-0.137	-0.194	1.000					
AC	0.450	0.472	0.562	-0.046	1.000				
SSN	0.264	0.282	0.105	-0.039	0.078	1.000			
AA	0.249	0.055	0.005	0.171	0.052	-0.002	1.000		
NAA	0.754	0.103	0.061	0.011	0.040	0.025	0.071	1.000	
S	0.053	0.073	0.099	0.004	0.116	0.008	0.005	0.004	1.000
Agro-pastoralists									
	R	*IFA*	*ABS*	*APT*	*AC*	*SSN*	*AA*	*NAA*	*S*
R	1.000								
IFA	0.866	1.000							
ABS	-0.113	-0.139	1.000						
APT	0.392	0.241	-0.136	1.000					
AC	0.413	0.420	-0.219	0.357	1.000				
SSN	0.089	0.159	-0.067	-0.001	0.065	1.000			
AA	0.360	0.144	-0.079	0.136	0.111	0.009	1.000		
NAA	0.867	0.616	-0.115	0.171	0.279	0.117	0.161	1.000	
S	0.015	0.078	-0.078	0.073	0.050	-0.006	0.010	0.018	1.000
Small-holder farmers									
	R	*IFA*	*ABS*	*APT*	*AC*	*SSN*	*AA*	*NAA*	*S*
R	1.000								
IFA	0.744	1.000							
ABS	-0.195	-0.240	1.000						
APT	0.258	0.201	-0.163	1.000					
AC	0.299	0.363	-0.269	0.268	1.000				
SSN	0.336	0.294	-0.089	0.044	0.108	1.000			
AA	0.785	0.307	-0.093	0.137	0.145	0.018	1.000		
NAA	0.567	0.212	-0.122	0.042	0.145	0.021	0.338	1.000	
S	0.019	0.050	-0.052	0.049	0.033	0.004	0.008	0.007	1
Large-holder farmers									
	R	*IFA*	*ABS*	*APT*	*AC*	*SSN*	*AA*	*NAA*	*S*
R	1.000								
IFA	0.688	1.000							
ABS	-	-	1.000						

	0.393	0.196							
APT	0.712	0.264	-0.237	1.000					
AC	0.558	0.455	-0.168	0.367	1.000				
SSN	0.121	0.305	-0.087	0.031	0.024	1.000			
AA	0.480	0.208	-0.046	0.215	0.236	0.018	1.000		
NAA	0.162	0.305	-0.223	0.140	0.231	0.162	0.022	1.000	
S	0.437	0.055	-0.098	0.130	-0.092	-0.053	0.040	-0.069	1.000
Entrepreneurs									
	R	*IFA*	*ABS*	*APT*	*AC*	*SSN*	*AA*	*NAA*	*S*
R	1.000								
IFA	0.769	1.000							
ABS	0.631	0.381	1.000						
APT	0.089	-0.158	-0.306	1.000					
AC	0.716	0.469	0.455	-0.090	1.000				
SSN	0.243	0.218	0.144	-0.068	0.131	1.000			
AA	0.261	-0.002	-0.033	0.172	0.029	-0.017	1.000		
NAA	0.564	0.470	0.201	-0.045	0.191	0.138	0.009	1.000	
S	0.076	0.039	0.072	-0.020	0.051	0.013	0.000	0.020	1.000
Wage Employees									
	R	*IFA*	*ABS*	*APT*	*AC*	*SSN*	*AA*	*NAA*	*S*
R	1.000								
IFA	0.736	1.000							
ABS	0.502	0.475	1.000						
APT	0.473	-0.073	-0.077	1.000					
AC	0.669	0.552	0.564	0.107	1.000				
SSN	0.349	0.287	0.078	-0.035	0.056	1.000			
AA	0.406	0.068	0.000	0.402	0.108	-0.011	1.000		
NAA	0.534	0.365	0.213	0.024	0.247	0.145	0.032	1.000	
S	0.058	0.090	0.134	0.012	0.127	0.007	0.000	0.019	1.000
Pastoralists									
	R	*IFA*	*ABS*	*APT*	*AC*	*SSN*	*AA*	*NAA*	*S*
R	1.000								
IFA	0.843	1.000							
ABS	0.598	0.284	1.000						
APT	0.510	0.264	0.342	1.000					
AC	0.570	0.274	0.396	0.460	1.000				
SSN	0.048	0.077	0.001	-0.007	-0.002	1.000			
AA	0.248	0.208	0.049	0.055	0.119	0.080	1.000		
NAA	0.354	0.128	0.047	0.014	0.016	0.000	0.044	1.000	
S	0.323	0.184	0.170	0.162	0.183	-0.029	-0.031	0.002	1.000

Annex 3. T-tests for Mean Comparisons between Male- and Female-Headed Households

Mean differences and t-statistic for each livelihood group

Livelihood Groups	Share female	Resilience		IFA		ABS		APT		AC		SSN		AA		NAA		S	
		Diff.	t-stat.	Diff.	t-stat.	Diff.	t-stat.	Diff.	t-stat.	Diff.	t-stat.	Diff.	t-stat.	Diff.	t-stat.	Diff.	t-stat.	Diff.	t-stat.
Kenya	30%	0.20	6.30	0.16	3.98	0.25	9.15	0.09	4.37	0.34	17.33	-0.04	-2.30	0.02	1.03	0.03	1.41	-0.01	-0.43
Agro-pastoralists	25%	0.04	0.70	-0.08	-1.11	0.06	0.98	0.10	1.55	0.12	2.17	-0.06	-3.55	0.12	1.24	0.00	-0.08	-0.04	-0.58
Small-holder farmers	35%	0.07	3.23	-0.07	-2.45	0.06	2.52	0.29	8.00	0.21	8.01	-0.05	-8.52	0.03	0.99	0.00	1.09	-0.06	-3.12
Large-holder farmers	32%	0.03	0.14	0.16	0.82	0.11	0.76	0.29	2.29	0.16	1.39	0.02	0.41	-0.67	-1.36	0.03	2.26	0.24	2.09
Entrepreneurs	29%	0.24	3.78	0.28	2.18	0.32	5.02	0.07	1.65	0.26	6.37	-0.06	-2.72	0.00	0.06	0.04	3.37	-0.05	-1.21
Wage employees	27%	0.27	5.55	0.27	3.27	0.35	5.92	0.06	2.25	0.57	13.45	-0.05	-0.90	0.01	1.20	0.01	1.74	0.12	2.72
Pastoralists	28%	0.32	0.88	0.02	0.42	0.01	0.23	0.10	1.45	0.17	2.81	-0.02	-2.09	0.19	1.28	0.20	0.62	-0.17	-1.29
Note: Highlighted differences are significant at 95% (t > 1.645 or p-value < 0.05). Significant at 99% if t > 2.326 (p-value < 0.01).																			