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Full Length Research Paper

Climate variability; enhancing adaptive utilization of browse trees for improved livestock production among agro-pastoralists communities in Southern Zambia

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Agro-pastoralists whose sources of livelihood depend on rain-fed agriculture are very vulnerable to ecological disturbance due to increasing climate variability. They are unable to adequately feed their animals in times of extreme weather conditions of floods and droughts thereby causing a disruption in their major source of livelihood. This study analyzed the feeding strategies employed by agro-pastoralists in Southern Zambia and important browse species used in extreme weather conditions, in order to improve their utilization for improved livestock production. The major feeding strategies during droughts include browse utilization, dambo grazing, grazing along streams and supplementary feeding. While during floods, upland grazing and browse grazing were the main strategies. However, most of the agro-pastoralists do not practice pasture management and fodder conservation for their animals. Of the 21 tree browse species identified by the agro-pastoralists, 18 species were found to be important during droughts and 8 during floods. Most of the agro-pastoralists neither knew how to plant these browse species nor how to manage them for better and sustainable use in feeding their animals. Therefore, the agro-pastoralists in the study area need to take up management and feed conservation measures for their animals. Deliberate effort should be made to teach the agro-pastoralists how to plant and manage the important browse species that are suitable in extreme weather conditions. This will enhance productive use of the browse species for improved animal feeding to ensure food security among the pastoralists.

Key words: Extreme weather conditions, adaption, browse species, Agro-pastoralists.

INTRODUCTION

Pastoral systems provide an important source of livelihood to many people in the world. About 40 million people and almost half of them being African pastoralists depend almost entirely on livestock for their livelihoods (AFORNET, 2005). Sustainability of these production systems has been facing a lot of challenges in Africa especially with reference to availability of adequate animal feed resources. In the horn of Africa, millions of people currently leave a lifestyle that is centered on the search for the increasingly scarce pasture and water (Ehrhart, 2009). Over the years climate change and variability has impacted negatively on the ability of the local ecosystems to faithfully meet the ever increasing demand for feed resources for their animals.

Pastoralism and climate variability

Climate variability refers to variations in the mean state of climate on all temporal and spatial scales beyond that of individual weather events (USAID, 2007). Climate variation manifests itself in extended drought, floods and

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conditions that result from periods of El Nino and La Nino events. Over the years the frequency of the climate variation in terms of temperature and rainfall has been increasing. It is estimated that by 2050, temperatures will be significantly higher and rainfall will greatly reduce in Southern Africa (Zeidler and Chunga, 2007). These climate projections are going to affect forage and animal production, and ecosystem functioning (McKeon et al., 2009). Climate change and variability will also cause water stress, land degradation, lower crop yields and increased risk of wild fires, resulting in more than 50% decline in agricultural productivity (Ehrhart, 2009). The pastoral communities and their livestock are very vulnerable to these ecological disturbances which often result in food insecurities and shortages (SoRPARI, 2005). They are unable to feed their animals on good quality feeds.

In Zambia, the mean temperature computed for the previous thirty years for the agro-ecological zones for three periods, November to December, January to February and March to April indicate that the summer temperature is increasing at the rate of 0.6°C per decade, which is ten times higher than the global or southern African rate of increase in temperature (CEEPA, 2006). The annual rainfall data for the 14 years from 1990/1991 to 2003/2004, show that at least ten years in each agro-ecological zone had below normal rainfall. The southern zone has experienced more severe dry seasons than the central zone in the last 20 years (CEEPA, 2006). The Agro-pastoralists in Zambia have not been spared from theses extreme weather conditions. METNR (2007) reported that in Zambia, the increase in frequency, intensity and magnitude of climate variability over the past two decades have adversely impacted on food security, water security, water quality, energy and sustainable livelihoods for the rural communities.

Feeding strategies in extreme weather conditions

African pastoralism has evolved in adaptation to harsh environments with very high temporal variability in rainfall (Ellis, 1995). Pastoralists have employed strategies such as moving to other areas unused in 'normal' dry season (Morton, 2007), keeping multispecies herds to take advantage of different ecological niches and the labour of men, women and children and supplementary feeding in their quest for proper feeding of their animals. However, proper feeding of animals has remained a challenge because of increase in climate variability and their animals are still on poor diets. Feeding animals with poor quality feeds has been associated with increased emission of greenhouse gases particularly carbon dioxide and methane that have been implicated in global warming (Beauchemin et al., 2008, 2009). Feeding animals on high quality pasture or balanced rations produce less methane (270 to 350 g methane/cow/day) than those on poor quality pasture or feeds (370 to 450 g methane/cow/day), linking productivity to emission rates (Eckard, 2007). To improve the quality of feed given to animals, use of locally adapted green fodder legumes and browse trees have been recommended in many parts of the tropics (Simbaya, 2002).

In Zambia there is lack of knowledge concerning the pastoral production systems and their adaptive use of browse trees in view of climate variability. The type of forage species that have higher adaptation to climate variability in these rangelands need to be given priority. For example, droughts have the effect of favoring some trees and shrubs while adversely affecting others (Primefact, 2007). In most arid and semi arid areas, browse play a critical role as livestock feed in the dry season. Trees produce leaves, shoots and fruits which are a source of nutritious livestock feed. Promotion of the use of browse is important because the browse is less affected by climatic variation compared to herbaceous species. The rangeland ecosystem needs to be re-examined in view of climate variability and the need to adequately provide animal feed resources.

In view of the foregoing, this study was conducted to determine the feeding strategies employed by agro-pastoralists in Southern Zambia in extreme weather condition and to identify important browse species for use so as to improve their utilization for improved livestock production.

MATERIALS AND METHODS

Study area

The study was carried out in Choma District in Southern Province, Zambia. Southern province has the largest number of cattle and goats of all Zambia's provinces, comprising 33 and 31% of the traditional herds, respectively (CSO, 2009). Choma district lies within the Tonga Plateau, an area between two of south central Africa's great rivers, the Zambezi and Kafue river (Araki, 2001). It has a population of 244,180 inhabitants and 24,321 households and a surface area of 7,289 km² (CSO, 2011). The area experiences uni-modal type of rain lasting from November to April. The annual rainfall ranges from 600 to 700 mm with an uneven distribution and is generally insufficient with 70% probability of drought.

For the last 20 years the area has been experiencing low, unpredictable and poorly distributed rainfall (CEEPA, 2006). The average monthly temperature is about 26°C with a maximum of 32°C in October and a minimum of 15°C in June. The vegetation type is miombo woodland (Fanshawe, 1966; Chileshe and Kitalyi, 2002). Characteristic tree genera are *Brachystegia, Fulbernardia, Combretum, Pinari, Pericopsis* and *Acacia* (Chileshe and Kitalyi, 2002). The major inhabitants of the study area are the Plateau Tongas who are mainly agro-pastoralists. The majority of the households in the district depend on agricultural related activities for their livelihood including crop production and livestock rearing. 84% of the households are small scale subsistence farmers (FAO/FASAZ, 2003). The main types of livestock reared are cattle and goats and over 90% of the livestock are managed extensively depending entirely on *in situ* grazing in the rangelands for nourishment. The population of cattle has increased by 40% over the past decade from 83,903 in 2000 to 117,406 in 2010 while that of goats has increased by 93% from 28,924 in 2000 to 55,832 in 2010 (CSO, 2011).

Sources of data

This study was done in 2010. Both primary and secondary data were used in this study. The primary data was collected using detailed pre-tested semi-structures questionnaires and personal observations. The interviews were done in the local Tonga language. Data gathered included the livestock ownership, feeding strategies of the livestock, forage management, and important browse species in extreme weather conditions. Human, cattle and goat population in the district was collected from the District Agricultural Office in the Ministry of Agriculture and Cooperatives. Selecting of the respondents was done with the help Agricultural Officers from the Ministry of Agriculture and Cooperatives. Households were selected from Sikalongo Sub-district. Within the sub-district, random sampling was used to select 60 agro-pastoral households from 10 villages near Mochipapa Research station. The households' heads were picked for the interviews.

Data analyses

Data were analyzed using GenStat Discovery Edition 3 software programe (2007). Data from the questionnaire survey were first coded and entered using Microsft Excel. Descriptive statistics were used to describe the respondents' demographics, socio-economic characteristics and other variables in the production system.

RESULTS AND DISCUSSION

Age and gender distribution of the respondents

The study revealed that 95% of the agro-pastoralists in the study area were males and 5% females. The majority of the agro-pastoral households were headed by members older than 40 years (74%). Of the respondents, 69% were in monogamous marriages, 29% in polygamous marriages whilst 3% were single. Household average sizes were higher, 16 individuals in polygamous marriages compared to 9 in monogamous marriages and 10 in singles. The large size of households is common in agro-pastoral communities because of the high labour requirement of farming operations.

Agricultural activities

All the respondents were involved in mixed farming which involves the growing of crops and the rearing of livestock. The main crops grown were maize the staple crop, groundnuts, sweet potatoes and cowpeas. Livestock rearing is important for rural households in Choma district and mainly involves poultry (100%) with an average of 58 chickens per household, goats (81.36%) with an average of 21 goats per household and cattle (100%) with an average of 15 animals per household. Goat and cattle rearing is higher than what was recorded by FAO/ FASAZ (2003), who found 54 and 49% of all the households interviewed to be involved in goat and cattle rearing, respectively. The increase has been due to deliberate government efforts through the cattle restocking programme.

The cattle restocking programme was introduced in 2003 to restore breeding stock and increase animal draught power (IRIN, 2004; Mulemba, 2009) and the Animal Disease Control Programme to preserve the current population of livestock. Goat rearing has also increased because a number of Non-governmental Organizations such as Land O Lakes; World vision have been promoting the rearing of goats because they are adapted to survive well in adverse weather conditions. Goats also reproduce much faster than cattle and are more hardy, less costly and easier to feed (Mortimore and Adams, 2001).

Cattle and goat ownership

Most of the livestock is owned by the nucleus family (Figure 1), 41.67% for goats and 35.00% for cattle. Ownership of cattle is four times higher for the husbands (25.00%) compared to wives (6.67%), while the ownership of goats among the wives is two times higher (10.00%) compared to husbands (5.00%). This is because traditionally, ownership of cattle has been more important among men than women. Ownership of goats is higher among women because there has been deliberate promotion of goat-keeping to women by Non-Governmental Organizations (NGOs). This has been done as a way of empowering women with some wealth. Promotion of goat-keeping is very important adaptability strategy especially in times of high climate variability because goats are able to withstand harsher climate compared to cattle. The agro-pastoralists are still practicing the keeping of animals from other relatives. This is one way of adapting to harsh climate because if there is drought in one region then the animals kept by relatives in other region which are not hit by drought would survive and thus, the owners will not lose all the animals. It is also one way of strengthening social relations because those without animals can keep and use animals from relatives.

Status of the grazing area

The status of the grazing area has been reducing over the years as indicated by 83% of the respondents (Figure 2). The reasons for the reduction are due to increase in human population, increase in livestock population and poor management of feed resources in grazing areas. The human population in the district has been increasing at a rate of 1.8% in the past 10 years (CSO, 2011).

Livestock data also shows that there has been 40%

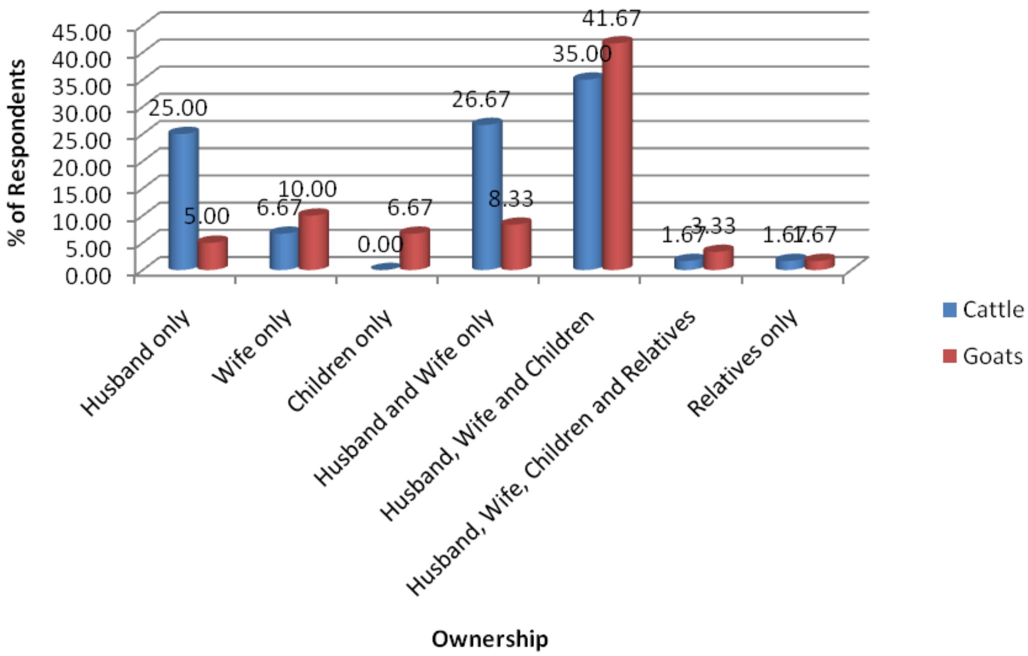

Figure 1. Cattle and goat ownership.

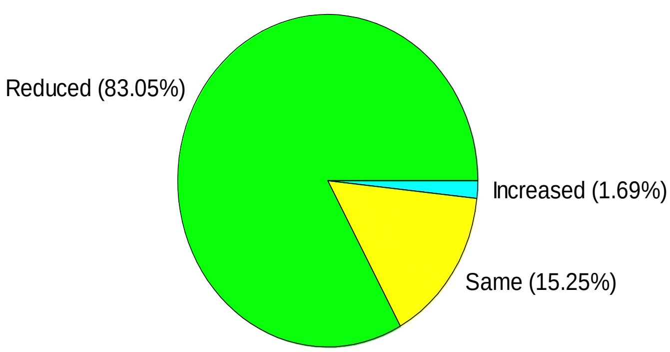

Figure 2. Status of the grazing area.

increase in population of cattle and 93% increase of goats over the past decade (CSO, 2011). Human population increase has increased the demand of land for settlement and for fields for growing of crops. Population increase cause reduction in grazing lands (FAO, 1996). The animals feed resources in grazing areas are further reduced by cutting of trees for charcoal burning and also having uncontrolled fires. The problem of reduced grazing is further compounded by increase in climate variability. With increasing temperatures and increasing frequency of droughts in the area (CEEPA, 2006), the moisture available for feed production will be decreasing, leading to decrease in livestock production and loss of livelihoods for the people. There is therefore, the need for adaptive feed strategies in the system by identifying and promoting utilization of climate adaptable indigenous forage species.

Animal feeding strategies during extreme weather conditions

The most important animal feeding strategies during drought included; browse utilization, dambo area grazing, supplementation and upland grazing while during floods upland grazing and browse use were very important (Table 1). Daodu et al. (2009) also found out that during the dry season, important feed sources for animals were from around brooks, dams, rivers and streams. Even during normal weather conditions, supplementation during the dry season is still very low among the farmers, 8.33% in goats and 48.33% in cattle. Supplementation is by use of crop residues such as maize and groundnut stover, velvet beans and maize bran. A large number of farmers do not practice feed conservation, 65 and 50% do not practice pasture management. The farmers indicated that they lacked knowledge on how to conserve and manage pastures while others indicated that they lacked labour. Browse utilization is very important both during drought and floods.

Water source

The most important sources of water for livestock use is from streams as indicated by 98.31% of the respondents while water from boreholes and wells are the most important for home use (Table 2). The dependence of streams as main water source for livestock makes them to be very vulnerable in times of drought because most of the streams do run dry. However, the fact that there is a

Table 1. Animal feeding strategies during extreme weather conditions.

Feeding strategy	Respondents during drought (%)	Respondents during flood (%)
Dambo grazing	67.80	-
Browse utilization	76.78	69.49
Supplementary feeding	8.47	-
Upland grazing	22.03	77.97
Grazing along streams	18.64	-

Table 2. Type of water source and distance to water source for home and animal use.

Type of water source	Home use (%)	For animal use (%)	Distance to water source (m)	Home use (%)	For animal use (%)
Borehole	50.84	0	less than 500	23.73	10.17
Stream	16.94	98.31	500 to 1000	71.19	40.68
Well	32.2	1.69	1100 to 2000	5.08	45.76
			more than 2000	0	3.39

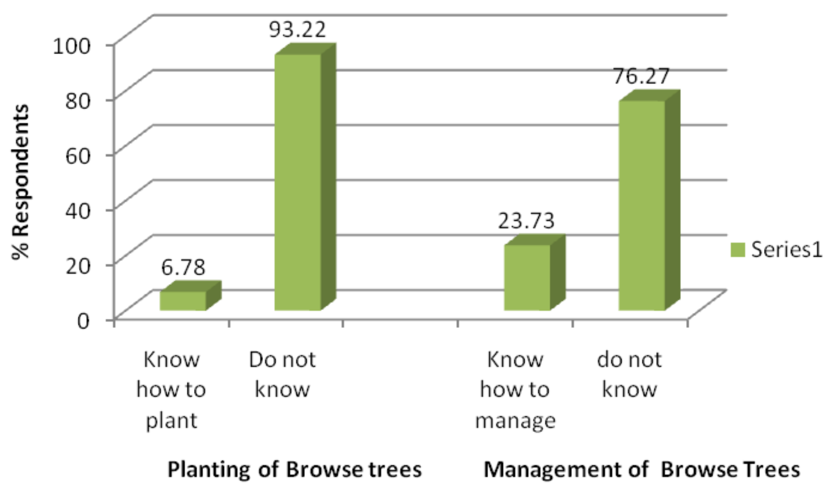

Figure 3. Planting and management of browse trees.

good number of boreholes in the area means that animals could still survive during drought because they can also use water from the boreholes as long as they do not dry up. Distance to the water supply for livestock is within one kilometer for 50% of the households. The distance to water supply could increase in times of drought as a number of steams could easily dry up. Some pastoralists indicated that during drought, animals could cover up to 10 km in search of water. It would be important to consider building a dams in the area since there are no dams.

Establishment and management of browse trees

Very few farmers (6.78%) know how to establish browse trees and 67.79% do not carry out any management on them (Figure 3). These figures are lower than that of Ansah and Nagbila (2011) who found that 66.25% of farmers were establishing browse trees in Ghana. Small holder farmers lack knowledge on establishment, conservation, and utilization of browse (Mupangwa, 1994; Mapiye et al., 2006). Establishment of effective training-research-extension-farmer and stakeholder linkages can alleviate this problem (Mapiye et al., 2006). It is therefore important that these farmers are taught how to establish and manage these trees so that they will not be depleted. A number of browse trees have been identified by the farmers as being important as a source of feed for their animals (Table 3). These trees have other important ecosystem services such as food, fiber, fuel, building materials, medicines, soil erosion control, biodiversity,

Table 3. Important browse species used for feeding livestock in Choma district.

S/N	Local name	Scientific name	Parts utilized by animals	Other uses
1	Mweeye	*Dichrostachys cinera*	Leaves, pods	Poles, firewood, medicine, live fence, nitrogen fixing in soil.
2	Muumba	*Julbernadia globiflora*	New flush of leaves	Firewood, fibre, poles building materials, charcoal, crafts.
3	Musekese	*Piliostigma thonningii*	Pods, shoots,	Fibre, fire wood, curvings, traditional medicine.
4	Musiwe	*Brachystegia spiciformis*	Leaves	Fibre, firewood, poles.
5	Mubula	*Parinari curatellifolia*	Leaves, Fruit	Food, curvings, medicine, charcoal.
6	Muyongolo	*Swartzia madagascariensis*	Pods	Curving, insecticides, fish poison, medicine, bee forage.
7	Mubombo	*Brachystegia boechmi*	Leaves, pods	Fibre, firewood, charcoal, poles.
8	Muunga/musangu	*Falbedia albida*	Ripe pods, beans, leaves	firewood, traditional medicine, indicator of soil fertility, flavouring pods.
9	Mango	*Mangifera indica*	Leaves, fruit	Firewood, traditional medicine.
10	Nakabombwe	*Combretum molle*	Young leaves	Firewood, timber, medicine.
11	Muyusa	*Bridelia micrantha*	Leaves	Curvings, medicine.
12	Mucecete	*Ziziphus mauritiana*	Leaves, fruit	Firewood, charcoal, timber, food, bee forage.
13	Mukuyu	*Ficus sur*	Fruits	Food.
14	Muntuntumba	*Terminalia spp*		Medicine.
15	Muwi	*Strychnos spinosa*	Leaves, fruit	Fruit for human food, firewood, timber, medicine, musical instrument.
16	Chiwehehe	*Boscia spp or Capparis tomentosa*	Leaves	Firewood,
17	Munego	*Dombeya rotundifolia*	Leaves	Food, wood, curvings.
18	Mulbery	*Morus alba*	Leaves	Food.
19	Mukunka	*Psuedolachostylis maprouneifolia*	Leaves, fruits	Food, fibers, medicine, gum, resin, dye.
20	Mubbiti	*Crotan guboga*	Leaves	Firewood.
21	Musuku	*Uapaca kirkiana*	Fruit	Fruit, firewood. Timber.

nutrient cycling, carbon sinks among others. They should be managed sustainably for continued supply of these services.

Adaptive use of browse in extreme weather conditions

Browse species are especially important in providing fodder during the dry season (Reddy, 2006; Mtengeti and Mhelela, 2006; Mogotsi et al., 2011) and during drought. In Zambia, browse use is critical during the six month dry season from June to November. With increased occurrences of droughts, the dependence on browse in going to increase. The agro-pastoralists indicated that in times of extreme weather conditions, they depend on climate adaptable browse species such as, *Dichrostachys cinera, Julbernadia globiflora* and *Piliostigma thinningii* among others; while during floods, *Dichrostachys cinera* and *Piliostigma thinningii were* more popular (Table 4). More emphasis should be put on coming up with strategies on how to use these highly ranked species more efficiently.

Management practices that could improve their utilization include lopping, coppicing, pruning and pollarding. Planting of these species should also be encouraged so that they are not depleted since some of them have uses such as for timber and making charcoal. One browse tree, *Parinari curatellifolia* was identified as important source of early warning information concerning drought, in that, it has a tendency to bear excessively in years preceding drought. This is an important climate indicator. This is in line with Roncoli et al. (2002) who reported that local climate indicator involve the use of a combination of tree flower production, duration and intensity of cold and hot

Table 4. Farmers response to browse species importance in extreme weather conditions.

S/N	Local name	Scientific name	Normal situation respondent (%)	Respondents during drought (%)	Respondents during flood (%)
1	Mweeye	*Dichrostachys cinera*	90.00	81.67	71.67
2	Muumba	*Julbernadia globiflora*	81.67	68.33	3.33
3	Musekese	*Piliostigma thonningii*	68.33	46.67	18.33
4	Musiwe	*Brachystegia spiciformis*	50.00	48.33	-
5	Mubula	*Parinari curatellifolia*	45.00	31.67	8.33
6	Muyongolo	*Swartzia madagascariensis*	33.33	23.33	-
7	Mubombo	*Brachystegia boechmi*	25.00	26.67	-
8	Muunga	*Falbedia albida*	23.33	18.33	3.33
9	Mango	*Mangifera indica*	13.33	-	-
10	Nakabombwe	*Combretum molle*	11.67	10.00	6.67
11	Muyusa	*Bridelia micrantha*	11.67	11.67	-
12	Mucecete	*Ziziphus mauritiana*	11.67	8.33	1.67
13	Mukuyu	*Ficus sur*	11.67	-	-
14	Muntuntumba	*Terminalia*	8.33	6.67	-
15	Muwi	*Strychnos cocculoides*	6.67	3.33	-
16	Chiwehehe	*Boscia spp or Capparis tomentosa*	1.67	1.67	-
17	Munego	*Dombeya rotundifolia*	1.67	-	-
18	Mulbery	*Morus alba*	5.01	3.39	-
19	Mukunka	*Psuedolachostylis maprouneifolia*	1.69	1.69	1.69
20	Mubbiti	*Crotan guboga*	1.69	1.69	-
21	Musuku	*Uapaca kirkiana*	1.69	-	-

periods, bird and insect behavior, and movement of stars and moon to predict precipitation. This indigenous knowledge should be further studied in order to determine its reliability.

Conclusion

The study showed that climate variability is affecting agro-pastoralists in the way they feed their animals and how they are using indigenous browse species. The important feeding adaptive strategies used by the agro-pastoralists include; browse utilization, dambo grazing, grazing along streams and supplementary feeding during drought, while during floods, upland grazing and browse grazing are important. There is need to teach the farmers how to manage the feed resources and replanting, and management of more climate adaptable indigenous pastures to increase livestock productivity and enhance food security. Replanting of climate adaptable indigenous browse species would also help in reforestation of the dry lands and bring stability in the ecosystem. This would ensure sustainable use of the feed resources.

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