Chapter 17

Innovation in rural West Africa

What changes in farming practices?

Frédéric KOSMOWSKI, Moustapha GIBIGAYE, Bertrand MULLER, Richard LALOU

Introduction

In rural parts of West Africa, farming is carried out in a context of poverty and farmers who already suffer many kinds of stress must face up to climatic changes. Here, adaptation to these changes has become a major research theme in recent decades.

From the political angle, the concept of adaptation to climatic changes is unambiguous: it consists of using appropriate policies to strengthen the capacity of the most vulnerable populations to respond to the challenges formed by climatic changes (UNFCCC, 2007). The International Panel on Climate Change (IPCC) defines adaptation as a change in farming systems in response to climatic changes or variability in a context of interacting social and environmental changes (ADGER, 2007). Guided by political objectives, adaptation is a direct, intentional response imposed by climate change that is external to human and natural systems.

The adaptation of agricultural practices to climatic changes is the subject of considerable empirical literature. Measuring adaptation to climatic changes involves the establishment of a relation of cause and effect between a stress, the climate and an adaptive response to this stress. The climatic cause of adaptation seems obvious in certain contexts, such as arid environments (MORTIMORE and ADAMS, 2001). However, identifying the response to a climatic stress is often difficult. Climatic phenomena seem to form a component that interacts with other stresses and climate is never the sole factor of an adaptation (MERTZ *et al.*, 2009); BERRANG-FORD, 2012; HUQ and REID, 2004; SMIT and WANDEL, 2006; KRISTJANSON *et al.*, 2012).

This makes it difficult to render the concept of adaptation operational with regard to climatic changes.

One way of rendering the IPCC stimulus-response model operational is to take the perception of climatic stress into account. This method is based on the idea that stakeholders must necessarily perceive the risk before taking action (VEDWAN and RHOADES, 2001; GROTHMAN and PATT, 2005). Numerous studies thus use measurement 'in two stages'. based on this link between perception and adaptation (MADDISON, 2007; GBETIBOUO, 2009; BRYAN *et al.*, 2009; OUÉDRAOGO *et al.*, 2010; FOSU-MENSAH *et al.*, 2012; SILVESTRI *et al.*, 2012). MADDISON (2007) describes this method: 'Open-ended questions were used to ask farmers whether they had noticed long-term changes in temperature and precipitation, and about the adaptations they had made as a response to whatever changes they had noticed.' Other authors used a similar method but replaced the perception of changes by the perception of risks (HISALI *et al.*, 2001; WILK *et al.*, 2013; TAMBO and ABDOULAYE, 2012).

This approach—dominant in the literature on climatic changes—has several limits. First of all, although perception of stress plays a role in the decision process, it is not sufficient for triggering an adaptive reaction (GROTHMAN and PATT, 2005). Furthermore, the collection of perceptions may be affected by bias (MADDISON, 2007; GBETIBOUO, 2009). Faced with a researcher, the persons surveyed may use a positive attitude with regard to the questions asked (by frequently giving affirmative replies) and the recording of perception of changes often displays little variance in the responses (see Chapter 4 of this book). Furthermore, an adaptation may reduce the risks linked with climatic variability/changes without having been knowingly made with this in mind (FAUROUX, 1989). The case of improved varieties is a good example as this generally has numerous advantages including tolerance to drought, pest resistance, better grain quality and larger yields. Finally, an adaptation to a climatic stress can be the result of a collective phenomenon not stopped by the filter of individual perceptions. This idea that certain social phenomena escape the awareness of individuals is the origin of sociology (DURKHEIM, 1897). Thus the overall dynamics of adaptation of a socio-ecological system can cause numerous mimetic reactions and the adaptation can potentially occur in this collective framework.

A comprehensive approach placing changes in practices at the heart of the procedure seems to be a much more relevant model of analysis for the study of strategies of adaptation to climatic changes. This is the approach that we present here, describing the changes made by farmers. Thus an adaptation measure should meet the following conditions in order to strengthen resilience to climatic changes and be sustainable: 1) integrate both social and ecological systems, 2) grasp the contextual nature of adaptation phenomena (the spatial dimension), and 3) take into account the multiple stresses (of climatic and non-climatic origin) in which these changes are set and that form a vulnerability factor.

In this chapter, adaptation is seen from the angles of change, decision-making and social dynamics. It is a change in farming practices implemented by farmers and set in a broader context. It is the taking of decisions and also social dynamics. A case study conducted in Djougou (Benin) shows what changes farmers have made to their practices and what meaning they ascribe to these changes. Based on combined qualitative and quantitative methodology, our analysis model uses several spatial scales. Five recent changes made by farmers are then described. These changes have the common feature of being inexpensive, driven by a search for rapid returns and involve only minor modifications to farming systems. The reasons put forward to explain these changes are related to commercial opportunities, prospects of increased yields or of a reduction of risks during the lean season.

Method

The research work is based on qualitative and quantitative methodology. First, a qualitative survey was applied in several villages (focus groups) and resource persons (interviews). The main aim was to identify changes or the introduction of new practices to provide guidelines for the questionnaire. Second, a quantitative survey of 1,211 farmers (1,102 households) was conducted in the Djougou administrative district in northern Benin. The town of Djougou is a trade hub at the centre of six roads around which the population is grouped. Two transects—in the north and the south of the district—were chosen for the quantitative survey (see Chap. 4. Fig. 1a).

Taken from agronomy and ecology, the transect method has several merits in study of changes in farming practices: 1) when used exhaustively, it can be used to study the spatial dimension of phenomena, an aspect generally made difficult by the use of sampling methods. It thus makes it possible to take into account the fact that agricultural production is subjected to constraints in access to inputs (seed, fertiliser, pesticides) and the sale of crops. The distance to the urban centre of Djougou can indeed be a constraint with regard to changes in practices; 2) it makes it possible to use several scales of analysis: the two transects form a socio-ecological system, that is to say a coherent system of social and ecological resources that interact at different space, time and organisational scales (BERKES, 2003). The geographic boundaries and system of governance of the villages form sub-systems constrained by the socio-ecological system. Thus the infrastructure of the socio-ecological system sets conditions for agricultural production (inputs, sales) and for access or privation in health and education for the households in each subsystem.

The transects were chosen to give zones with different infrastructure assets (roads, health centres and schools). The study zones total 155 sq. km and lie between latitudes N 10°02'30 - 09°27'14 and longitudes E 01°53'05 - 01°39'07. Each household was questioned in both transects. A household is defined as a set of persons, related or not, who recognise the authority of a person referred to as the 'head of the household' and who live under the same roof. The 'household' questionnaire included different modules related to the composition of the household, access to land, expenditure and the living conditions of the household. The 'farmer' questionnaire was centred on the profile of the farm operator, his perception of climatic changes and his farming activity.

Context

The study zone is at the southern boundary of the Sudan-Guinean zone and average precipitation is 1.100 mm per year (MAHÉ et *al*., 2012). Households live from rainfed farming on small areas. With a historical role of trade hub 'where practically all the caravans from east to west pass' (FONSSAGRIVES, 1900), the Djougou district thus has substantial agricultural development potential that remains non-exploited.

Farming is practiced in a context of poverty. An aggregate consumer index of expenditure shows that 54% of the households live below the extreme poverty threshold of $1.25 per day. Monetary poverty is accompanied by privation in education and health. No member of one household in two has completed five years of school attendance. As regards health, access to a potable water supply varies considerably from one sub-system to the next and malaria is endemic. Difficulties of access to care in case of malaria results in high infant mortality: nearly two-thirds of households have experienced the death of a child.

At sub-system level, local governance is handled by State representatives (counsellors and delegates) and holders of customary power (King). The latter is responsible for land tenure and decides on the attribution of land in the village. The *Centre régional de promotion de l'agriculture* (CeRPA), a decentralised Ministry of Agriculture institution, aims at ensuring the development of agriculture at the local level. Officers provide training and give advice on certain crops identified as being important. The CeRPA also handles the distribution of inputs and certain certified seed (maize, cotton, soya and rice).

The socio-ecological system of our study zone consists of 18 sub-systems of different sizes (Tab. 1). The northern transect is much more heterogeneous in terms of ethnic origin. In particular, it includes zones recently settled by Peuls or Ditamari. All or nearly all households live on rainfed farming using mainly family labour. Most households are polygamous and large. The households surveyed possessed an average land area of close to 10 hectares. There are differences between sub-systems related to soil quality (stony soil), the availability of land and the time elapsed since installation. In a general manner, land is not a limiting factor and 79% of households practice fallows, which is positive in terms of the maintenance of soil fertility. Small areas are devoted to each crop (average 0.8 ha). Two main types of crop can be considered: 1) crops for on-farm consumption: yam, cassava, maize, sorghum and millet, part of which can be sold but that are fundamental for food security; 2) commercial crops: groundnut, cotton, soya, cowpea, rice and sesame. Use of inputs is small as 82% of the crops are grown with no added substances. Inputs are used for cotton, a crop subsidised by the State, which supplies them (92% of crops), maize (41%) and lowland rice (24%).

Table 1.
Characteristics of the households and farming activity of the different sub-systems forming the two transects

	Population	Average size of households	Main ethnic groups	Land owned (ha)	Land cultivated (ha)
Northern transect					
Kpéré road - End of transect	52	9.3	Peuls	5.0	3.4
Kpéré (+ Barri road)	51	9.1	Peuls, Bariba	9.1	7.7
Kpébouco	86	8.8	Yoa, Lokpa, Ditamari and others	13.7	5.4
Aféou Nor	41	8.2	Yoa, Lokpa, Peuls	12.7	6.2
Route Tébou - Aféou Nor	32	7.6	Ditamari, Peuls, Yoa	12.3	6.4
Tébou	80	9.4	Bariba, Yoa, Peuls	14.9	6.6
Foumdea	125	8.1	Lokpa	8.3	5.0
Kolokondé	138	7.9	Peuls, Yoa, Lokpa ; Ditamari	6.0	3.7
Southern transect					
Route Kpayerou	28	9.3	Yoa	16.5	5.5
Wassa	18	7.8	Yoa	5.4	2.9
Route Djeou	49	8.0	Yoa	11.1	2.8
Faka-Faka	25	8.4	Yoa	8.1	3.3
Goumbakou (+ Kpahouya road)	113	8.1	Yoa	8.4	3.2
N'Kontaga + Tchognari	47	8.0	Yoa, Peuls, Lokpa, others	7.5	3.3
Kakindoni (+ Kokohou road)	43	7.9	Yoa, Lokpa	9.6	3.8
Koutouga road	12	8.5	Yoa, Peuls	14.0	6.4
Pélébina	130	7.8	Yoa, Peuls, Lokpa, others	8.0	6.7
Gbessou	32	9.1	Peuls, Yoa, Lokpa	5.5	2.6

Changes in farming practices

The identification of changes was performed in two stages. The changes identified by qualitative methods using interviews and focus groups then received quantitative attention. The proportion of farms that have adopted a practice varies considerably from one sub-system to the other, as is shown in Figure 1.

The most common changes made by farmers during the last ten years are discussed here: 1) tree planting; 2) changing sowing dates; 3) using new crop combinations; 4) growing new crops, especially soya; 5) growing new varieties. Care is taken to describe the context of each change and the meaning that the stakeholders ascribe to the practice.

Tree planting

Planting trees is the most widespread change in practice among the farmers in the study zone: 62% of them had planted a tree during the 10 years preceding the survey.

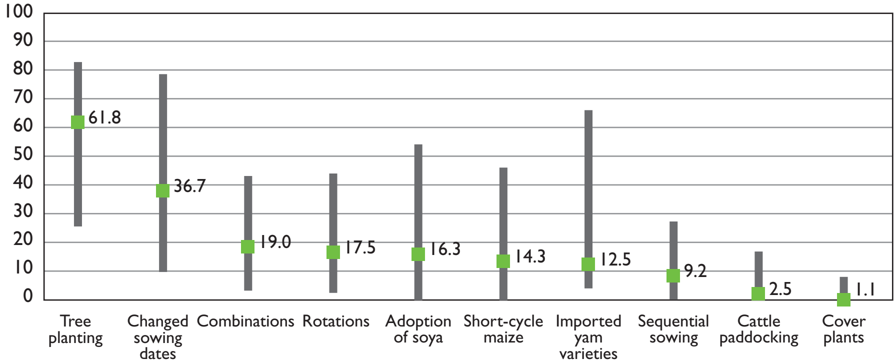

Figure 1.
Changes introduced by the farmers in the study zone.
The graph shows the average proportion of farmers who have changed their practices and shows the minimums and maximums in the sub-systems that form the study zone.
For example, while 62% of farmers planted at least one tree, the figure was only 26% in Kpéré and 83% in Kpébouco and Goumbakou.

As they absorb CO_2, trees are considered as a means for reducing the quantity of greenhouses gases in the atmosphere. In the socio-ecological system, trees slow strong winds, reduce evaporation and provide organic matter for the soil.

Table 2 shows the extent of tree planting in the various sub-systems. Three sub-systems adopted the practice strongly, planting the equivalent of 10 trees per farmer during the last decade. These sub-systems (Wassa, Faka-Faka and Koutouga) are small and a vast ecological system is available. In contrast, less planting was performed in the zones in which population density is higher (Kolokondé, Foumbéa, Pélébina) and in the recently settled zones (Kpéré road, Tébou road-Aféou Nor). The last result is somewhat contra-intuitive, given the availability of land on the pioneer fronts, and suggests a planting difficulty in a context of newly acquired and still uncertain land tenure. Planting a tree shows that the land is being appropriated and this cannot be done without the approval of the customary authorities.

Most of the trees planted (69%) are cashew). It is mentioned in the interviews that sales of cashew have improved in the last ten years, with the nuts going to local markets. Some people interviewed also mention that training was provided by the CeRPA. Then come teak and eucalyptus (17%). Finally, some farmers planted fruit trees (13%): citrus, mango and papaya. The types of tree planted differ according to the aims of the plantation, the time horizon of the returns expected and the mode of access to plants.

The reasons stated by farmers vary according to the trees. Sales form a clear objective in the case of cashew, citrus and oil palm. Eucalyptus, teak and softwood are planed for construction timber or for the sale of timber for this purpose. The time horizon of the expected return from the plantation is an important component in decision

Table 2.
Description of tree planting in the two transects during the preceding ten years.

	% of farmers who planted a tree	Total trees planted	Number of trees par head of population
Northern transect			
Kpéré road - End of transect	25.0	28	0.5
Kpéré (+ Barri road)	68.6	130	1.8
Kpébouco	81.4	167	1.4
Aféou Nor	75.6	256	5.7
Route Tébou - Aféou Nor	34.4	88	2.4
Tébou	73.8	239	2.4
Foumdea	72.8	86	0.6
Kolokondé	45.7	74	0.5
Southern transect			
Kpayerou road	57.1	116	3.5
Wassa	50.0	241	12.7
Route Djeou	67.4	113	2.4
Faka-Faka	76.0	295	11.3
Goumbakou (+ Kpahouya road)	81.4	171	1.6
N'Kontaga + Tchognari	55.3	147	2.9
Kakindoni (+ Kokohou road)	72.1	153	3.2
Koutouga road	58.3	126	9.7
Pélébina	56.2	185	1.4
Gbessou	62.5	106	3.1
Total	61.8	2 721	2.2

making by farmers. Cashew gives fruits after only a few years. Teak can be felled for use after five years. In a context of multiple stresses, the long-term prospects seem uncertain and returns from plantations should be seen in the short term by farmers. This was highlighted forcefully by several focus groups (FG):

> 'It takes 3-4 years before a return from sales for cashew. With teak, if you are unlucky you'll die before profiting from it' (FG, Kpébouco).

Finding planting material is not difficult for the trees most commonly planted (cashew and teak). Cashews are a gift or collected in the country. Wild teak saplings are replanted on the farmer's land. Minority trees require access to a nursery. This is the case in Kolokondé where a recently opened nursery has eucalyptus and fruit tree saplings at CFAF100 each.

Changes in sowing dates

The date on which crops are sown is of crucial importance. After tillage, sowing marks the start of agricultural work and is generally performed by women. The choice of planting date is linked with the beginning of the rainy season, the cycle of the varieties chosen and the farming system. Highlighted in the literature on adaptation (Bryan *et al.*, 2009; Fosu-Mensah *et al.*, 2012), changing plantation dates is often presented as an adaptation to climatic changes. In a general manner, cycles that are as long as possible are sought in traditional farming as this means larger yields (Rosenzweig and Tubiello, 2007). Adjusting sowing enables farmers to set the cycle (its length) in relation to the 'average' (in the statistical sense) progress of the rainy season.

Although choosing a sowing date can be an opportunity, it is also a risk. The focus groups set up among farmers resulted in identifying two different rainfall situations that the farmers said were dangerous: on the one hand, seasons with (too) abundant rainfall in frequency (distribution) or volume (and intensity) that causes degradation, loss of fertiliser and flooding. Crops on bottomland are particularly vulnerable. Abundant rainfall can also prevent maize from flowering or drying, which must be carried out under conditions of low relative humidity. Then there are drought periods. Good rainfall distribution is essential in particular for maize and soya: a pause in rainfall can seriously compromise these crops (Foyet-Rabot and Wybrecht, 2006).

Maize sowing dates had been adjusted by 37% of farmers during the three years preceding the survey. This means that they sowed on a different date at least once in the three previous years. Maize sowing dates in 2012, 2011 and 2010 are shown in Figure 2. It can be seen that few farmers risk sowing at the beginning of the rainy season, that is to say before May (7% of farmers). Farmers consider that June is the most propitious period as this is when slightly less than half of sowing is carried out. It is not possible to identify a clear trend in changes of sowing date from one year to another during the three years in question.

Although changing sowing dates is often considered to be an adaptation to climatic changes, it seems to be inadequate as an indicator. Indeed, constraints such as illness or unavailability of labour (structural for the farms or occasional, caused by illness

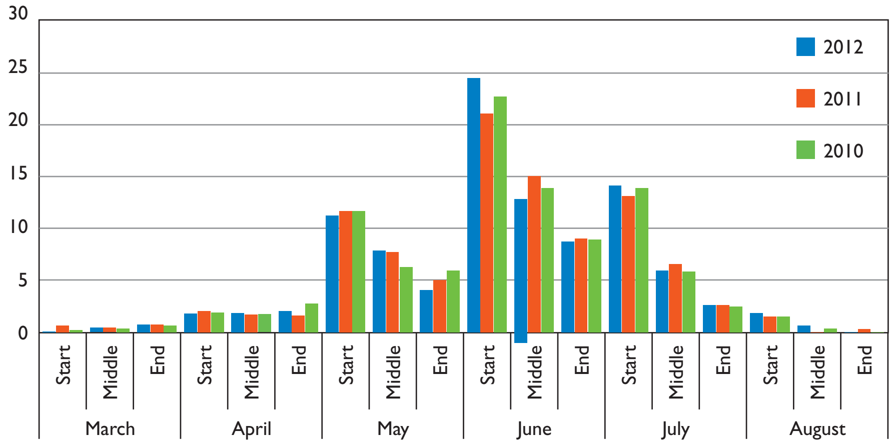

Figure 2.
Maize sowing dates in 2012, 2011 and 2010.

for example), no access to loans and/or inputs in time and/or quite simply because the ranking of their priorities for several crops can result in farmers changing their sowing dates without this being a response to the onset of the rains. Thus plantation dates here seem to be determined not according to the start of the rains but according to a risk minimisation strategy. Sowing is carried out when the rains are firmly present (June) and when farmers consider that the risk of stretch of drought is small (FG, Kpébouco).

Introduction of new crop associations

Among all the crops grown by farmers, only a quarter are accompanied by a companion crop. Crop association—defined as growing several species in a field with the cycle overlapping—generally results in competition between crops (for water, root deployment and light). However, associating certain species can generate complementarity between cycles and species (Foyet-Rabot and Wybrecht, 2006).

The introduction of new crop associations concerns nearly one farmer in five. Sorghum is the companion crop in most cases. It is associated with maize, groundnut and yam. Sorghum has an important feature for crop association: it has a long cycle and can regulate its physiology. The yield of sorghum associated with maize is close to that of single cropping. The other associations involve maize, generally combined with yam, and millet combined with yam or groundnut.

Most of the new associations introduced in the last ten years involve maize/sorghum and yam/maize. Thus the introduction of new associations consists above all of the progression of an association already used by a fair number of farmers (maize/sorghum). Associations with legumes (maize/cowpea), that regenerate land, form a very small minority. Recommended by CeRPA agronomists, the maize/soya association is practically non-existent.

These results did not reveal a newly introduced association that would form a response to a change in climatic parameters. Crop association in Djougou is a farming practice with substantial prospects for improvement. A response to rising temperatures resulting from climatic changes and that will generate stress in numerous species could be envisaged in the form of appropriate crop associations.

The introduction of new crops: soya

At the scale of the two transects, nearly one farmer in two (47%) has planted a new crop in the past ten years (Fig. 3). The range of these crops provides a glimpse of the strong dynamics of the farming systems.

The crops most frequently introduced during the last ten years are soya (16%), maize (12%) and lowland rice (11%). Soya displays the strongest growth with obvious spatial dynamics and the crop is examined closely in this chapter. A major innovation in certain sub-systems, soya also has various possibilities (consumption, soybean cheese processing or sale,).

The introduction of soya in certain sub-systems concerned one farmer in two. This is the case in Kpéré, where soya was introduced 20 years ago and has spread widely.

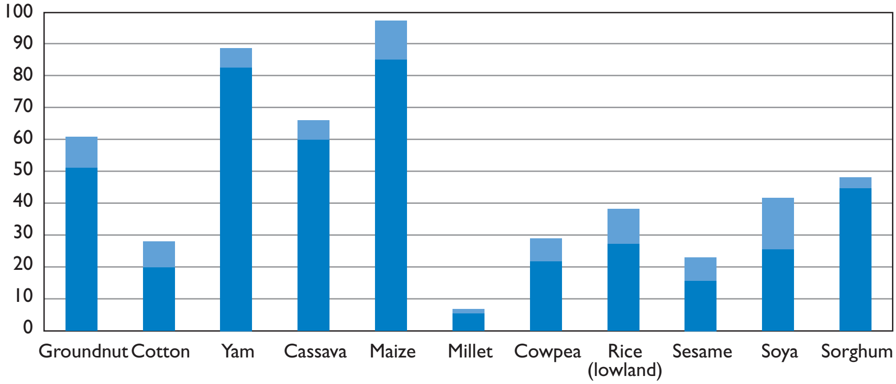

Figure 3.
The proportion of farmers who planted the crop listed during the 2012 farming season. The crops introduced during the past 10 years are shown in pale blue.

More 3-month soya (71%) is grown than 4-month soya and the local market is the main source of seed. Soya growing is involved in very different strategies.

First, soya forms a commercial opportunity and can generate immediate returns. It is sold at a higher price than maize (CFAF300 to CFAF700 per kg in comparison with CFAF200 to CFAF500 per kg for maize according to the time of year) and keeps well. Soya can be eaten and sold throughout the year to face difficulties. Women also use soya to make soy cheese. Although only 10% of the farmers in our study zone are women, they form 28% of soya growers. Soya can be eaten in the household, generally accompanied by a sauce. Health centres highlight its nutritional merits, especially for children (FG, Wassa). It can also be sold, providing a source of income for women. Several projects have been run in the zone to promote the technique for processing soya to make cheese. At Wassa, three-legged stoves have been set up in the centre of the village so that the women can make and sell soy cheese. Mastery of the technique is generally via a family member who is often from another village. Soya is purchased at an average CFAF1,000 and cheese is sold at CFAF1,500.

The farmers who have not started to grow soya mention the poor quality of their soil, not mastering the technique (FG, Koutouga) or the presence of pests (FG, Wassa). The shortage of available labour is also an important factor (FG, Goumbakou and Aféou Nor), leading to suppose that those who start growing soya have labour mobilisation strategies. Indeed, for farmers who are heads of households growing soya is always a complement to the traditional food crops yam, sorghum and maize.

Introduction of new maize and yam varieties

Maize and yam form the foundation of food security for households, and farmers have succeeded in profiting from the opportunities provided by new varieties. They are short cycle varieties sold by the CeRPA in the case of maize or varieties with higher yields, generally imported from Nigeria in the case of yam.

Usually accompanied by the abandoning of the traditional varieties, the adoption of short cycle maize concerns 14% of farmers. Bred by the *Institut national des recherches agricole du Bénin* (Inrab) in collaboration with the International Institute for Tropical Agriculture (IITA), two varieties are sold at the CeRPA in Djougou. The varieties EV DT 97 STR W, called *Mougnangui* ('tough'), 90 days, and 2000 syn. EE W, called *Ku Gnaayi* ('famine fighter'), 75 days, are described as drought-tolerant (MAEP technical document, 2010). This shortened maize cycle is an improvement in comparison with the 120-day cycle of traditional maize (*Inspection générale de l'agriculture coloniale*, 1908). These are composite maize varieties whose seed can be used for 2-3 years although performances decrease with time.

Obtaining seed supplies from the CeRPA in Djougou is still a barrier for a fair number of farmers. The obstacles are geographic and economic. First, some sub-systems are far from the CeRPA, encouraging the use of seed purchased on the markets and more readily available. It was thus seen that several sub-systems—generally small and not on the main road route (Kpayérou, Koutouga, Kpéré)—have hardly switched to short cycle maize at all. Second, the short-cycle varieties available from the CeRPA are sold at higher prices on the markets. In 2012, EV DT 97 STR W maize was sold at CFAF500 per kg while a 90-day maize could be purchased on the market for the equivalent of CFAF300 per kg. However, numerous farmers mention that they are certain to obtain a 3-month maize variety from the CeRPA, which is not the case when seed is purchased on the market:

> 'On the market, people mix the varieties and you end up with any old thing. You can never be sure that it really is 3-month maize' (FG, Faka-Faka).

As a result, one in two farmers who sowed short-cycle maize in 2012 obtained it from the CeRPA. Use of a short-cycle variety has obvious links with climatic variability: the longer a variety takes to ripen, the more it is exposed to the risk of the plant failing to reach maturity.

In contrast with maize, a plant imported to Africa from America, yam growing has a long history in the region (*Inspection générale de l'agriculture coloniale*, 1908; CHEVALIER, 1912). Two types of yam are grown: *Dioscorea cayenensis*, large 12-month yams, and *Dioscorea rotundata*, small 8-month yams. Large yams are generally grown in sandy soil and the small ones in hard soil. Yam requires fertile soil and organic matter, especially for the early varieties (FOYET-RABOT and WYBRECHT, 2006).

In addition to the traditional varieties Assouna and Noudoss, varieties from other regions have developed and are sometimes commonly called 'Bariba' or 'Yoruba' yam. The main varieties imported to the zone and grown by farmers are Yanouha, Morkonnoudje, Coutonouma, Kpataga, Idolona, Palacana and Wotanam. These are names in vernacular languages and it has not been possible to link them to their scientific names. The great majority consists of early varieties. They also stand out for their multiplication, considered to be easier.

In the last ten years, 12.5% of farmers started growing a new type of yam. However, this figure hides considerable differences from one sub-system to another. Some sub-systems are particularly innovative as this practice sometimes concerns one in two of the farmers (Wassa) and two in three (Faka-Faka). But the trend is very weak in some zones such as Tébou, Kpébouco and the Koutouga road (less than 5% of farmers). Migration phenomena seem to account for the origin and dispersion of the varieties in the study zone. The introduction of a variety in a sub-system may go back to the migration of the farmer's family members (FG, Pélébina): when they returned, they had no more planting material and brought with them yam varieties from their migration zone. This feature may also be linked with more recent migration. In Faka-Faka, the variety Yonouha has taken precedent over the others because of its better productivity and the multiplication method (a piece of yam can be used, unlike the local varieties planted from material formed after the harvesting of the first tubers). It was imported by one of the farmers in the village who had gone to do farm work in Kissi in Nigeria. The variety then spread in the village by gifts of planting material and subsequently by sale of seed. Now, a few years later, it is grown by two-thirds of the farmers of Faka-Faka.

Table 3 shows the reasons for the adoption of short maize varieties and imported yams. It is seen in both cases that the climatic reasons (drought/irregular rainfall for short cycle maize) or environmental features (poor soils for yam) are in the minority. For maize, the varietal characteristics of the plant (short cycle and better yield) are

Table 3.
Reasons put forward to justify the introduction of a new maize or yam variety during the last 10 years. Several possible replies.

	Maize	Yam
Availability of seed/planting material		
Varieties with free/inexpensive seed/planting material	0.8	6.3
Varieties with easily obtained seed/planting material	7.3	7.5
Variety recommended by the CeRPA	1.1	0.0
Variety recommended by friend/family	3.5	7.7
Varietal characteristics		
Better yield	18.6	24.9
Several harvest each year	1.4	4.0
Can be harvested earlier	30.9	9.1
Less fertiliser required	4.3	0.7
Better resistance to drought/irregular rainfall	3.0	1.0
Better resistance to flooding	0.1	0.0
Better resistance to weeds	0.1	0.2
Contains more meal	4.6	/
Better suited to poor soil	0.0	0.9
Better taste	6.9	12.2
Harvest and sales		
Easier to sell	4.7	6.8
Keeps better	0.5	0.3
Ready during the lean period	5.8	8.7
Other	6.1	9.8
Total	*100*	*100*

the main reasons put forward. Farmers stress the fact that this variety can be harvested during the lean period when resources are generally lacking. In the case of short cycle maize, although climate is an adaptation factor it is neither the only one nor the triggering feature. For yam, better yield is the main reason mentioned by farmers (25%). This is followed by taste qualities and the fact that it cannot be harvested earlier, coinciding with the lean period. Emphasis on taste qualities and culinary preparation and fact of relying more on recommendations form the distinction between yam and maize.

In both cases these changes in practices are linked with household food security. Better yields and, above all, an earlier crop are the main reasons that encourage farmers to use new varieties. This being so and considering the uncertainties and risks in farming, farmers first examine the time scale of the farming cycle and the lean period to justify these changes. The time scale of rainfall seems little or not at all involved in their decision-making. At most we can see perhaps a convergence of interests between the decrease in the rainfall risk and the fact of being able to harvest earlier during a period that is usually difficult.

Conclusion

Farmers are innovating and modifying their farming practices in a context of poverty that is characteristic of West African rural communities. The common features of the changes described in this chapter are their low cost, a relatively small degree of adjustment of systems and the search for returns within a limited time horizon. In their changes, farmers favour short-term food security above all. These strategies may seem to be forms of response to poverty and its consequences and provide information about the past and present capacity of farmers to adapt to climatic changes.

Examined in a comprehensive manner, the reasons for changes in practices has allowed us to show that a change can reduce the risks associated with climatic variability/changes without this change being implemented knowingly with this in mind. On the one hand, the meaning stakeholders award to their adaptive practices leaves little room for climatic or environmental reasons. Farmers mention more the commercial opportunities available, the prospect of increasing yields or reducing risks during the lean period. Thus the introduction of new drought-resistant maize varieties that increase resilience with regard to climatic changes is little mentioned as such by farmers. On the other hand, as is the case of tree planting, it is seen that certain changes can increase resilience to future climatic changes by contributing ecological value-added (contributing organic matter and absorbing CO_2). Although this is not at all the objective of farmers, we consider that from the angle of sustainable development it is important to consider the consequences of adaptations for the socio-ecological system.

Our approach has also shown that adaptation seems to be intrinsically linked to its context, guided by social norms and interactions that, beyond individual decisions, express the dynamics of the sub-systems. Through using different space scales (the socio-ecological system, subsystems and households), this work shows that each sub-system outlines a different figure of the adaptation. At the socio-ecological system level, spatial variables play an important role, conditioning farmers' constraints and opportunities. At sub-system level, social phenomena potentially escaping perception by farmers are probably in progress. At household and farmer level, different objectives and priorities can explain the decision-making that leads to the adaptation. It therefore seems entirely possible that an adaptation strategy can result from a collective phenomenon, going through the filter of individual perceptions.

Acknowledgements

Particular thanks go to Pascal Marnotte, weed scientist (CIRAD) for his advice during the design of the survey and the interpretation of the results. Our thanks also go to the entire survey team, without whom this work would not have been possible.

References

Adger W. N., Agrawala S., Mirza M. M. Q., Conde C., O'Brien K., Pulhin J., Pulwarty R., Smit B., Takahashi K., 2007
« Assessment of adaptation practices, options constraints and capacity ». *In* Parry M. L., Canziani O. F., Palutikof J. P., van der Linden P. J., Hanson C. E., eds : *Climate Change 2007: Impacts, Adaptation and Vulnerability,* Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge, UK, Cambridge University Press : 717-743.

Berkes F., Colding J., Folke C., 2003
Navigating social-ecological systems: building resilience for complexity and change. Cambridge, UK, Cambridge University Press.

Berrang-Ford L., Ford J. D., Paterson J., 2012
Are we adapting to climate change? *Global Environmental Change,* 21 (1) : 25-33.

Bryan E., Deressa T.G., Gbetibouo A. G., Ringler C., 2009
Adaptation to climate change in Ethiopia and South Africa: Options and constraints. *Environmental Science & Policy,* 12 (4) : 413-426.

Chevalier A., 1912
Rapport sur une mission scientifique dans l'Ouest africain (1908-1910).

Document technique du MAEP, 2010
Répertoire des variétés de maïs vulgarisées du Bénin. Bibliothèque nationale du Bénin.

Durkheim E., 1897
Le suicide.
Paris, Presses universitaires de France, Quadrige Grands textes.

Fauroux E., 1989
« La grêle à Cangahua (Équateur andin) ». *In* Eldin M. et Milleville P., éd. : *Le risque en agriculture,* Paris, Éditions de l'Orstom, coll. À travers champs.

Fonssagrives J.-B., 1900
Notice sur le Dahomey : publiée à l'occasion de l'Exposition Universelle/sous la direction de M. Pierre Pascal.

Fosuh-Mensah B. Y., Vlek P. L. G., MacCarthy D. S., 2012
Farmers' perception and adaptation to climate change: a case study of Sekyedumase district in Ghana. *Environment Development Sustainability,* 14 : 495-505.

Foyet-Rabot C., Wybrecht B., 2006
« Les associations et les successions de cultures ». *In Le Mémento de l'agronome,* Paris, éditions Quae.

Gbetibouo A. G., 2009
Understanding farmers' perceptions and adaptations to climate change and variability. The Case of the Limpopo Basin, South Africa. IFPRI Discussion Paper 00849.

Grothmann T., Patt A., 2005
Adaptive capacity and human cognition: the process of individual adaptation to climate change. *Global Environmental Change,* Part A 15 : 199–213.

Hisali E., Birungi P., Buyinza F., 2011
Adaptation to climate change in Uganda: evidence from micro level data. *Global Environmental Change,* 21 : 1245-1261.

Huq S., Reid H., 2004
Mainstreaming Adaptation in Development. *IDS Bulletin,* 35 (3).

Inspection générale de l'agriculture coloniale, 1908
L'Agriculture pratique des pays chauds.

Kristjanson P., Neufeldt H., Gassner A., Sayula G., Thiede B., Förch W., Coe R., 2012
Are food insecure smallholder households making changes in their farming practices? Evidence from East Africa. *Food Security*, 4 : 381-397.

Liebmann B., Marengo J. A., 2001
Interannual variability of the rainy season and rainfall in the Brazilian Amazon basin. *Journal of Climate,* 14 : 4308-4318.

Maddison D., 2007
The perception of and adaptation to climate change in Africa. *CEEPA Discussion Paper* 10, Centre for Environmental Economics and Policy in Africa, University of Pretoria, South Africa.

Mahé G., Rouché N., Dieulin C., Boyer J.-F., Ibrahim B., Crès A., Servat E., Valton C., Paturel J.-E., 2012
Carte des pluies annuelles en Afrique 1940-1999. IRD, Service de cartographie.

Mertz O., Mbow C., Reenberg A., Diouf A., 2009
Farmer's perceptions of Climate Change and agricultural adaptation strategies in rural Sahel. *Environmental Management,* 43 : 804-816.

Mortimore M., Adams W. M. 2001
Farmer adaptation, change and "crisis" in the Sahel. *Global Environmental Change,* 11 : 49-57.

Ouédraogo M., Dembélé Y., Somé L., 2010
Perceptions et stratégies d'adaptation aux changements des précipitations : cas des paysans du Burkina Faso. *Sécheresse*, 21 (2) : 87-96.

Rosenzweig C., Tubiello F. N., 2007
Adaptation and mitigation strategies in agriculture: An analysis of potential synergies. *Mitigation and Adaptation Strategies for Global Change,* 12 : 855-873.

Silvestri S., Bryan E., Ringler C., Herrero M., Okoba B., 2012
Climate change perception and adaptation of agro-pastoral communities in Kenya. *Regional Environmental Change,* 12 (4) : 791-802.

Smit B., Wandel J., 2006
Adaptation, adaptive capacity and vulnerability. *Global Environmental Change,* 16 (3) : 282-292.

TAMBO J. A., ABDOULAYE T., 2012
Smallholder farmers' perceptions of and adaptations to climate change in the Nigerian savanna.
Regional Environmental Change, 13 : 375-388.

UNFCCC, 2007
Climate Change: Impacts, vulnerabilities and adaptation in developing countries.
68 p.

VEDWAN N., RHOADES R., 2001
Climate change in the Western Himalayas of India: a study of local perception and response.
Climate Research, 19 : 109-117.

WILK J., ANDERSSON L., WARBURTON M., 2013
Adaptation to climate change and other stressors among commercial and small-scale South African farmers.
Regional Environmental Change, 13 : 273-286.

Kosmowski F., Gibigaye M., Muller B., Lalou Richard.

Innovation in rural West Africa : what changes in farming pratices ?

In : Sultan Benjamin (ed.), Lalou Richard (ed.), Amadou Sanni M. (ed.), Oumarou A. (ed.), Soumaré M.A. (ed.).

Rural societies in the face of climatic and environmental changes in West Africa.

Marseille : IRD, 2017, p. 335-350. (Synthèses). ISBN 978-2-7099-2424-5