Working Paper

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World Agroforestry Centre
TRANSFORMING LIVES AND LANDSCAPES

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ABSTRACT

This paper aims to understand the linkages between adaptive capacity and social protection within agroforestry contexts through a case study approach. It examines how elements of adaptive capacity which include assets, institutions, knowledge, innovation systems and governance, can support or be supported by social protection measures that enhance income and capabilities. For instance, a case study from Zambia demonstrates how adaptive capacity of farmers has led to the strengthening of their social protection to minimize the impact of drought. Another case study from Honduras demonstrates how formal social protection measures have, in turn, enhanced adaptive capacity. Understanding the linkages between adaptive capacity and social protection is important, especially in planning of adaptation initiatives. Analyzing adaptive capacity also helps to identify the element of adaptive capacity that should be invested upon in order for social protection measures to work.

Key words: adaptive capacity, social protection, agroforestry, Zambia, Honduras

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LIST OF ABBREVIATIONS

CDC	Community Development Committee
CGIAR	Consultative Group on International Agricultural Research
CIMMYT	International Maize and Wheat Improvement Centre
FAO	Food and Agriculture Organization of the United Nations
FAR	Fourth Assessment Report
GIS	Geographic Information System
GPS	Global Positioning System
ICRAF	World Agroforestry Centre
IDS	Institute of Development Studies
IPCC	Intergovernmental Panel on Climate Change
NGO	Non-Governmental Organization
ODI	Overseas Development Institute
PLS	Lempira Sur Project
UK	United Kingdom

INTRODUCTION

The Intergovernmental Panel on Climate Change (IPCC) (Magrin et al 2007) prediction of temperature increase between 1.1°C and 6.2°C by the end of the century will most likely create extreme changes in temperature and precipitation. On the one hand, the human impact of ecological change may also be severe, leaving people more exposed and vulnerable. Farmers in developing countries who depend on rain-fed agriculture and natural resources for food production and income generation may particularly experience greater levels of poverty and hunger as their sources of livelihood become increasingly exposed to climate-related risks. On the other hand farmers have always had to cope with climate variability and extreme weather events to survive. Adaptation strategies in agriculture have mostly revolved around changes in natural resource management, such as planting climate-resilient crops and/or managing water resources more efficiently. Although these are important strategies, there has been limited documentation of other adaptation strategies focusing on social protection schemes within agricultural settings. Social protection is an intervention aimed at boosting resilience and managing risk through prevention, mitigation and coping strategies.

Social protection will become more and more important as an adaptation strategy as the frequency of climate-related events increase. Social protection schemes are important means of preventing further increase in poverty and hunger. For instance, micro-credit schemes in Bangladesh have helped flood-affected households access finance to rebuild their lives and livelihoods (Khandker 2007). Grain and cereal banks have helped to store food to create emergency buffer stocks in times of natural disasters (Bhattamishra and Barrett 2010). Starter packs have been successfully used in countries such as Malawi to assist farmers to plant more drought-tolerant crops (Devereux and Coll-Black 2007). Management of common pool resources that are ubiquitous have helped to distribute resources and labour in times of drought and floods (Ismail et al 2003). Therefore, it is highly likely that dependence on existing social protection structures are bound to grow and new structures may yet be developed as weather patterns become more extreme.

Social protection in agricultural settings, however, has not been examined through the lens of adaptive capacity where elements such as assets, institutions, information, innovation and decision-making come into play (Jones et al 2010). Social protection has also not been thoroughly explored within agroforestry contexts, which is an agricultural system that encourages the planting of trees on farms and which currently globally covers 46% of agricultural land where 558 million people live (Zomer et al 2009). Therefore, the current

understanding of the linkage between adaptive capacity and social protection within agroforestry is limited. This paper addresses these limitations by examining how a deeper understanding of adaptive capacity can enable us to better understand social protection using case studies from Honduras and Zambia within the context of agroforestry systems. The case study in Zambia demonstrates how the adaptive capacity of farmers has led to strengthening of their social protection to minimize the impact of drought. The case study from Honduras demonstrates how formal social protection measures have, in turn, enhanced adaptive capacity. Through these case studies, this paper shows how adaptive capacity and social protection are linked.

LITERATURE REVIEW

Adaptive capacity

Adaptation to climate change, as defined by the IPCC (Magrin et al 2007), is an adjustment in ecological, social or economic systems in response to observed or expected climatic changes. Adaptive capacity is the ability of individuals and groups to adapt or adjust to climate variability and change (Gupta et al 2010); and accommodate shock and stress to systems (Smith et al 2003)[1]. Adaptive capacity also includes communities' capacity to take advantage of the benefits and opportunities associated with a changing climate (Jones et al 2010). Jones et al (2010) identify five key elements that contribute to adaptive capacity, which this paper will reflect on. These include: the asset base; institutions and entitlements; knowledge and information; innovation; and flexible forward-looking governance. This approach to understanding adaptive capacity will be used because these elements are derived from IPCC's assessment reports. Although the asset base and institutions are the most influential elements of adaptive capacity as they lay the foundations for all other elements, the other three elements will also be briefly described.

First, the asset base constitutes various financial, physical, natural, social, political and human capital needed to enable a system to respond appropriately to a changing climate. Natural capital consists of natural resource stocks (soil, water, air, genetic resources, etc.) and environmental services (hydrological cycle, pollution sinks, etc.); physical capital refers to infrastructure and machinery; financial capital is the capital base (cash, credit/debt, savings and

[1] It should be noted that in this paper, adaptive capacity will be defined differently from coping capacity, which in many cases is used interchangeably (Levina and Tirpak 2006). Adaptive capacity refers to a longer timeframe where people draw upon their resources to implement both ex ante and ex post strategies to adapt to climate stress and shocks. Coping capacity, however, refers to adjustment after a shock by using ex post strategies, and involves short term adaptation strategies to provide immediate relief. Coping strategies do not contribute to enhancing or building assets and institutions needed for long term adjustments to climatic stresses and shocks.

other economic assets, which include basic infrastructure and production equipment and technologies); human capital consists of the skills, knowledge, ability to labour, good health and physical capability; and social capital are the social resources (networks, social claims, social relations, affiliations, associations) upon which people draw when pursuing different livelihood strategies requiring coordinated actions (Scoones 2005). Political capital is not typically linked with the other five capitals, which are associated with the sustainable livelihoods approach. The definition of political capital ranges from the (favourable) opinion people have about an individual or a group to an asset that links an individual or a group to power structures and policy outside the locality (Baumann 2000). This is a term that is vague and ill-defined but extremely important as it relates to power and authority where a person with high levels of political capital can influence how others behave and what he/she has that can influence adaptive capacity.

Second, formal or informal institutions or rules; norm and beliefs that facilitate decision-making and social practices are considered fundamental characteristics of adaptive capacity. Institutions may include public (i.e. governmental agencies), private (i.e. seed banks, businesses, service organizations) or civic (i.e. labour exchanges, collective gatherings, cooperatives) groups. Institutions help to structure the distribution of climate risk impacts; and constitute and organize incentive structures for adaptation responses at an individual and collective level. They also mediate interventions into local contexts and "articulate" between local and extra-local processes, such as finances, knowledge and information, skills training, new institutional inputs and technological support that facilitate adaptation (Agrawal and Perrin 2008). Local institutions play a key role in acquisition and distribution of interventions at the local level. Although institutions can empower actors to have access and entitlement to assets vital to adaptive capacity, access and entitlement may be based on age, ethnicity, class, religion and gender (Adger et al 2007). Access and entitlement is also dependent on the types and number of assets an individual or group has. Institutions that promote equitable entitlement to resources can foster adaptive capacity in many ways, such as encouraging a variety of perspectives and solutions; enabling people to learn and improve their institutions; motivating actors to adjust their behaviour; mobilizing leadership qualities and resources for implementing adaptation measures; and supporting principles of fair governance (Gupta et al 2010).

Third, knowledge and information refers to the system's ability to collect, analyze and disseminate knowledge and information in support of adaptive activities. This includes understanding of future change, adaptation options, the ability to assess them and the capacity to implement the most suitable interventions (Frankhauser and Tol 1997). The fourth element of adaptive capacity is innovation, which helps the system explore "niche solutions" to take

advantage of new opportunities (Smith et al 2003; Wongtschowski et al 2009). Finally, the fifth element, which is flexible forward-thinking decision-making and governance, is based on the idea that the system should be able to anticipate change and incorporate initiatives into future planning through informed decision-making, transparency and prioritization especially in a changing environment (Adger et al 2007; Smith et al 2003). These last three assets are highly dependent on the asset base and institutions. It is the interplay between the various types of assets that an individual or groups has access to and the types of institutions that support the individual or group that would allow exchange of knowledge and information, innovation to take place, and allow for “forward-thinking” decision-making. This section has primarily focused on the asset base and institutions as the main elements of adaptive capacity. This is largely because most adaptation strategies in rural areas draw on natural, financial and social capital, and common pool institutions (Agrawal and Perrin 2008).

It is important to note that the determinants of adaptive capacity function differently in different contexts (Smit and Wandel 2006). Drawing upon social protection and climate change literature, the next section reviews the various social protection measures that have been put in place to minimize the negative social and economic impacts of weather-related events such as droughts and floods. These social protection measures incorporate many of the aforementioned five elements of adaptive capacity.

Social protection

Social protection is thought of as an initiative or intervention that is provided to boost resilience and manage risk by implementation of prevention, mitigation and coping strategies through formal or informal mechanisms. Social protection helps people cope with and respond to the uncertainty and perturbations which climate change brings to human-environment systems (Folke et al 2005; Tompkins and Adger 2004). Social protection has typically included economic mechanisms to create buffers in times of climatic stress. For instance, economic safety nets were used to diversify income through the use of social connections. Labour market interventions have been used to support skill development and market mechanisms to reduce unemployment (Jones et al 2010). However, what constitutes social protection has expanded beyond the economic sphere. Devereux and Sabates-Wheelern (2004) provide a wider view of social protection, defined as “all initiatives that transfer income or assets to the poor, protect the vulnerable against livelihood risks [including climatic shocks and stresses], and enhance the social status and rights of the marginalized” (p.14 cited in Davies et al 2009). This view includes social and political dimensions and goes beyond suggesting that social protection is a formal economic intervention.

Devereux and Sabates-Wheelern (2004) stress that social protection can include informal interventions such as collective action and include other sectors such as the private sector and civil society who may play key roles in providing services and access to assets beyond financial capital to boost adaptive capacity. They provide a useful typology that suggests four types of social protection. The first category provides protective measures such as relief from deprivation based on targeted safety nets. This includes social assistance programmes like targeted resource transfers that are publicly financed (i.e. cash transfers). The second category provides formal preventive measures against deprivation through formal social insurance programmes (i.e. weather-indexed insurance) and informal mechanisms (i.e. savings clubs). The third category provides promotive measures which enhance income and capabilities through livelihood-enhancing programs, such as socioeconomic finance and insurance schemes. This includes microfinance, access to common property, as well as risk diversification strategies (i.e. crop or income diversification). Finally, the fourth category provides transformative measures that address concerns of social justice and exclusion arising from social inequity and exclusion of the poorest and most marginalized groups. This may be in the form of collective action for workers' rights.

The four types of social protection measures that Devereux and Sabates-Wheelern (2004) describe may not be as distinctive from one another when discussing climate change. Protective instruments such as cash transfers, which may be provided after a natural disaster can lead to promotive activities since cash transfers may in the future help boost income, in which case protective instruments can actually be promotive. Similarly, preventive instruments, such as weather-indexed crop insurance are highly relevant to climate change strategies. Although this may primarily be a short-term coping strategy and does not directly build adaptive capacity, the funds from the insurance may indirectly lead to a farmer reinvesting in farming activities that not only involve planting drought or flood-tolerant crops that could help build ecological adaptive capacity, but also boost income from these crops in the long run. (Davies et al 2009). Although the typology is useful, it is important to note that one type of social protection measure may influence the other, and therefore, they are not as distinctive as the literature suggests. Although we recognize that one type of social protection may influence others, the case studies in this paper fall within "promotive" social protection since this type of social protection directly relates to building adaptive capacity that enhances income and capabilities.

METHODOLOGY

Empirical evidence on adaptive capacity and social protection in this paper is provided through two case studies from Zambia and Honduras within agroforestry contexts. The case studies describe the current climatic threats within an agroforestry context and the key actors who must adapt to climate variability and change. In order to examine adaptive capacity of farmers, the case studies describe the main asset base that farmers rely on and the institutions that help govern endowments and entitlements to the asset base. This involves an analysis of social interactions between individual actors and groups, as well how they create and use formal and informal institutions to help them adapt. Such an analysis helps determine what enhances adaptive capacity and whether their levels of adaptive capacity can allow for social protection to reduce the negative impacts of climate variability on social, economic and ecological systems.

Various methods were used to collect information for the case studies. In the Zambia case study, assessments of property rights and institutions were carried out through two surveys. In the first survey conducted in 2002, information was collected from 182 households to assess the level of implementation and effectiveness of the property rights over time. The second survey was based on a sample of 197 households and was conducted in 2005 to identify the intended and non-intended impacts that the property rights had on different members of the household and the various social interest groups in eastern Zambia. In the Honduras case study, initial fieldwork was conducted in 1997. Extension agents and personnel who promoted the Quezungual agroforestry system conducted semi-structured interviews with 58 farmers (49 practitioners and nine non-practitioners). Farmers were not systematically selected for an interview; the choice was dictated by whether or not they were actually working in their fields at the time of the visit study of the Quezungual system. The findings of this study were first published in 1999 (Hellin et al 1999) but during the following decade researchers and development practitioners continued to promote both social protection and adaptive capacity amongst local farmers.

CASE STUDY: COLLECTIVE AGREEMENTS AND SOCIAL CAPITAL AS AN ADAPTATION STRATEGY IN ZAMBIA

Zambia has experienced an increase in drought frequency and intensity in the last 20 years. The droughts of 1991/92, 1994/95 and 1997/98 especially worsened the quality of life for subsistence farmers (Jain 2006). The temperature in Zambia is increasing at the rate of about 0.6°C per decade, which is ten times higher than the global or southern African rate of increase in temperature. Drought impacts most negatively on

farmers because of the loss of crop production and cattle. According to del Ninno and Marini (2005), in the decade between 1991 and 2001, Zambia suffered four droughts of different severity (1991/92, 1994/95, 2000/01 and 2001/02). In rain fed agriculture of southern Africa, production is well below its potential due to poor quality of rainfall seasons that are often associated with prolonged dry spells (Chikowo 2011). Increasing dryness has negatively affected soil conditions, leading to poor growth of crops.

Elements of adaptive capacity in Eastern Zambia

Assets

Management systems that positively alter the soil-crop environment help farmers cope with the negative impacts of limited access to production resources and climate change, especially when rainfall is projected to decline by 30% in the next 50 years in the region (Chikowo 2011). One way to positively alter the soil-crop environment is to plant “fertilizer trees”, which is an agroforestry practice where farmers plant fast growing trees or woody shrubs species that (usually) fix nitrogen, and produce easily decomposable biomass (Kwesiga et al 2003; Akinnifesi et al 2010). Using nutrient recycling systems, the trees replenish soil fertility by transforming atmospheric nitrogen and making it available in the soil. In addition to improving the fertility and physical properties of the soil, fertilizer trees reduce the effects of droughts because under the tree system, soil aggregation is higher and this enhances water infiltration and water holding capacity which reduces water runoff and soil erosion (Chirwa et al 2003; Chirwa et al 2007; Phiri et al 2003). Fertilizer trees decrease soil erosion by maintaining a leaf canopy during the dry season and more vigorous growth during the rainy season (Sanchez 2002). These environmental services extend to other farms beyond the fields of a farmer who has planted the legume trees (Ajayi et al 2010). Based on field studies, Akinnifesi et al (2011) conclude that integrated nutrient management through fertilizer trees offers opportunities for adaptation to climate change and ensure food security in rain fed agriculture in Sub-Saharan Africa where food production is affected by increasing variable rainfall and other weather conditions.

In addition to increasing ecological resilience, Franzel et al (2002) identified four main ways in which fertilizer trees help to protect financial capital by minimizing financial risks to farmers in drought years and under changing climatic conditions. First, where crop failure occurs, farmers using inorganic fertilizers would lose all the investment used to procure the input at US$164, whereas the loss is US$90 (cost of labour and tree seedlings) for farmers who planted fertilizer trees. Second, fertilizer trees require little or no direct cash transactions, in contrast with inorganic fertilizers in which almost all investment is done by cash or purchased on credit.

During years of drought, the opportunity cost of using inorganic fertilizer thus become higher because the loss of crops may result in the inability of farmers to repay the loans used to procure the inputs, and the attendant problems from such incapacity. Third, the effect of drought is worse for those who use inorganic fertilizers because the soil replenishing effects of fertilizers occur mainly in a single year (i.e. the year the inputs was applied to crops). For fertilizer trees, however, residual effects to soil replenish spanning over 2-3 years and as a result, if crop fails in a given drought year, there is the possibility of a good response in the following year. Therefore, fertilizer trees in agroforestry landscapes protect financial capital by minimizing farmers' risk of being in debt or losing income. This helps to protect their food security and livelihoods.

Institutions

The ability of farmers to adopt and take advantage of fertilizer trees as a resource for adapting to climate change is constrained by informal tenure arrangements and ambiguity in property rights over land and natural resources which create social conflicts in rural communities of Zambia. In most rural communities of Zambia, in the rainy season when crops are in the field, the customary practice mandates that cattle and other livestock are tethered by their owners and kept away to prevent damage to the crops. In this case, agricultural fields are privately owned. However, after crops are harvested, cattle are left to roam and graze freely on the crop residues and other vegetation in the field, making the field a common property in the dry season. During this period, the bush may be set on fire without posing harm to anyone's interest. These changing practices by seasons and shifting between private and common property creates ambiguity over access to land, which not only leads to conflicts between farmers and herders, but also reduces the chances of benefiting from fertilizer trees. For example, a study in eastern Zambia found that 43% of the time, animal browsing was one of the main reasons why some farmers were not planting fertilizer trees (Kabwe 2001) needed for climate change adaptation. Free-ranging livestock destroy newly planted fertilizer trees and consume maize cobs not yet harvested. They destroy young trees by browsing the barks and leaves or physically trampling over them. This situation is worsened by those who hunt mice by burning agricultural fields, which further reduces access to fertilizer trees. The failure of existing local institutions to reduce tenure ambiguity based on seasons and address the interests of farmers and herders within the community creates a dilemma because poor farmers (and often the less powerful) are inadvertently made to subsidize relatively richer farmers who have livestock and who are more likely able to afford fertilizer. The increasing human population, pressure over land and the quest to access new opportunities provided by fertilizer trees to meet agricultural production by poorer members in the rural communities increased social

disputes and conflicts between rich cattle-owning farmers and poor farmers who do not own livestock (Ajayi and Kwesiga 2003).

Given this challenge, the communities took advantage of the benefits of fertilizer trees to respond to changing climate especially for the more vulnerable poorer families. They did this by socially mobilizing collective agreements among three key actors in the community: livestock owners, farmers who plant fertilizer trees and youth who hunt for mice during the dry season. The main economic interest of livestock farmers is a desire for free crop residues and fodder to feed their animals. For farmers who plant trees, their interest is to protect their trees from damage by animals so that they can benefit from fertilizer trees. Mice hunters are interested in catching the "free gift of nature" (mice), a traditional delicacy in the community. The three actors are homogeneous in terms of ethnic group and education levels but the only difference is in terms of wealth (ownership of livestock) and defence of their economic interests.

These three groups of actors consulted the traditional authorities, such as paramount chiefs who are custodians of conflict resolution in their respective domains, to come up with a solution on how to minimize conflict and protect fertilizer trees[2]. The two paramount chiefs in the study area upheld the community's collective agreement in the form of bylaws that mandates cattle owners to herd their animals, and mice hunters to avoid careless bush burning to avoid damage to fertilizer trees in their respective communities. The implementation of the agreements in the respective communities began in 2000. A sample survey of households in eastern Zambia was conducted in 2005 to assess the effectiveness and impacts of the agreements. The study shows that five years after the collective agreements began, fire and grazing, which are the major constraints to tree planting, have reduced greatly (Ajayi et al 2010). For example, while only 16% of rural households mentioned that the new agreement on grazing was effective in 2000, this proportion increased to almost half (46%) five years after it was introduced (Table 1). This has led to remarkable improvements in the protection of the resource available to poor farmers to adapt to climate risks in their agricultural production and allowing poor farmers in particular to plant fertilizer trees.

[2] Chiefs are highly respected and could lend legitimacy to the actions agreed by the communities to respond to the problems (Ajayi et al 2010).

Table 1: Households' assessment of the implementation and effectiveness of the collective agreements in Zambia

Households' assessment	Collective agreement on grazing (%)		Collective agreement on fire (%)	
	Initial period	Five years after	Initial period	Five years after
Effective	16	46	13	14
Average	20	34	21	42
"Not working"	64	20	66	44
Total	100	100	100	100

From only 12 farmers who participated in the initial on-farm testing of fertilizer trees in 1994, the number of those planting fertilizer trees has increased steadily, especially from 2000 onwards, to over 66,000 farmers in Zambia as of 2006[3]. The level of effectiveness of the collective agreements to protect the interest of households who plant fertilizer trees varies depending on the specific type of bylaw (more effective to minimize browsing); the traditional inheritance system (more effective in communities practising the patrilineal system) and the power structure in the rural community (composition of cattle owners and non-owners in the traditional council). Nevertheless, in general, the collective agreements resulted in reduced conflict in the community. The innovative social system of collective action and informal governance mechanism has allowed farmers to take advantage of agroforestry systems that provide promotive social protection. Poor farmers in particular are able to better manage risks of droughts and protect their food and income security by benefiting from fertilizer trees.

Knowledge and information

One reason why institutional arrangements have been able to support the planting of fertilizer trees is because community members are well aware of the changing rainfall patterns and the increasing occurrence of mid-season droughts in their locality. In addition, they have traditional knowledge about tree planting in general and, the use of fertilizer trees to respond to the changing weather patterns. Their knowledge and action regarding the planting of fertilizer trees have been supported and enhanced by agricultural extension agents and several NGOs (e.g. Plan International, World Vision) in eastern Zambia which disseminate information on fertilizer trees. The methods of disseminating information on fertilizer trees range from on-farm demonstration plots, to farmer training to support the use of fertilizer trees. The involvement of farmers in development of fertilizer trees contributed greatly to enhancing their knowledge about the trees.

3 We cannot, however, attribute the increase in number of fertilizer tree farmers during this period to the social action alone. Other reasons could be due to increased dissemination of agroforestry, but this has not been researched.

Influence of adaptive capacity on social protection in eastern Zambia

A combination of natural capital where fertilizer trees were key assets, informal institutions that support positive collective action to minimize conflict and damage to the trees and to promote access to information on climate conditions and fertilizer trees have given farmers in Zambia a high level of adaptive capacity. The combination of these elements of adaptive capacity has led to interventions to protect fertilizer trees that reduce the risk of drought and has enhanced the farmers' level of social protection against climate hazards, such as droughts by enhancing income, capabilities, and ecological resilience.

Due to the system of chiefs that have allowed for a solution to plant fertilizer trees, as well as farmers' knowledge and action regarding the planting of fertilizer trees which have been supported and enhanced by agricultural extension agents and several NGOs, farmers are more capable of protecting and benefiting from fertilizer trees both financially and ecologically. Dissemination of information on fertilizer trees and on-farm demonstration plots has helped farmers improve their ability to use fertilizer trees.

Using nutrient recycling systems, fertilizer trees replenish soil fertility by transforming atmospheric nitrogen and making it available in the soil. Fertilizer trees decrease soil erosion by maintaining a leaf canopy during dry season and more vigorous growth during the rainy season (Sanchez 2002). Fertilizer trees increase soil water recharge over time due to improved infiltration and reduced soil evaporation, and subsequent changes in water balance in the deeper soil layers that can be exploited by the roots. Fertilizer trees in crop fields help to create a buffer against weather changes such as mid-season drought associated with climate, and increase resilience of farming systems. With soil structure and physical properties improved, soil moisture is retained with the potential to withstand the extent of the effects of droughts.

CASE STUDY: QUEZUNGUAL AGROFORESTRY SYSTEM OF HONDURAS

Climate change and agricultural context in Honduras

Countries such as Honduras in Central America are at considerable risk from climate change. The fourth assessment report (FAR) of the IPCC for Latin America (Magrin et al 2007) concluded that "*in terms of food security, a significant number of smallholders and subsistence farmers may be particularly vulnerable to climate change in the short term, and their adaptation options may be more limited. Of particular concern are farmers in Central America".* Growing evidence suggests a scenario of rising temperatures, declining rainfall and an increase in extreme weather events. Observed negative precipitation trends are already being reported for

Central America (e.g. IPCC 2001). Lobell et al (2008) looked at the combined outputs of 20 of the latest Global Circulation Models for 2030, under three different emission scenarios, and reported median precipitation declines of approximately -5% for Central America in both the winter (December-February) and summer (June-August) seasons. Rising temperatures are another major factor for the region. The IPCC FAR (Magrin et al, 2007) reports that an average temperature increase of nearly 1°C in Mesoamerica has already been observed and projected temperature increases for Central America in the wet season are +0.5 to +1.7°C by 2020, and +1.0 to +4.0°C by 2050.

Decreasing rainfall and increasing temperatures will have an adverse impact on maize production in Honduras. Jones and Thornton (2003) investigated potential effects of climate change on maize production in 2055 using crop simulation models. Decrease in yields were predicted for Central American and increased probability of crop failure from drought was found in Honduras, Nicaragua and Panama. There is, hence, an urgency to work with Honduran farmers to develop climate change adaptation. Two decades of land management work in the department of Lempira in western Honduras under the auspices of the Honduran government and the United Nations Food and Agriculture Organization (FAO), Lempira Sur Project (PLS), suggest possible ways forward. While the focus of this case study is on the agroforestry component of PLS, a key feature of the project was to embed this in a broader promotive social protection context, thus, enhancing local farmers' adaptive capacity, increasing their livelihood security and strengthening their ability to minimize the negative impacts of climate variability.

Elements of adaptive capacity in Honduras

Assets

The Department of Lempira is one of the poorest and most isolated parts of Honduras and is located in hilly terrain close to the border with El Salvador. Prior to the start of the Lempira Sur Project (PLS), natural capital was low: soils in the region are predominantly Entisols with low soil organic matter content and phosphorus, and have a gravely or stony loamy sand texture (Ayarza et al 2010). The average annual temperature varies from 17 to 25^{o}C and annual precipitation ranges from 1400 to 2100mm. The rainy season extends from early May to the end of October. Smallholder farmers traditionally practised slash and burn agriculture which, by the end of the 1980s, had contributed to accelerated soil and land degradation. The result was low yields of the basic grains (maize, beans and sorghum), severe malnutrition and almost 75% of population living below the poverty line (FAO 2011).

The Lempira Sur Project was implemented by the Government of Honduras, with technical support from the FAO and financial resources from the Netherlands, from 1990 to 2004. PLS focused its activities in an area of 2,178 km^2, corresponding to 50% of the total surface area of the Department. The target population was approximately 130,000 inhabitants in 20 municipalities. The principal objective of PLS was to improve the quality of life of the rural population through organized participation in new economic activities and diversified agricultural systems. There was a strong emphasis on increasing social and human capital through institutional innovations thus, strengthening the aforementioned five key elements that contribute to adaptive capacity identified by Jones et al (2010).

PLS adopted people-centred approaches where local people were at the centre of identifying their needs and problems. The first priority identified by local people was food security. Project development practitioners subsequently analyzed with farmers the obstacles to attaining higher and more stable agricultural yields. The result was the emergence of the Quezungual agroforestry system which, by improving soil quality, also contributes to greater natural capital. By working with groups of farmers and enhancing their understanding of soil and crop management, PLS also contributed to enhanced human and social capital.

The Quezungual system is based on planting annual crops under a slash-and-mulch management system (Hellin et al 1999; Ayarza et al 2010). The distinctive feature of the system is the existence of various naturally-regenerated trees and shrubs that are pollarded to a height of approximately 1.5m. Farmers also leave taller trees in the fields and these include *Cordia alliodora* (laurel) and various fruit trees such as *Psidium guajava* (guayabo). A variety of crops is grown within the system including *Zea mays* (maize), *Sorghum bicolor* (sorghum) and *Phaseolus vulgaris* (beans) (Hellin et al 1999). The Quezungual system has been widely adopted since the 1990s. Advantages of the system, identified by farmers, include retention of soil moisture, increased production of crops, fruits and timber, and the fact that plots can be cultivated for longer periods than is normal practice before being left in fallow.

One of the prerequisites for the establishment of the system is that farmers abandon the practice of burning their fields prior to the beginning of the rains in April. This was a challenge in a region where slash-and-burn agriculture was common and where burning is often a labour-saving way to prepare fields for planting. The labour issue is of particular importance for those families where out-migration of family members (often to the United States) had led to a labour shortage. This shortage has pushed up daily labour rates and, hence, the cost has risen for those farmers who have abandoned burning and who have to hire daily labour to clean their fields prior to planting. PLS, as part of its broader development remit supported the

establishment of community banks. These banks enhanced the abandonment of burning and the adoption of the Quezungual system because credit was given only to farmers who did not burn their land. This new 'moral order' was, in turn, supported by national and local laws forbidding the use of fire and protecting common forestlands and water reservoirs (Ayarza et al 2010).

Institutions, knowledge and information

The Quezungual system was first officially documented in 1998 (Hellin et al 1999). At the time, all the practitioners had customary rights to land but people did not have legally-recognized titles to their land. The land tenure situation in Honduras is complex; some farmers have titles to their land (*dominiopleno*) and others have usufruct rights (*dominioútil*). Many farmers also rent from larger landowners or occupy land illegally. Although these different tenure systems exist creating insecurity of access to land, it did not affect agricultural practices and most farmers adopted the slash-and-mulch Quezungual system (Hellin et al 1999). This was because of the institutional innovations that enhanced farmers' understanding of soil management processes (enhanced human capital) and that encouraged farmers to work together (enhanced social capital). Farmers' knowledge and understanding of the Quezungual system and the importance of improving soil quality was heightened by the role of PLS' extension agents. At its initiation, PLS held a series of participatory diagnosis workshops in local communities, during which local people identified key development needs. The creation of community development committees (CDC) was a crucial step in increasing the influence of local families over decision-making processes in their communities.

Innovation and forward flexible thinking

Above all, innovation was a key component of the success of PLS. Farmers participate in social change not as passive subjects, but rather as social actors whose strategies and interactions shape the outcome of development within the limits of the information and resources available (Sumberg et al 2003). The Quezungual system emerged from a community-focused learning process during which local indigenous knowledge pertaining to no burning, slash-and-mulch and pruning of native forest vegetation was combined with technical knowledge such as use of spot fertilization, improved crop varieties and zero tillage/direct planting (Ayarza et al 2010). The PLS, hence, built on existing farmer knowledge and worked with innovative farmers to develop the Quezungual system.

The creation of the CDCs in isolated and remote communities enabled local inhabitants to participate actively in decision-making within the municipality and to negotiate incentives and benefits for the region. Furthermore, through these formal structures, the central government was better able to channel its financial resources to the most remote communities, thus, enhancing formal safeguard mechanisms. For example, local governments were able to negotiate with the central government to implement long distance learning radio programmes and to upgrade the curricula of local schools and achieve better access to health services (Ayarza et al 2010).

Influence of social protection on adaptive capacity

This case study from Honduras shows that it is formal social protection mechanisms that can enhance adaptive capacity to minimize risks against droughts. The Quezungual system emerged from the knowledge and information generated by extension agents from PLS working closely with innovative farmers who practised Quezungual. Based on the results of participatory diagnosis workshops, PLS placed a lot of emphasis on enhancing farmers' incomes through diversification of income-generating activities and improved market access. With the close proximity of the border, many farmers were able to sell their agricultural products in El Salvador. Both practitioners and non-practitioners of the Quezungual system were able to take advantage of increased market access that has led to an increase in financial capital.

PLS has also enhanced farmers' capacity to adopt improved soil and water management under the Quezungual system. Early practitioners who were interviewed stressed that converting from a slash-and-burn to a slash-and-mulch system was not technically difficult, but that they did rely on the information and training provided by PLS e.g. the use of spot fertilization, improved crop varieties and zero tillage/direct planting (Ayarza et al 2010). Hence, the PLS worked with farmers to increase human capital and subsequently enable them to gain skills to adopt the innovative Quezungual system. It can also be argued that the establishment of community banks enhanced the abandonment of burning and the adoption of the Quezungual system because credit was given only to farmers who did not burn their land. This has created an incentive to build capacity in practising the Quezungual system.

The Quezungual system has led to an improvement in soil quality (chemical, biological and physical) due to the absence of burning and the built up or organic matter (Pauli et al 2010). This in turn has led to an increase in agricultural production and productivity. Yields of beans under the system increased from 0.8 to 2.0 tonnes per hectare and those of maize from 1.9 to 3.2 tonnes per hectare. FAO (2005) reported that maize and bean yields were 54% and 66% higher respectively on land under the Quezungual system compared to land managed in the

'traditional' slash-and-burn systems. In a region still plagued by food insecurity this has important implications for farmers' livelihood security, their ability to feed their families and also to enhance income from market sales. Therefore, the formal adoption of this system has improved natural capital of farmers with more access to agricultural produce and their financial capital as they are able to sell more of their crops. This has resulted in greater food security and a reduction in poverty.

Improved soil quality and a greater capacity to capture, retain and slowly release water is part of climate change adaptation especially in the face of predicted decreases in rainfall. A big breakthrough in terms of adoption of the agroforestry system came in 1997 when an El Niño-associated drought hit the area. The crops on the farms using the agroforestry system withstood the drought while farmers who had not adopted the Quezungual systems suffered crop losses (Welchez and Cherrett 2002). The ability of the Quezungual system to withstand the particularly severe drought in 1997 is encouraging because it suggests that the system may become even more relevant as Honduras and its neighbours suffer from more frequent droughts over the coming decades. There is also evidence that the Quezungual system may be more resilient in the face of very intense rainfall. During Hurricane Mitch at the end of October 1998, for example, farmers who practised this system suffered less landslide damage compared to those practising the traditional slash-and-burn agricultural systems (Holt-Gimenez 2002). Again, this can be attributed to the soil's improved ability to absorb water and protect the soil from the erosive power of the rain.

CONCLUSION

The case studies from Zambia and Honduras demonstrate that although local context may be very different, the combination of assets, institutions, knowledge and information, innovation, and forward flexible thinking are key ingredients needed for adaptive capacity to combat drought. In both cases, natural capital, such as fertilizer trees, agricultural land and social capital were very important assets. In the case of Zambia, social capital was used in an informal and innovative manner where farmers were able to decide on how farmers and herders could use agricultural fields supported by a traditional governance systems of chiefs. In Honduras, however, social capital was developed and used in a more formal manner though programme implementation of PLS and CDCs that encouraged farmers to work together and allow for participatory and transparent informed decision-making as to planting trees that would prevent drought.

Institutional structures between the two case studies was also quite different. In Zambia, common property rights governed the land. Although collective action was allowed in such an institutional structure, it is not clear how transparent and participatory decision-making processes were in terms of resolving conflicts and protecting fertilizer trees. In Honduras, it was a combination of formal and informal land rights that allowed farmers' access to agricultural land where they could adopt the Quezungual system. The work of extension agents facilitated the combining of both traditional and modern understanding of soil management to protect trees to fight drought. Knowledge and information also played a significant role in building adaptive capacity where in Zambia traditional knowledge about changing rainfall patterns and tree planting were common. However, similar to Honduras, the Zambian case study also demonstrated how agricultural extension agents play an important role in helping farmers understand the value of tree planting. Extension agents in Zambia introduced new types of trees that would cater to both farmers and herders, leading to an innovative way of minimizing conflict between the two groups.

Even though these cases studies are quite different, they not only demonstrate the importance of the combination of the five key elements of adaptive capacity, but they also highlight the role of agroforestry in boosting adaptive capacity. Because farmers chose to plant trees on farms this helped improve on soil and water quality, leading to increased ecological resilience against drought. Most literature on adaptation in agricultural landscapes does not mention the value of agroforestry systems, which this paper highlights as an adaptation strategy.

Although both case studies demonstrate the adaptive capacity of farmers, the way in which adaptive capacity in Zambia and Honduras relates to social protection, which includes enhancement of income and capability, is very different. In the case of Zambia, adaptive capacity of farmers leads to their own social protection. Farmers' income is protected or enhanced because they are able to protect their crops that they sell to earn income by planting fertilizer trees, which also makes economic sense as they are the cheaper option compared to chemical fertilizers. Farmers that are especially poor have been able to plant fertilizer trees through support from chiefs and extension agents.

Unlike the case in Zambia, in Honduras formal social protection measures that have allowed Quezungual systems to thrive have increased adaptive capacity. The role of PSL and CDC were critical in supporting a system that not only allowed participation of all farmers and institutionalized income diversification, but allowed for trees to be planted that improve soil quality. Formal initiatives such as providing credit to farmers to reduce burning of fields also supported planting of tress that minimize drought. The protection of trees on farms allowed

farmers to reduce their levels of poverty and provide income. Furthermore, PLS and CDC increased human capital of farmers by building their capacity to adopt the Quezungual system, thus enhancing their capability of protecting soil moisture.

This paper demonstrates the importance of understanding not only how adaptive capacity can be analyzed, but the linkages between adaptive capacity and social protection, which is not commonly made in literature on climate change adaptation. The case studies in this paper have shown how, on the one hand, adaptive capacity at the local level can informally lead to social protection of farmers where planting of fertilizer trees leads to enhancement of income and capabilities. On the other hand, local yet formal measures as demonstrated by the Quezungual system in Honduras can boost adaptive capacity. Understanding the linkages between adaptive capacity and social protection is important especially in planning of adaptation initiatives. Understanding adaptive capacity helps to assess the types of assets, institutions, knowledge, innovation systems, and governance are already in place that needs to be supported for improved adaptation and to benefit from social protection mechanisms. Analyzing adaptive capacity also helps to identify what element of adaptive capacity needs to be invested upon in order for social protection measures to work.

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