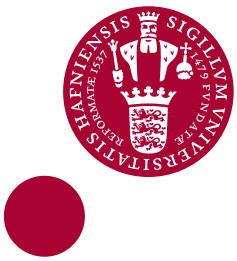

Weather, climate, and resource Information should meet the needs of Sahelian pastoralists

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Published in:
Weather, Climate, and Society

DOI:
10.1175/WCAS-D-14-00010.1

Publication date:
2014

Document version
Early version, also known as pre-print

The DOI for this manuscript is doi: 10.1175/WCAS-D-14-00010.1

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Weather, climate, and resource information should meet the needs of Sahelian pastoralists

Abstract

There has been an increasing focus on providing better weather, climate, and resource information for decision making in drylands. This study explores what kind of information pastoralists in the Sahel received in 2013 and how they responded to this information. Moreover, the study assesses whether the disseminated information corresponds to the actual needs of pastoralists. The overall objective is thus to identify the outcome of providing weather, climate, and resource information to pastoralists and thereby to explore whether and how various products may guide their mobility and decision-making patterns. The results show that few of the interviewed pastoralists receive the seasonal rainfall forecasts, which have been produced since 1998 by the Climate Outlook Forum for West Africa. The pastoralists who did receive the forecasts used the information to adjust their crop cultivation strategies rather than to support livestock management decisions. To do the latter, pastoralists need information pertaining to the availability of grazing resources in various areas, the onset date of the rains, flooding events, and fine-scale information on rainfall amount during the first weeks of the rainy season. Such information could be used to adjust the purchase of supplementary fodder, to make qualified choices on transhumance destinations and to make changes in herd composition. As pastoralists primarily acquire this information by calling friends and family in nearby areas, the results point to a strong disconnect between the parameters and scale of information that pastoralists need and those currently provided.

Keywords

Herd management; Sahel; supplementary fodder; transhumance; user response; weather forecasts

1. Introduction

In many drylands of the tropics, agricultural and pastoral systems have adapted to erratic weather patterns, including droughts, excessive rainfall, strong winds, and temperature extremes, which are the main challenges for crop and livestock production (Mertz et al., 2009; Mortimore & Adams, 2001). Climate change is likely to exacerbate these conditions (IPCC, 2007) and consequently there has been an increasing focus on providing better weather and seasonal climate information to farmers in order to improve decision-making (Crane et al., 2011). Prominent studies from Africa, however, have pointed to a strong disconnect between the parameters and scale of the climate and weather information that African villagers need and those of scientific forecasts (Ingram et al., 2002; Luseno et al., 2003). It has, for example, been suggested that most villagers are more interested in down-scaled forecasts of the duration and distribution of seasonal rainfall than in the currently available forecasts of the total amount of seasonal rain. Predictions of the onset and the end of the rains and water deficit periods during the season may thus be some of the products of high value at the local level in Africa (see e.g. Ingram et al., 2002). While such information needs have been highlighted for African small-scale farmers, very few studies are available on the information needs of the estimated 50 million pastoralists in sub-Saharan Africa (Weibel, 2010). Moreover, 65% of global drylands consist of grassland used for livestock production as these areas often are marginal for agriculture because of low or erratic rainfall or flood risks (Mortimore, 2009).

In East Africa, a few studies have assessed the type of information pastoralists are assumed to be interested in (Luseno et al., 2003; Kaitho et al., 2007). Kaitho et al. (2007) used real-time satellite weather data to simulate daily forage conditions and near-term forecasts of these conditions, while Luseno et al. (2003) suggested that timely information on forage supplies might be of value. In the

West African Sahel, no studies have so far explored information needs among pastoralists. Hence, this study will focus on the user group of Sahelian pastoralists, and the first aim is to identify the relevance of the currently available seasonal rainfall forecast compared to other types of information. As farmers and pastoralists from a practical point of view tend to be concerned with an annual time scale rather than longer time periods (Adger et al., 2003), the focus is on meteorological information and intra-seasonal and seasonal climate information instead of decadal and long term climate information. Pastoralists, however, most likely need more than just information pertaining to the rainfall of the next season. They are also likely to be interested in non-meteorological information, such as the availability and quality of grazing resources, and sources of water. Thus, this paper looks at weather information, intra-seasonal and seasonal climate information, and resource information.

Due to the apparent knowledge gap concerning pastoralists' information needs, it remains also unknown how pastoralists would actually use different types of weather, climate, and resource information. This gap is worrying as the value of the information ultimately depends on whether or not people respond to the available information (Vogel & O'Brien, 2006). Recent literature on the utility of climate information has suggested that knowledge producers regard their product as useful when they have engaged in the research they think users need (Lemos et al., 2012). But because the users' decision-making processes and contexts are not completely understood the knowledge produced remains often underutilized. Users, in turn, may have unrealistic expectations of how knowledge fits their decision-making, so although all forms of user-inspired knowledge are in principle useful, they are not always usable, unless users and producers take specific steps to make them so (Dilling & Lemos, 2011). In this context, Cash et al. (2003) have argued that information is usable only if perceived by users as salient, credible and legitimate. Yet, even as these conditions

are met, information must be accessible and actionable for it to be incorporated into user's adaptive decisions (Hansen et al., 2011). This highlights the critical role of interaction between producers and users in order to overcome the barriers to usability.

A few studies have assessed how African farmers have used or are likely to use weather, climate, and resource information. A number of these evaluations have been based on theoretical models (Roudier et al., 2011; Ziervogel et al., 2005; Sultan et al., 2010; Thornton, 2006), while Roudier et al. (2014) employed a participatory approach to simulate possible responses among farmers in Senegal. Roncoli et al. (2009) and Ingram et al. (2002), on the other hand, studied actual response options to seasonal forecasts among farmers in Burkina Faso. These studies suggested that people may change crop variety, planting date, field size, and fertilizer use, or that they may relocate fields, start storing and selling food, and diversify from farming to non-farming activities. However, these studies have some limitations. Firstly, too few strategies might have been taken into account (Meza et al., 2008). Secondly, a narrow focus on the linkage between seasonal forecasts and for example the chosen crop varieties could prevent researchers from learning how people use seasonal forecasts in combination with other types of weather and climate information. Thirdly, production decisions by African farmers as well as pastoralists may be shaped by many environmental, agronomic and economic factors beyond weather, climate, and resource information (Roncoli et al., 2009; Crane et al., 2011; Bryan et al., 2009; Lenton, 2013; Mertz et al., 2010).

Hence, these studies point to a need for research on both the relevance and use of weather, climate, and resource information, especially among pastoralists. In addition to identifying the relevant information for West African pastoralists, this paper thus aims to improve the understanding of how and why pastoralists use available information in the way they do, and how they might use other

types of weather, climate, and resource information. By doing so, the overall objective is to identify the actual outcome of providing different types of weather, climate, and resource information to pastoralists, and thus to assess whether and how various products can guide the mobility and decision-making patterns of pastoralists.

2. Weather, climate, and resource information context

The research efforts on identifying and communicating relevant weather, climate, and resource information to local end-users in West Africa – i.e. small-scale farmers – have mainly been carried out by the Climate Forecasting for Agricultural Resources (CFAR) project (Ingram et al., 2002; Roncoli et al., 2000; Roncoli et al., 2001; Kirshen & Flitcroft, 2000). The CFAR project was a research initiative aimed at identifying opportunities for and constraints to the application of seasonal rainfall forecasts to improve agricultural production and livelihood security in West Africa. Emphasis was on seasonal rainfall forecasts delivered by the Climate Outlook Forum for West Africa PRESAO (PREvisions Saisonnières en Afrique de l'Ouest), which has issued seasonal rainfall predictions (with 1- to 2-month lead times) since 1998 (Tarhule & Lamb, 2003). The Climate Outlook Forum was launched by a consortium that included a number of regional institutions, such as the Centre Regional de Formation et d'Application en Agrométéorologie et Hydrologie Opérationelle (AGRHYMET), the African Centre of Meteorological Applications for Development (ACMAD) and the Niger Basin Authority (NBA) as well as international partners such as the UK Met Office, Météo-France and the International Institute for Climate and Society (IRI). Each year in May the consortium and experts from the region's National Meteorological and Hydrological Services create seasonal forecasts for dissemination to relevant stakeholders. The seasonal forecasts are based on a 30-year rainfall record and formulated as the probability of the rainfall being like the driest 10 years, the middle 10 years, or the wettest 10 years (Patt et al., 2007).

After the seasonal forecast is created, the National Meteorological and Hydrological Services present the forecast information relevant to each country to the *Groupe de Travail Pluridisciplinaire* (GTP) as well as other related multidisciplinary working groups. The group composition varies among countries, but the GTP generally consists of representatives of various government agencies (e.g. the Ministry of Agriculture), international organizations (e.g. World Food Program), and research institutes (e.g. the International Agriculture Organization (IAO)). Decisions regarding the national forecast and courses of action are reached by consensus, and the forecast is then released to the media (Tarhule & Lamb, 2003). Agricultural field extension workers collaborating with the GTP may carry the forecast information to the village level for dissemination. However, the dissemination system is characterized by discontinuities as there is no formal dissemination strategy or follow-up to ensure that the information actually reaches farmers and pastoralists. Likewise, limited effort is made to obtain feedback from farmers and pastoralists on how the forecasts are received and utilized.

The CFAR research project carried seasonal forecasts to the village level in Burkina Faso in the early 2000s. In 2000, villagers from the CFAR study sites participated in the Climate Outlook Forum held in Ouagadougou, and during a workshop, scientists from the CFAR project explained the forecast to the villagers (for a more detailed description see Ingram et al., 2002). This step was an early pilot phase of the project, while the main experimental dissemination was done at the onset of the 2002 and 2003 rainy seasons. The dissemination efforts included farmer workshops, village meetings, radio broadcasts, and flyers in the local language. By the end of the two rainy seasons CFAR researchers conducted fieldwork at the village level and a final workshop was held in 2007.

The seasonal forecast for 2013 is shown in Fig. 1, and it was stated that '*Near average or above average precipitation is very likely over western Sahel from Mauritania and Senegal to western and central Niger. About 80% to 130% of normal precipitation is expected over much of this zone*' (ACMAD et al., 2013). Along with the seasonal forecast, the Climate Outlook Forum for West Africa provided a list of 22 recommendations, of which 18 were related to crop cultivation and the following four were related to pastoral activities:

1. *Prepare for a more extensive collection and storage of fodder*
2. *Keep animals away from river banks to avoid drowning*
3. *Plan for more vaccines and drugs for water related diseases*
4. *Plan for a late transhumance*

3. Pastoral behavior context

The pastoralists of dryland West Africa have a diverse range of decision options to the risks and uncertainty they face in their daily life. Such risks include fluctuating livestock prices, climate variability, and a highly varying natural resource base (Toulmin, 1994). This study will focus on decisions that relate to weather, climate, and the natural resource base. Emphasis is on the following three categories of decisions:

- Decisions related to herd location and transhumance
- Decisions related to the possible use of supplementary fodder
- Decisions related to buying and selling of livestock.

The three categories are obviously interrelated, since moving livestock to areas where fodder is available may be an alternative to buying supplementary fodder, and selling livestock may become relevant if means of providing fodder are not available.

Regarding the first category, Sahelian pastoralists cover a spectrum from 'free nomadism' to sedentary systems that might be supplemented with emergency transhumance during droughts (Adriansen & Nielsen, 2005). Between these ends of the spectrum, other types of pastoralist behavior include firstly, the seasonal transhumance, whereby pastures around a permanent residence are replaced by pastures in other areas during either the dry or rainy season and secondly, the year-round small-scale movements around a permanent residence. The information needs may differ greatly between pastoral communities in different ends of this spectrum. In general, pastoral mobility is believed to be gradually diminishing in the Sahel because of constraints imposed by an expanding cultivated area as well as changes in land tenure systems and in labor availability (Powell et al., 2004). However, the considerable benefits of maintaining high mobility imply that this trend may also be reversed. Adriansen (2006) has, for example, shown increased mobility in commercialized pastoral systems based on small-stock production. Land reforms designating pastoral areas such as grazing lands, livestock corridors and resting areas have also improved conditions for livestock mobility and reduced conflicts in the Sahelian ecological zone, though less so in the more intensively farmed areas of the Sudan and Guinean ecological zones (Mertz et al., 2010).

Related to the second category, supplementary fodder such as millet bran and rice bran used to be perceived as 'emergency feeding' in times of drought (Toulmin, 1994). However, during the past decade, the conservation of crop residues from the fields has become a more permanent strategy among both pastoralists and farmers as a result of the increased grazing pressure on the common grazing lands (Rasmussen & Reenberg, 2013; Powell et al., 2004). By preserving the crop residues after harvest, each household secures a certain quantity of fodder for the livestock.

Concerning the third category, buying and selling of livestock, destocking has, like the purchase of supplementary fodder, been associated with droughts. Destocking early in a drought cycle has been encouraged by national policies as well as by NGOs, since holding on to animals as drought conditions intensify might be a risky strategy (Toulmin, 1994). The relevance of destocking should, however, not only be seen in a drought context. Rather, destocking may also be a recurrent strategy embraced by pastoralists with the aim of purchasing food for the family (Turner & Williams, 2002).

How pastoralists embrace these three categories of decisions will vary greatly depending on the bio-physical environment, especially the spatio-temporal distribution of water and vegetation resources, the access and property rights to these resources, the degree of involvement in a market economy, and the cultural norms of specific ethnic groups. Moreover, decisions will most often be based on incomplete information on climate, weather, and the status of the natural resource base. As decisions are not only taken in times of drought, it is evident that information on climate, weather, and resources could improve the decision making. As water and vegetation resources are often non-limiting in the rainy season, the critical decisions made by pastoralists are mainly associated with the dry season and, accordingly, information demands of pastoralists are expected to concentrate on the availability of water and vegetation resources in the dry season. However, a few exceptions exist as conditions during the rainy season certainly have an impact on the availability of grazing resources during the dry season. Firstly, in relation to destocking pastoralists may be interested in knowing if the rainy season is going to be relatively wet or relatively dry. Secondly, there is a possible need for information on the northward advance of the monsoon, as such information will support decisions on when and if pastoralists should migrate southwards to ‘meet’ the rains (Adriansen, 1999) as well as decisions on whether it is necessary to buy supplementary fodder

while awaiting monsoon rains. To summarize, the information needed to support pastoralists' decisions on transhumance, the purchase of supplementary fodder, and destocking and restocking is assumed not only to relate to coarse-scale drought predictions, but also to include up-to-date, fine-scale information on water and vegetation resource availability.

4. Study area

The study was carried out in the northern part of Burkina Faso among *Fulbe* households (*Fulani* in the English-language literature and *Peul*s in the French-language literature), who are predominantly pastoralists whose principal form of property is cattle. The villages of Koria and Belgou in the Seno province were selected. Koria had also been used as a study site in the CFAR project (see e.g. Ingram et al., 2002; Roncoli et al., 2000), and the present study aimed to illustrate possible differences in information needs between a village where seasonal rainfall forecasts had been distributed and a village where the awareness of seasonal rainfall forecasts was likely to be more limited. The location of the study sites is shown in Fig. 2.

Rainfall is a major constraint for both agriculture and livestock production in the region with a rainy season of only five months, from May to September. The closest meteorological station to the two sites is Dori. The average annual rainfall in Dori ranged from 600 to 700 mm in the 1950s and 1960s, but declined to 400-500 mm during the 1970s and 1980s. During the 1990s and 2000s average annual rainfall increased again, but greater annual variations in precipitation were observed (Proud & Rasmussen, 2010). A study of rainfall in villages of the nearby Oudalan Province also showed a decline in August rainfall, which is crucial for crops and vegetation, in the first half of the 2000s compared to the previous decade (Mertz et al., 2012).

The *Fulbe* household is typically composed of a man, his wives, and their children. They live in small separate camps, which are generally located in the periphery of sedentary village communities (Diallo, 2012). This structure is especially present in Belgou, where the village is primarily inhabited by the sedentary *RimayBé* but with scattered settlements of *Fulbe* households about 2 km from the main village. Koria, on the other hand, has six *quartiers*, two of which are the homes of *Fulbe* pastoralists.

All members living in a pastoralist camp are under the legal authority of the head of the family, who is the oldest man. The head of the family makes decisions on transhumance destinations, the buying and selling of livestock and the purchase of supplementary fodder. Cattle herding is an exclusively male activity, in which adult men manage herds and children as well as adult men are herders. During the dry season, households may choose to divide a herd into satellite herds and milk herds. The milk herds are kept close to the *Fulbe* settlement as the cattle produce milk for consumption, while the satellite herds move depending on the available pastures. During the rainy season, the most widespread strategy is to graze both satellite herds and milk herds in the vicinity of the village.

Many *Fulbe* households combine transhumant pastoralism with some crop production during the rainy season. Pearl millet is the main staple crop in the Sahel and is grown mostly on sandy soils. Medium-duration sorghum varieties, which ripen before local millet varieties, are also planted, especially in valley bottoms and on clayey soils that were previously used for pasture.

5. Methodology

Field work was carried out in October 2013 and multiple methods were used at each of the two study sites.

5.1 Survey

A survey was conducted with 30 heads of household in Koria and 31 heads of household in Belgou. The questions covered pastoral strategies relating to the household unit and not the individual household members. In Belgou, all *Fulbe* households living in the periphery of the village were interviewed, seven of whom had arrived within the past three years, primarily due to the gold deposits in the surrounding areas. In Koria, the respondents were selected to represent the two pastoralist *quartiers* of the village. The survey provided a broad base of information, which was useful in establishing a contextual framework or a baseline for the two villages, for example, on the level of education and the assets owned (see Fig. 3). Moreover, the survey explored how the households acquired weather, climate, and resource information and their pastoral strategies, such as the sale and purchase of livestock, the use of different fodder resources, and engagement in transhumance. The aim was to have a questionnaire design that facilitated the exploration of possible associations between variables like the weather, climate, and resource information received and engagement in transhumance.

All interviews were carried out with the help of a local assistant in the respondents' homes. Each interview lasted approximately two hours.

5.2 Semi-structured interviews

In Koria and Belgou, the semi-structured interviews were conducted with pastoralist households – either the head of the household, the eldest son, or the wife. In total, 22 interviews in Koria and 21 interviews in Belgou were conducted. Fifteen of the interviewees from each village had also

participated in the survey and they were selected to represent differences in age, education and assets (radio, TV, telephone) within the village. The heads of household, who had participated in the survey, were divided into three main age groups: young, middle-aged, and elderly. It was attempted to have approximately the same number of interviews with individuals belonging to each age group. The remaining interviews were carried out with other household members than the heads of the household. They were selected randomly from the pool of households who participated in the survey. The sample included women as well as young and middle-aged men who were about to become the head of household.

The interviews lasted approximately two to three hours and they took place in Fulfulde, the local language. An important aim of the semi-structured interviews was ascertaining how pastoralists used or would use various types of weather, climate, and resource information. Respondents were asked, for example, what they would do if they had access to information on the start of the rainy season in various areas. They were also asked whether they had received seasonal forecasts and what other type of information they found relevant. Visual aids were also employed during interviews, namely, a laminated map of the 2013 seasonal rainfall forecast was used to discuss respondents' interpretation as well as use of the forecast.

5.3 Focus group discussions

Eight focus groups, four in each village, were carried out. The discussions lasted approximately two hours and the groups consisted of 7-10 persons who were either already or soon to become heads of household. These participants were selected according to age as the use and knowledge of different

information channels may be confounded with age, so focusing exclusively on, for example, elderly pastoralists was likely to result in an age bias. As a focus group is a research technique that collects data through group interaction on a topic determined by the researcher (Morgan, 1997), the groups were initiated by a collective activity guided by the researcher. Although the initial focus was given, the group was allowed to discuss other issues within the scope of the discussion. During all focus groups a sketch of the group configuration was drawn, indicating, for example, the participants' names, ages, other relevant characteristics, and their position within the group. This configuration helped in trying to differentiate between individual speakers when going through the notes. The last topic of each discussion was to raise any unresolved issue that the researcher had identified for the group to confirm or clarify.

While one focus group was conducted prior to the survey and the interviews, the remaining three took place towards the end of the fieldwork. Due to the selection of heads of household as participants, the majority of the participants were also included in the survey and the interviews. The first focus group elicited pastoralists' ways of obtaining information on the upcoming rainy season and their opinions about the accuracy and reliability of the various information channels. The group was asked about the information channels they were aware of. When participants mentioned radio, telephone, and television, pictures of these channels were presented to the group. As extension officers, the market and the village also were mentioned as information channels, the group was presented with drawings of these channels. Following this, the group was asked to rank the pictures and drawings according to accuracy and reliability. Such exercises involved people working together and the material existence of pictures and drawings of the different information channels seemed to embolden some people. For example, if the picture of a radio was at the bottom, a dissenting participant might twitch or flinch; another might articulate their dissent. Whether the

researcher observed a participant react physically to the ranking or a participant expressed dissent, the researcher called upon the participant to explain the response.

Another focus group aimed to explore pastoralists' understanding of the seasonal forecast. If the participants indicated that they had received seasonal forecasts for previous seasons, they were asked to discuss the 2013 forecast. If participants seemed uninformed about seasonal forecasts, an exercise was introduced to help pastoralists understand the notion of probability distribution. The exercise was similar to the one adopted in the CFAR project, where probabilities were presented by laying out differently colored slips of paper (10 blue, 10 yellow, and 5 red), and then placing them in a bowl and randomly selecting one slip of paper. The selection was repeated several times to show that the low probability scenario could occur, though with lesser frequency (for more details, see Kirshen & Flitcroft, 2000; Ingram et al., 2002). After this exercise, participants were asked, as a group, to discuss the usefulness of the seasonal forecast.

A third focus group served to determine the kind of weather, climate, and resource information pastoralists were most interested in. The group was asked to list all the possible information types they were aware of and then point out the most relevant information. Toward the end of the session, a forage supply map was presented and explained to the group, and the group was then asked to discuss the relevance of the map. The aim was not only to have a list of the most relevant information, but also to observe how participants would react when a new information type was brought forward: would participants help each other understand the map and would they try to persuade the others of their own points of view of the new information type?

Finally, a fourth focus group addressed how pastoralists may respond to various types of information. With a point of departure in the list of relevant weather, climate, and resource information made in the previous focus group, participants were asked to discuss the possible changes in herd management that could result from the information. The aim was to assess whether participants were likely to take action on the basis of the information.

6. Analysis

6.1 The seasonal forecast

In 2013, only 7% of the interviewed pastoralists in Koria received the seasonal forecast (Fig. 4) and none of them got the recommendations provided along with the forecast. The few interviewees who did get the seasonal forecast had heard it either on the national radio in French or from other villagers in Koria. As fluency in French is very limited among villagers and only 17% of the interviewed households have a radio (Fig. 3C), dissemination only by national radio will not be sufficient. This point to a lack of appropriate communication formats and channels after the termination of the CFAR project. The argument may also apply to Belgou, where no interviewees received the seasonal forecast (Fig. 4). These observations are in accordance with the findings from the one other study that assessed information needs among pastoralists, albeit in East Africa. Here Luseno et al. (2003) found that external forecasts of the total amount of rain did not reach pastoralists as most pastoralists either were not aware that forecasts were available or had no access to a radio.

It may be argued that there is simply a lack of interest among pastoralists to access the forecast. During a focus group session in Koria on the usefulness of a seasonal forecast, one pastoralist stated that '*information on the total amount of rain gives you an idea about how well the fields will do, but we want to know where there is grass'.* As this claim came from an elderly participant, it seemed to embolden other participants in directing the conversation towards the problems with a seasonal forecast. Accordingly, it was mentioned that *'the rain is never the same in all villages here. You need to have information from each village'*. In Belgou, the attitude towards seasonal forecasts was clear: *'this map is for people who know how to read and write'.* Participants agreed that although the 2013 seasonal forecast had been explained verbally, the information was too complex. Moreover, participants seemed puzzled about how the information from the southern parts of Burkina Faso could be the 'same' as for the northern parts, and although it was explained that it was the probability distribution that was the same, not the total amount of rainfall, the participants did not seem to accept this explanation.

Consistent with these assertions, Ingram et al. (2002) observed that even among farmers a forecast of total seasonal rainfall is of limited use unless it includes estimates of the duration and distribution of rainfall over time and space. In order of declining priority, the most salient rainfall parameters that farmers want are 1) the timing of the onset and end of the rainy season, 2) the rainfall distribution, and 3) the total amount of rainfall (Ingram et al., 2002).

6.2 Identification of weather, climate, and resource information needs among pastoralists

In assessing the reach of external forecasts, it was found that 30% of the interviewed pastoralists in Koria had received two- to three-day rainfall forecasts during the 2013 rainy season (Fig. 4). The

forecasts were received through radio (78% of the respondents who had received a two- to three-day rainfall forecast) and television (22% of the respondents who had received a two- to three-day rainfall forecast). As with the seasonal forecast, the two- to three day forecast failed to reach any of the pastoralists in Belgou. The difference between the two villages may on the one hand be explained by a greater awareness of various types of weather, climate, and resource information in Koria due to the CFAR project, but on the other hand, it may also be attributed to very low educational levels in Belgou. While 70% of the pastoralists in Koria had attended either Koranic or elementary school, the percentage was only 45% in Belgou (Fig. 3B). When cross-referencing the information received with the educational levels, it was found that all pastoralists receiving the seasonal forecast and information on flood events through formal sources such as radio and television had attended school (Fig. 5). Of the pastoralists who received the two- to three-day rainfall forecast, which was likewise disseminated by formal sources, 89% had some years of school attendance. Information on the availability of grazing resources and the start of the rain was obtained from informal sources, such as telephone conversations and was received by pastoralists with varying educational levels. This indicated that information disseminated through formal channels was more successful in reaching pastoralists with some level of education, while the information sought for through informal channels did not depend on educational level.

During the semi-structured interviews in Koria pastoralists said that they heard the two- to three-day rainfall forecasts on the radio or saw it on television by chance when listening to music or watching a television show with neighbors. Moreover, the pastoralists who had watched it on television said that because the information broadcast was in French, they mainly watched images. The forecast was considered of limited value as it was not really understood and more importantly, it was not necessarily watched at the time when pastoralists needed information.

During 2013, pastoralists in Koria and Belgou mainly received information pertaining to the availability of grazing resources in various areas as well as the onset date of the rains (Fig. 4). The information was primarily gained by calling friends and family in other areas on a mobile phone. At the beginning of the rainy season, the question asked was whether the rain had arrived, while the nature of the forage conditions was the main concern during the dry season. In addition to the use of mobile phones, information on the onset date of the rains was available from indigenous forecasting methods such as readings of stars, winds and fauna behavior (see also Tarhule & Lamb, 2003), whereas information on the status of the forage conditions was gained by sending scouts in advance.

The final type of weather, climate, and resource information respondents reported having received in 2013 was related to flooding (13% of respondents in Koria and 6% in Belgou), including flood warnings as well as updates on flood impacts in Ouagadougou and elsewhere. However, as the information did not cover flooding risks or impacts specifically in northern Burkina Faso, it was perceived to consist mostly of general flood warnings.

As highlighted by Tarhule and Lamb (2003), the information farmers receive may not conform well to the type of information they prefer to receive. In order to determine whether this also applies to pastoralists, respondents were asked to indicate the type of information they would be most interested in receiving (Fig. 6). Pastoralists in both Belgou and Koria were mainly interested in information pertaining to the availability of grazing resources in specific areas. Oursi, Yomboli, Dèou, Seytanga, and Sebba were mentioned as these areas often have good water sources such as temporary lakes during most of the dry season. Information on grazing resources was the first choice of more than 80% of the respondents in both villages, which was also the case when

respondents reported on the received information. In contrast, fine-scale information on the rainfall amount during the first weeks of the rainy season turned out to be the second most preferred information type, although such forecasts were not received by any of the respondents. During the semi-structured interviews, pastoralists expressed that while the first rain was important to understand when grasses would sprout, a good rain by the end of the season was mainly important for crop maturity. Hence, for pastoralists the total amount of rain as presented by the PRESAO was of less interest than the amount of rain at the beginning of the season. Moreover, it was stated that such information would only have value if it was available at a finer scale than what is currently available, which is consistent with findings among the user group of South African farmers (Archer, 2003).

Two other information types of interest to pastoralists were the onset date of the rain and flood warnings. The percentage of pastoralists preferring information on the onset date was, however, slightly lower than the percentage reporting actual receipt of that information. Some respondents argued that if they were to receive fine-scale information on the amount of rain at the beginning of the rainy season, information on the onset date would be unnecessary.

6.3 Application of weather, climate, and resource information

A key question is how pastoralists actually react to the currently available information. The seasonal and the two- to three-day rainfall forecast seemed to have more bearing on crop cultivation strategies than on herd management strategies (Table 1). The changes in behavior included constructing stone bunds to halt the process of soil erosion (Atampugre, 1997) as above-average rain was expected and adjustments in the time of sowing the fields according to the two- to three day rainfall forecast. Although the proportion of pastoralists receiving these particular types of

information was rather limited, the results indicate that pastoralists did act upon it. But as the information was gained by coincidence, it could have easily been missed.

Pastoralists seemed more inclined to change their behavior related to herd management when they received information on flooding events, the availability of grazing resources, the onset date of the rain, and the amount of rain during the first weeks of the rainy season. The information-based changes included choices of when and where to move the herds (Table 1). Such response options are consistent with literature on key pastoral management strategies (Thébaud & Batterbury, 2001; Adriansen, 1999; Dyson-Hudson & Dyson-Hudson, 1980). Information on the rainfall early in the season and on the onset date primarily influenced decisions on transhumance southwards during the very late dry season with the aim of meeting the rain. Most pastoralists receiving this information moved the herds towards the areas around Sebba, depending on where the rain had started. This type of transhumance was often of limited duration as many pastoralists returned to their village during the rainy season in order to cultivate their fields. Pastoralists without fields were more mobile at the end of the dry season and moved their herds further south.

Information on the onset of the rainy season also shaped decisions related to the buying of supplementary fodder. Of the pastoralists who had received information on the onset either from friends and family in the more southern areas or by the use of traditional signs such as the wind, 17% mentioned that if the rain was about to start, they adjusted the quantity of fodder they bought. If possible, pastoralists preferred to save money by purchasing less fodder because food shortages and high food prices are common during this time of the year.

All the pastoralists, who reported receiving flood information, reacted by adjusting the herd composition so that the milk herd that stayed in the vicinity of the village consisted of the weakest animals, while the satellite herd on the move was composed of the strongest animals. Pastoralists said that the strong animals were more likely to avoid drowning in the mud. Another change made by all the pastoralists who had received flood information was in terms of the person herding the cattle (Table 1). Information about flooding events initiated worries about children being too small and inexperienced to herd in difficult situations. Therefore, adults took over the herding.

7. Conclusions and policy implications

Pastoralists in the Sahel can and do respond to various types of weather, climate, and resource information by enacting different strategies. However, the information they act on is primarily obtained by calling friends and family in nearby areas rather than being delivered by central authorities, such as the Climate Outlook Forum for West Africa. Thus, there seems to be a strong disconnect between the parameters and scale of information that pastoralists need and those currently provided. This disconnect becomes particularly evident when looking at the low proportion of pastoralists who have received the seasonal rainfall forecasts issued by the Climate Outlook Forum. Although an informal dissemination system characterized by discontinuities may be partly responsible for the limited use of seasonal forecasts, it is also remarkable that pastoralists responded to the forecast by adjusting their cultivation strategies rather than by using it to support livestock management decisions. Rather, a demand for other types of weather, climate, and resource information seemed to be widespread. Yet, because pastoralists lack an effective voice in weather and climate information services, the currently available products and dissemination of these remain poorly designed for pastoral needs.

There are a several feasible avenues for providing more relevant information to pastoralists:

- Information on the availability of grazing resources in various areas and flooding events should be acknowledged as highly demanded information.
- Although it remains a major challenge to predict the onset date of the rains in West Africa (Laux et al., 2008), it should be recognized that such information as well as fine-scale information on the rainfall amount during the first weeks of the rainy season is of prime importance among pastoralists.
- Methods to quantify dry season grazing resources should be developed.

However, there is also a number of constraints related to the access, the understanding, and the capacity to respond to the information among pastoralists. If weather, climate, and resource information is to be incorporated into pastoralist's adaptive decisions, we suggest that:

- A formalized system for information transfer should be established in which pastoralists must be given some kind of effective voice.
- The information should be disseminated in a proper format, e.g. orally by telephone in local languages.
- Other types of information that support the range of pastoral response options (decisions on transhumance destinations, the purchase of supplementary fodder, and herd size and composition) must be identified and provided.

Dissemination of information requires planning and coordination at various levels and across sectors. As strategies for disseminating have tended to focus on farmers, pastoralists have found their own ways of receiving information on the availability of grazing resources, i.e. by calling friends and family in nearby areas, and they are unaware of the potentially useful information

provided by AGRHYMET and other suppliers. In developing a dissemination system, attention must therefore be given to how weather, climate, and resource information can supplement rather than replace the existing system for acquiring information. For example, efforts could concentrate on the dissemination of flooding forecasts or fine-scale information on rainfall amounts during the first weeks of the rainy season as this type of information is highly demanded by pastoralists but not widely accessible.

ACKNOWLEDGEMENTS

The field research was funded by the Danish Ministry of Foreign Affairs (DANIDA) as part of the project 'Knowledge based climate adaptation in West Africa'. We thank the villagers of Koria and Belgou. Helpful comments given by three anonymous reviewers are gratefully acknowledged.

Literature Cited

ACMAD et al.. Seasonal Climate Outlook valid for July-August-September 2013 in West Africa, Chad and Cameroon. 2013. Abuja - Federal Republic of Nigeria.
Ref Type: Report

Adger,W.N., Huq,S., Brown,K., Conway,D., Hulme,M., 2003. Adaptation to climate change in the developing world. Progress in Development Studies 3:179-195.

Adriansen,H.K., 1999. Pastoral mobility as a response to climate variability in African drylands. Geografisk Tidsskrift-Danish Journal of Geography Special issue 1:1-8.

Adriansen,H., 2006. Continuity and Change in Pastoral Livelihoods of Senegalese Fulani. Agriculture and Human Values 23:215-229.

Adriansen,H., Nielsen,T., 2005. The geography of pastoral mobility: A spatio-temporal analysis of GPS data from Sahelian Senegal. GeoJournal 64:177-188.

Archer,E.R.M., 2003. Identifying Underserved End-User Groups in the Provision of Climate Information. Bulletin of the American Meteorological Society 84:1525-1532.

Atampugre,N., 1997. Aid, NGOs and Grassroots Development: Northern Burkina Faso. Review of African Political Economy 24:57-73.

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

Cash,D.W., Clark,W.C., Alcock,F., Dickson,N.M., Eckley,N., Guston,D.H., Jäger,J., Mitchell,R.B., 2003. Knowledge systems for sustainable development. Proceedings of the National Academy of Sciences 100:8086-8091.

Crane,T.A., Roncoli,C., Hoogenboom,G., 2011. Adaptation to climate change and climate variability: The importance of understanding agriculture as performance. NJAS - Wageningen Journal of Life Sciences 57:179-185.

Diallo,Y. 2012. Forms and Modalities of Property Rights in Cattle in a Fulbe Society (Western Burkina Faso). *in* Khazanov,A., Schlee,G. editors. Who owns the stock?: collective and multiple forms of property rights in animals. Berghahn Books.

Dilling,L., Lemos,M.C., 2011. Creating usable science: Opportunities and constraints for climate knowledge use and their implications for science policy. Global Environmental Change 21:680-689.

Dyson-Hudson,R., Dyson-Hudson,N., 1980. Nomadic Pastoralism. Annual Review of Anthropology 9:15-61.

Hansen,J.W., MASON,S.J., SUN,L.I.Q.I., TALL,A.R.A.M., 2011. REVIEW OF SEASONAL CLIMATE FORECASTING FOR AGRICULTURE IN SUB-SAHARAN AFRICA. Experimental Agriculture 47:205-240.

Ingram,K.T., Roncoli,M.C., Kirshen,P.H., 2002. Opportunities and constraints for farmers of west Africa to use seasonal precipitation forecasts with Burkina Faso as a case study. Agricultural Systems 74:331-349.

IPCC, 2007. 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 University Press, Cambridge, UK.

Kaitho,R.J., Jama,A.A., Stuth,J.W., Kariuki,G., Abdirahman,A., MacOpiyo,L., Ndung'u,J., 2007. Livestock early warning information resource in the Horn of Africa: Forage and livestock marketing information analysis and forecasts. Outlook on Agriculture 36:267-272.

Kirshen,P.H., Flitcroft,I.D., 2000. Use of seasonal precipitation forecasting to improve agricultural production in the Sudano-Sahel: an institutional analysis of Burkina Faso. Natural Resources Forum 24:185-195.

Laux,P., Kunstmann,H., Báírdossy,A., 2008. Predicting the regional onset of the rainy season in West Africa. International Journal of Climatology 28:329-342.

Lemos,M.C., Kirchhoff,C.J., Ramprasad,V., 2012. Narrowing the climate information usability gap. Nature Climate Change 2:789-794.

Lenton,T.M., 2013. What early warning systems are there for environmental shocks? Environmental Science & Policy 27, Supplement 1:S60-S75.

Luseno,W.K., McPeak,J.G., Barrett,C.B., Little,P.D., Gebru,G., 2003. Assessing the Value of Climate Forecast Information for Pastoralists: Evidence from Southern Ethiopia and Northern Kenya. World Development 31:1477-1494.

Mertz,O., Mbow,C., Nielsen,J.O., Maiga,A., Diallo,D., Reenberg,A., Diouf,A., Barbier,B., Moussa,I.B., Zorom,M., Ouattara,I., Dabi,D., 2010. Climate factors play a limited role for past adaptation strategies in West Africa. Ecology and Society 15.

Mertz,O., Mbow,C., Reenberg,A., Diouf,A., 2009. Farmers' Perceptions of Climate Change and Agricultural Adaptation Strategies in Rural Sahel. Environmental Management 43:804-816.

Mertz,O., D'haen,S., Maiga,A., Moussa,I., Barbier,B., Diouf,A., Diallo,D., Da,E., Dabi,D., 2012. Climate Variability and Environmental Stress in the Sudan-Sahel Zone of West Africa. AMBIO 41:380-392.

Meza,F.J., Hansen,J.W., Osgood,D., 2008. Economic Value of Seasonal Climate Forecasts for Agriculture: Review of Ex-Ante Assessments and Recommendations for Future Research. Journal of Applied Meteorology and Climatology 47:1269-1286.

Morgan,D.L., 1997. Focus groups as qualitative research. 2 edition. SAGE Publications.

Mortimore,M., 2009. Dryland Opportunities: New paradigm for people, ecosystems and development. New York, Switzerland/London: UNDP/IUCN/IIED..

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

Patt,A.G., Ogallo,L., Hellmuth,M., 2007. Learning from 10 Years of Climate Outlook Forums in Africa. Science 318:49-50.

Powell,J.M., Pearson,A., Hiernaux,P., 2004. Crop-Livestock Interactions in the West African Drylands. Agronomy Journal 96:469-483.

Proud,S.R., Rasmussen,L.V., 2010. The influence of seasonal rainfall upon Sahel vegetation. Remote Sensing Letters 2:241-249.

Rasmussen,L.V., Reenberg,A., 2013. Multiple outcomes of cultivation in the Sahel: a call for a multifunctional view of farmers' incentives. International Journal of Agricultural Sustainability1-22.

Roncoli,C., Ingram,K., Kirshen,P., 2001. The costs and risks of coping with drought: livelihood impacts and farmers' responses in Burkina Faso. Climate Research 19:119-132.

Roncoli,C., Ingram,K., Kirshen,P., 2000. Can Farmers of Burkina Faso Use Seasonal Rainfall Forecasts? Practicing Anthropology 22:24-28.

Roncoli,C., Jost,C., Kirshen,P., Sanon,M., Ingram,K., Woodin,M., Somé,L., Ouattara,F., Sanfo,B., Sia,C., Yaka,P., Hoogenboom,G., 2009. From accessing to assessing forecasts: an end-to-end study of participatory climate forecast dissemination in Burkina Faso (West Africa). Climatic Change 92:433-460.

Roudier,P., Muller,B., d'Aquino,P., Roncoli,C., Soumaré,M.A., Batté,L., Sultan,B., 2014. The role of climate forecasts in smallholder agriculture: Lessons from participatory research in two communities in Senegal. Climate Risk Management (In press).

Roudier,P., Sultan,B., Quirion,P., Baron,C., Alhassane,A., Traoré,S.B., Muller,B., 2011. An ex-ante evaluation of the use of seasonal climate forecasts for millet growers in SW Niger. International Journal of Climatology 32:759-771.

Sultan,B., Barbier,B., Fortilus,J., Mbaye,S.M., Leclerc,G.g., 2010. Estimating the Potential Economic Value of Seasonal Forecasts in West Africa: A Long-Term Ex-Ante Assessment in Senegal. Weather, Climate, and Society 2:69-87.

Tarhule,A., Lamb,P.J., 2003. Climate Research and Seasonal Forecasting for West Africans: Perceptions, Dissemination, and Use? Bulletin of the American Meteorological Society 84:1741-1759.

Thébaud,B., Batterbury,S., 2001. Sahel pastoralists: opportunism, struggle, conflict and negotiation. A case study from eastern Niger. Global Environmental Change 11:69-78.

Thornton,P.K., 2006. Ex ante impact assessment and seasonal climate forecasts: status and issues. Climate Research 33:55-65.

Toulmin,C. 1994. Tracking through drought: options for destocking and restocking. Pages 96-115 *in* Scoones,I. editor. Living with Uncertainty - New Directions in Pastoral Development in Africa. Intermediate Technology Publications, London.

Turner,M.D., Williams,T.O., 2002. Livestock Market Dynamics and Local Vulnerabilities in the Sahel. World Development 30:683-705.

Vogel,C., O'Brien,K., 2006. Who can eat information? Examining the effectiveness of seasonal climate forecasts and regional climate-risk management strategies. Climate Research 33:111-122.

Weibel,D., 2010. Health and demographic surveillance in Sahelian mobile livestock production systems. PhD dissertation, University of Basel.

Ziervogel,G., Bithell,M., Washington,R., Downing,T., 2005. Agent-based social simulation: a method for assessing the impact of seasonal climate forecast applications among smallholder farmers. Agricultural Systems 83:1-26.

Table 1. Management changes during the 2013 season among pastoralists in Koria and Belgou when receiving different types of weather, climate, and resource information. Calculations of the percentage of pastoralists making management changes are based on the number of pastoralists who received particular types of information: seasonal precipitation forecast (n=2), two- to three-day rainfall forecast (n=9), the start date of the rain in other areas (n=48), the availability of grazing resources (n=57), and flooding events (n=6).

Information	Changes in herd management due to the information	% of pastoralists	Changes in cultivation practices due to the information	% of pastoralists
Seasonal precipitation forecast			Construction of stone bunds as above average rain was predicted	50%
2-3 day rainfall prevision			Sowing the field	11%
The start date of the rain in other areas	Buying of supplementary fodder can be better adjusted to the start of the rain	17%		
	More qualified choices of destinations when walking towards the rain	53%		
	Destocking if the rain is late	6%		
The availability of grazing resources	More qualified choices of transhumance destinations during the dry season	75%		
Flooding events	Limited movements of the herd normally performed by children during the rainy season are undertaken by adults during heavy rains	100%	Increase the cultivated area, as some of the fields will be flooded	50%
	The herd composition in the limited movements is changed so the herd only consists of strong animals during heavy rains	100%		

Fig. 1. Seasonal forecast for 2013 delivered by the Climate Outlook Forum for West Africa. The precipitation is issued by tercile probabilities for below, near and above normal precipitation. The tercile probabilities are based on a historical precipitation record. From ACMAD et al. (2013).

Fig. 2. Map of northern Burkina Faso showing the location of Koria and Belgou

Fig. 3. A) Age distribution, B) educational attainment, and C) assets of pastoralist respondents in the two study sites (n= 31 in Belgou and n=30 in Koria).

Fig. 4. Received information during the 2013 season among pastoralists (n= 31 in Belgou and n=30 in Koria). Each pastoralist received several information types. These were either obtained from formal sources (radio and television), informal sources (e.g. traditional forecasting systems) or a combination of the two.

Fig. 5. Educational attainment among pastoralists who received a seasonal forecast (n=0 in Belgou and n=2 in Koria), information on flooding events (n= 2 in Belgou and n=4 in Koria), a two- to three-day rainfall forecast (n=0 in Belgou and n=9 in Koria), information on the availability of grazing resources (n=30 in Belgou and n=27 in Koria), and starting date of the rain (n=25 in Belgou and n=23 in Koria).

Fig. 6. Preferred information among pastoralists (n= 31 in Belgou and n=30 in Koria). Each pastoralist could identify up to three distinct types of information.

fig1
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Fig. 1. Seasonal forecast for 2013 delivered by the Climate Outlook Forum for West Africa. The precipitation is issued by tercile probabilities for below, near and above normal precipitation. The tercile probabilities are based on a historical precipitation record. From ACMAD et al. (2013).

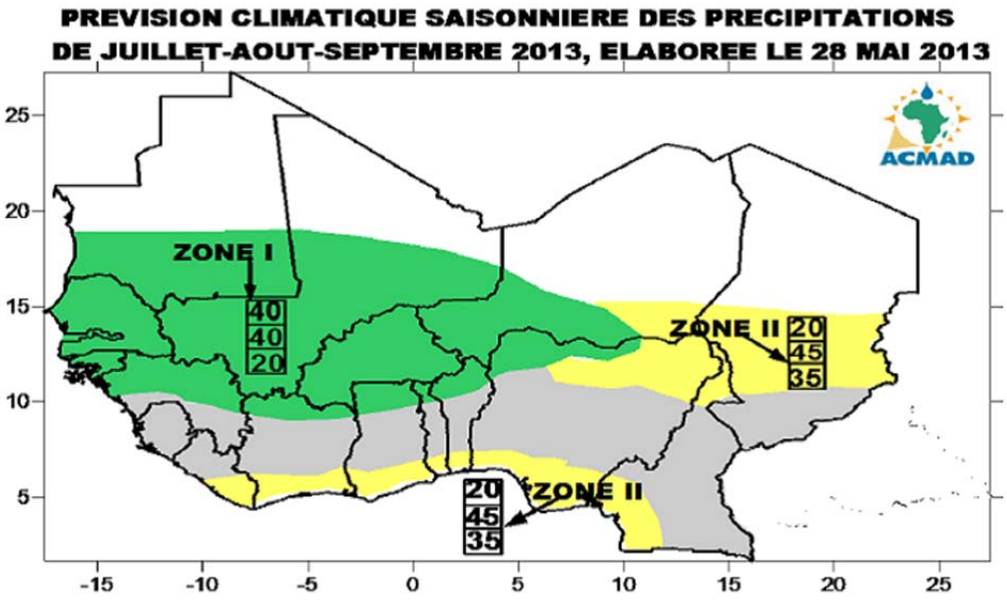

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Fig. 2. Map of northern Burkina Faso showing the location of Koria and Belgou

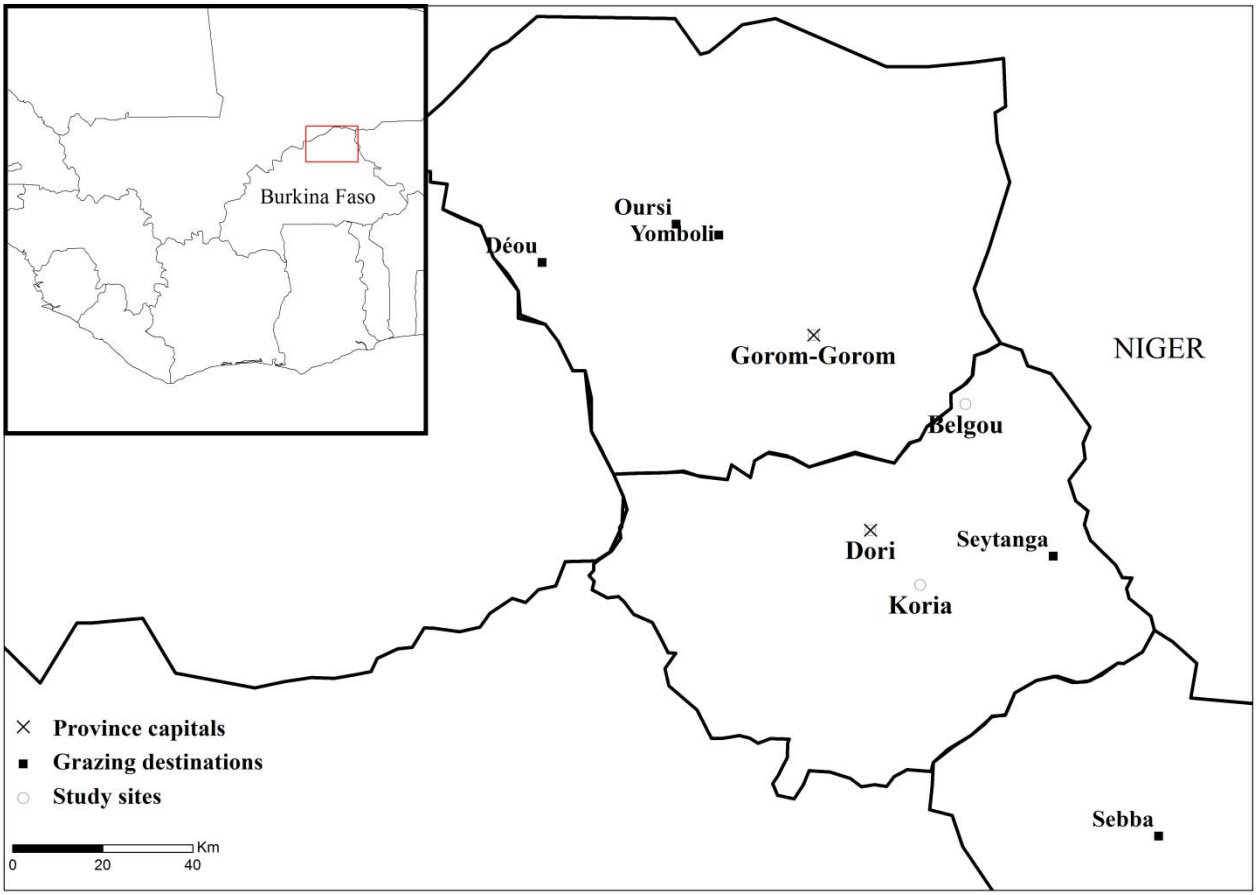

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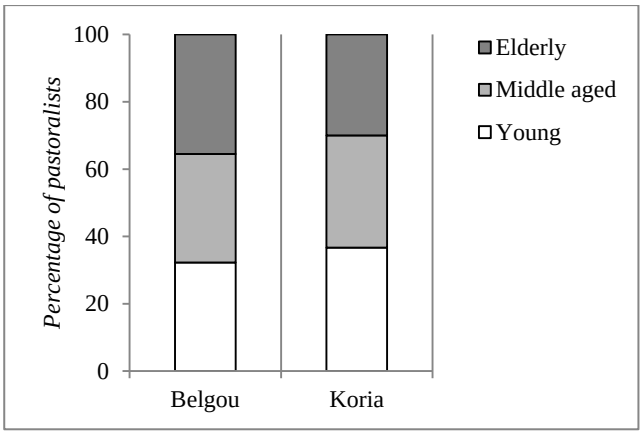
Fig. 3. A) Age distribution, B) educational attainment, and C) assets of pastoralist respondents in the two study sites (n= 31 in Belgou and n=30 in Koria).

A



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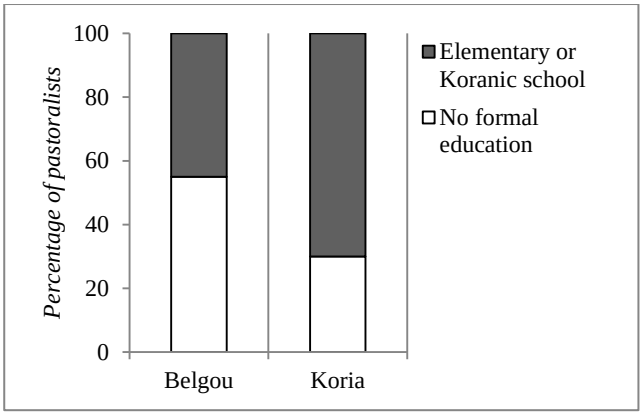

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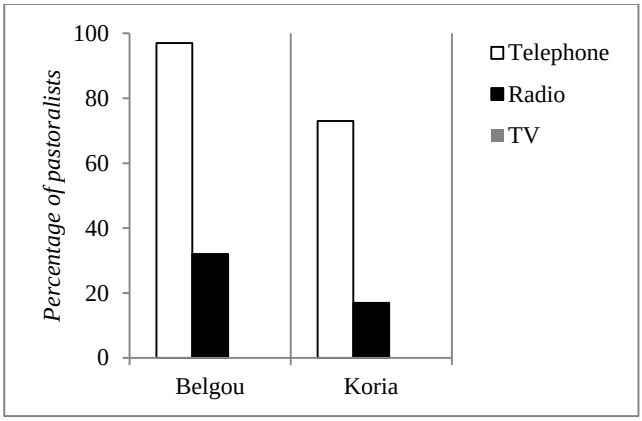

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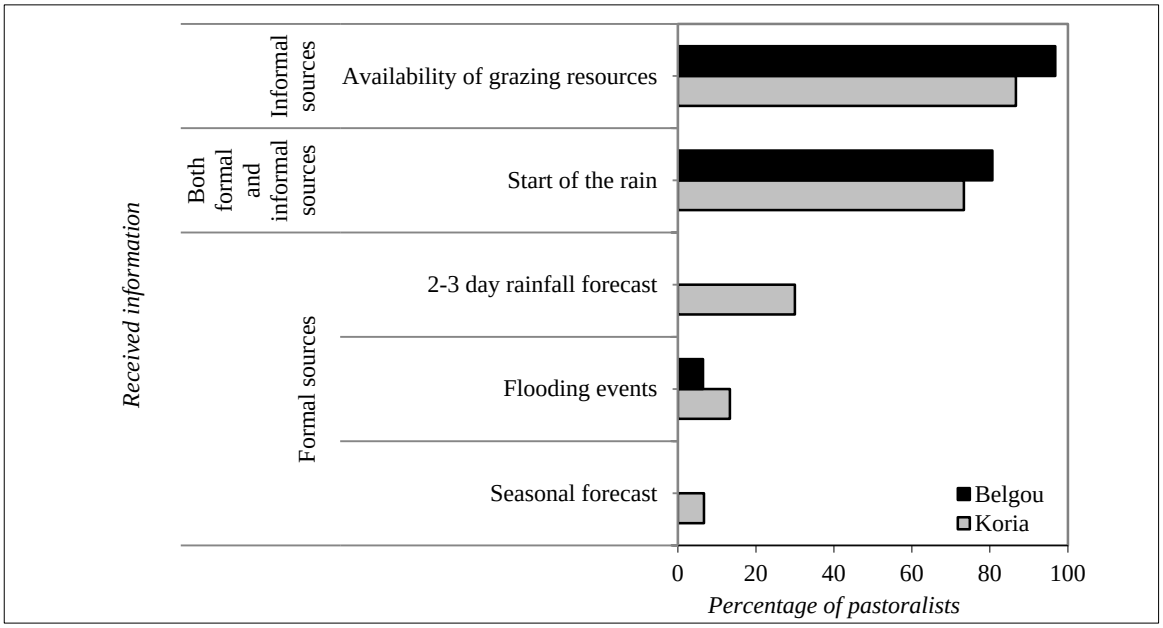

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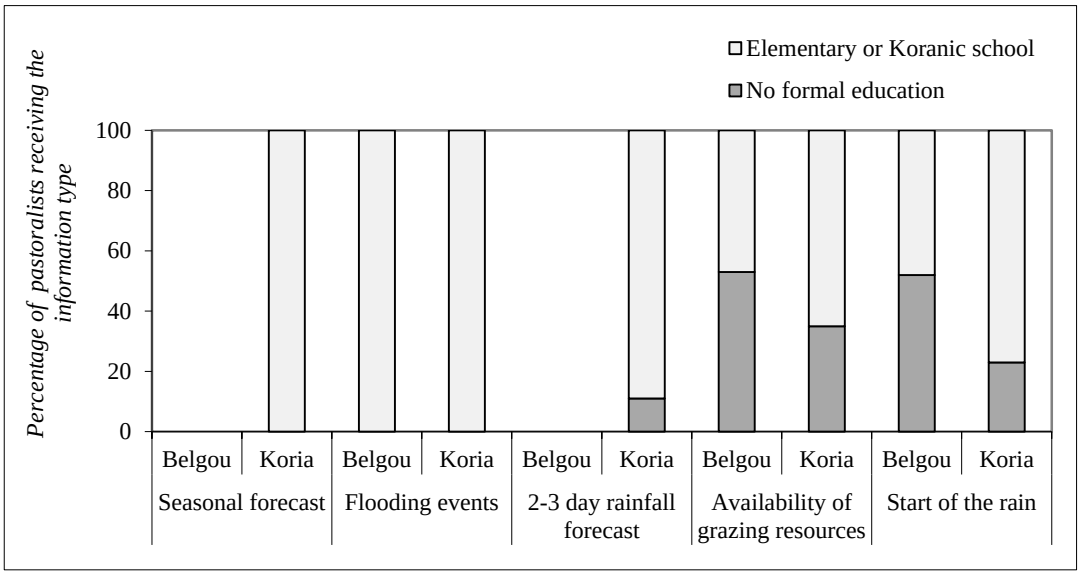

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Fig. 6. Preferred information among pastoralists (n= 31 in Belgou and n=30 in Koria). Each pastoralist could identify up to three distinct types of information.