RISK, AGRO-PASTORAL DECISION MAKING AND NATURAL RESOURCE MANAGEMENT IN FULBE SOCIETY, CENTRAL MALI

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Introduction

Risk and uncertainty dominate life in the semi-arid tropics where most of the world's pastoralists live. Due to erratic rainfall, fluctuating markets for basic food and livestock and political turmoil, most people have to face insecurity with respect to the basic necessities of life and consequently with respect to their physical and mental well-being. In fact so-called 'pastoral adaptations' can be conceptualised as technological, social and cultural means of dealing with risk and uncertainty (de Bruijn & van Dijk 1995). The strategies by which people deal with risk and uncertainty are based on their 'cultural understandings' of these insecurities, giving rise to specific cultural and social complexes, which show a high degree of dynamism.

These cultural complexes as well as modes of resource use have been described extensively by anthropologists and geographers. However, the relations between these dynamic cultural complexes, individual behaviour and individual perceptions of insecurity have remained rather obscure. Among other things this obscurity hinges upon our own understandings of how individuals deal with risks in making decisions with respect to the management of natural and social resources. Scientific approaches to risk in semi-arid zones have been dominated by agro-ecology and agro-economics. Within these paradigms risk is treated as a stochastic occurrence, and decision-making strategies are analysed with the help of simulation models. These models are based on assumptions from rational choice decision-making theory, and presume that people are either geared towards profit maximisation or towards risk minimisation. As I will try to show this approach is too narrow, because people operate not only in an ecological and economic environment, but also in social and cultural environments. Within social science little effort has been devoted to how all kinds of variability in rainfall – amount, dry spells, onset of the rains – and other risks affect small farmers (Vincent 1981:69).

It will be argued that we may further our understanding of individual behaviour and cultural dynamics in high risk environments by treating risk and uncertainty as total events, i.e., that we learn more by tracing the consequences of single events across space and time, and the tracks that people follow to deal with calamities (see Scoones 1995). Every drought and pest has its own dynamics in timing, duration, severity and consequences, and consequently demands a different response of the people affected.

First, I will discuss the ways in which risk has been dealt with within agro-ecological and agro-economic approaches. Next I will discuss a framework for the understanding of the role of risk and uncertainty in decision making by pastoralists and the cultural dynamics of their societies. Then I will discuss a case study of decision making by pastoralists and their cultivating neighbours to illustrate this framework.

Decision making in agricultural science

Within agricultural ecology and agricultural economy most research views decision making with respect to agricultural risks against objectified indicators. Farmers and herdsmen are supposed to strive at an optimal allocation of the resources they have available for their specific production purposes, which may range from optimisation of profit, production or productivity, to risk avoidance or long-term continuity and stable levels of production. To study decision making a specific theoretical and methodological apparatus has been developed, which has evolved from the simple appraisal of different agricultural technologies to the assessment of the performance of agricultural systems, and the interaction between their subsystems and finally to the development of all kinds of simulation models to generate prescriptive and predictive statements about the most efficient operation of these agricultural systems and their planning. In this development a systems approach has become the dominant theoretical and methodological tool of agricultural science. This systems approach is characterised by a stress on quantitative data and a number of assumptions about the nature of the agricultural system and farmer behaviour in response to ecological and other conditions. The analysis of decision making is based on a measurement of the inputs and the outputs. It is supposed then that the outputs are a result of the decision maker and his decisions to combine a specific bundle of inputs.

Within this approach risk and uncertainty are laid down in probabilities, and land use strategies are appraised for their capacity to prevent hazard and to avoid risk.[1] Huge amounts of quantitative data about inputs, the resource base and outputs of the agro-ecosystem are collected, mostly over one agricultural season, and analysed with the help of statistics, within the framework of a model specifying the most basic cause-effect relations in the farming system. Subsequently causal relations are quantified, so that predictive statements can be made about, for example the relations between soil fertility, rainfall, labour input, crop varieties and productivity of the farming system. A similar procedure is followed for livestock production systems. So, risk and uncertainty are reduced to stochastic occurrences and statistical means, as if the data belong to a knowable and predictable set of phenomena. Based on rainfall data and simulation models of biomass production under semi-arid conditions, predictions are made of useful production for human and animal consumption, and hence how many animals and humans a specific ecosystem may support (see e.g., Breman & de Ridder 1991, Kessler 1994). The result is a prognosis, which may be fairly accurate at regional or national level. However, the amount of error increases with decreasing geographical scale.

A recurrent problem in modelling crop and pasture production is the difference between real life production figures as collected on the farm and/or the test site and calculated production figures. Toulmin (1992:109-111) found very few real-life millet production figures falling within the range ± 25 per cent of her calculated production figures. Similar results have been achieved for models of pasture production (de Leeuw et al. 1993). So, the predictions derived from the model can hardly be taken as the correct estimate for the value of a specific site or an actor. A difference of ± 25 per cent will have an enormous impact on an individual decision maker.

To solve this problem differences in socio-economic variables are identified as important explanations of variability in crop and livestock production, and natural resource management in general. One of the basic tenets of the systems approach is that no significant differences in systems output are expected given the same agro-ecological and socio-economic conditions (de Steenhuijsen Piters 1995: 11). Unfortunately, all kinds of unexpected problems wreck this solution. A research project designed to pin down this variety in stratification along socio-economic dimensions of fields belonging to the same agro-ecological type revealed that the composition of diversity was not the same in each stratum, and that constraints on sorghum production were different for each cropping system and field type, and that the impact of different socio-economic and agro-ecological variables contributing to crop production varied wildly from one year to another (de Steenhuijsen Piters 1995). Toulmin (1992:121) found considerable differences in estimated marginal value products of each production factor at the mean from one year to another despite the fact that rainfall and crop production did not differ much. In other words the ways in which production factors contributed to final crop production varied from one year to another.

Still, it may theoretically be possible to solve these practical problems of quantification by adding variables, data, computer power etc., but this solution demands enormous investment. It may be more practical to develop a different approach (Scoones 1995). There are also a number of theoretical arguments to change our focus in research. The first problem is that of bounded rationality. A model of a given crop or livestock production system is insensitive to changes in relations between its variables and those of other production systems such as trade and livestock production. It regards the composition of the variables and the boundaries of the system as well as the social unit which is operating the system as given. However, the decision maker is not insensitive to the impact of these factors. When livestock production fails he/she will operate the crop or livestock production system in a different manner. But he might also draw other conclusions and leave the area to seek refuge in town. Key variables may change in the course of the operation of the cropping or herding system. For example Berti cultivators in Sudan always sow more land than they can possibly cultivate. If the rains are good and last for a longer period they are able to weed more land. If the rains are bad they weed much less land (Holy 1988). What is a field in this case? The area worked, sown or harvested? Should we add the harvest on the uncultivated land too? Should we regard this as a separate cropping system? Can we use these data as a basis for comparison with other ethnic groups with different cropping strategies?

Models in which social scientists try to condense decision-making by farmers into formal models (see e.g., Barlett 1980) are based on the assumption that actors make rational choices, and can make an assessment of the probabilities of certain events (e.g., Cancian 1980). Uncertainty is reduced to a stochastic occurrence. This may be helpful to clarify general characteristics of farmers and herdsmen, but certainly not day-to-day decision making. In (semi-)arid environments most key events, such as rainfall, the incidence of pests and diseases are unpredictable.

Another assumption in models is that the cause-effect relations they specify are valid for all states of the crop or livestock production system. An example is the relation between labour input and production of such a system. The more labour is invested the more productive the system. However, it has been observed among the Fulbe in Central Mali that labour input was lowered because the sowing kept failing. So the harvest did not fail because a small amount of labour was applied to the crop, on the contrary for many people the harvest had already failed because of difficulties earlier in the season. Harvest expectation was so low that workers no longer weeded their fields. The cause-effect relation between labour and production was thus the reverse in this case (De Bruijn & Van Dijk 1995: 261).

This brings us to a related assumption in decision-making models, namely that the harvest and the crop produced do indeed reveal the intentions of the cultivator (Ortiz 1980:189), and the result of the decisions taken. If not, farmers and herdsmen are supposed to change their strategies (considering that he has perfect knowledge of all the factors involved). Adaptation to hazard, in this view is part of a general evolutionary process which involves the increase of control over the natural environment, and is supposed to reduce variability and to increase stability (Henderson 1987: 252). This would lead us, however, to the rather bizarre conclusion that in a given Sahelian society persistent crop failure is a reflection of the cultivator's intentions and decisions. Otherwise they would behave irrationally by the standards of the model. So we have to allow for the possibility that farmers and herdsmen are not in control and may fail to adapt to variable conditions.

Another problem with the systems approach and models is the fact that they are based on the assumption that processes unfold as a chain reaction, as a result of the supposed cause-effect relations between the variables in the model or the components of the system, leading to all kinds of adaptive feed-back mechanisms, which essentially steer the system towards equilibrium. The outcome of these adaptation processes is expected to be a balanced set of relationships, meaning that the carrying capacity of the environment is not exceeded and the system is capable of self-replication over time. Any deviation from this norm is negatively valued (Henderson 1987: 257), and should be corrected by expert technological and governmental interventions. Farmers and herdsmen are assumed to take decisions with the same vision on systems dynamics and are also believed to aim for equilibrium and the calibration of risks. This seems to suggest that given the same agro-ecological conditions there is one optimal combination of inputs so as to produce the maximal output with a minimal amount of risk (see e.g., van Noordwijk et al. 1994). The only problem is that in no two years conditions are alike in (semi-) arid zones and that consequently farmers and herdsmen do not know the risks, and do not know for which risk to prepare.

Agro-ecological approaches to agricultural decision making have in common that they suppose that the decision makers stand in a direct functional relation with their agro-ecological environment and production system. Outside motivational factors such as embedded in social organisation, culture, religion, land tenure arrangements, social security, prices and government policies are assumed to be objectively given and constant for the (groups of) decision makers. However, dynamic economic, political and social systems and the positions individuals and groups occupy in these systems are important intervening variables. They co-determine to a large extent the impact of (and response to) hazard on individual farmers and herdsmen (see Henderson 1987: 256). Consequently, as is consistently shown by case studies of real-life decision making key decisions are taken as sequential adjustments as all kind of relevant events evolve in the course of the agricultural season without prior knowledge of climatic and market conditions (Watts 1983). While taking these decisions people develop new tracks to deal with high-risk environments. Individuals take these decisions on the basis of a wide range of experiences, rather than on a vision of the future, while these recollections of the past depend to a great extent on their intellectual concerns in the present (Ortiz 1980:188).

An alternative view

Pastoralism is a major subsistence activity in high risk environments such as the semi-arid tropics. Pure pastoralism may be defined as a mode of existence based on the exploitation of successive generations of domestic animals. The accumulation of animals and herd mobility are the main elements of the pastoral pursuit in order to deal with the environmental instability. For the accumulation of livestock the herd managers, generally a herdsman with his family, has to protect the livestock from all kinds of hazards, such as predators, animal diseases and lack of pasture and water. The latter two may even wipe out (large parts of) the herds in a short span of time. The accumulation of animals is therefore not an irrational strategy geared towards prestige, but an insurance strategy (Horowitz 1986). '[The] reason for accumulating livestock lies not in the desire to increase yield beyond a fixed domestic target, but in the need to provide [the] his household with some security against environmental fluctuations' (Ingold 1986:134). Such a strategy may be labelled 'opportunistic' (see Sandford 1983) rather than profit oriented.

This strategy seems to be oriented towards the reduction of risks. Yet, the protection of herds introduces a new element of instability into the pastoral enterprise.

In comparison with natural conditions in which natural hazards such as animal diseases and predators dampen the random herbivore-pasture oscillations – i.e., the disparities between pasture production and livestock population – livestock numbers may be pushed beyond the limits of natural pasture production. Due to the fact that more animals stay alive because of the protective measures effected by the pastoralist, there is an increasing chance that pasture production will fall short of the minimum amount of feed needed to keep the animals alive, or that (new) epidemics of animal diseases claim a lot of victims among the livestock population. The 'corrective disasters' may lead to wild oscillations in animal numbers (Ingold 1986:148). So, the pastoral enterprise is not only inherently unstable, the risks are even enhanced by the very management decisions that enable humans to exploit the animals. In this perspective the dictum that 'disaster always looms over the pastoral enterprise' (Ingold 1986:80) must be understood.

Another source of risk for the pastoralist is the necessity of obtaining calories of vegetable origin by cultivating, gathering, exchange or force. Either the pastoralist has to produce these himself, or he/she has to engage in social relations with people who produce cereals. This has important consequences for the cherished mobility of pastoralists, because cereal production or exchange is tied to specific localities (fields and markets), which hamper the free movement of the pastoralist and his animals.

However, risk is also an intrinsic element of cultivation. Just as the pastoralist introduces an element of hazard into his own undertaking by protecting his animals against predation and the vagaries of the environment, the cultivator enhances the chances for disaster by removing the natural vegetation, and replacing it with the desired crop. This agro-ecosystem also needs to be protected against the invasion of weeds, birds, rodents and other pests. If not, the crop will not survive. Moreover, whereas the pastoralist may move his herd from one place to another to deal with erratic rainfall, the cultivator cannot move his field and has to wait for better times.

Lastly the cultivator has to prevent the continuous deterioration of the productive capacities of his field because of the extraction of nutrients from the soil by the crop. This is particularly a problem in the semi-arid tropics as owing to the combination of long dry periods, high temperatures, and low humidity the level of organic matter is very low. This is often aggravated by the low natural fertility of the soils. An obvious solution to this problem would be to replace the fields, when the soil is exhausted, to have soil fertility recover by a fallow period. In this way soil fertility can never be pushed beyond the limits of natural fertility. To do this the cultivator may also bring in nutrients from outside in the form of manure of animal animals and/or mulching material.

Surprisingly little attention has been given to the dynamics of the combination of pastoralism and the cropping of cereals. This 'agro-pastoral strategy' is extremely important in dry-land Africa. Contrary to what is suggested by the myth of the wandering pastoralist, most pastoral populations in West Africa do not exclusively rely on livestock keeping for their subsistence, but cultivate and keep animals at the same time (see e.g., Dupire 1970, Riesman 1977, Delgado 1979, Marchal 1983, Grayzel 1990). In the same ecological zones most cultivating neighbours keep significant numbers of animals, and sometimes even move with these animals (see e.g., Holy 1988, Thebaud 1988, Toulmin 1992, Van Beek 1995). Over the past century the importance of the combination of pastoral and agricultural production within one organisational unit has grown under the impact of market integration and the transformation of political and labour relations following the liberation of slaves.

As a diversification strategy agro-pastoralism seems to be quite successful in high-risk environments such as the African Sahel. Production failures in one production system can be accommodated with the help of the other production system and vice versa. This may be done directly by substituting livestock products with cereals, but also indirectly via exchange relations and market transactions. In this way the pastoralist gains more independence from the market and (defunct) political relations with other people to supply him/her with cereals. The cultivator solves the problem of the deteriorating soil conditions with the manure of his own livestock, and builds up a capital base to survive a bad grain harvest.

However, agro-pastoralism not only has advantages from the perspective of dealing with risk and uncertainty. In a number of ways the cultivation of cereals and the keeping of livestock are also incompatible. The need to stay around when cultivating cereals, and to apply manure after the harvest imposes restrictions on herd mobility, and consequently on optimal herd management (see van Dijk 1997). There is also an important trade off between cultivation and herding with respect to labour input. One has to devote labour power to herding – though less than average – when labour demands for cultivation are at their peak. As a result labour input in cultivation is reduced and leads to less than optimal harvests. The combination of herding and cereal cultivation in one geographical area further necessitates the careful timing and co-ordination of herd movements and cropping practices. This requires that land tenure arrangements are sufficiently flexible and leave room for continuous negotiations between all the parties involved to allow for adjustments both to the exigencies of the production systems and to climate fluctuations (see van Dijk 1996).

This dialectical relation between cropping and herding is also exemplified by the fact that there is a minimum number of hectares needed to pasture the animals in order to sustain production on one hectare of crop land (see e.g., Toulmin 1992). When the proportion of cultivated land is approaching this limit the relation between the two production systems becomes inversely affected and may even become antagonistic and inimical in social terms. These conflicts occurred in the past (Marchal 1983), but it seems that in some areas the range and content of these conflicts is increasing (e.g., Bassett 1993).

So, there is no pastoral nor agro-pastoral land use system where risk can be eliminated, or where all risks can be foreseen by the decision makers. As we will see in the next sections this view is closer to the empirical reality of agro-pastoral decision making because it allows for a greater variety of conditions to be taken into consideration in decision making than the formal agro-economic models.

Agricultural decision making by herdsmen and farmers in Central Mali

The research area

This section is based on a field study in an agro-pastoral community in the centre of the Niger Bend, 30 kilometres south of the mountains which connect the Bandiagara plateau with Mount Hombori in the *cercle* Douentza, region of Mopti, Central Mali. Three agro-ecosystems may be distinguished in the research area: the mountains; the flatlands surrounding the mountains, where a thick bush vegetation (tiger bush, *brousse tigrée*) can be found alternating with bands devoid of any vegetation on clay soils; and an area of fixed aeolic dunes with a very sparse tree cover and a herbal layer of annual grasses. In the area separating the tiger bush from the dunes a number of agro-pastoral settlements of Fulbe herdsmen and Riimaybe and Hummbeebe cultivators can be found, some of which were established in the nineteenth century and before. Others were until recently (1950-1970) only inhabited during the rainy season, because of the lack of a dry season water supply. Long-term average rainfall in the area is about 400 mm per annum, and falls predominantly (over 80 per cent) in the months from July to September. However, observations by ILCA in the 1980s somewhat to the east indicate that total rainfall is probably less (Hiernaux et al. 1990). In particular rainfall in the month August has declined (Hesse & Thera 1987). Variance in rainfall is more than 20 per cent with sometimes an extreme observation of ± 50 per cent from the mean.

These rainfall variation leads to enormous fluctuations in resource availability and food production. In the *cercle* Koro south of the research area, millet production varied between 19,000 and 51,000 tons during the 1980s (Harts-Broekhuis & de Jong 1993: 194), and between 13,000 and 42,000 tons in the *cercle* Douentza over the period 1975 to 1986 (Hesse & Thera 1987: 38). The most telling indicator of the consequences of natural hazards is the amount of fiscal revenue in the Mopti region, which fell from 2 billion Francs CFA in 1983 to only 13 per cent of that amount in 1986 (Moorehead 1991: 241).

The community where the data were gathered, Serma, consists of a permanent sedentary hamlet of Riimaybe cultivators surrounded by eight temporary settlements of Fulbe herdsmen. Approximately 500 people (400 Fulbe and 100 Riimaybe) inhabit the area, but the number of people varies over the seasons and over the years following dry and wet periods. Both population groups combined livestock keeping and crop production in various mixes, with the Fulbe emphasising transhumant livestock production and the Riimaybe stressing the production of millet. Both Fulbe and Riimaybe belong to Fulbe society, though there are marked differences between these population groups. Before the colonial period the Fulbe pastoralists formed the noble stratum of society together with the political and religious elite. The Riimaybe are the descendants of the former slaves in Fulbe society. At present they have become free and independent cultivators, whereas the Fulbe have lost their political influence and have become impoverished agro-pastoralists. Despite this development, up to now the Fulbe have avoided certain types of work as much as possible such as the cultivation of cereals, the gathering of bush products, construction work, and other types of manual labour, which are considered unworthy for nobles. They leave all this work to the Riimaybe. At present the Fulbe cannot avoid cultivation of cereals, because their herds are too small to provide for a subsistence.

The livestock is herded in the surroundings of the settlements. To the south there are vast pastures of predominantly annual grasses on the sandy soils of fixed dunes. Here the cattle are grazed. To the north the soils are clayey and trees dominate the vegetation. This area is used predominantly for the grazing of sheep and camelids. When the fields are harvested very little labour is invested in herding. The cattle are only collected for milking.

When the herding family falls short of cereals or when pastures in the surroundings of Serma are bad, people go on transhumance to cultivators' villages to the south and west either to look for pastures and water for their animals or for possibilities to barter/market their milk for cereals.

The inhabitants of Serma were cultivating several types of fields with different soil and management properties: (1) the fields on the sand dunes (Tiile), with sandy soils and little manure; (2) some fields around the Riimaybe hamlet, Debere, located in a depression with heavier soils and relatively well fertilised with dung and village waste; (3) fields around the well called Yaraama, sandy soils, but regularly fertilised; and (4) deserted campsites (Wiinde) which were heavily fertilised, but only occasionally cultivated. Fields of type 1 were used by Fulbe herdsmen and Riimaybe cultivators, of type 2 by Riimaybe only. Type 3 and 4 were exclusively in use by Fulbe herdsmen.

The situation in which the research was conducted was difficult.[2] In 1989 the complete harvest was destroyed by local grasshoppers. The rains of 1990 were bad and only somewhat better in 1991, so that a near-famine situation existed during most of the fieldwork. According to the population this had been a permanent characteristic of the past decade (1981-1991), with only one good harvest in 1988. So we may consider this situation as a good example for a discussion of decision making under conditions of insecurity, and of how people manage risk.

The data base

In the following subsections I will attempt to analyse the dynamics of livestock and cereal production. However, this description hides much of the state of chaos and

the anxiety of the people about the course events and the decisions they had to take. At times we talked with people who were very insecure, almost desperate about what to do in their situation. Moreover, the information given in this paper concerns the relatively wealthy. The near-famine situation affected the process of the gathering of data, and made it especially difficult to gather consistent sets of quantitative data. We did not want to push people, because of the extra drain on their time and energy and for fear of getting distorted information because of window-dressing. Poverty is considered as shameful in Fulbe society (de Bruijn 1994).

In general, people were very reluctant to talk about the 'wealth' they possessed. A favourable remark by the interviewer or his assistant about, for example, the number of cattle or children (labour power) would cause the person being interviewed to close up like an oyster. The normal explanation of the 'fear-of-the-tax-collector syndrome' does not hold in this case. People obviously experience shame (*yaage*) loaded with fear and suspicion that someone may destroy their wealth out of jealousy (*haasidaare*). When people owned only few cattle, the discussion of animal ownership was much less of a problem. Attempts to count animals in the camps and to record all kinds of data met with suspicion. Men who were willing to provide information on these subjects did so in barely audible voices. So we had to resort to wealth ranking exercises to acquire data on livestock ownership, which is not a very sensitive and error-proof method, but was probably the most reliable in this case.

Most people were less hesitant to discuss crop production. Nevertheless many problems were also encountered in this domain. In the first place many fields were abandoned in 1990, and to a lesser extent in 1991, so that no data could be gathered for two consecutive years for most fields. Information about the fields that had failed was hard to obtain, because the workers did not see any point in going to a field that had not produced anything. For them it was not relevant. Secondly, field size was hard to determine. A lot of fields were only partly covered with seedlings or weeded. Should the area measured reflect the intentions of the worker or the actual outcome? Sometimes he did not know either. A similar problem was encountered at harvest time. Crop production had to be estimated by the number of loads of spikes carried home, which was the easiest to ask. We could not possibly monitor sixty households, or even ten, and weigh all the millet brought home. However, the variation in loads was tremendous depending on the length of the stalks used for binding, and the quality of the spikes. Moreover a lot of millet was carried home in baskets without being bound, because of its bad quality or because it needed additional drying.

Data on labour input proved a menace. The labour devoted to cereal cropping over both seasons was not equal in character. In 1990 most labour was spent on sowing and chasing birds, and very little on weeding. At times people seemed almost apathetic because of the bad rains. Their answers to questions with respect to labour hours were based on social desirability or the intentions of the person interviewed, rather than actual working hours spent on the field. In 1991 the people were more hungry, and thus less effective while working. However, the rains were better and they spent much more time on their fields.

The same sort of problems applied to the management of soil fertility. Most people applied manure to their fields with their own livestock by contracting a herdsman or by carrying household refuse to the field. The question was how to establish the amount of manure applied. How many and for how long were the animals corralled on the field? Were they taken to graze at night and for how many hours? What was the composition of the herd? How did they spread the manure over the field? How to compare goats dung with cow dung? To get some idea one needs to be present everywhere all the time.

The aggregation of data at the level of the family or the production unit also proved to be difficult. There was a clear difference in the organisation of production between the Fulbe and the Riimaybe. The Fulbe have all kinds of arrangements to undertake millet production. All the men of a *wuro*, the basic unit for organising agricultural production, normally work on the family's fields. Mostly the sons work. The women never work on the fields, because their task is the processing and marketing of milk because of ideological reasons. When older men work, they normally have separate fields. Production may be stored in a common granary, but also in individual granaries, even when the producers belong to the same *wuro*. Riimaybe work a number of fields with their family, men, women, children and old people alike. At the same time individuals, mostly women, but also men, work personal fields with the help of their children. The harvest of these personal fields is put into private granaries.

Both Fulbe and Riimaybe possessed livestock on an individual basis. Among the Fulbe herd management was organised at the level of the household (*wuro*) by its male head. Among the Riimaybe various forms of management could be observed. Some families managed their own livestock. Others had their cattle herded by Fulbe herdsmen. Small ruminants were in general taken care of by the family, sometimes at the level of the household, sometimes at the individual level mainly by women, who invested the revenues of petty trade in goats. As we shall see these different management regimes have consequences for the maintenance of soil fertility.

Beside these structural differences the organisation of the production units themselves proved to be very dynamic in the sense that a number of families, Fulbe as well as Riimaybe, changed their organisation over the course of the two seasons that were observed. In one case, a Fulbe family, split into five sub-units. In the second year the head of one of the sub-units refused to provide us with data on production, so that the data over the two years were not comparable.

So there are numerous sources of error in quantitative data, which only become clear after prolonged observations over more than one season. Moreover, what is observed this year cannot necessarily be observed next year. Data which are normally considered as constant over time may vary or change at a much faster rate than assumed. Examples of these are the productivity of an hour of extra labour, the composition of production units, the number of livestock available to maintain soil fertility, the tree cover, and the time devoted to specific agricultural activities.

Livestock production

Over the past decades livestock numbers fluctuated heavily in accordance with the occurrence of droughts. In a neighbouring village the Fulbe lost 62 per cent of their cattle and 55 per cent of their small ruminants during the droughts of 1972-1973 (Diallo 1977). In this instance the herds recovered at a fast rate, for by 1977 the number of cattle had increased by 43 per cent in just four years. There is no reason to think that things were different in Serma. According to the Fulbe herdsmen they again lost most of their cattle in the drought of 1983-1985, this time 3 out of 4, which is close to official estimates (ca. 65 per cent, RIM 1987: 54). Recovery from this last disaster has been much slower because rainfall did not pick up until 1994. So, a total number of 1,000 head of cattle at the time of the fieldwork owned by 62 families (Fulbe and Riimaybe) seems a reasonable estimate (see Table 1).

The total village herd may produce at most 600 litres of milk a day for human consumption during the rainy season, and almost nothing during the dry season. During the post-harvest season (October-December) of 1990 and the cold dry season (January-February) of 1991 on average 8 women marketed their milk each day, while their average turnover was sufficient for 2 kilos of millet. This means that the women's economy has suffered enormously from the fluctuations in cattle numbers (De Bruijn 1997). Consequently the selling of animals, which is a male prerogative, has taken over the role of supplier of cereals during the dry season, putting women and children at even more risk. The Riimaybe women never marketed their milk. It was all used for home consumption, or the livestock was herded by Fulbe herdsmen who consumed the milk.

In general the Fulbe own more livestock, especially cattle, than the Riimaybe. However, one has to keep in mind that these cattle are very unevenly distributed over the community. This leaves 37 Fulbe families and 10 out of 12 Riimaybe families with less than 5 head of cattle (most of them without any) (see Table 1) at

Table 1: *Cattle ownership over various categories of wealth*

No. of cattle per family	No. of families	Total cattle per category	% of total
ca. 200	2	400	40
ca. 50	1	50	5
25–30	6	165	17
15–24	9	180	18
5–14	7	70	7
1–4	25	75	8
–	12	0	0
	missed	60	6
total	62	1,000	100%

the time of the field research. The ownership of cattle is, however, not translated into political influence for the two wealthy (Fulbe) families. Political domination is instead based on closeness to the Fulbe chief who resides in Booni 27 kilometres north of Serma, family and lineage size, or the occupation of positions such as tax-collector or lineage head which were created by the colonial administration and subsequently perpetuated by the Malian government.

If we compare the fluctuations in livestock numbers with the instability in pasture production, it is clear that at least as far as the last drought is concerned a major dip in pasture production in 1983 and 1984 preceded the massive dying (75 per cent) of cattle in the dry season of 1985 (see Table 2). The variance in forage production for specific components of the vegetation is even higher (see De Bruijn & Van Dijk 1995: 284). It also appears, when comparing the production figures for 1984 and 1987 that total rainfall is not the only important factor, but it is also the timing and spacing of showers, which was much better in 1987 than in 1984. The high cattle mortality related to the drought of 1985 was further due to the massive influx of livestock from northern regions and the administrative decisions concerning access to water points and pasture areas, which led to catastrophic overstocking (Van Dijk & De Bruijn 1995).

In addition food and livestock markets collapsed. Cereals doubled in price because of short supply and speculation – though eventually the rise of cereal prices was stopped by the massive distribution of food aid. Official market prices for livestock dropped to approximately 20-25 per cent of pre-drought levels, while the proportion of all animals offered at the market which were sold dropped from 50 per cent to 30 per cent, and the number of animals offered increased by 600 per cent (Hesse 1987). Locally, animals fetched much lower prices, and were even given away by herdsmen just to get rid of the burden, hoping that the new owner would manage to keep them alive.

Table 2: *Primary production (PP) and carrying capacity (CC) of pastures in the research area for various years*

Year	P in mm	PP in kg	CC in TLU.ha^{-1*}
1984	196	347	0.048
1985	n.d.	1,276	0.175
1986	198	983	0.135
1987	155	717	0.098
1988	284	1,660	0.227
1989	225	1,350	0.185
Mean	**212**	**1,055**	**0.145**
s_n (%)	20 %	41 %	41 %

Note: one TLU is a standard animal of 250 kg, 1 camel is 1 TLU; one head of cattle is 0.7 TLU; one goat or one sheep is 0.1 TLU
Sources: Diarra & Hiernaux 1987, Hiernaux et al. 1984, 1988, 1989, 1990

Table 3: *Prices of millet, bulls and kilos of millet per bull in the research area over various seasons*

Year	season	Millet price in FCFA per 100 kg	Price of a bull	kilos of millet per bull	s_n
1990	rainy	8,893	50,071	541	92
1991	dry hot	12,500	68,653	549	67
1991	rainy	12,500	59,833	479	95
1991	post-harvest	6,438	60,750	953	107
Mean		**11,000**	**61,348**	**577**	**167**

During the fieldwork period (1990-1991) herd growth stagnated because of tick-born diseases. Official livestock prices were structurally depressed because of subsidised beef exports by the European Union to the coastal countries of West Africa (Ruben et al. 1994), and official cereal prices were high due to bad harvests (see Table 3). As a result the amount of millet obtained for a head of cattle was low, which meant an extra drain on the growth of the herd. When a good harvest was obtained in 1991, cereal prices dropped and livestock prices rose immediately.

So, in this case herdsmen had to face the hazards caused by three factors. First of all, climatic risk, which caused a dramatic fluctuation in pasture (and cereal) production. A second source of risk was the cereal and livestock market, which responded inversely to the drop in agricultural production. The third source of risk was political in nature, i.e., the political decisions which led to the admission of too much livestock on the pastures of Serma. These factors led to the 'corrective disaster' as predicted by our framework.

Cereal production

A similar picture can be sketched for cereal production. Both the Fulbe and the Riimaybe cultivate millet to compensate for the gaps left by the livestock production system. Some Riimaybe occasionally sow sorghum and beans. Surprisingly, the Fulbe herdsmen work more land per worker than the Riimaybe (see Table 4). This is due to the fact that Fulbe women never take part in cultivation work. On a per capita basis the Fulbe cultivate on average less land than the Riimaybe, but given the range of variation ($x \pm s_n = 0.28\text{-}0.40$ for the Fulbe and 0.29-0.61 for the Riimaybe) the differences are not worth mentioning.

Table 4: *Area cultivated per worker and per capita for various population groups in Serma, Central Mali*

	Mean area cultivated (ha)				
group	**per worker**	**s_n %**	**per capita**	**s_n %**	**N**
Fulbe	1.70	35	0.34	18	11
Riimaybe	0.95	26	0.45	36	9
Total	**1.37**	**44%**	**0.39**	**33%**	**20**

Much more important are the differences in production per worker and per capita, the coefficient of variance of these figures and the differences between the two years that observations were made (see Table 5). In 1990 the average Fulbe worker produced less grains with twice as much land as an average Riimaybe worker. On a per capita basis this difference is even more impressive. The difference in per capita production remains large in 1991 but the relative gap becomes less, due to a spectacular increase in production per Fulbe worker surpassing the Riimaybe workers by almost 300 kilos. However, we must be cautious here because of the small data base. The difference between Riimaybe and Fulbe in inter-annual variation is particularly large.

If we then take the inter-annual variation for all the fields monitored in 1990 and 1991 it seems clear that average productivity of fields was higher in 1991, especially when one considers that the figures for 1990 are inflated because a

Table 5: *Crop production per worker and per capita for various population groups and various years in Serma, Central Mali.*

	Mean crop production (kg)				
			1990		
group	**per worker**	**s_n %**	**per capita**	**s_n %**	**N**
Fulbe	212	27	56	52	5
Riimaybe	261	43	136	56	7
Total	**240**	**40%**	**103**	**71%**	**12**
			1991		
group	**per worker**	**sn %**	**per capita**	**sn %**	**N**
Fulbe	676	33	127	30	6
Riimaybe	393	*	180	*	2
Total	**606**	**38%**	**140**	**55%**	**8**
			1990/1991		
Total	**386**	**63%**	**118**	**55%**	**20**

Table 6: *Mean field size (x in ha), and productivity (p' in kg.ha^{-1}) and its coefficient of variance (s_n in %) of millet fields at different cultivation sites in 1990* and 1991

			Productivity		
location	**year**	**mean field size (x)**	**per ha p'**	**s_n %**	**N**
Tiile	1990	1.52*	281	98	16
	1991	0.99*	402	49	16
	1990/91	1.25	341	74	32
Debere	1990/91	2.55	381	49	9
Yaraama	1990/91	0.89	377	45	7
Wiinde	1991	0.38	656	57	5
year	**location**	**mean field size (x)**	**per ha p'**	**s_n %**	**N**
1990	all	1.85*	305	80	25
1991	all	0.89*	452	56	28
total		**1.34**	**382**	**67%**	**53**

Note: * The differences in mean field size between 1990 and 1991 have to be attributed to the fact that just before the growing season of 1991 a family of five brothers and their nuclear families decided to split their fields. The fields on *biile* (plural of *wiinde*) are always very small.

number of fields failed and were not monitored for that reason. Moreover, the coefficient of variance in 1990 is much higher than in 1991. If we split the data into field type (Table 6), no clear pattern emerges, only that the heavily fertilised fields of the Wiinde (a deserted campsite) do particularly well in a year of good rainfall and that the cultivation of the sandy soils on the Dunes (Tiile) is extremely risky in a year of bad rainfall given the enormous variance. Productivity of the heavier soils around the Riimaybe village (Debere) and the sandy soils around the pastoral well (Yaraama) is relatively stable.

Farm management

So it seems that there are two main production strategies. The first is mainly pursued by the Riimaybe. They cultivate the heavier soils around the Riimaybe hamlet, sometimes in combination with fields on the dunes. This strategy results in relatively stable cereal production figures. The second strategy is mainly followed by the Fulbe, who cultivate the sandy soils on the dunes and around the well at Yaraama, and sometimes heavily fertilised campsites. Given the soil characteristics in combination with the quantities of manure applied to these fields this second strategy is much more risky than that of the Riimaybe, which is made clear by the high coefficients of variance (Tables 5 and 6).

Within the cropping system itself there is no ready made explanation for the differences between these two groups. Riimaybe may own and/or operate the same resources in nature and quantity as the Fulbe. Moreover, as is made clear by the data, the differences within each group are just as big. So, variations in cereal and livestock production cannot be brought down to a simple socio-economic indicator. We will have to look at particular mixes of crop and livestock production at 'farm level', and the way in which soil fertility is managed, this is the most important link between the two production systems.

This becomes clear if we compare two relatively rich families, one Fulbe and one Riimaybe, of equal size, and a poor Fulbe family. In 1990 the wealthy Fulbe family harvested far too little for the subsistence of the family (see Table 7). This was quite understandable since they cultivated only fields on the dunes. In order to compensate for the gap, the family went on transhumance to barter their milk for cereals in a village of sedentary cultivators. But during the dry season the cows ran dry because of the bad quality of the forage and the inhabitants of the village where they had camped were unwilling to sell millet and buy milk, since they had also had a bad harvest. The only option left was to sell cattle. In this case, five

Table 7: *Budget of a relatively well off Fulbe family in 1990.*

Consumption	kg millet
Millet harvest (1990)	335
market transaction 13 sacks of 100 kilo	1,300
bartered for milk	300
support by son-in-law	147
gift of cultivator	13
subtotal	2,095
needed 7 kg per day*	2,555
Deficit	**–460**
Cash income	**FCFA**
Bull (8 years)	36,000
Bull (one year)	16,000
cow (12 years)	36,000
heifer (3 years)	30,000
bull (3 years)	33,000
Total budget	**151,000**

Note: * This figure is corrected for the fact that they had a number of milk cows and derived part of their subsistence from the self-consumption of milk.

head of cattle were converted into 1,300 kg of millet (260 kg of millet per head of cattle) and other necessities such as clothes, cola nuts and tobacco. The prices which this herdsman obtained for his cattle were lower than the official prices (see Table 3).

The following year (1991) the rains were much more abundant, and the family took a deserted campsite into production, which produced very well (500 $kg.ha^{-1}$). The other fields more than doubled in production (from 99 to 238 $kg.ha^{-1}$). The disappointing returns per hectare from these fields indicated that soil fertility was low. This is due to the fact that owing to cereal deficits the family was obliged to look for cereals elsewhere, leaving no time to manure their own fields. In 1991 they harvested much more (though still not sufficient) and decided to stay in the village to apply manure to their own fields.

The Riimaybe family was the only one who harvested sufficient millet for the whole of 1990 from their family fields (424 $kg.ha^{-1}$ on the heavier soils, 22 $kg.ha^{-1}$ on the dunes).[3] In addition, the wives of the household head harvested several hundred kilos from their own personal fields. In 1991, however, they harvested little more. As Riimaybe they did not consider going on transhumance. Instead, they corralled their own livestock on their fields, and invited other people to do the same. One son of the family was sent away to Bamako, the capital of Mali, to earn money to pay for the head taxes. He was not very successful, as he did not even earn enough money for his return journey.

Table 8: *Budget of a poor Fulbe family in 1991.*

Consumption	kg millet
Millet harvest (1991)	833
bought in small quantities for FCFA 24,500	250
bartered for milk	100
borrowed from Riimaybe	35
subtotal	1,218
needed 5 kg per day*	1,825
Deficit	**-607**
Spending	**FCFA**
donkey	7,500
2 goats	5,350
one she-goat plus kid	2,800
one goat	1,500
one goat	1,500
wage labour for Riimaybe	5,000
Total budget	**23,650**

Note: * This figure is corrected for the fact that this family relied almost totally on cereals for their subsistence as they possessed very few livestock

However, these were the well off. Differences within each group, Fulbe and Riimaybe, are great, greater than between these two families. The poorest have to rely on quite different strategies to cope with cereal deficits. They cannot count on their own harvest or the sale of cattle, as the rich do. Instead they have to muddle through on a day-to-day basis. In Table 8 a budget of such a poor family is summarised for 1991, a relatively good year. This family spent the dry season wandering from village to village, bartering the (little) milk of their goats, and doing work on an occasional basis for the sedentary cultivators. They were lucky that year, because they harvested a lot of cereals. Despite the fact that they had no livestock to apply dung, nor the means to contract a herdsmen to corral his livestock on their field, it had received a lot of village waste by way of manure, because it was located close to the Riimaybe hamlet. However, the year before their crop had 'burned', due to water stress. As the result of the high amount of manure in the soil, the water requirements of the crop were too high to survive a dry spell in the middle of the rainy season.

Natural resource management

It is clear that there is a large element of risk and uncertainty involved in farming and herding, given the high variability in crop production figures each year, and the cyclical oscillations in livestock numbers. Actors, whether individuals or groups have to deal in a comprehensive manner with each event, in order to survive each calamity, while not eroding the basis of their existence. Nevertheless, they do so within their own particular framework, ideologies and their membership of a particular herding or farming community. The Riimaybe have always been defined as low status people. Culturally they are not allowed to behave like the Fulbe and follow their herds on transhumance. Herd following as a way of earning a subsistence is just not done. It is not part of their identity. Instead, they entrust their animals to the Fulbe or keep them near their homesteads. Nonetheless, the Riimaybe conform very well to the picture of skilful survivors. They cultivate, keep animals, gather, engage in wage labour and petty trade etc.

The Fulbe on the other hand have strong prejudices against the gathering of tree fruits and wild grains as this is the work of the 'poor', and in fact only cultivate cereals because they have to. Wage labour is a last resort. They prefer to move through the pastures in a rather haphazard way, sometimes going to places where the forage is bad and food is lacking, instead of employing fine-tuned grazing strategies to accumulate cattle as rational pastoralists are supposed to do. Even worse, if they cultivate, they farm the most drought-prone soils in their home area, after applying tons of manure, so that their crops constantly 'burn' and fail. They leave the wild grains in the bush, and their women buy their spices and other necessities from Riimaybe women, instead of engaging in petty trade by themselves.

Nevertheless, it would be quite premature to conclude that they behave in an irrational fashion. Applying a lot of manure to light sandy soils in a semi-arid region may seem illogical, because it enhances the risk of crop failure. However, because

of the labour in cultivating light soils, a herding family is able to manage a herd at the same time, to liberate the women from agricultural labour in order to process and market milk, and to harvest a bumper crop once every five years. It adds in another way to the variety in subsistence, because this composite strategy permits the Fulbe to stay mobile and to shift from herding to farming and vice versa.

However, specific strategies work only under specific conditions. People lack the technical means to develop fine-tuned strategies to tame the environment and can only react to extremely variable conditions. For both Riimaybe and Fulbe there have been no two years over the last decades in which the growing conditions, and hence the productive capacity of the ecosystem, were the same. This year's loser may be tomorrow's winner and vice versa. Given the differences in strategies between the Riimaybe and Fulbe, the Riimaybe opt for lower risks in the form of more reliable outputs of cereals, whereas the Fulbe choose a high risk strategy, where both the gains and losses are higher.

At the level of Fulbe society as a whole there are even more complicated patterns of interaction. The differences in strategies between the Riimaybe and Fulbe can be understood as opposites in a dialectical relation. The presence of the Riimaybe as a sedentary core in Fulbe society, and the fact that they perform all kinds of services for the Fulbe herdsmen, enables the Fulbe to maintain the flexibility and mobility to move around with their prime resource cattle. If the Fulbe took part in gathering, petty trade, repairing wells and water reservoirs and the plastering of granaries etc., they would not be able to exploit the variety of pastures and cereal markets in far away cultivators' villages as they do now.

The Riimaybe profit from this situation in two ways. Firstly, by allying themselves to the Fulbe they have better employment and trading opportunities. The second manner in which they profit is the fact that they are able to exploit a larger area for manure production with the help of the livestock and the herding capacities of the Fulbe. When they contract a herdsman for fertilising their fields or herding their cattle they gain access to much larger pasture resources than if they operate on their own.

To further investigate these interactions we would have to include property and tenure relations, and the regulation of access to grazing and gathering to see how they enable people to occupy specific 'risk positions' (see Beck 1992), and move or negotiate themselves from one position to another. As can be concluded from the budgets of rich and poor families, people do not start from the same position when confronted with hazard, and consequently do not have the same options for responses to risk, and may have to deal with hazard in a sub-optimal manner.

Conclusion

Given the large variety of factors involved in agricultural decision making in high-risk environments, the dynamics can only be understood in a larger framework, which comprises ecological, economic, legal political and cultural factors. As has been shown in this paper one cannot understand the role of risk and uncertainty in decision making with reference to agricultural input and output data alone, for they suppose linear feedback relations between the factors involved. On the contrary decisions in one domain may have far-reaching consequences for other domains. This means that decision makers will often choose to operate specific domains in a sub-optimal manner, so that negative consequences in other domains can be prevented.

The feedback processes in these domains seem to evolve in a non-linear manner due to their complex character, and the compounded effects of numerous decisions and environmental factors, which leads to changes in system characteristics and key variables. This results in a number of emergent properties of the land use system, which cannot be reduced to the decisions of individuals. Given the numerous differences between the decision makers and the large variety of conditions in which they operate it seems that there is not just one optimal strategy. Rather there are a number of possible tracks for herdsmen as well as cultivators in each and every situation, with each their own risks and having possibilities for gains.

A last word on risk and uncertainty itself. The dynamics of risk and uncertainty are very important to our understanding of agricultural decision making in semi-arid environments and high risk environments in general. It has been shown that these dynamics have a multi-dimensional character and cannot be brought down to individualised decision making. Firstly, individuals occupy a variety of risk positions. This means that they are vulnerable to the impact of risk in a different manner. Secondly, individuals coordinate their decisions with, and adjust themselves to, the decisions of other people, such that the compounded effect of large numbers of individual decisions are transformed into all kinds of emergent properties in higher order social entities, such as camps, villages, ethnic groups, land tenure arrangements and even the land use system as a whole. This implies that we will have only a partial, if not one-sided, understanding of risk-coping behaviour, if we focus on individual decision making alone. To do full justice to these larger dynamics of risk and uncertainty we need to develop logical chain models which include these motivational, cultural and institutional factors.

Notes

1. Risk in this perspective is an aspect of any unforeseeable event that impinges directly or indirectly on the productivity of natural resources and the production, consumption, and distribution of agricultural products. Hazards are a possible consequence of risk.
2. The fieldwork in this community took place between July 1990 and February 1992, with a pause of three months during the dry season in 1991. Funding for this research project was granted by the Netherlands Foundation for the Advancement of Tropical Science (WOTRO: grant W 52-494). Data were gathered by two researchers, Mirjam de Bruijn and myself. The initial purpose of the study was to assess the consequences of political change and drought for local-level strategies of natural resource management, and social security arrangements. For the study on land use, to which we will limit the discussion here, data were gathered by means of participant observation, open and semi-structured interviews, field observations, archival research and oral history. Most of the data were qualitative. Some quantitative data were gathered to get some idea about the economics of cereal and livestock production.
3. The big difference between the two fields cannot be explained with reference to soil type alone. It is probable that there was no labour invested in the field on the dunes when it became clear that the rainy season would not be good and that the harvest was bound to fail on that field, and that it would be wise to devote all attention to the field with the heavier soils.

References

Barlett, P.F. (ed.) 1980, *Agricultural Decision Making: Anthropological Contributions to Rural Development*, New York: Academic Press

Bassett, T. J. 1993, 'Land Use Conflicts in Pastoral Development in Northern Côte d'Ivoire', in Thomas J. Bassett and Donald E. Crummey (eds) *Land in African Agrarian Systems,* Madison WI: University of Wisconsin Press: 131-154.

Beek, W. E.A. van 1995, 'Local Management of Moving Resources: The Case of the Dogon Village Herd', in J.P.M. van den Breemer, C.A. Drijver and L.B. Venema (eds) *Local Resource Management in Africa*, Chicester: John Wiley & Sons: 47-64.

Beck, U. 1992, *Risk society. Towards a new modernity*, London: Sage

Breman, H. and N. de Ridder 1991, *Manuel sur les pâturages des pays sahéliens*, Paris: Karthala

Bruijn, M.de 1994, 'The Sahelian Crisis and the Poor, the Role of Islam in Social Security among Fulbe Pastoralists, Central Mali', *Focaal*, 22/23: 47-65

Bruijn, M. de 1997, (forthcoming) 'Milk , Social Relation and Drought: the Hearthhold in Pastoral Fulbe Society, Central Mali'

Bruijn, M. de and H. van Dijk 1995, *Arid Ways: Cultural Understandings of Insecurity in Fulbe Society, Central Mali.* Amsterdam, Thela Publishers, also Ph.D. thesis Utrecht University, Wageningen Agricultural University.

Cancian, F. 1980, 'Risk and Uncertainty in Agricultural Decision Making' in P.F. Barlett (ed.) *Agricultural Decision Making: Anthropological Contributions to Rural Development*, New York, Academic Press: 161-176

Delgado, C. L. 1979, *The Southern Fulani Farming System in Upper Volta: A Model for the Integration of Crop and Livestock Production in the West African Savannah.* African Rural Economy Paper, 20. Department of Agricultural Economics, Michigan State University

Diallo, H. B. 1977, 'Les sociétés pastorales de la zone d'Hombori face à la sécheresse; Réaction à la crise et degrée de rétablissement 4 ans après', Mopti: ODEM, Katibugu: Institut Polytechnique Rural

Diarra, L. and P. Hiernaux 1987, 'Évolution de la végétation Sahelienne après la sécheresse: Bilan de suivi des sites du Gourma en 1986', Bamako: Centre International Pour l'Elevage en Afrique, Document de Programme DP AZ-172

Dijk, H. van 1996, 'Land Tenure, Territoriality and Ecological Instability: A Sahelian Case Study', in: J. Spiertz and M. J. Wiber (eds) *The Role of Law in Natural Resource Management*, Den Haag VUGA Uitgeverij: 17-45

Dijk, H. van 1997, 'Farming and Herding after the Droughts: Fulbe Agro-Pastoralists in Dryland Central Mali', *Nomadic Peoples*, 36-37, pp. 65-85
Dijk, H. van and M. de Bruijn 1995, 'Pastoralists, Chiefs and Bureaucrats: A Grazing Scheme in Dryland Central Mali', in J.P.M. van den Breemer, C.A. Drijver & L.B. Venema (eds.) *Local Resource Management in Africa*, Chicester, John Wiley & Sons: 77-96
Dupire, M. 1970, *Organisation social des Peuls*, Paris: Plon
Grayzel, J. A. 1990, 'Markets and Migration: A Fulbe Pastoral System in Mali', in: J. G. Galaty and D. H. Johnson (eds) *The World of Pastoralism: Herding Systems in Comparative Perspective*, New York, The Guilford Press: 35-68
Harts-Broekhuis, A. and A. de Jong 1993, *Subsistence and Survival in the Sahel: Responses of Households and Enterprises to Deteriorating Conditions, and Development Policy in the Mopti Region of Mali*, Netherlands Geographical Studies, 168, Utrecht: Faculteit der Ruimtelijke Wetenschappen
Henderson, C. 1987, 'Famines, Droughts, and the "Norm" in Arid Western Rajastan: Problems of Modelling Environmental Variability', *Research in Economic Anthropology*, 9: 251-280
Hesse, C. 1987, *Livestock Market Data as an Early Warning Indication of Stress in the Pastoral Economy*. Pastoral Development Network, paper 24f. London, Overseas Development Institute
Hesse, C. and S. Thera 1987, Famine Risk and Early Warning in the Cercle of Douentza, Mali, Bamako: OXFAM UK, draft report
Hiernaux, P., M.I. Cissé and L. Diarra 1984, 'Bilan d'une saison des pluies très déficitaires dans le Gourma (Sahel Malien)', Bamako: Centre International Pour l'Elevage en Afrique, Document de Programme DP AZ-140
Hiernaux, P., L. Diarra and A. Maiga 1988, 'Évolution de la végétation sahellienne après la sécheresse bilan du suivi des sites du Gourma en 1987', Bamako: Centre International Pour l'Elevage en Afrique, Document de programme DP AZ-181
Hiernaux, P., L. Diarra and A. Maiga 1989, 'Dynamique de la végétation Sahelienne après sécheresse: Un bilan du suivi des sites pastoraux du Gourma en 1988', Bamako: Centre International Pour l'Élevage en Afrique, Document de programme DP AZ-192
Hiernaux, P., L. Diarra and A. Maiga 1990, 'Dynamique de la végétation après sécheresse: Un bilan de suivi des sites pastoraux du Gourma en 1989', Bamako: Centre International Pour l'Élevage en Afrique, Document de travail 001/90
Holy, L. 1988 'Cultivation as a Long-Term Strategy of Survival: The Berti of Darfur' in D.H. Johnson and D.M. Anderson (eds) *The Ecology of Survival: Case-studies from Northeast African History*, London, Boulder, Lester Crook/Westview Press: 135-154
Horowitz, M. 1986, 'Ideology, Policy, and Praxis in Pastoral Livestock Development', in M. Horowitz and T. M. Painter (eds..) *Anthropology and Rural Development in West Africa*, Boulder, Colorado: Westview Press: 251-272.
Ingold, T. 1986, *The Appropriation of Nature: Essays on Human Ecology and Social Relations*, Manchester: Manchester University Press
Kessler, J.-J. 1994, 'Usefulness of the Human Carrying Capacity Concept in Assessing Ecological Sustainability of Land-Use in Semi-Arid Regions', *Agriculture, Ecosystems and Environment*, 48: 273-284
Leeuw, P. de, L. Diarra and P. Hiernaux 1993, 'An Analysis of Feed Demand and Supply for Pastoral Livestock: The Gourma Region of Mali', in R.H. Behnke, I. Scoones and

C. Kerven (eds.), *Range Ecology at Disequilibrium: New Models*, London: ODI, IIED, Commonwealth Secretariat: 132-152
Marchal, J.-Y. 1983, *Yatenga, Nord Haute Volta: La dynamique d'un espace rural Soudano-Sahelien*. Mémoires de l'ORSTOM, 167. Paris: ORSTOM.
Moorehead, R. M. 1991, 'Structural Chaos: Community and State Management of Common Property in Mali', Ph.D. thesis, Brighton: University of Sussex
Noordwijk, M. van, G.H. Dijksterhuis and H. van Keulen 1994, 'Risk management in crop production in fertilizer use with uncertain rainfall; how many eggs in which baskets' *Netherlands Journal of Agricultural Science*, 42(4):229-238
Ortiz, S. 1980, 'Forecasts, Decisions, and the Farmer's Response to Uncertain Environments' in P.F. Barlett (ed.) *Agricultural Decision Making: Anthropological Contributions to Rural Development*, New York, Academic Press: 177-202
Riesman, P. 1997, *Freedom in Fulani Social Life. An Introspective Ethnography*, Chicago, University of Chicago Press.
RIM 1987, Refuge in the Sahel, Livestock Populations and Production Systems in the Mali Fifth Region, a Rapid Assessment of Current Resources by Low Level Aerial Survey and Complementary Ground Studies, Jersey UK: Resource Inventory and Management Ltd.
Ruben, R., J. Attema and H. Breman 1994, 'Europese exportrestituties op rundvlees: Verdere daling noodzakelijk', *Internationale Spectator*, December 1994 – XLVIII – 12: 599-602
Sandford, S. 1983, *Management of Pastoral Development in the Third World*, Chichester: Wiley
Scoones, I. 1995, 'New Directions in Pastoral Development in Africa', in Ian Scoones (ed.) *Living with Uncertainty. New Directions in Pastoral Development in Africa*, London: Intermediate Technology Publications Ltd: 1-36
Steenhuijsen Piters, B. de 1995, *Diversity of Fields and Farmers: Explaining Yield Variations in Northern Cameroon*, Wageningen: Wageningen Agricultural University, also Ph.D. thesis
Thebaud, B. 1988, *Élevage et développement au Niger: Quel avenir pour les éleveurs du Sahel*, Genève: Bureau International du Travail
Toulmin. C. 1992, *Cattle, Women and Wells: Managing Household Survival in the Sahel*. Oxford: Clarendon Press
Vincent, L. 1981, 'Drought, risk and agricultural production in Maharasthra state' *Transactions*. 1(2): 56-101
Watts, M. 1983, *Silent Violence: Food, Famine and Peasantry in Northern Nigeria*. Berkeley, University of California Press

Résumé

Les modèles conventionnels pour analyser l'impact des risques et pour saisir la prise de décision considèrent principalement des facteurs écologiques et économiques. Dans cet article la thèse est avancée que le risque et l'incertitude doivent être analysés comme des faits totaux et que nous pourrions développer une meilleure compréhension de démarches pour aménager les risques par suivre les conséquences d'un fait singulier dans l'espace et dans le temps. Basé sur cette conception de risque un cadre d'analyse est présenté pour saisir le rôle des risques et l'instabilité qui en résulte pour les décideurs et les dynamiques culturelles et institutionnelles de leurs sociétés. Ce cadre est discuté par l'analyse de l'impact de la variabilité des pluies sur la prise de décisions par des éleveurs peuls au Mali central et leurs voisins sédentaires. La thèse est avancée que les décideurs souvent optent pour des stratégies de façon non-optimale et que les processus de rétroaction évoluent de façon non-linéaire. Pour une compréhension plus approfondie de la prise de décision dans un environnement de hauts risques il est nécessaire de développer des modèles qui englobent des facteurs culturels et intentionnels ainsi que les motivations des décideurs.

Resumen

Modelos convencionales para la evaluación de riesgos y procesos de toma de decisiones solamente tienen en cuenta factores ecológicos y económicos. Uno de los argumentos centrales de la contribución es, que riesgo e incertidumbre deberían ser tratados como eventos totales y que obtendremos una mejor comprensión del comportamiento frente a riesgos si estudiamos el impacto de un evento en el espacio y a lo largo del tiempo. A partir de este argumento se desarrolla un marco de análisis de riesgos y de la inestabilidad resultante tanto para los que tienen que tomar decisiones como para la dinámica cultural e institucional de sus sociedades. Este marco es aplicado al análisis del impacto de la variabilidad de precipitaciones en las decisiones de pastores Fulbe en Mali Central y de sus vecinos agricultores. Se concluye que los actores mucha veces optan por estrategias sub-óptimas y que procesos retroactivos se desarrollan de una manera no lineal. Para un entendimiento más profundo de la toma de decisiones en entornos de alto riesgo se tendrían que desarrollar modelos que incluyan factores motivacionales, culturales e institucionales.

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TRANSHUMANCE – A PASTORAL RESPONSE TO RISK AND UNCERTAINTY IN THE HIMALAYAS

Minoti Chakravarty-Kaul

It will be sufficient to speak of original property in land, for among pastoral peoples property in such natural products of the earth as, e.g., sheep is at the same time property in pastures they pass through. In general, property in land includes property in its organic products

Karl Marx, *Pre-Capitalist Economic Formations*: 89

Nomadism in the Indian Himalayas, as organised by Gaddi shepherds, is an institutional arrangement to reap economies of pastoral value from the limited and uncertain pastures of the Himalayan country side. Their transhumance is a method of scaling down risks by spreading pastoral activity over time and space. During the process transaction costs are reduced. Such traditional practices have, however, been disrupted by a combination of structural and institutional changes; consequently the Gaddis today are commonly perceived as shiftless nomads who deforest and degrade the Himalayan environment.

In the first section I will describe the characteristics of risk and uncertainty specific to this region and the measures shepherds have taken to tackle these. My major source of information has been historical documents relating to the entire region of Greater Punjab, i.e., Punjab prior to the end of colonial rule and the partition of the Indian subcontinent in 1947 into the states of India and Pakistan. These suggest that in the first instance, transhumance was not an isolated phenomenon, but was much more integrated into the mainstream structure of rural life than it is today; what remains now are only fragments of long-haul trails which ran across the entire 'land of the five rivers'. Secondly, it appears that such transhumance was part of an overall land use pattern obtaining among various communities with arable and pastoral occupations where long and short fallows were alternated to suit the wide regional variation of soil, elevation, temperature and precipitation over the year. Thirdly, it is perceived that such a complex land use pattern was governed by institutions of collective reciprocity, in turn facilitated by a 'property rights' structure which combined individual and 'primunal' (private for some parts of the year and communal the rest of the time) holdings in the arable, and communal control in the pastoral. Only then could arable and pastoral strategies be accommodated in the different seasons. Fourthly, such institutional arrangements reflected the ability of both the cultivators and the pastoralists to self-govern resource use (for details on all these aspects see Chakravarty-Kaul 1996).

In the second part of this paper I examine the impact of legal and administrative intervention by the State and of technology which changed the structure of land use and institutions of property rights, altering the context in which pastoralism was related to agriculture. Canals in the *doabs* (land lying between two rivers)