

# Adaptation to climate variability: the role of past experience and institutions

Arjan Ruijs<sup>1,4</sup>, Mark de Bel<sup>1</sup>, Minna Kononen<sup>2</sup>, Vincent Linderhof<sup>3</sup>, Nico Polman<sup>3</sup>

1. Royal Haskoning, Nijmegen, The Netherlands,

2. The World Bank, Washington D.C., U.S.A.

3. LEI part of Wageningen UR, The Hague, The Netherlands

4. PBL – Netherlands Environmental Assessment Agency, The Netherlands

## Summary

Currently, climate change adaptation receives a lot of attention. It is, however, sometimes forgotten that people all over the world have been coping with the impact of climate variability on their ecosystems already for decades. Their experiences can be helpful in designing appropriate policies for climate change. This paper presents the results of a World Bank study on costing adaptation through local institutions in Ethiopia, Mali and Yemen. The study raises three questions. Firstly, which adaptation strategies were adopted in the past by rural households to deal with the impacts of climate variability? Secondly, to what extent do institutions provide assistance to adopt adaptation strategies? Thirdly, which are the reasons or constraints for households for not adopting suitable strategies? For this paper, institutions are defined as structured, formal or informal organizations.

Based on field surveys, focus group discussions and institutional stakeholder interviews, first, the components of vulnerability of households - the stresses to which household are *exposed*, their *sensitivity* and their *adaptive capacity* - were analysed. Sensitivity refers to the extent to which people are affected by climate change. In general, high levels of exposure and sensitivity and low levels of adaptive capacity result in high levels of vulnerability. High exposure of a household, however, not necessarily results in high vulnerability e.g. if the adaptive capacity of the household is high. Based on these components of vulnerability, clusters of households were formulated. Secondly, reasons for differences in households' choice of adaptation strategies were analysed. Thirdly, the role of institutional assistance, like public and private extension services, in adopting adaptation strategies was investigated.

Almost all households in all three countries use adaptation strategies such as improved seeds and changed planting dates, to make yields less susceptible to climate variability. In all three countries, adaptation options chosen differ between types of households. The results also show remarkable differences in adaptation strategies used between the studied countries. In Yemen, less adaptation strategies were adopted than in Ethiopia and in Mali. In Yemen, especially the more wealthy households adopted capital intensive strategies like irrigation pumps. In Ethiopia, wealthier households participated more in communal strategies, like soil erosion, communal irrigation or reforestation, for which external help is necessary. Also pastoralists adopted communal water harvesting and rangeland management strategies to reduce exposure, which cannot be financed by the households individually. In Mali, the only communal strategy chosen is irrigation, which is adopted by only a few, wealthier households. Income diversification techniques outside of agriculture were chosen only by a few households. A problem here is that rural areas lack an enabling environment in which non-agricultural trade activities can sustain. Finally, migration as income diversification strategy was chosen more often in Mali than in Ethiopia. In Yemen only few households migrated. In all three countries, especially the wealthier households migrated to urban areas.

With respect to the institutional assistance that is provided to households, especially in Ethiopia, the network of public extension agencies is well developed. Most Ethiopian households received assistance from these institutions/agencies, especially in terms of training. In Mali, extension agencies are almost absent and their assistance is focused on providing inputs for irrigation and home-garden agriculture. The role of NGO's, cooperatives, micro-finance institutes and religious communities was small in all three countries. In Yemen, households hardly received any assistance from outside institutions, neither from formal governmental extension agencies, nor from NGOs. In all three countries, wealthier households had more access to outside assistance.

In all three countries, people living in rural areas are exposed and sensitive to climate variability. Various strategies are adopted and wealth level is an important explanatory variable for applying adaptation strategies. Differences in coverage of institutional assistance and type of assistance provided, however, were substantial, in this way affecting prospects for future development.

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## 1 INTRODUCTION

Climate change is a global phenomenon. Even though local projections of climate change are unsecure, the envisaged increase of climate variability especially affects the world's most vulnerable populations (see e.g. Adger and Vincent, 2005; IPCC, 2007). These are also the people who in their daily lives have been struggling with the variability of rainfall patterns already for decades. To what extent does increasing climate variability affect households in different regions of the world?

In this paper, it is assessed to what extent rural households in Ethiopia, Mali and Yemen currently deal with climate variability. All three countries have a semi-arid climate, face drought risks and have experienced several periods of extreme droughts over the last decades. Due to cultural, historical, political, institutional and geographical differences, however, agricultural systems and development paths differ between the three countries. As a result, strategies to deal with climate variability vary between the three countries. By comparing lessons learned from each of the three countries, more insight can be obtained in the process to adapt to climate variability. Therefore, the aim of this study is to provide recommendations regarding the options rural households have with regard to adapting to increasing climate variability and the institutional support necessary to facilitate this adaptation process. The research questions of this paper are threefold:

1. What are the main adaptation strategies currently adopted by households?
2. Which (formal and informal) institutions support households to adapt to climate variability, and how do these institutions facilitate adaptation to climate variability?<sup>1</sup>
3. Which constraints prevent households from adopting promising adaptation strategies?

This study is an in dept reflection of the insights that (Agrawal and Perrin, 2008)

- poor, rural households are facing most of the climate variability related hazards;
- adaptation is more than techniques, also involving socio-economic aspects;
- understanding local adaptation processes is important for informing policies and
- for prioritizing future adaptation, it is crucial to analyze historical adaptation strategies.

In this paper, it is investigated for three case studies which hazards households face, which socio-economic aspects and local adaptation processes are important and which lessons can be learned for assisting households in successfully adapting to climate variability.

In the climate adaptation literature, recently a number of global estimates of costs of climate adaptation has been presented (see e.g. Stern, 2006; OECD, 2008; The World Bank, 2010a). Most global studies, however, do not discuss concrete adaptation activities at the household level, focus on technical solutions or do not discuss the reasons why particular options are or are not chosen by poor, rural households. The danger of focussing too much on 'hard', top-down, technical measures is that insufficient consideration is given to low cost strategies that households can adopt themselves, to critical social and behavioural processes that facilitate adoption and to factors that prevent the enabling environment to function properly (OECD, 2008). Moreover, it should be prevented that development programmes focus too much on climate variability and climate change without recognizing the multiple stresses households face, which also require adaptation. Adaptations are a response to risk associated with the interaction of environmental hazards, of which climate change is only one, and human vulnerability which is aggravated by climate variability but also has other causes (Smit and Wandel, 2006; TerrAfrica, 2009). For adaptation planning to be successful, several studies indicate that proper institutional structures should be in place to deliver climate-proofed development programmes that result in the necessary behavioural and structural changes (see e.g. Adger, 2003; Adger et al., 2007;

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<sup>1</sup> 'Institution' often refers to roles or organizations—this is especially true of approaches inspired by organizational theory, public administration, and management. Another large body of scholarship, particularly in economics and in rational-choice approaches in political science and sociology, refer to institutions as rules. This latter view of institutions includes organizations, but also includes more diffuse and loosely connected groups – see also Section 2.1.

Challinor et al., 2007; Twomlow et al., 2007; Wilby et al., 2009). It is, however, still difficult to indicate which factors cause institutional structures to be successful and what institutions should do for stimulating rural households to take the proper actions that reduce their climate variability vulnerability.

The number of case studies which focus on local level climate change adaptation in developing countries and the role of local institutions in adaptation is growing (see e.g. Thomas et al., 2007; Barbier et al., 2009; IFPRI, 2009; Paavola, 2009; Stringer et al., 2009; TerrAfrica, 2009; World Bank, 2010c). There is consensus about the conclusions among the different studies. Households in several countries have adopted low-cost agricultural strategies in order to become less dependent on rainfall variability even though exact strategies differ per region. More structural measures to reduce vulnerability, however, have been adopted by much less households, among other things due to financial, market and knowledge constraints. Next to that, in several countries climate adaptation is insufficiently mainstreamed within broader development policies and local adaptation strategies are not integrated within local policies.

This paper assesses the adaptation options rural households in Ethiopia, Mali and Yemen pursue. Different from other studies, the differential access and adoption rates of various vulnerability groups are investigated as well as the drivers for adopting particular strategies or constraints or considerations for not adopting others. The focus is on how rural households have dealt with hazards related to climate variability in the past, irrespective whether these hazards will change in the future. This is a focus that has not been adopted in many other studies, but which provide us with insights in reasons why households do or do not adopt particular strategies. For decades farmers have been facing severe climate related hazards like extreme droughts, rainfall fluctuations, and temperature fluctuations. The focus of the paper is not on how households will respond to an intensification of these climate hazards, but on how they have responded in the past. As a result, the list of strategies presented here, should not be interpreted as being the best or most wanted strategies to cope with climate variability. It reflects current practice in Ethiopia, Mali and Yemen and shows what households currently do themselves, possibly with institutional assistance, and how it affects their vulnerability. Furthermore, it considers what households do not see as viable adaptation strategies, which factors constrain their set of feasible adaptation strategies and what is needed to relieve these constraints.

In this paper, the results from the different country surveys are compared. In Section 2, a brief summary is given of the methodology and the type of data collected for the study. Moreover, the study countries and villages selected are briefly described. The core of this paper is Section three. First, differences in vulnerability characteristics are explained and it is assessed which elements explain vulnerability in the study countries. Secondly, the adaptation strategies are discussed. Differences between countries are shown and it is explained which characteristics may explain disparities in strategies adopted. Thirdly, it is assessed what type of assistance is provided by institutions that are assisting households with reducing climate related hazards. Finally, in Section 4 conclusions are drawn.

## **2 METHODOLOGY AND DATA COLLECTION**

### **2.1 Methodology**

The methodology adopted in this paper is based on Agrawal and Perrin (2008). It is noted that the focus of this study is on the local level actions. We do not consider macro-level strategies as described in the National Adaptation Programmes of Action (Yemen NAPA Team, 2006; Ministère de l'Équipement et des Transports, 2007; Tadege, 2009). These macro-level initiatives, especially early warning systems and improved weather prediction systems, however, may improve efficiency of some of the discussed local level adaptation options.

*Focus on climate related hazards without neglecting other hazards*

The focus of the study is on hazards related to changes in climate variability, namely

- Drought risk: changes into the pattern and timing of rainfall;
- Flood risk: changes into the intensity of rainfall resulting in floods;
- Average temperature changes; and
- Heat waves: extreme temperature peaks.

Next to these climate variability related hazards, rural households also face other hazards. These include soil erosion, agricultural or livestock pests or diseases, human diseases, increasing population pressure, credit or market problems, rising food prices and hazards related to access to land or other resources (see e.g. FAO, 2006; Thomas et al., 2008). Some of these hazards may indirectly result from climate related impacts (e.g. food price increases due to bad harvests) but it is difficult to identify whether they originate from climatological or economic drivers (Adger et al., 2005).

*Adaptation strategies can be categorized into four major categories*

The focus of the analysis is on selected adaptation strategies, i.e. the strategies households currently choose in anticipation or in reaction to external stresses, phenomena or events which lead to changing agro-ecological and livelihood characteristics and which therefore demand for behavioral changes (Nelson et al., 2007; Stringer et al., 2009). Many of these strategies have been introduced or promoted since the droughts in the 1970s which partly destroyed traditional farming systems. Combined with other reasons such as increasing population pressures, civil unrest and changing social and political structures, farming systems have changed substantially since the 1970s, which in some cases made them more vulnerable. The strategies households currently adopt to adapt themselves to changing levels of climate variability can be classified as follows (see Agrawal and Perrin, 2008):

- *Agricultural techniques* to adapt to changes in rainfall regime, which include e.g. seed selection, adapt planting dates, adapt fertilizer application, adapt feed techniques, improve food storage facilities, change of pastoral system;
- *Water management techniques* to adapt to changes in rainfall regime, which include e.g. use of water harvesting techniques, rehabilitate terraces, improve irrigation techniques, improve watering sites in pastoral areas;
- *Diversification techniques* in order to diversify the income sources, which include e.g. temporal or permanent migration, use of alternative sources for fuel wood, home-garden agriculture, changes in the consumption pattern or reductions of livestock herds; and
- *Communal pooling techniques*, which include e.g. reforestation, rangeland preservation, communal food storage facilities or local water management rules.

*Vulnerability depends on exposure, sensitivity and coping capacity*

To explain differences in the adoption of strategies, households and communities are compared with each other on the basis of their vulnerability profiles. Vulnerability is composed of exposure to risk, sensitivity to that risk and adaptive capacity (IPCC, 2007; see also UNEP, 2002; Adger, 2006; and Kok and Jäger, 2009).

- Exposure refers to the external stress to people or communities, which is caused by e.g. changes in rainfall and temperature patterns due to climate change.
- Sensitivity refers to the extent to which households are affected by exposure to the stress. For example, farmers using irrigation are less susceptible to variations in rainfall than farmers applying rainfed farming.
- Adaptive or coping capacity refers to the ability to cope with the external stress. Factors affecting coping capacity are e.g. level of education and access to other resources.

This definition supports the notion that vulnerability is a socially constructed phenomenon shaped by a set of institutional and economic dynamics (Adger et al 2003). In general, high levels of exposure, high levels of sensitivity and low levels of coping capacity result in high levels of vulnerability. Individual households are not able to affect exposure to climate variability.

Sensitivity and coping capacity can be affected. Table 1 presents examples of sensitivity reducing or coping capacity increasing strategies.

**Table 1:** Strategies to reduce sensitivity or increase coping capacity

Sensitivity reducing strategies	Coping capacity increasing strategies
Crop selection (more drought resistant crops)	Temporal or permanent migration to urban centres
Adapt planting dates	Migration to other rural areas
Adapt feed techniques (zero grazing)	Home garden agriculture
Adapt cropping densities	Reduce livestock/savings
Adapt fertilizer/pesticide application	Improved food storage facilities
Improved seeds (use seeds that have been improved to be e.g. more drought resistant)	Handicrafts
Use of manure of family herd on the fields	Increase market sales
Use water harvesting techniques	Communal cereal bank
Use irrigation	
Improve, construct or rehabilitate terraces	
Soil erosion prevention	
Restore and preserve forests	
Rangeland preservation / management	
Communal water harvesting	

### *Institutions*

For the purpose of this study, institutions are defined as structured, formal or informal organizations that are the means through which local households cooperate with each other or through which central governments and donors channel resources for local development (Agrawal and Perrin, 2009). The focus is on groups of people, who are organized formally or informally and whom can be approached as a group. For understanding why particular strategies are not adopted or why assistance structures may differ per country, use is made of the broader definition of institutions as adopted in the New Institutional Economics literature (see e.g. North, 1990, and Williamson, 2000) in which institutions also cover norms and rules which govern behaviour of households and organisations. In particular the role of kinship (clan, ethnical group), factors affecting commitment among community members and factors affecting market functioning are important in this respect.

## **2.2 Data collection**

For this study, village surveys were performed in Ethiopia and Mali in May 2009 and in Yemen in January 2010.<sup>2</sup> Within each country, six villages were selected in which the field surveys were conducted, institutional stakeholders were interviewed and focused group discussions were organized. The study villages were selected in consultation with ongoing development programmes and national and local authorities. They were selected on the basis of the following criteria:

- Cover the main climate variability related hazards and choose villages with different levels of exposure (e.g. low drought risk vs. high drought risk).
- Cover the main agricultural systems in the country.
- Choose some villages which are participating in ongoing development programmes.

In consultation with local authorities, within each village, 50 households were randomly selected and about 10 institutional stakeholders were identified. Moreover, people were selected for the focus group discussion in such a way that different sexes, age classes and wealth classes were present. In total 901 households were interviewed, about 150 institutional stakeholders were consulted and 18 focus group discussions were organized. Next to that, (inter)national experts were consulted to discuss the set up and results of the study. The data were analyzed using statistical methods (descriptive analysis, cluster analysis and factor analysis).<sup>3</sup>

The household questionnaire contained three categories of questions. First, for creating a household profile, questions were raised on household composition, education, occupation,

<sup>2</sup> See Ruijs et al (2010), De Bel et al. (2010) and Linderhof et al (2010) for a detailed description of the set up and results of the field surveys in Ethiopia, Mali and Yemen, respectively.

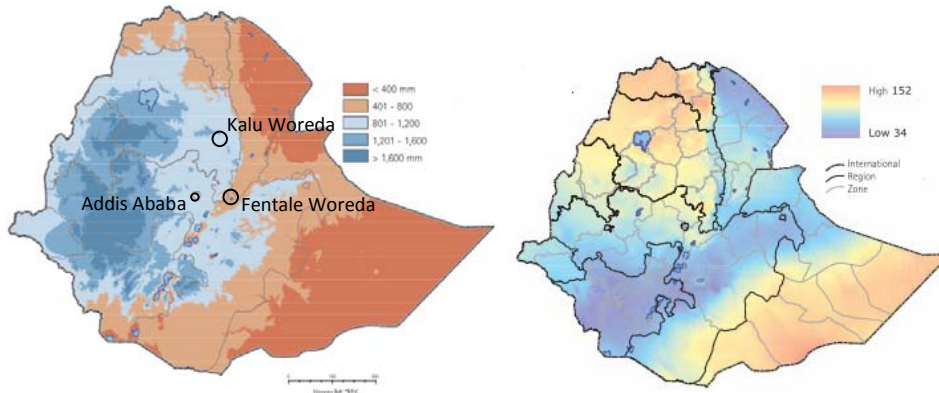
<sup>3</sup> It is to be noted that this study covers observations from six villages in each country. When interpreting the results, it should be taken into consideration that the differences within each country are so large that the results cannot be extrapolated to the national level to represent the entire country. Many of the observations and recommendations made throughout this report, however, do apply to other regions as well and therefore cover not just the study villages.

migratory behavior, crops cultivated, livestock owned and assets owned. Here also information was collected about the types of hazards the household is facing in order to find out whether climate variability related hazards are indeed perceived as important problems. Secondly, information was elicited about the choice of adaptation strategies. Which strategies have been adopted in the past, for reducing which hazard, and what were the necessary investments for this? Finally, questions were raised about the assistance institutions provide for adopting adaptation strategies. Which institutions did assist, what type of assistance did they provide and was this assistance helpful? Questionnaires can be obtained from the authors upon request. The focus of the institutional stakeholder interviews was especially on the types of services they provide, their role in assisting households with adaptation, their linkages with authorities and the main constraints limiting their activities. Finally, in each village, a focus group discussion was organized with a group of between 15 to 20 people. These group discussions give additional information about the perceptions on the main (climate) hazards and their changes; about the reasons for adopting strategies; about the advantages, disadvantages, bottlenecks, strong points or weak points of the different adaptation options; about the institutions facilitating the adoption of strategies; and about differences in strategy adoption between socio-economic groups.

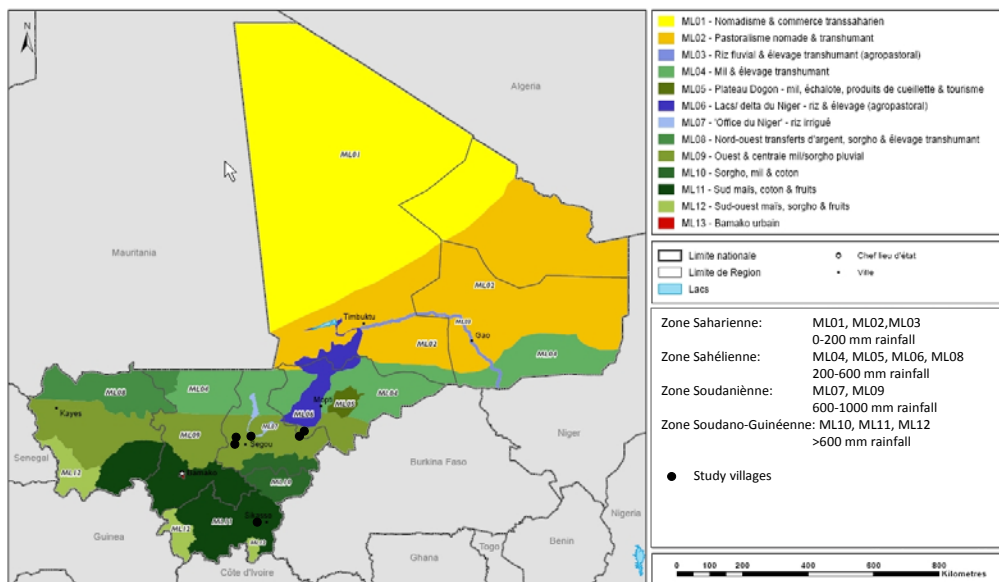
### 2.3 Country profiles

In this section, the main characteristics of the study countries and the regions of the field surveys are discussed. **Ethiopia** is vulnerable to climate variability due to its low adaptive capacity (i.e. low level of socioeconomic development, high population growth and inadequate infrastructure) and heavy reliance on natural resource-based activities. The north- and south-eastern parts of the country are facing lower rainfall and higher temperature levels than the rest of the country (see Fig. 1). Climate variability is mainly manifested through the variability and decreasing trend in rainfall and increasing trend in temperature as observed in the last decades (NMA, 2001, 2007). The major climate hazards observed in Ethiopia include drought, flood, and livestock and human diseases (LIU/DMFSS, 2009). Although flood is more a lowland phenomenon, it is noted that flood in the lowlands are partly attributable to activities in the highlands. Generally, due to the varying rainfall and temperature patterns, the arid, semi-arid and sub-humid lowlands are more vulnerable than the highland areas (see e.g. Admassie et al., 2008; Deressa et al., 2008). If the trend of warming and drying continues, vulnerability among the rural livelihoods is expected to increase.

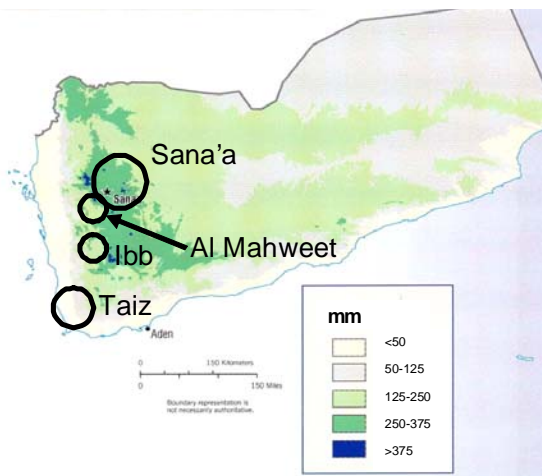
The field surveys are conducted in four kebele in Kalu woreda and two kebele in Fentale woreda (see Fig. 1). In Kalu, villages are selected from the highland and midland agro-ecological zones. The mountainous area is highly degraded and has a bimodal but erratic rainfall pattern. The midland areas have a relatively reliable rainfall pattern which feeds several major rivers. Rain-fed crop production mainly during the *kremt* season (June to mid-September) and livestock are the main economic activities. Fentale is predominantly a lowland area. Crop production is only a recent phenomenon in the predominantly pastoralist region. The main hazards include drought due to erratic and delayed rainfall, crop pests and floods. In Fentale, two villages are selected; one remotely located, pastoralist village, and one village which currently is in a transformation process from pastoralism to sedentary farming.



**Figure 1** Mean annual rainfall (left) and rainfall variability (right) in Ethiopia.  
 Source: Atlas of the Ethiopian Rural Economy, 2006.



**Figure 2:** Agro-ecological and rainfall zones in Mali.  
 Source: FEWSnet livelihood zones Mali.



**Figure 3:** Annual rainfall (mm) in Yemen

In **Mali**, climate variability is very high with extreme periods of drought during the 1970s and 80s. The climate zones more or less prescribe the agricultural potential of Mali (see Fig. 2). An exception is the Inner Niger Delta wetland located in the Sahel and Sudan climate zones which stretches along the Niger river and its tributary the Bani. The country has one rainy season which lasts six months in the south to three months in the northern regions. The country has become hotter and drier over the last decades. Projections show that rainfall levels continue to decline and become more variable and that temperature will increase (Butt et al., 2005; Parry et al., 2007). As a result, both drought and flooding probabilities increase. Even though climate variability has an important effect on the rural environment, also other factors have a significant impact, like increasing population pressure leading to intensified agriculture and changes of social structures due to which mitigation of vulnerability through trusted kinship networks has considerably reduced.

The field surveys have taken place in three regions, covering four farming systems. In the region of Ségou three villages are selected. Two villages are in the Southern Sahel millet based cropping system. Households in these two villages apply rainfed cereal based farming as applied most often in the Sahel region. The area is threatened by desertification. In the third village, households apply irrigation by controlled flooding (submersion contrôlée) managed by the Office du Riz Ségou. From the region of Sikasso, in the Northern Guinean agro-ecological zone, one village has been selected. This village is in a more favourable rainfall zone, faces lower drought risks than the other villages and is located in the area where the cotton cooperative CMDT is operating. In the region of Mopti, two villages are selected, which represent the receding flood farming system (agriculture de décrue). They are situated in the Niger Inner Delta and benefit from the Bani and Niger rivers. The areas face a higher flood risk but also benefit from the water resources for rice cultivation and fisheries.

In **Yemen** rainfall varies widely across the country. Precipitation occurs primarily in spring and summer. Not only rainfall has decreased over a large part of Yemen, the timing of rainfall, the intensity of individual storms, the delay between falls and the frequency of inter-annual variability changed as well in the last decades. When projected annual changes in rainfall are combined with changes in potential evaporation, a new climate regime for Yemen is likely to exist by 2050 (World Bank, 2010d). Yemen can be divided into five agro-ecological regions: Mountain Massif, Eastern Plateau, Desert Regions, Coastal Plains and Yemen Islands. In most areas, the reliability of rainfall is of critical concern, reflected by the fact that little or no truly rainfed agriculture is practiced. In virtually all cases, there is some form of rainfall supplementation, whether tube-wells, hand-dug wells or flood-water harvesting.

The villages selected are in four governorates: Sana'a and Al-Mahweet Governorates in the central mountain massif and Ibb and Taiz Governorates in the southern mountain massif. The southern and western coastal plains and lower mountain slopes have an *arid tropical climate* which is characterized by high temperatures and low precipitation (0 to 400 mm). The lower and upper mountain slopes areas and the eastern plateau region (Taiz, Ibb and Al-Mahweet governorates) have an *arid sub-tropical climate* with temperatures between 16 to 28°C and precipitation ranging from less than 100 mm to 800 mm. Finally, the high mountains ranging from 1,800 to 3,700m above sea level (Sana'a) have a temperate climate with relative low temperatures (10-18°C) and precipitation varying from 200 to 1,200 mm. The field survey was conducted in three villages with rainfed agriculture in the Sana'a, Ibb and Al Mahweet governorates, two villages in the highlands with rainfed agriculture supplemented by spring-irrigation in the Sana'a and Taiz governorates and one village with mixed agriculture in the dryland area in Taiz governorate. The rainfed village in Sana'a governorate is relatively close to the capital. Both highland villages are rather difficult to reach. Even though all villages face a drought risk, this risk is highest for the low lying, dryland village in Taiz.

### 3 COMPARING ADAPTATION IN ETHIOPIA, MALI AND YEMEN

In this section, the results of the field studies are presented. It is indicated to what extent differences within and between the countries explain how climate hazards are perceived and what actions are taken. First, differences in vulnerability are explained. Secondly, differences in strategies adopted are shown and it is discussed why different categories of strategies are adopted. Thirdly, differences in the roles of the institutions are discussed. Fourthly, it is indicated to what extent costs of adaptation options can be financed by the households themselves.

#### 3.1 Vulnerability profiles

For explaining differences of vulnerability within and between the three countries, the villages are compared and clusters of households are distinguished. Differences in village vulnerability are explained by differences in exposure, sensitivity and coping capacity. As exposure and the options to reduce sensitivity are location specific, also household clusters are distinguished based only on coping capacity characteristics. This shows why some households are better equipped to deal with hazards.

The **Ethiopian** study villages show clear differences in the level of vulnerability. Generally, households in the lowland villages are more vulnerable to climate shocks than those in the mid- and highlands. Exposure to drought risk is higher and coping capacities are more limited due to their large household size and low levels of income diversification and education. High erosion makes the highlands sensitive to climate variability. For all villages, drought is the main climate hazard. Also in the highlands, prolonged periods of drought and reduced rainfall levels have appeared more often in the last decade. Not all hazards, however, are directly related to climate. High food prices, soil erosion and animal diseases are important as well.

Vulnerability in **Mali** depends to a large extent on exposure to climate variability. Exposure to drought is highest in the rainfed study villages in the Sahelian rainfall zone in the Ségou area. Sensitivity to climate variability is also high in this area due to a low agro-ecological capacity combined with dependence on agriculture and livestock. Even though exposure and sensitivity are relatively low in the study village in the climatologically more favourable Sikasso area, the households have a limited coping capacity through a strong focus on agriculture. The other three villages in the Mopti and Ségou area, practicing receding flood farming or controlled flooding systems, currently have a medium exposure to climate variability. Furthermore, their coping capacities are better than in the other villages due to their higher rates of migration, cash crop earnings, and income diversification (e.g. from fisheries).

In **Yemen**, the village most exposed, most sensitive and with the lowest coping capacity is the study village in the coastal plains in Taiz. This village scores low on agro-ecological capacity whereas the households have low cash crop earnings, low income diversification and relatively low educational levels. The more exposed villages, however, are not necessarily the most vulnerable. The least vulnerable village seems to be the rainfed agriculture village in Sana'a governorate. They are highly exposed but compared to most other villages, they have a better coping capacity and lower level of sensitivity due to higher cash crop earnings (both from qat and fruits and vegetables), higher land holdings, more livestock, more assets and higher education levels. Least exposed are the two villages in the highlands with a relatively high precipitation, but still vulnerability is very different. Coping capacity is relatively good in the village in Sana'a governorate, with relatively good land holdings, income from livestock and migration and relatively good levels of education. It is worse in the highland village in Taiz governorate, with lower land holdings and also a low income level. Vulnerability in the Yemeni study villages seems to be less dependent on climate exposure but more on other factors. For example, proximity to the capital Sana'a makes the villages in the Sana'a governorate less vulnerable.

From the comparison of the vulnerability characteristics of the different villages two conclusions can be drawn. First, exposure to climate variability is an important factor causing vulnerability among farm households. The three countries lie in the semi-arid regions and are regularly threatened by prolonged periods of droughts and experience years with low levels of

rainfall. For all three countries it holds that the more erratic rainfall and the lower rainfall levels, the higher vulnerability. Therefore, the lowlands in Ethiopia, the Sahelian villages in Mali and the coastal plains and low mountain areas in Yemen have a more disadvantaged starting position compared to the other villages. Climate adaptation policies cannot change this disadvantage. Secondly, many of the other hazards faced by households are related to a mix of climate variability and human induced factors. Increased levels of soil erosion, high food prices and increased incidence of human, animal or crop diseases are indirectly related to rainfall variability. Other hazards, which are seemingly climate related, may be caused by human induced factors. Flood hazards of villages nearby the Malian rivers are partly caused by construction activities in low-lying, flood prone areas. Flood hazards in one of the villages in the Ethiopian lowlands are caused by dikes built to protect neighbouring estates which prevent water from freely flowing towards lower areas. Flood hazards in Ethiopia's highlands and in Yemen are partly caused by decreasing water infiltration due to deforestation and soil erosion. One has to be careful blaming all effects on climate change. Instead of focussing too much on climate adaptation only, in order to obtain a full picture of vulnerability an integrated approach is recommended in which other developmental stresses are accounted as well (Smit and Wandel, 2006; Stringer et al., 2009; Wilby et al., 2009; World Bank, 2010a).

If clusters of households are composed based on coping capacity characteristics only, it becomes clearer which types of households are better capable of dealing with the hazards, aside from the role played by agro-ecological or climatological characteristics which are more or less similar for all households in a region. Within each country, six clusters of households are distinguished using cluster analysis. The clusters emerging from the analysis are described in Table 1. The main characteristics of each cluster are shown in spider diagrams in Fig. 4. These diagrams show that all household types are at least to some extent vulnerable. They show the multifaceted character of vulnerability. The diagrams are set up in such a way that the larger the spider web, the less vulnerable households are. They do not give absolute values of vulnerability, but clearly show the relative differences between the household types from one country. Note that it is not possible to compare household types from different countries.

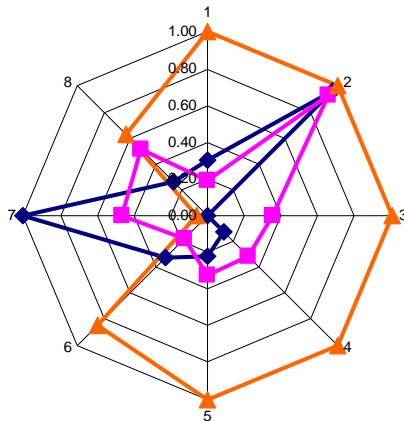
**Table 1:** Household types resulting from the cluster analysis.

<u>Ethiopia</u>
<ol style="list-style-type: none"> <li>1. Low-educated pastoralists: lowland pastoralist households, having a large household size and low migration rates, education levels and asset ownership and cultivating only few plots;</li> <li>2. Young agro-pastoralists: agro-pastoralists, having a high dependency ratio, little temporary migration, low education levels and cultivating average acreages of land;</li> <li>3. Large, landowning households: farmers cultivating a relatively large acreage, having only few children, relatively high education levels, and high migration rates;</li> <li>4. Asset rich households: farmers with average household characteristics, but a relatively high education level and ownership of assets and owning many fruit trees;</li> <li>5. Small, poor households: farmers with a high percentage of female headed households, low education levels and low asset, land and livestock ownership;</li> <li>6. Average household: average farm household having an above average migration rate, cultivating especially cereals and some qat as cash crop.</li> </ol>
<u>Mali</u>
<ol style="list-style-type: none"> <li>1. Educated, wealthy livestock farmers: better educated livestock farmers, owning large herds of small and large cattle, and producing cereals and cash crops.</li> <li>2. Diversified, rich farmers: households which are rich in assets, land holdings, and livestock and which have a diversified income.</li> <li>3. Large fisheries households: households producing cereals and few cash crops, involved in fisheries, and having a high percentage of permanent migration.</li> <li>4. Larger cash-crop growing households: better educated cash crop producers with low migration and a high percentage of cash crops.</li> <li>5. Poor households: households having especially small ruminants, producing cereals and some cash crops, having low levels of education, a relatively high dependency ratio, and low migration.</li> <li>6. Smallholder cash crop growers: smallholder cash-crop growers, cultivating especially cereals and cash crops and owning only few animals.</li> </ol>
<u>Yemen</u>
<ol style="list-style-type: none"> <li>1. Diversified, wealthy farmers with livestock who are better educated, own large herds of cattle, and produce</li> </ol>

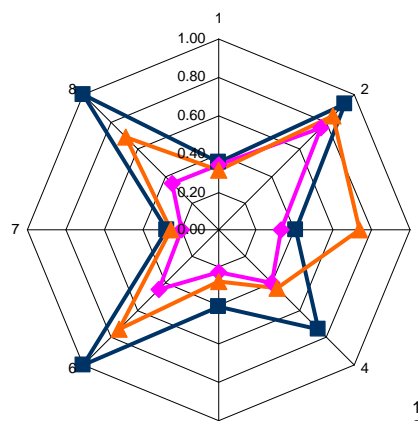
cereals and cash crops (qat);

2. Highland smallholders in the Southern highlands with relatively low land holdings, moderate in asset ownership, and which mainly produce grains;
3. Diversified households with a high share of females and low dependency ratio, rich in land holdings, producing herbs and legumes, and a high share of migration;
4. Highly educated cash-crop growing farmers with a high dependency ratio, small land holdings, relatively many assets and producing cereals and cash crops (qat);
5. Fruit and vegetables farmers producing cereals, vegetables and fruits, with some livestock, a relatively high dependency ratio and relatively low levels of education.
6. Dryland farmers with large landholdings, producing cereals but no cash crops, low in education, owning only few animals and having a high dependency ratio.

### Ethiopia



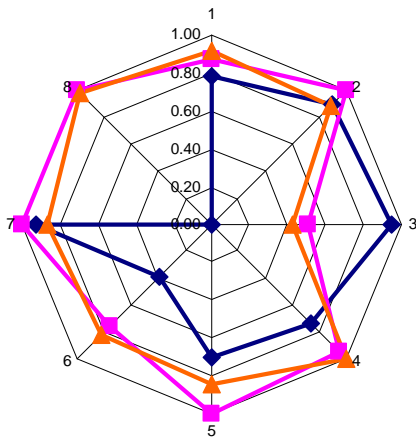
- low-educated pastoralists
- young agro-pastoralists
- large, landowning farmers



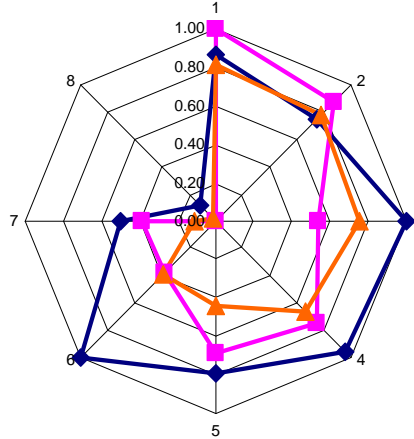
- asset rich farmers
- small, poor farmers
- average farmers

- 1 inverse of dependency ratio
- 2 % of male headed hh
- 3 % of hh with migrated members
- 4 average years of education
- 5 average acreage per hh
- 6 Acreage cash + oil crops and trees
- 7 Livestock (in Tropical Livestock Units)
- 8 Mean asset score

### Mali

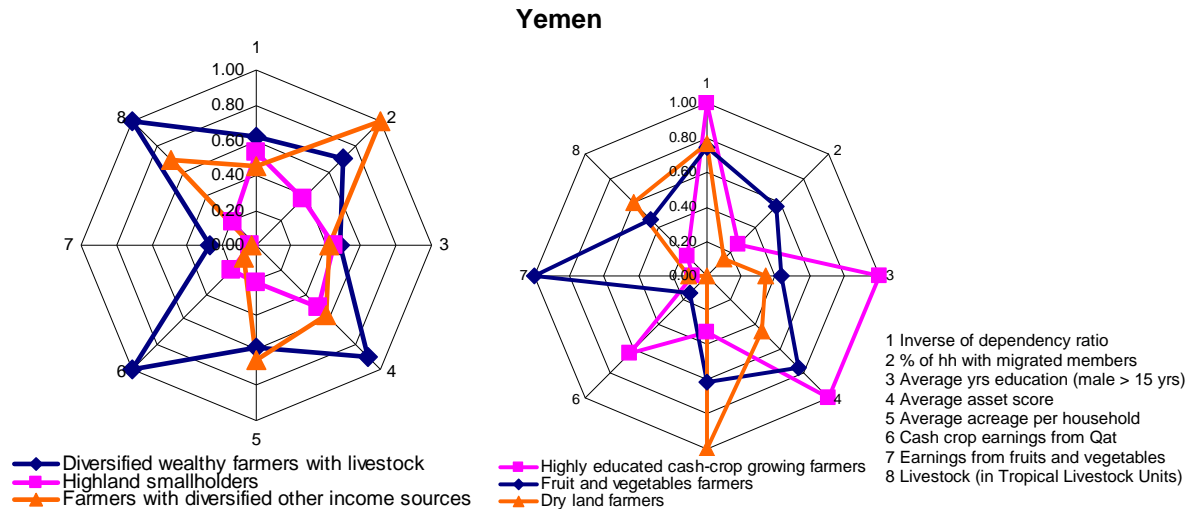


- Better educated livestock
- Diversified rich
- Large fisheries



- Larger cash-crop growing
- Poor households
- Smallholder cashcrop growers

- 1 Inverse of dependency ratio
- 2 % of hh with migrated members
- 3 Average years of education
- 4 Average asset score
- 5 Average acreage
- 6 Cash crop earnings
- 7 Livestock (in Tropical Livestock Units)
- 8 Involvement in fisheries



**Figure 4:** Spider diagrams on the main vulnerability characteristics for Ethiopia, Mali and Yemen.

The spider web diagrams show interesting differences between the different household types within each country. For **Ethiopia**, the following observations are made:

- Most household types are dependent on only one source of income and only have limited fall back options.
- The large herd size currently gives the ‘low-educated pastoralists’ a relatively wealthy position, but climate change may deteriorate their situation, which will be difficult to alter due to their dependence on livestock and low education levels.
- The ‘small, poor farmers’ are in the most difficult position with limited income earning possibilities, little fall back options and a larger percentage of female headed households.
- The ‘large, landowning farmers’ have the highest coping capacity; however, they only cover 2% of the sample.
- The ‘asset rich farmers’ are in a relatively good position as they can fall back on their assets in difficult years and their scope for future improvement is positive due their above average education levels.
- The ‘young agro-pastoralists’ currently are in a vulnerable situation. But once their children grow older, their scope for exploiting more income diversification activities improves.

From this, it follows that differences between household types are substantial for all characteristics. As a consequence, it is difficult to identify which characteristics affect vulnerability the most. From this it follows that it is difficult to identify general limitations for development on which interventions should focus.

For **Mali**, the spider diagrams show the following:

- The ‘poor households’ and the ‘smallholder cash-crop growers’ are most vulnerable to climate change. The ‘diversified rich farmers’ and the ‘large fisheries households’ are the least vulnerable. Their income is more diversified, they have higher cash crop earnings and own more land and livestock.
- For Mali, the dependency ratio and rate of migration are not determining factors of household vulnerability. All households score more or less the same. Education, cash crop earnings and livestock are important characteristics explaining the differences between the clusters. Involvement in fisheries is important for increasing income diversification and thus for coping capacity.
- From the analysis it follows that the ‘better educated, wealthy livestock farmers’ and the ‘poor households’ are living in the three study villages in the Ségou area. In these villages there seems to be a social divide between the better-off and worse-off households. Furthermore,

the fisheries community in the Mopti area is divided into two groups (cluster 2 and 3) which both are relatively well off.

- The 'large, cash-crop growing households' cluster is a relatively small group. They have a less diversified income, but their higher education levels and higher cash earnings put them in a less vulnerable situation.

From this it follows that sensitivity to climate variability and coping capacity are two of the major determinants of vulnerability. Even in regions with a lower sensitivity to climate variability, however, those with a low coping capacity are still in a vulnerable situation.

For **Yemen**, the spider web diagrams show that the clusters vary across the villages.

- The 'diversified, wealthy livestock farmers' and the 'highland smallholders' account for two-third of the respondents in the survey. The first group is the least vulnerable and they are present in all six villages, although most of them are from the village nearest to Sana'a. The second group is most vulnerable. They score much lower on all characteristics, which is a sign that villages are divided in better off and worse off households.
- Most household in the vulnerable dryland village in Taiz are 'fruit and vegetable farmers' or 'dryland farmers'. They are in a vulnerable situation. The 'fruit and vegetable farmers' are somewhat better off as they have a higher and more diversified income. Both household types, however, have low education levels, which gives them a low capability of improving their livelihoods themselves.
- The situation of the "highly educated cash-crop growing farmers" is difficult to assess. Their low dependency ratio and high levels of education and assets indicate they are more capable of deciding about adaptation themselves. Low landholdings and income earning capacities, however, put them in a vulnerable situation.

From this it follows that, like for the other two countries, the social divide between better off and worse off households is based to a large extent on coping capacity and the capacity to reduce sensitivity to climate variability. The worse off groups seem to be in a vicious cycle in which they are hit hardest by climate variability but have the least opportunities to change this situation.

The cluster analysis shows that high exposure does not necessarily cause a high level of vulnerability. Low sensitivity to climate variability and high coping capacity can protect the households against the threats from high exposure. For Mali, the villages close to water resources, having the opportunity to apply irrigation, face lower sensitivity to rainfall variability. Their dependence on flood irrigation, however, still makes them more sensitive than households that are part of (multi)village irrigation schemes or use independent on-farm irrigation systems. Note, however, that communal schemes require good institutional backing to assure sustained operation of the schemes. As will be discussed in the next section, in Ethiopia many households adopt sensitivity reducing measures in order to become less dependent on rainfall variability. In Yemen many farmers apply groundwater pumps to reduce their sensitivity to rainfall variability. Moreover, those living nearer to urban areas have more opportunities to improve their coping capacity.

The analysis also shows that households in areas with low exposure can still be vulnerable if their coping capacity is low. Many of the households in the Sikasso area in Mali are still vulnerable because of their dependence on income from agriculture. If harvests fail, they only have limited fall back options and limited capacities to repay debts from their cotton input purchases. Households receiving remittances from migrating household members, owning more assets and having more diverse income sources (from e.g. fisheries, livestock, trade) have better options to respond to income shocks. Also households having better education levels have better capacities to find alternative ways of living.

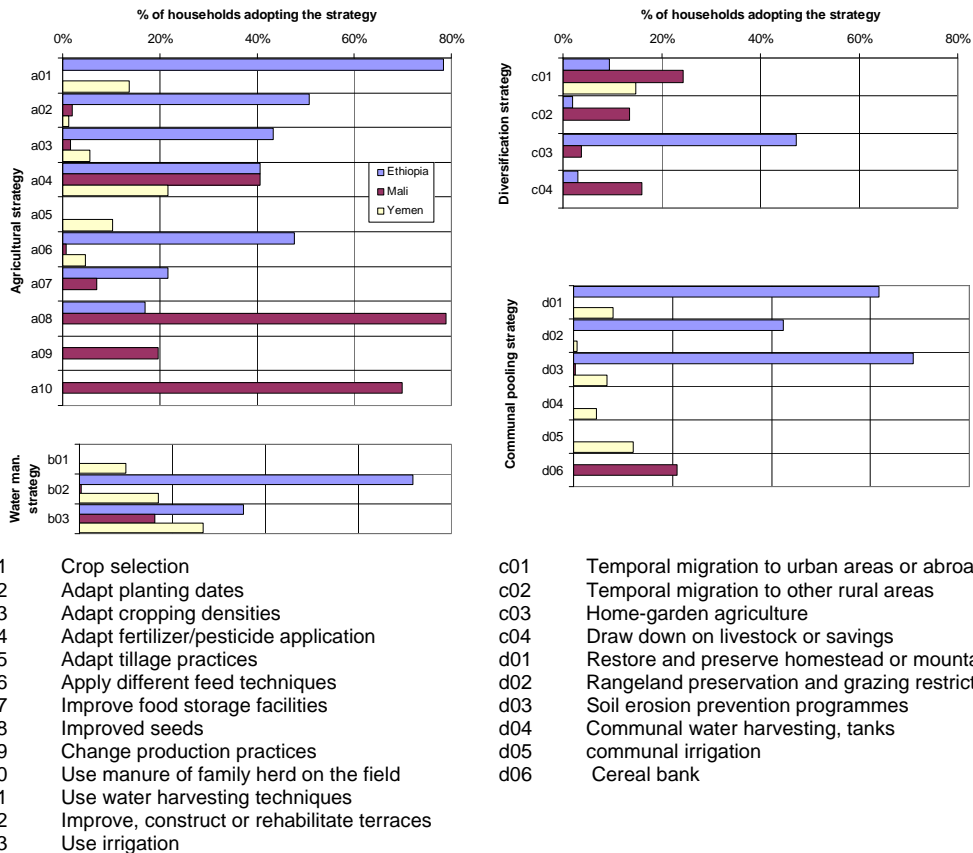
The spider web diagrams give evidence that inter-household differences in Ethiopia and Yemen are larger than in Mali. As a result, for these countries not all groups can be reached with general aid interventions but more tailor programmes will be needed, focussing on particular groups. On the other hand, generally speaking, coping capacities of the Malian households seem

to be better than in most of the Ethiopian households. Households are larger, migration is more common practice, more households own some cattle and (in the study villages) almost all households cultivate some cash crops. In Ethiopia, the lowland households transforming from pastoralism to a sedentary mixed farming-livestock system acknowledge the importance of income diversification. In many of the other villages, households still focus on livestock or agriculture instead of broadening their income sources. In Yemen, differences between households are also large. Proximity of Sana'a seems to be beneficial for households and many households benefit from cash incomes from qat sales and migration. Within villages, differences may be large. For designing appropriate, tailor-made aid programmes, attention should be given to the particular constraints households face. As the data show that better educated households are in a better position, improving school enrolment remains an important development priority.

Finally, based on the survey, it is difficult to judge the position of women in the different household types. A disadvantage of the small household sizes in Ethiopia is that women have few fall back options if they become single. On the other hand, the results indicate that Ethiopian women have a greater influence in household decision making than in the other two countries. In Mali, the larger household sizes may serve as some sort of insurance as women can support each other in difficult times. There is, however, also evidence of hidden poverty in extended households because of hierarchical differences. In Yemen, due to cultural reasons, women only have a marginal vote in household decisions even though their role is important in nearly all household tasks. When designing gender specific development programmes, attention should be given on how to reach the most destitute groups, especially for Yemen.

### **3.2 Adaptation strategies**

The field survey clearly shows that the number and types of strategies differs between the three countries. The number of different strategies in Mali is much smaller than in Ethiopia (3.5 versus 8.5 per household), while in Yemen households hardly use any strategies (on average 1.7 strategy per household with 40% of the households adopting no adaptation strategy at all). Fig. 5 shows the differences between the three countries and shows what category of strategy is adopted the most (agricultural, water management, diversification or communal pooling). There are some country specific patterns. Individual water harvesting techniques are adopted in Yemen more than in the other countries. In Ethiopia, water harvesting techniques are currently promoted by the extension programmes, but they are still not adopted by many households. Improved seeds are adopted especially in Mali, whereas in Ethiopia and Yemen households switch to more drought resistant crops if necessary. One could conclude that Malian households, especially those in the Sahelian regions, already have switched from sorghum to more drought resistant millet. The other countries are still in this process. In Ethiopia, more effort is put on solving the problem of deforestation. This is a typical example of an institution-based strategy which individual households will not easily adopt and which requires the presence of effective institutions.



**Figure 5:** Bar-diagrams showing the percentage of households adopting a particular strategy for Ethiopia, Mali and Yemen.

In Mali, the selected strategies are mostly individual strategies, while in Ethiopia and Yemen there is a mix between individual and communal strategies – see Fig. 6 which shows the main strategies adopted in the study villages according to the characteristics communal versus individual and coping capacity enhancing versus sensitivity reducing. In Mali, only one of the top-5 strategies is a communal strategy (cereal bank). Water management strategies, which usually are communal strategies, are rarely used, even though they are expected to have positive benefits in climate zones where drought is one of the major threats to peoples' livelihoods<sup>4</sup>. Communal actions seem to be difficult to set up in the Malian study villages. Households seem to be much more on their own. Well-functioning individual strategies may spread throughout the community, but jointly implemented strategies, which require cooperation between neighbours and community members, do not occur regularly. Communal actions need on the one hand investments and training from external institutions, but on the other hand a sense of urgency and a feeling of ownership from the side of the households. In Mali, this seems to be less well developed than in the other countries.

For Ethiopia, three of the top-5 strategies are communal strategies that have to be implemented jointly with other households and often with the help of institutions. This shows that in Ethiopia, institutions play an important role in improving livelihoods in the villages. Similar conclusions are drawn in Deressa et al. (2008) and Bryan et al. (2009).

Although for Yemen there also is a mix between individual and communal strategies, in general very few strategies are adopted and differences between households are large, which makes it difficult to assess them. Impressions from the field are that in Yemen few innovations are

<sup>4</sup> Note that the irrigation techniques used in the study villages are mainly flood dependent which only require limited management.

used in the efforts by the households to reduce vulnerability. Especially the percentage of households that do not make use of adaptation strategies is considerable. Apparently, there still is much less attention for climate adaptation in Yemen than in the other two countries. Recently, a number of multi-donor programmes have started focussing especially on this issue. Due to a lack of institutional backup, Yemeni households do whatever they can, even though this is limited, especially for the worse off groups.

In Ethiopia, the attention for adaptation is stronger which results in more and more diverse strategies. Awareness of the issues at stake and the options available seem to be different between the countries as well, showing the importance of awareness creation. It is noted that communal strategies are important, as they may create conditions under which individual strategies become more efficient. Soil erosion prevention, reforestation, communal irrigation, terrace rehabilitation have public good characteristics. All community members benefit from better agro-ecological conditions whereas nobody can be excluded. When initiating such activities, effective institutions are necessary which have to create commitment among community members and account e.g. for free rider behaviour. Moreover, attention should be given to the worse off households who seem to have less access to communal strategies.

<b>Coping capacity increasing</b>	
<b>Individual strategy</b>	<p><b>Ethiopia</b> 7. Home garden agriculture (47%)</p> <p><b>Mali</b> 4. Temporal migration to urban centres (24%) 7. Reduce livestock/savings (16%) 9. Temporal migration to other rural areas (14%)</p> <p><b>Yemen</b> 4. Temporal migration to other rural areas (15%)</p>
	<p><b>Ethiopia</b> 1. Crop selection (78%) 5. Adapt planting dates (51%) 6. Adapt feed techniques (zero grazing) (48%) 8. Adapt cropping densities (43%) 10. Adapt fertilizer/pesticide application (41%)</p> <p><b>Mali</b> 1. Improved seeds (79%) 2. Use of manure of family herd on the fields (70%) 3. Adapt fertilizer/pesticide application (41%) 6. Change production practices (20%)</p> <p><b>Yemen</b> 1. Use irrigation (26%) 2. Adapt fertilizer/pesticide application (22%) 6. Adapt tillage practices (10%) 7. Use water harvesting techniques: roof water collection, tanks (10%)</p>
	<p><b>Ethiopia</b> 2. Improve, construct or rehabilitate terraces (72%) 3. Soil erosion prevention (69%) 4. Restore and preserve forests (69%) 9. Rangeland preservation / management (42%)</p> <p><b>Mali</b> 8. Use irrigation (16%)</p> <p><b>Yemen</b> 3. Improve, construct or rehabilitate terraces (18%) 5. Communal irrigation (12%)</p>
	<b>Communal strategy</b>
<b>Sensitivity reducing</b>	

**Figure 6:** Adaptation strategies adopted by households, categorized by individual vs. communal strategies and sensitivity reducing vs. coping capacity increasing strategies. Only strategies adopted by at least 10% of the households are shown.

From Fig. 6, it also follows that in all three countries households focus on individual, sensitivity reducing strategies. Moreover, the sensitivity reducing strategies are quite similar between the three countries, even though percentages of households adopting the strategies differ substantially. These are predominantly individual strategies aimed at introducing improved agricultural techniques on the farm level. Although the individual strategies are similar, e.g. for the strategy “crop selection” or “improved seeds”, there can still be considerable differences between the countries in the actual crops that are selected or the type of seed improvement that best fits the characteristics of the region and preferences of the population. Also optimal cropping

strategies, planting dates, cropping densities and fertilizer/pesticide application are dependent on regional characteristics. As a result, these strategies should be promoted in all three countries, even though their exact implementation is region and culture specific. Similar results are observed by Stringer et al. (2009) for case studies in southern Africa.

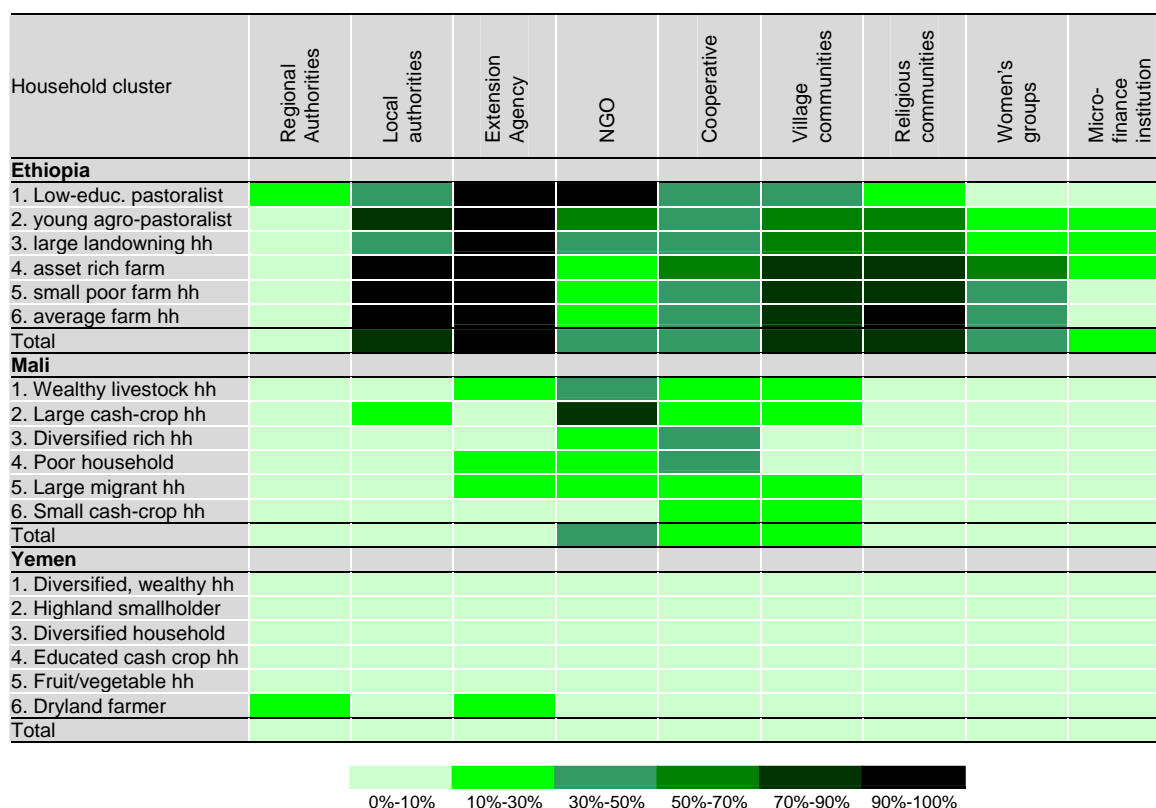
Compared to the other two countries, in Mali, more emphasis is put on coping capacity increasing strategies, even though this is mainly limited to migration. Most of the regions in which the study villages are located only allow for a limited number of strategies to diversify income. Due to low income levels, the consequential low levels of household demand and underdeveloped or malfunctioning market institutions (like credit markets, input markets and infrastructure), there is only limited scope for broadening the strategies households can choose from to diversify their income. This is an important reason why migration is such a commonly used coping strategy. Due to the skewed focus on sensitivity reducing strategies, households will remain dependent on only one income source which is highly dependent on climatic factors. In order to reduce vulnerability more, it is recommended to continue efforts to improve coping capacities and take away the constraints which prevent households from adopting these strategies.

The results show that strategy choice is gendered and wealth dependent. In Yemen, men make most decisions and the role of women is marginal. Also in Mali men make most decisions, but women play roles particularly in some activities like handicrafts and petty trade. In Ethiopia, women play a larger role. They especially decide about trade, handicrafts and home-garden agriculture, but they are also involved in decisions about agriculture. Next to that, results for all three countries show that the more marginalized and remote villages and the more marginalized groups invest less in adaptation strategies than the better off households. Better off households not only invest more resources in their livelihoods, they also spent more money and time on soil erosion prevention and water management strategies. They have easier access to institutional assistance and are better capable to mobilize community members to jointly initiate activities. For assuring that interventions reach the target groups, it is important that institutions target their activities to those groups making the decisions and implementing the strategies. This means that for particular strategies women have to be approached. Moreover, it is important that particular attention is paid to the needs of the worse off groups.

### **3.3 Institutional assistance**

Institutional coverage and types of institutions present differs per country. The type of institutions most prevalent in each of the countries is partly explained by government policy. The extension services in Ethiopia, supported by large-scale, integrated development programmes, have a strong and extensive network of agencies covering a large part of the country – see Fig. 7 and 8. Those regions not or marginally covered by the extension services host a higher number of NGO's. In Mali, the extension services have a much weaker network. They cover fewer regions, seem to have fewer resources and reach fewer farmers. They also seem to have less well coordinated development programmes. In Yemen, households in the study villages hardly have contacts with the government institutions. Also NGOs are not consulted regularly. Households seem to be much more on their own without much help from any institution, except for the informal community institutions (clan and neighbours). Community institutions in Ethiopia also play an important role. In Mali, communities seem to be much more loosely organized. Due to the large household sizes and high rates of migration, strong community links seem to have become less important. Micro-finance institutions, through formal institutions or as part of community institutions, are important in Mali and Ethiopia. In Yemen, financial capacities of households seem to be larger, among other things due to the cultivation of qat and other cash crops. The growing role of formal micro-finance institutions may be a sign that the financial requirements of modern adaptation strategies outweigh the capacity of informal institutions. As these, more innovative strategies, require more financial means, the role of micro (or meso) finance institutions may become more important in the future.

Differences in the role of institutions between the three countries are partly explained by historical and political reasons. Rural presence of authorities has always been much more prevalent in Ethiopia than in Mali or Yemen due to which spreading knowledge and planning development assistance in Ethiopia can be done in a much more coordinated way. In Mali, development assistance is scattered over a large number of organisations and funded by a large number of donors and it lacks the integrated, multi-donor, government coordinated development programmes such as in Ethiopia. For Yemen, the clan culture explains why authorities only play a minor role in some parts of the countries. As a result, the recent initiatives to set up integrated, nationwide development programmes will be a challenging job and should include at least the set up of a network of trustworthy extension agencies with minimum political interference, which have the assurance of long-term financing and planning.

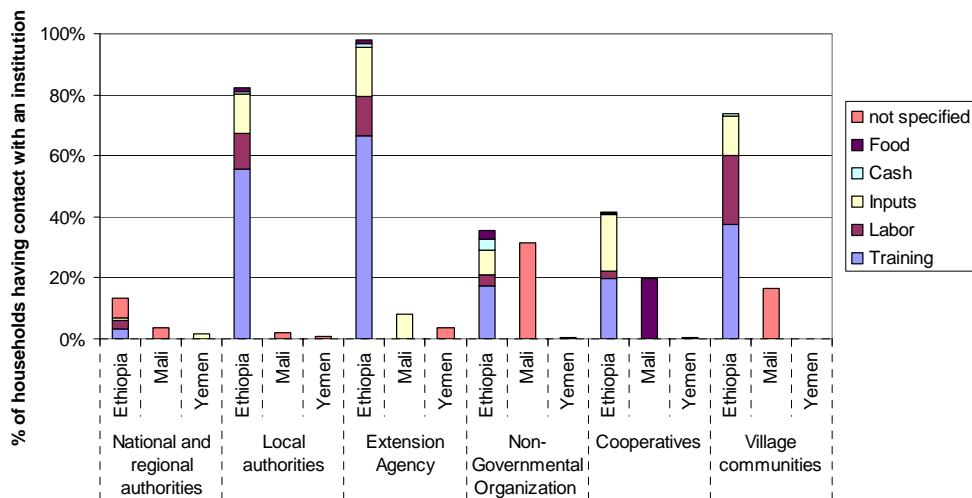


**Figure 7:** Percentage of households having contacts with institutions.

In all three countries, there is evidence that the better off households have easier access to the services provided by the institution. In Ethiopia, the somewhat better off, 'large, land-owning farmers' and 'asset rich farmers' clusters have more contacts with the village community. This indicates that they, who also adopt communal strategies more often, have the strongest position in the informal community institutions and that they better succeed in bringing their requirements forward. Accessibility to the community institutions is more difficult for the marginalized groups, especially for the female headed households, or these groups lack information on the assistance the village community can offer. In Mali, especially the NGO's and village communities provide assistance to the cluster of poor households in terms of assistance to adopt adaptation strategies. International donors, national authorities and religious communities are not mentioned as institutions that are in contact with the households. However, from the interviews with the institutional stakeholders, it follows that many of the institutions that are in contact with the households receive financial and sometimes technical support from the national authorities and international donors. For Yemen, it seems as if the better off households (cluster 1 and 5) have

somewhat more contact with institutions than the worse off households; these results, however, are not significant. Next to the few 'outsiders' who provide help to the households, the respondents indicate that they receive some help or cooperation from neighbours or people from the clan group. Even though these are community institutions, the respondents apparently do not judge them to be an institution. The low institutional coverage and dependence on kinship is well known in Yemen. In rural Yemen, the role of the national government is often contested and officials are suspected, due to which setting up national extension services is difficult.

Moreover, the results also show that institutional access is gendered. Especially in Ethiopia and Mali, female headed households and households with a larger share of adult women adopt fewer strategies than male headed households. These lower adoption rates are valid for all strategies but especially so for the more demanding strategies like irrigation. Female dominated households do adopt more often strategies like handicrafts and charcoal sales. Unfortunately, they also receive less assistance from institutions. In Ethiopia, this is especially so from authorities, extension agencies but also from the community institutions and women's groups. This is partly compensated by extra attention received from religious institutions and micro-finance institutions. In Mali, especially extension agencies provide less assistance to the female dominated households. When targeting assistance, donors have to pay special attention to the question how to reach female dominated households.



**Figure 8:** Percentage of households having contact with an institution. The subdivision of the bars shows the allocation of the types of assistance households receive.

The type of assistance provided by the institutions differs across countries. In Ethiopia, extension agencies provide assistance especially in terms of training, which improves the skills of household to improve their own situation. Other tasks, like input provision is especially done by cooperatives and cash provision by NGO's and formal microfinance institutions. It seems that the informal micro-credit, community institutions are less important for obtaining cash; the cash requirements may outweigh their capacity due to which formal institutions have to be approached.

In Mali, assistance is predominantly given in the form of inputs like seeds, fertilizers and pesticides. Training is virtually absent in the listing of assistance received by the households. Although from the institutional stakeholder interviews training was mentioned as an activity that was provided to the households. Apparently, the households do not envisage this as training. It seems that development assistance in the Malian study villages is focussing more on setting up top-down initiatives, in maintaining traditional cooperative institutions and providing inputs. Also trade organizations such as the Compagnie Malienne pour le Développement des Textiles (CMDT) focus more on input provisioning than on training to improve peoples' capacities. This

approach gives an advantage especially to the people that already have a more than average education. They are better capable of identifying the opportunities to improve their livelihoods.

In Yemen, most of the adaptation strategies adopted by the households were financed and realized by the households themselves using their own resources. Formal institutions hardly provided any assistance in terms of training, inputs or cash. Only people from the community helped each other through the provision of labor for rehabilitating terraces and setting up irrigation or water management measures. The low number of strategies adopted may partly be explained by this low institutional coverage. Households adopt the strategies they know and of which the majority is applied already for centuries and only few modern strategies are adopted. Households often lack the knowledge, awareness and financial means to adopt such strategies. Moreover, it often is difficult to adopt them due to malfunctioning markets. Because of the virtual absence of formal institutions, reducing market problems is difficult.

The analysis shows that for many strategies cooperation is needed between the households and institutions. Even for cheap and individual strategies like seed selection or the adaptation of planting dates, implementation is expected to be more successful if back-up is provided by institutions in terms of training and knowledge transfers. In Ethiopia extension agencies play such a role – see Fig. 8. In Mali, training is almost absent but institutions fulfil other tasks, like providing inputs. In Yemen, the institutions are almost absent and households are more or less on their own. Next, for the communal strategies commitment is very important. It requires a sense of ownership on the side of all stakeholders and the will to cooperate. More training and knowledge transfer about the pros and cons of the different strategies helps improving this sense of ownership and stimulates households to make their own choices. Moreover, some communal strategies require substantial investments in terms of money or labour input. It depends on the strategy whether institutions provide these investments or whether they are (partly) financed by households. Most commonly observed constraints for all strategies are the financial constraints and the difficulty to obtain affordable loans by the households and managerial and budgetary constraints by the institutions. Solving these constraints requires intervention from higher level institutions. When properly targeting interventions, account should be given to these constraints. Adaptation strategies will not be successful if these constraints are not resolved.

The different institutions play different roles that depend on the level at which they aim their intervention. Institutions do not operate individually but are part of a network of institutions that support and depend on each other. The central government has a role in realizing a better functioning social and market environment (e.g. improved roads, telecommunication, input and output markets, credit facilities, veterinary facilities and meteorological information dissemination). These options provide the enabling environment needed for a well functioning society. Other institutions aim their interventions at the household level. Households need support in terms of training, financial support, techniques and inputs which give them the skills and means to improve their situation themselves in a sustainable way. This level of intervention is mostly done by NGOs, extension agencies and community organisations. Institutions have to be aware of their role and their position and responsibilities in the network of nationally operating institutions. If these roles and responsibilities are formulated clearly, institutions can be held accountable for their activities and it can be checked whether all tasks to come to a successful development strategy are covered. In Ethiopia, the ramified network of extension agencies, that covers almost all of the households in the villages where they are working, and that is supported by nationally operating, integrated development programmes, is an important asset. It gives the authorities the means to reach the households in a relatively easy manner. Moreover, the broad focus of the safety net programmes, which make investments both in the public (roads, irrigation canals) and in the private domain (assistance households with their individual household strategies), is a promising strategy. It strengthens the enabling environment and households' capacities to improve their own situation.

### 3.4 Costing adaptation

The household surveys provide insight into the types of investments the stakeholders have to make for implementing adaptation strategies. For many strategies, households are not, or only to a limited extent, capable of selecting and implementing these themselves. Households may lack the knowledge, the skills, the labour or the financial means. Given the general lack of information about the costs of implementing adaptation strategies, the sensitivity to ask this type of information from households and the low response rate on these questions, it has not been possible to elicit reliable quantitative costing information on the different adaptation strategies. Reliable costing information from other sources is also almost nonexistent. For these reasons, a qualitative cost assessment per household is provided here.

In order to properly interpret the qualitative costing assessment, one has to be aware of the limited investment capacity of most of the households in all three countries. Average cost observations for adaptation strategies in Mali are in the order of XOF 110,000 (\$200) per household, which is mainly caused by the high investment costs for cereal banks (without cereal banks average costs are XOF 63,000 or \$120).<sup>5</sup> For Ethiopia, average cost observations are in the order of Birr 780 per household (\$57). Without the communal strategies, costs per household are Birr 575 (\$43). For Yemen, the irrigation schemes are costly (YER 680,000 = \$3000). The other strategies are much cheaper and in the range of YER 40,000 per household (\$182). As discussed above, these numbers should not be interpreted as the investment costs for the adaptation strategies as these should also include the regular costs made for e.g. seed, fertilizers and labour, of which labour is generally not seen as 'cost' by the households. On the other hand, especially for Mali and Ethiopia, the costs provided by the households seem to be rather high as their earning capacities are generally rather low. Moreover, in all three countries, rural households spend 50% to 80% of their income on food, due to which only a limited amount of money remains for making productive investments.<sup>6</sup>

The results show that low-cost strategies for which households expect immediate gains are already selected by many households. This is especially true for sensitivity reducing agricultural strategies (e.g. seed selection, change planting dates, change cropping densities). For these strategies, little institutional assistance is required. Training, however, may improve efficiency. Furthermore, institutions can play a role in mitigating some of the constraints, like malfunctioning markets which constrain the purchase of inputs or sale of proceeds. Without assistance, adoption of strategies may reach a saturation level and new innovative strategies, for even more severe climatic variability, may not be developed. Given the low adoption rates of communal and more encompassing strategies in Mali and Yemen, the results already give some evidence for this. The most common individual strategies are mostly adopted, but the essential back-up is lacking to initiate the more demanding communal strategies. In order to prepare the households in Mali and Yemen for future adverse climatic variability, cooperation between households and institutions is necessary in order to develop new innovative strategies that will meet the new challenges.

There are several other promising low-cost strategies, like handicrafts or non-timber forest product commercialization which are selected by only few households. Also home-garden agriculture is a technique that could be selected by many more households and which is expected to have high benefits both in nutritive value as cash earnings. There may be several reasons why expected benefits turn out to be negative:

- markets for these goods may be too distant or malfunctioning;
- inputs may be difficult to acquire if markets are missing;
- households may lack the knowledge to implement the strategies;

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<sup>5</sup> Exchange rates for December 2010.

<sup>6</sup> For Yemen, expenditures on food are estimated to be on average 45% of household income rising to 60% for the poorest quintile (WFP, 2010). For Mali and Ethiopia, average food expenditures reach 75% of household income, rising to 82% for the poorest quintile (Kpodar, 2006; World Bank, 1998). With average income levels for Ethiopia and Mali ranging between \$150 and \$250, households only have a limited investment capacity. In Yemen, with an average income of around \$1,000, investment capacities are somewhat larger.

- for home-garden agriculture, households may lack seeds, irrigation/watering equipment or storage techniques to make it a successful strategy
- home garden agriculture may not be adopted because of coinciding peak labour demands with other farm activities;

Alternatively, households may not perceive the focus on coping capacities as being useful in reducing their vulnerability even if net benefits are positive. For most people, agriculture has been the main income source already for decades, without any major additional income source (maybe except for migration). It is not evident that people easily initiate new income earning activities, especially if an enabling environment for this activity is missing and if education levels are low. As shown in Section 3.2, in all three countries only few coping capacity improving strategies are adopted. Again one can observe the important role of both formal and informal institutions in the adoption of these strategies, as these institutions can provide e.g. training, raise awareness and promote good examples.

The more expensive individual adaptation strategies, like the use of water harvesting techniques, improved food storage facilities and the use of individual irrigation (e.g. pumps) are also constrained by knowledge and credit availability. Many of these strategies have positive expected net benefits but face financing constraints and require higher skills. For Yemen, the use of pumps for irrigation is in many regions a necessity to cultivate crops. Households do not receive institutional assistance but use income from cash crop sales. So, on the one hand cultivating cash crops provides them with the cash income to improve their coping capacities in more difficult years. On the other hand, cash crop sales are a necessity for earning sufficient cash in order to operate and maintain the pumps. This necessity also creates a new vulnerability as the risk of bad harvests may cause financial problems. Due to this additional hazard, rural households not always are keen to engage in financing schemes (Stringer et al., 2009). In Ethiopia, several of these more expensive strategies are adopted in cooperation with the (non)governmental institutions active in the area. In Mali, the more expensive individual strategies are hardly used, while required institutional assistance for these strategies is lacking.

Implementation of communal strategies requires coordination between households in order to avoid free rider behaviour and share the costs and benefits in an equitable way. Expected net benefits of these strategies are in many cases positive, but they are constrained by financing and managerial skills. Such projects often have high costs which cannot be raised by the participating households themselves and which can only be recovered over several years. For that reason, the involvement of (non)governmental institutions is necessary to provide required skills development and credit services. In the three study countries, only in Yemen strategies that require significant financing are adopted without much assistance from formal institutions. Additionally, this type of project often requires technical skills that most households do not possess. Moreover, informal community institutions play an important role in safeguarding sufficient commitment among participating households. The longer term investments (in terms of money and labour) to operate and maintain e.g. communal irrigation schemes, require commitment among all participants. This also implies creating a sense of ownership among the participants to assure that the strategies can also be applied in the long run. Under pressure of changing economic circumstances in each of the three study countries, social networks have changed. This has had effects on social cohesion and therefore commitment to jointly initiate investments. It is expected that more training and knowledge transfer on the requirements and pro's and con's of the different strategies helps improving this sense of ownership and stimulates households to make their own choices. Finally, (non)governmental institutions implementing these communal strategies should strive to have their presence and involvement assured over a longer period. For this, it is important to have coordinated, long term and integral commitment from international donors.

From the above, three conclusions can be drawn. First, low cost, individual strategies, having low requirements for labour and skills, are already adopted by almost all household types in the study

countries. Although monetary benefits will be limited, the strategies especially reduce sensitivity of the households and thus limit climate related hazards.

Secondly, adoption of promising strategies, even though their expected net benefits are positive, may be constrained by financial, labour or knowledge requirements. As discussed above, these strategies have different types of cost elements, each of which may constrain adoption. Relatively wealthy household types, usually having more cash income, more assets, more cash crop cultivation and more diversified income sources, can adopt the more expensive strategies that reduce their sensitivity or increase their coping capacity. Larger households, with many productive household members, can adopt strategies that are more labour demanding. Higher educated households, having a larger share of household members who attended at least primary education, are better capable of choosing the strategies that best fit their livelihoods. Interference from formal and informal institutions may lessen some of these constraints. It requires, however, tailor made strategies of the institutions, targeting carefully the different constraints to strategy adoption.

Thirdly, implementation of communal strategies requires back-up of formal and informal institutions. These strategies require awareness raising, creation of commitment, technical expertise, financing support and managerial back-up. Each of these cost elements may limit the successful implementation of communal adaptation strategies. Long-term commitment and integrated coordination by the international donor community may lessen some of these constraints. Some of the requirements are specific for particular strategies; others are more general investments in public goods necessary to create an environment that is suitable for sustaining adaptation strategies.

#### **4 CONCLUSIONS AND RECOMMENDATIONS**

The field studies in Ethiopia, Mali and Yemen generated a number of insights into differences in household vulnerability, adaptation strategies adopted, reasons why promising strategies may not be adopted and the type of assistance institutions provide. These insights make it possible to draw conclusions on why particular patterns are observed and provide recommendations on possible directions for future interventions on the level of household strategies and on the level of the role of institutions.

The first important finding from the study was that household characteristics often are more important determinants of vulnerability than exposure. In the three study countries, drought is the major climate related hazard faced by the households and the majority of the households see droughts to be a larger threat than flood hazards or extreme rainfall and extreme temperatures. Nevertheless, households less exposed can still be very vulnerable if they are sensitive to climate variability or have a low coping capacity. Therefore, for interventions, it is recommended to focus both on sensitivity reducing and coping capacity enhancing measures. Sensitivity to climate variability can be reduced in mountainous areas by investing in water infiltration improvement measures (e.g. soil erosion prevention, terrace rehabilitation) and in water management techniques (water storage and irrigation). Coping capacities are improved when households have more income earning opportunities and higher education levels. Especially investments in education should remain an important priority in all three countries.

The second important finding is that interventions should be targeted to particular groups and their characteristics. Especially in Yemen and Ethiopia, differences in household characteristics within and between villages are considerable. As a consequence, within each of the villages a diverse set of strategies has to be promoted that considers the differences in characteristics between the households. In all three countries, the worse off households have in general more difficulties in adopting the more demanding, the communal and the more expensive strategies. Moreover, roles of men and women differ between the three countries. Where men make almost all decisions in Yemen and Mali, the role of women in Ethiopia seems to be more important. However, women generally receive less assistance from institutions than men. For these reasons, it is important that interventions are targeted, considering strategies on how to

reach the most vulnerable groups, including women. Without their involvement some low cost strategies making the households less sensitive (e.g. seed selection, changed planting dates) or increasing coping capacities (e.g. home garden agriculture, petty trade) will be adopted less successfully by these households.

As for the role of institutions, the results suggest that effective institutions are necessary for successful implementation of new strategies. Well functioning formal and informal institutions improve efficiency of adoption of even the traditional, low-cost strategies that have already proven their value (like adopting drought resistant crops and adapting planting dates). Moreover, formal institutions can assist governments and households to overcome some of the market, financing and knowledge constraints which prevent the creation of an enabling environment in which new initiatives can sustain. Currently, adaptation initiatives may be hampered by poorly functioning markets (including credit markets), low quality infrastructure (road, electricity and telecommunications) and low purchasing power. These constraints can only be overcome through public investments with the help from a well functioning network of institutions.

The results suggest that four conditions are important: 1) strive for a high level of coverage of formal institutions over the country and a strengthening of informal institutions within the villages, 2) ensure long-term presence of institutions in the villages, 3) coordinate institutional activities and make cooperation between institutions the norm and 4) do not make input provisioning and financial aid the institutions' main task, but invest in training and awareness raising.

Firstly, better institutional coverage over the country and within the villages leads to the adoption of both an increased number of strategies and a more diverse set of strategies. The number of households adopting strategies and the number of strategies adopted per household varies significantly between the countries. Ethiopia has used more community based and more innovative strategies. Mali and Yemen where support through institutions is small (Mali) to negligent (Yemen) households stay with more individual and "proven" strategies and strategies that can be realized within own resources. With higher coverage, also the worse off households can be identified and reached.

Secondly, longer-term presence within the villages is necessary for building trustworthy relationships with the village households and for creating commitment among the households. This is necessary to jointly improve livelihoods and prove the additional gains that can be reached through cooperation on the more demanding and communal strategies. Especially for the worse off households, adoption of the more demanding strategies like communal irrigation, reforestation, soil erosion prevention and terrace rehabilitation, is hampered by a number of managerial, knowledge and technical constraints which can only be overcome through a long-term presence of institutions.

Thirdly, coordination and cooperation between institutions makes it easier to reach more households. Promoting adaptation strategies requires institutional cooperation on three levels.<sup>7</sup> At the informal community level, (informal) community institutions play an important role in setting up community strategies and spreading good practices over the households. Informal community institutions are necessary for creating and maintaining commitment among all households, also the worse off households, which is essential for setting up and maintaining community strategies. For Mali, these community institutions play a much smaller role than in Ethiopia. For Yemen, the strong clan culture explains why communal strategies like terrace rehabilitation and irrigation are applied without much outside assistance. At the regional level as many villages as possible have to be covered by either extension agencies or NGOs. The network of extension agencies in Ethiopia is a good example. In Mali, institutional assistance is scattered over a number of non-governmental institutions making it more difficult to set up well coordinated programmes. At the national level, national coordination of interventions can avoid duplication of work, makes it easier

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<sup>7</sup> It is noted that the ABDCC-study also concludes that assistance to households has to include cooperation between community-based organizations, local administrative and technical services, traditional rulers, civil society organizations as well as NGOs (see World Bank, 2010b).

to communicate 'lessons learned' and makes it possible to raise the macro-level constraints to the relevant authorities. It depends on the country context whether it is best to realise this through formal, government related extension agencies (like in Ethiopia) or through non-governmental channels (like in Mali).

Fourthly, despite its importance, many institutions do not provide training. Training and awareness raising are important ways to provide households with the knowledge and skills to make their own informed choices and to create a sense of ownership of the strategies adopted. Without a sense of ownership, households will most often remain dependent on institutional assistance. Both in Yemen and in Mali, training by institutions is virtually absent. The Ethiopian network of extension agencies is an interesting example as it invests, next to individual assistance, also in communal strategies (e.g. irrigation schemes or community reforestation) and public infrastructure (e.g. roads and electricity). They not only improve household skills but also relieve some of the public constraints limiting the adoption of particular promising strategies. In Yemen, recent initiatives have a similar focus as the multi-donor, integrated development programmes in Ethiopia.

To conclude, the results of this study confirm the view that it is important to place greater emphasis on the importance of integrated development. Climate change adaptation strategies therefore have to go hand-in-hand with sustainable development strategies for these to be successful (see also Schipper, 2007). The focus on a single issue will most likely not result in the envisaged results. Several constraints, ranging from constraints on a household, village, regional or national level, prevent households from successfully improving their livelihoods and preparing adequately for changing climate variability. It is important that further steps are taken to mainstream climate change adaptation across relevant policy sectors and not make climate change adaptation the responsibility of a single ministry or agency nor create parallel structures (see also Kok and Coninck, 2007; Stringer et al., 2009). Moreover, due to differences between households there is not one overall strategy for solving the different problems. The study showed that in order to develop the appropriate strategies, institutional presence and institutional coordination and cooperation are important.

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