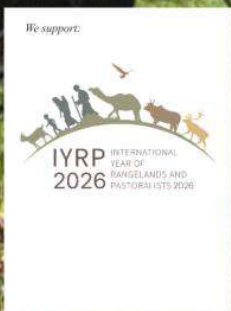


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Despite awareness of the critical roles of rangelands in sustaining livelihoods of pastoralists and ecological safeguarding, rangelands have felt the pressure of habitat fragmentation, land use change, industrialization, enclosure, privatization, militarization, and ecosystem devastation. Gradually, rangelands are being converted into other land uses or enclosed for exclusive uses under various national laws or policies. Resilience of pastoralist communities to the changing environments – ecological, economic and political – has great potential to protecting and conserving the rangeland landscapes or waterscapes. Such resilience is more talked in context of climate change and its impact on the herder communities surviving in marginal environments. In the view of widespread regional and national policy failures and modernity-catalyzed societal rejection of transhumance and nomadic pastoralism, International Year of Rangelands and Pastoralists 2026 declared by the United Nations General Assembly is a grand opportunity for all to revitalize the least-external-input driven systems of livestock raising and mobility across the continents. This international blind peer-review journal, 'Pastures & Pastoralism', will contribute to the science, policy and practice across the world by providing a novel platform to seasoned, budding and young scientists, experts and practitioners, including the pastoral community members.

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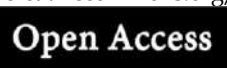


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Editor's Note: Why is the Pastures-Pastoralism Nexus Critical?

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Dear Readers,

Pasturelands are the most ancient sources of subsistence economy in human history. Pastoral communities, especially nomadic pastoralists, are considered some of the most sustainable societies in the world. Normally, pasturelands are chiefly owned or controlled by governments and under communal tenures of agro-pastoral communities with custodianship of local governance institutions. In large number of developed countries a substantial area of pasturelands has been privatized and managed by ranchers. Despite awareness of the critical roles of pasturelands in sustaining livelihoods of pastoralists and ecological safeguarding, pasturelands have felt the pressure of habitat fragmentation, land use change, industrialization, enclosure, privatization, militarization, and ecosystem devastation. The recent phenomenon of land grabbing has also affected the remaining pasturelands and dependent pastoralism. Gradually, pasturelands are being converted into other land uses or enclosed for exclusive uses under various national laws or policies. Worldwide, there is a common trend of governing bodies increasingly declaring pasturelands unproductive, waste or under-productive lands and term the pastoralist lifestyles outdated and obsolete. Thereafter, with the help of weak rangeland or pastures related laws/policies and by using powerful land acquisition or conversion laws/policies, countries either have given up massive rangeland territories to other forms of land uses or enclosed tenures or have restricted/ circumvented the grazing activities of pastoralist herders. Thus, by changing land use criteria, the results have been the exclusion of indigenous herder communities, fragmentation of habitats, militarization of territories, and enclosure of pasturelands. This has affected the sustainability of both rangeland ecosystem services and viable pastoralism and transhumance.

It is believed that subsistence pastoralism is a sustainable strategy of livelihood and ecosystem conservation in the pasturelands. Very few studies have been undertaken to demonstrate that the nomadic pastoralist way (on pasturelands) of livestock production with hardly any economic investment produces some of the most nutritive foods as well as other sustainable products. Unfortunately, such products have not been desirably priced in modern markets, and the nomadic grazing (which is helpful to biodiversity, not detrimental) is perceived by ecologists and policy makers as a threat to conservation. The deep ecologists and green missionaries had/have advocated against grazing in natural ecosystems, especially in protected areas. Hence, pastoralists as well as the rangeland ecosystems have suffered as a result. Fading fast all over the world, the (most sustainable) livelihoods and lifestyles of nomadic pastoralists can, therefore, only sustain/conserves the rangeland commons, which are most productive ecosystems on planet (even more productive than forests).

Resilience of indigenous pastoralist communities to the changing environments – ecological, economic and political – has great potential to protecting and conserving the rangeland landscapes or waterscapes. Varied aspects of pastoralists' resilience have been documented mostly in context of climate change. However, resilience of nomadic pastoralists particularly needs to be studied in respect to drying water sources, changing vegetation composition, reducing fodder resources, degrading rangeland ecosystem, changing political or policy environment, militarization of pasturelands, and alike. Of course, the scientific studies of pastoralists' resilience and adaptation abilities would contribute to inclusive policy processes or reform meant for landscape conservation and management.

International journal, *Pastures & Pastoralism*, is dedicated to the complex issues raised above and faced by the pastoralist communities across the world. We seek a cooperation of every one and all.

Issues of Declining Livestock Breeds: Revisiting Domestic Animal Diversity in Pastoral Systems

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Abstract

Concerns for the disappearance of local breeds go back to the beginning of scientific breeding and the early national policies of agriculture intensification in Europe at the time of the industrial revolution. That initial Eurocentric framing of domestic animal diversity as 'local' breeds, largely the result of natural selection and potentially a useful source of 'raw' genetic material, remains dominant. Today, however, the debate around domestic animal diversity has been globalized, and so includes livestock breeding populations and livestock systems that developed *outside* the European experience. This paper looks at domestic animal diversity from the vantage point of one of such cases: cattle breeding among the Wodaabe pastoralists in Niger. The research is based on a combination of qualitative methodologies standard in social anthropology and quantitative analysis of memorized herd genealogies over a 20-year period. Results show that a competent herder can control cattle mating in over 90 percent of cases. Complex learned behaviour in cattle, particularly related to feeding competence, is a major selection criterion. The Wodaabe specialize in using the short-lived and unpredictable grazing opportunities, which is characteristic of Sahelian rangelands. To successfully interface the unpredictable variability in potential inputs, they breed herds with exceptional levels of within-breed diversity, crucially including epigenetic traits. The common practice of conflating Domestic Animal Diversity (DAD) with Animal Genetic Resources (AnGR), therefore, falls short of adequately representing the relationship between 'local breeds' and livelihood in pastoral systems.

Keywords

Domestic animal diversity; Breeding; Wodaabe; Pastoralism; Animal genetic resources

1. Introduction

A concern for Domestic Animal Diversity (from now on referred to as DAD) formally entered the international arena in 1946, when the then newly created FAO was assigned the 3 aspects of 1 task of cataloguing, maintaining, and utilizing livestock

biodiversity (Phillips, 1981)¹. Today, the FAO publishes the *State of the World's Report on Animal Genetic Resources for Food and Agriculture*, in collaboration with some 150 scientists around the world (Rischkowsky & Pilling, 2007; Scherf & Pilling, 2015). According to the most recent of these reports, 17% of known livestock breeds are classified as 'at risk of extinction'. The actual proportion could be higher, as for about half of the known breeds there is no sufficient information to assess the risk level. The risk of loss of domestic animal diversity is mainly seen as triggered by changes within the livestock sector, driven by economic, social, demographic and political factors. Domestic animal diversity is included in the Convention on Biological Diversity, which outlined its roots in 'traditional knowledge, innovations and practices', emphasizing the necessity of conserving domestic animal species 'in the surroundings where they have developed their distinctive properties' (UN, 1992: Art. 2).

Concerns about the disappearance of local breeds go back to the early days of animal science, concomitantly with the industrial revolution and the launch of national policies of agricultural intensification. The first comprehensive description of livestock breeds in the British islands (Low, 1842) worried about the preservation of 'centuries old environmental fitness'. This was seen as a 'raw material', resulting from centuries of natural selection, difficult to reproduce, and yet a potentially useful base for the new practice of scientific breeding in the context of the new practices of agricultural intensification (Hall & Clutton-Brook, 1989). While wrapped in scientific universality, this was an entirely Eurocentric view at a very particular moment of history.

That early framing has never stopped dominating the debate. Today, it is at the root of the common practice of using the concepts of 'Domestic Animal Diversity' (DAD) and 'Animal Genetic Resources' (AnGR) interchangeably. An argument often used for promoting the conservation of domestic animal genetic resources is that many livelihood systems depend on it. While sound in its intentions, this argument remains captive of the initial Eurocentric view of domestic animal diversity as breed-based, as genetic material and as a product of adaptation to a *local* natural environment understood as a constraint to production.

Conservation strategies focusing on AnGR target a representative sample of genotype-environment adaptation, with priority given to breeds presenting particularly desirable and rare traits — for example, a resistance to certain diseases (FAO-CGRFA, 2004; Reist-Marti et al., 2003). But what about the livestock-based livelihood systems that developed *outside* the European experience? What if the livelihood system specializes in engaging *positively* with the variable natural environment rather than trying to shelter from it (FAO, 2021)? And what if the system is mobile, and, therefore, 'local conditions' are not stable but variable, and largely the outcome of management, as in pastoral systems?

Thus, this paper looks at the domestic animal diversity from the vantage point of the study of cattle breeding among Peul Wodaabe pastoralists in Niger. As evident, the importance of domestic animal diversity for livelihoods can go well beyond the European experience and the current AnGR focus.

2. Methodology

This paper is based on *i.* research among the Wodaabe in Niger carried out in 2000-2005 (19 months of fieldwork) and 2008 (3 months); *ii.* qualitative data on cattle breeding and feeding selectivity using semi-structured interviews among Turkana and Karamojong pastoralists in Kenya and Uganda, Arab pastoralists in Chad and

¹ A series of seminal reference works followed, on cattle breeds in India and Pakistan (Joshi & Philips, 1953), Africa (Joshi et al., 1957), Europe (French et al., 1966), and on Mediterranean sheep breeds (Mason, 1967).

Sudan, and Somali, Boran, and Dassenetch pastoralists in Ethiopia between 1999 and 2020; and *iii.* ten years of work (since 2013) on pastoralism and pastoral development in relation to the role of mobility in environments characterized by high levels of unpredictable variability.

The study of the cattle breeding system among the Wodaabe used standard methods from social anthropology² and a method for analyzing herd genealogies and herders' breeding decisions. The latter was specifically developed for handling memorized cattle genealogies and, therefore, embedding multiple cross-checking mechanisms. Data collection included the year of birth, sale or death — and, where relevant, the year of borrowing or lending — for each animal in the herd (males and females) over a 20-year period (1985-2005). It also included the name of the mother and father of each animal; the name of the owner of the father; the reason for selling the animal; and, in case of animals, whether had been borrowed or lent, the nature of the herder's relationship with the owner or receiver. Two herds, for a total of 101 cattle as of 2005, were analyzed with this genealogical method. Building a 'map' of the herd in this way allowed for real-time crosschecking of new data against those already collected. Crosschecking was also done by asking the same questions a second time, about random animals, during interviews weeks apart from one another. A quantitative analysis of this data using a commercial database, later enabled the production of 'snapshots' showing all the animals in the herd, their age and gender and their kinship relations, and whether they were sold, lent, returned or died, in each of the 20 years covered by the study. Finally, herders' breeding decisions and their explanations were analyzed in light of scientific literature from a range of disciplines including animal science, rangeland management, animal behaviour science, evolutionary biology and social anthropology.

The bulk of findings in the next section are from Krätli (2008a)³. When the information presented was already in the public domain at the time of the study, references are provided.

3. Results: Domestic Animal Diversity and Pastoralism

3.1 What is pastoralism?

On about 40 per cent of land on Earth, rainfall is highly unpredictable. For food producers who specialize in being in the right place at the right time, these unpredictable environments offer important opportunities. Mobile pastoralists are such producers (FAO, 2021; Kaufmann et al., 2018).

Pastoral systems all over the world are highly diverse, but they all share the same adaptive approach: working closely with livestock interacting with rangelands, and making decisions based on learning from such interaction (Sharifian et al., 2022). From the Sahel to the Arctic, pastoral systems developed as an integral part of their natural environment, not by trying to separate from it. They manage livestock's grazing itineraries so that the animals feed better than they would without the herder, and this is done at a variety of spatial and temporal scales depending on the level of specialization (Krätli & Schareika, 2010; Meuret & Provenza, 2014; Molnár et al., 2020).

Pastoral systems specialize in making use of highly unpredictable environments, using livestock to take advantage of the important, but scattered and short-lived opportunities offered by the rangelands. When the functional processes in the pastoral system can be kept variable enough to match the pace of unpredictable

² Participatory observation, focus group discussions, semi-structured interviews, and Participatory Rural Appraisal (PRA) techniques.

³ Published as synthesis in Krätli (2008b).

change in the environment, the system's outputs are relatively stable even in highly variable conditions (FAO, 2021).

In the face of the uncertainty associated with making use of a highly unpredictable environment, the logic of pastoralism is to keep options open: flexibility of options compensates for lack of certainty (Krätli & Schareika, 2010). Promoting and maintaining high levels of domestic animal diversity in the herds is part of this logic. For example, with a few exceptions (especially in the Arctic region), pastoralists typically keep several species in their herds — for example cattle, camels, sheep, goats and donkeys — and even different lineages within the same cattle breed. This helps them match the diversity of opportunities in their environment. But the most important strategy in this regard is by fostering variability within the breeding population itself.

Hall (2004) finds that some of the highest levels of within-breed diversity are found in pastoral systems. In his description, 'within-breed variation provides the flexibility that the breeds need to have if they are to respond to changing conditions'. We will see that pastoralists foster within-breed diversity in their own way. A livestock breeding population developed to perform under pastoral management conditions is a different entity compared to a breed developed to maximize a single trait. Despite the long interest in local breeds by the international community, livestock breeding in the most specialized 'local' contexts — pastoral systems — has so far received surprisingly little attention.

3.2 Wodaabe Pastoralism in Niger

The Wodaabe in Niger one of the largest cattle-breed in Sub-Saharan Africa, the long-horned *na'i bodeeji* ('red cows' in Fulfulde, Wodaabe's vernacular language). These animals were formally characterized as 'Red Bororo zebu' in the early 20th century, during the French colonial administration (Krätli, 2009; Mornet & Koné, 1941). The cattle of the Wodaabe have been recorded to feed on more than 60 varieties of plants, including bushes, trees and grasses — often thorny and and/or toxic at certain stages of their life cycle (Bonfiglioli, 1981). The Wodaabe and their livestock operate in a natural environment where the temperature reaches 50°C, with precipitations between 0 and 400 mm in one rainy season stretching over a maximum of four months. By comparison, in 2021, livestock experts in the United Kingdom warned that "with 'temperatures now regularly reaching 20°C and beyond... [our] cows are extremely susceptible to heat stress"⁴.

The Wodaabe's herd management strategy is equally remarkable. In order to keep their animals on the best possible pasture also during the nine-month-long dry season, they can camp as far as 30 kilometers away from the water point. Watering is done every other day during most of the dry season, and every second day in the last couple of months. This strategy also exploits the ability in cattle to keep them in a positive energy balance when a low-protein roughage diet is combined with a degree of water restriction (Granier, 1968; Rogerson, 1963).

The Wodaabe literally live with their livestock. Their camp includes a space for the herd where a fire is lit every evening only for animals and they gather around it. The herd gathers around the fire. No fence is used. At night, the cattle leave the camp at their own and return after a few hours of grazing. When moving with their herders, these animals *follow* the herder rather than being herded from behind, and are able to respond to numerous commands. All this contributes to optimizing feeding efficiency and facilitating management in conditions where even the smallest

⁴ Dairy Global, <https://www.dairyglobal.net/health-and-nutrition/health/a-greater-issue-in-uk-heat-stress-impact-on-dmi/>

advantages can make an important difference (Breman & De Witt, 1983; Krätli & Schareika, 2010).

3.3 Engaging with the natural environment: variability in nutrients over time and space

In the Sahel, the rain falls in itinerant showers. In most of these rangelands, it is impossible to predict from one year to the next where pasture will grow. Nutrients for livestock are distributed unevenly and unpredictably. Variability rules at all scales, both in time and space. Variations between seasons (time) and between macro-ecological zones (space) are the most obvious examples. Following the rains, the concentration of nutrients in pasture also *increases* as one moves north towards the Sahara — drier areas have less pasture biomass but of higher quality (Breman & De Wit, 1983). The concentration of nutrients also varies between plants and between the parts of a plant (Breman & de Ridder, 1991). In terms of variability in time, during the life cycle of a plant, nutrients first peak and then decrease as the plant uses them for its own reproduction (Alimaev, 2003; Ball et al., 2001; Ronga et al., 2020). Nutrient content in pasture also changes between day and night, peaking in the evening after a day of photosynthesis (Ball et al., 2001; Burns et al., 2005; Scialdone & Howard, 2015).

Livestock feeding opportunities also expand and contract at unpredictable intervals between years, often dramatically. In order to keep productivity as high as possible on highly variable resources, livestock need to feed in the right place at the right time, and be able to select the best bites. For all that to happen, herders need the right herd: animals capable of moving quickly even over long distances, and capable of feeding discerningly and efficiently once presented with the opportunity. In other words, they need herds highly skilled in interacting successfully with the natural environment. So, what makes a pastoral herd ‘right’?

3.4 Breeding Cattle among the Wodaabe

Wodaabe’s pastoralism rests on a sophisticated cattle breeding system supported by several customary institutions — most importantly, a matrilineal cattle naming system shared among all Wodaabe clans and Peul livestock-keepers more broadly, from Senegal to Sudan. New born calves, males and females, are named after the mother. This naming system organizes the herd into matrilineal families and makes it possible to track the outputs of breeding, both across herds and across human generations. A name refers to a cattle lineage as well as each one of its members. For example, in talking about a cow currently in herd, named ‘Guddel’, a herder might say ‘Guddel was already in the herd of my grandfather, when my father was a child’— although at that time the actual cow, or even her mother, had not yet been born (interview with Jiima bi Ardi, March 2004).

Cattle genealogies are systematically memorized, although of course this is not achieved by all herders to the same degree. Close monitoring and a period of heat (oestrus) in these cattle that lasts only a few hours⁵, allow for a strict control of reproduction. In 2005, the analysis of herd genealogy indicated that a competent herder can control mating in over 90 percent of cases (Krätli, 2009).

Non-productive animals are systematically sold. Breeders borrow reproductive bulls and lend cows across open networks including tens of herds. Lending of heifers between friends and relatives is institutionalized. These animals remain in the receiving herd for the time it takes to deliver one or two calves, and are returned pregnant. Crossbreeding is a traditional practice, used to expand the range of

⁵ This information from the herders matches general descriptions of oestrus cycle in zebu. Cuq (1973) reports a much wider difference between extremes compared to *Bos Taurus*, with an average time of acceptance of a male spanning between 4 and 8 hours.

production strategies available to the household, or to adapt the herd when moving into entirely new areas or when facing new socio-economic conditions (Boutrais, 2007).

3.5 A Particular Attention to Learned Behaviour

Animals in a pastoral system need to be productive and sufficiently robust to reproduce under demanding conditions of environment and management. To date, Wodaabe's livestock achieve this with minimal inputs of feed supplement or veterinary services. Besides matching the basic requirements for survival and reproduction, selective mating is aimed at building and maintaining diversity within the herd. In order to thrive in the highly variable environmental conditions of the Sahel, building a capacity for variability into the herd takes priority for the Wodaabe over maximizing a single trait. The following statement is enlightening in this context:

'We have preferred lineages but do not maximise their number in the herd. If we did that, the entire herd would be made of similar animals and we don't want that. We need different lineages with a variety of functional skills' (focus group discussion with herders, May 2004).

A major criterion for selection is *behaviour*, including complex learned behaviours passed from mothers to calves and between peers. Feeding competence is crucial. Social behaviour within the herd, and an animal's attachment to the herders, are also important as they can have positive outcomes on the animals' health, learning ability and feeding efficiency, for example by reducing antagonism and stress. Social interactions can jeopardise or favour cattle feeding performance in various ways (Bouissou et al., 2001; Dumont & Boissy, 1999; Waiblinger et al., 2006). The mere proximity of dominants can cause subordinates to slow down their bite rate and even stop feeding (Bennet & Holmes, 1987). Work on African buffalo revealed that an animal's physical condition is heavily affected by the herd's social organisation and its position within it (Prins, 1996).

In the herds of the Wodaabe, antagonistic and aggressive behaviours are minimized by removing most of the males above a certain age, and by actively promoting bonding relationships between the animals. For example, at night the calves are tethered to both sides of the 'calf-rope' stretched north-south across the camp; they are always attached in the same position relative to one another. The herders explain that this is in order to favour the creation of bonds between the animals (called 'preferential relationship' by animal behaviour specialists) at a time when they most need reassurance as the mothers (dams) leave for night grazing.

Having a high number of preferential relationships within the herd results into reduced aggressiveness, increased tolerance in competitive situations, and enhanced positive interactions, such as grooming through licking. Research from applied animal behaviour science highlights the potential economic return of management strategies that minimize negative social interaction within the herd, and recommends measures apt to stabilize dominance and favour preferential relationships (Boissy et al., 2001; Bouissou et al. 2001). Preferential relationships between animals are described by Wodaabe herders with the same vernacular word they also use to talk about friendship between people. Their cattle management system also enhances calf-dam bonds. Calves are allowed to spend several hours per day with their mothers, both around the camp in the evening and during the morning grazing — also a critical learning opportunity.

Wodaabe herds are complex social organizations not dissimilar to the herds of wild herbivores but with lower levels of internal antagonism. Favouring the number of bonds within the herd works towards improving herd nutrition: more even feeding patterns across ranks without cost for the high-ranking ones, and, therefore, a better feeding performance of the herd as a whole. Here below are some other examples of

learned behaviour, the functionality of which Wodaabe herders appreciate and strive to build into their herds through their breeding practices:

- *noppina*: feeding on new grass when it is still young, ingesting only minimum sand by pinching the short grass with the muzzle as sheep would — gives extra days feeding on green pasture at the beginning of the rainy season.
- *geeti*: being very attached to the household's members and ferociously mistrustful of strangers and unfamiliar practices — helps managing the herd and makes it hard to steal.
- *dikku* (also *halhonge*): to have 'character', for example a cow that has collapsed on the ground out of exhaustion yet that when helped to stand up does not collapse again but starts feeding;
- *gamtudi*: on the range, these animals are always some distance from the group, exploring for better pasture — when managed by the herder, they can improve overall feeding performance of the herd.

Herders welcome specific behavioural patterns to a higher degree, but lineages showing exceptional levels of such traits are not maximised within the herd at the expenses of the other lineages.

4. Discussion: Breeding for Variability

Working on camel breeding among the Rendille in Kenya, Brigitte Kaufmann found that the animals producing most milk during the rainy season — those that animal science would see as the best milk producers in the herd — were considered by the herders to be the 'weakest animals' (Kaufmann, 2007). This was because they were barely able to feed their calves during the dry season. On the other hand, animals that did not perform particularly well during the rainy season were the best milk producers during the dry season. The Rendille herders valued multiple *types* of performance — to match variability of conditions — over absolute best performance in best conditions (Kaufmann, 2007).

In the case of cattle breeding among the Wodaabe, multiple *types* of performance are actively pursued and maintained. The role of within-breed genetic variation is important, but clearly within-breed diversity used in pastoralism stretches well beyond genetic traits. This is a breeding system aimed at embedding not only variability of genetic resources, but also epigenetic gene-expression that complements complex learned behaviour functional to interfacing with the environment (Day et al., 2003; Jablonka & Lamb, 2006; Lewontin, 2000). In other words, breeding practices are aimed at introducing and maintaining particular learned behaviours. The focus of the breeders is more on the herd and its lineages than on individual animals. We know from decades of research on ruminants' feeding behaviour that the mother's influence begins in the womb (as flavors of foods she eats reach her amniotic fluid), continues after birth (through flavors in her milk). When offspring begin to forage, the mother is a model for what and what not to eat, and where and where not to go. Learned behaviors and abilities involve anatomical and physiological changes in organ systems, including the microbiome (Landau & Provenza, 2020). Many of such changes are inheritable, in epigenetic ways, and, therefore, subject to breeding strategies.

Besides feeding competence, animals' attachment to the herders and social organization within the herd are very important. Other examples of sought-after behavioural traits include knowledge of the territory and orientation and experience in managing difficult terrains or high temperatures. There are many more, and combinations of these learned behaviours create the pastoral herds adapted to successful interaction with the multiple, biodiverse and variable landscapes they inhabit.

The primary objective of breeding under these variable conditions is not to maximise a trait or set of traits towards some absolute optimum with the right combination of genes. The primary objective is to keep as high as possible the capacity of a given herd to function as a matching interface with ever-changing landscapes. Pastoral breeds are constantly in the making; they are developed to interface production with landscapes that are also constantly in the making; they are *defined* by their variability.

This peculiar approach to breeding — *breeding for variability* in interacting with a variable environment — seems to offer an important lesson now particularly important also in the face of climate change (FAO, 2021). In this light, livestock breeding in pastoral systems, and the different meaning it gives to domestic animal diversity beyond the current focus on genetic material, carries new relevance well beyond pastoralism.

5. Conclusion

The analysis of Wodaabe cattle breeding shows high levels of systematic monitoring and control of mating and routine culling. It also shows a strong emphasis on the generation and maintenance of domestic animal diversity, especially within-breed diversity including both genetic *and* epigenetic traits. Of particular importance to the herders are multiple types of complex learned behaviour that are functional to the animals' interaction with the natural environment. Both the reproduction and the effectiveness of these learned behaviours depend on the social organization within the herd: mother-calf and peer-to-peer learning; and as low-stress feeding conditions. Within this approach, the breeding unit is the herd rather than the individual animal.

The 'domestic animal diversity' which is *economically relevant* in pastoralism — and most likely in many traditional livestock breeding systems in family-farming contexts (Provenza, 2008) — is, therefore, not limited to genetic resources and to individual animals' performance. In fact, this particular kind of DAD found in pastoral systems remains largely outside the conventional genetic notion of domestic animal diversity — which for the time being continues to focus at the level of the individual animal in isolation from the environment or with the environment merely seen as a constraint⁶.

The common practice of conflating DAD with AnGR with its narrow focus on 'adaptation to local conditions' is inadequate to represent the relationship between livestock breeds and livelihood in pastoral systems.

6. References

- Alimaev, I. I. (2003). Transhuman ecosystems: fluctuations in seasonal pasture productivity. In: Kerven, C. (ed.), *Prospects for Pastoralism in Kazakhstan and Turkmenistan: From State Farms to Private Flocks*. London: Routledge-Curzon.
- Ball, D. M., Collins, M., Lacefield, G. D., Martin, N. P., Mertens, D. A., Olson, K. E., Putnam, D. H., Undersander, D. J., & Wolf, M. W. (2001). *Understanding Forage Quality*. Park Ridge, IL: American Farm Bureau Federation Publication 1-01.
- Bennett, I. L., & Holmes C. R. (1987). Formation of a feeding order in a group of cattle and its relationship with grazing behaviour, heat-tolerance and production. *Applied Animal Behaviour Science*, 17, 9-18.
- Boissy, A., Nowak, R., Orgeur, P., & Veissier, I. (2001). Les liens sociaux chez les ruminants d'élevage: limites et moyens d'action pour favoriser l'intégration de l'animal dans son milieu. *Productions Animales (INRA)*, 14, 79-90.

⁶ In the face of climate change, this model of food production based on externalizing nature has itself become a critical distinguishing trait in the current call to rethink agricultural systems before it is too late (Pretty, 2002; Scherr & McNeeley, 2007; Shiva et al., 2019; UNEP, 2021; FAO, 2021).

- Bonfiglioli, M. A. (1981). *Ngaynaaka. Herding According to the WoDaaBe*. Niger Range and Livestock Project, Discussion Paper n. 2. Tahoua: Republic of Niger, Ministry of Rural Development and USAID.
- Bouissou, M. F., Boissy, A., Le Neindre, P., & Veissier, I. (2001). The social behaviour of cattle. In: L. Keeling & H. Gonyou (eds.), *Social Behaviour of Farm Animals*. Wallingford, UK: CAB International.
- Boutrais, J. (2007). The Fulani and Cattle Breeds: Crossbreeding and heritage strategies. *Africa*, 77(1), 18-36.
- Breman, H., & de Ridder, N. (eds.) (1991). *Manuel sur les pâturages des pays sahéliens*. Paris: Editions Karthala.
- Breman, H., & De Wit, C. T. (1983). Rangeland Productivity and Exploitation in the Sahel. *Science, New Series*, 221 (4618), 1341-1347.
- Burns, J. C., Mayland, H. F., & Fisher, D. S. (2005). Dry matter intake and digestion of alfalfa harvested at sunset and sunrise. *Journal of Animal Science*, 83, 262-270.
- Cuq, P. (1973). Bases anatomiques et fonctionnelles de la reproduction chez le zébu (*Bos indicus*). *Revue d'Élevage et de Médecine Vétérinaire des Pays Tropicaux*, 26(4), 21a-48a.
- Day, R. L., Laland, K. N., & Odling-Smee, J. (2003). The Niche Construction Perspective. *Perspectives in Biology and Medicine*, 46(1), 80-95.
- Dumont, B., & Boissy, A. (1999). Relations sociales et comportement alimentaire au pâturage. *INRA Productions Animales*, 12(1), 3-10.
- FAO (2021). *Pastoralism: Making Variability Work*, Animal Production and Health Paper No. 185. Rome: Food and Agriculture Organization of the United Nations (FAO).
- FAO-CGRFA (2004). *Measurement of Domestic Animal Diversity. A review of recent diversity studies*. Commission on Genetic Resources for Food and Agriculture. Working Group on Animal Genetic Resources for Food and Agriculture, Third Session Rome, 31 March – 2 April 2004. Rome: Food and Agriculture Organization of the United Nations (FAO).
- French, M. H., Johansson, I., Joshi, N. R., & McLaughlin, E.A. (1966). *European breeds of cattle* Vol. I and II, FAO Agricultural Studies No. 67. Rome: Food and Agriculture Organization of the United Nations (FAO).
- Granier, P. (1968). Etude sur la digestibilité chez le zébu. *Terre Malgache*, 2: 139-159.
- Hall, S. J. G. (2004). *Livestock Biodiversity. Genetic Resources for the Farming of the Future*. Oxford, UK: Blackwell Publishing.
- Hall, S. J. G., & Clutton-Brock, J. (1989). *Two Hundred Years of British farm Livestock*. London: British Museum of Natural History.
- IPCC (Intergovernmental Panel on Climate Change) (2021). Summary for Policymakers. In: V. Masson-Delmotte, P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu and B. Zhou (eds.), *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge, UK: Cambridge University Press.
- Jablonka, E., & Lamb, M. J. (2006). *Evolution in Four Dimensions. Genetic, Epigenetic, Behavioral, and Symbolic Variation in the History of Life*. Cambridge, MA, US: The MIT Press.
- Joshi, N. R., & Phillips, R. W. (1953). *Zebu Cattle of India and Pakistan*, FAO Agricultural Studies No. 19. Rome: Food and Agriculture Organization of the United Nations.
- Joshi, N. R., McLaughlin, E. A., & Phillips, R. W. (1957). *Types and Breeds of African Cattle*, FAO Agricultural Studies No. 37. Rome: Food and Agriculture Organization of the United Nations.
- Kaufmann, B. A. (2007). *Cybernetic Analysis of Socio-biological Systems: The Case of Livestock Management in Resource-Poor Environments*. Weikersheim, Germany: Margraf Publishers GmbH.

- Kaufmann, B. A., Hülsebusch, C. G., & Krätli, S. (2018). Pastoral Livestock Systems. In: Ferranti, P., Berry, E.M., Anderson, J.R. (eds.), *Encyclopedia of Food Security and Sustainability*, vol. 3. Amsterdam, The Netherlands: Elsevier.
- Krätli, S. (2008a). Cows Who Choose Domestication. Generation and management of domestic animal diversity by WoDaaBe pastoralists (Niger), PhD thesis. Brighton, UK: Institute of Development Studies, University of Sussex.
- Krätli, S. (2008b). *Time to outbreed animal science? A cattle-breeding system exploiting structural unpredictability: the WoDaaBe herders in Niger*, STEPS Working Paper 7, Brighton, UK: STEPS Centre, Institute of Development Studies, University of Sussex.
- Krätli, S. (2009). Animal Science and the Representation of Local Breeds: Looking into the Sources of Current Characterisation of Bororo Zebu. In: K. Brown and D. Gilfoyle (eds.), *Healing the Herds: Essays on Livestock Economies and the Globalization of Veterinary Medicine*. Athens, Ohio, US: Ohio University Press.
- Krätli, S., & Schareika, N. (2010). Living off Uncertainty. The Intelligent Animal Production of Dryland Pastoralists. *European Journal of Development Research*, 22(5), 605-622.
- Landau, S. Y., & Provenza, F. D. (2020). Of browse, goats, and men: Contribution to the debate on animal traditions and cultures. *Applied Animal Behaviour Science*, 232, 1-12.
- Lewontin, R. C. (2000). *The Triple Helix*. Cambridge MA, US: Harvard University Press.
- Low, D. (1842). *The Breeds of the Domestic Animals of the British Isles*. Vol. I. The Horse and the Ox. Vol. II. The Sheep, the Goat, and the Hog. London: Longman, Orme, Brown, Green & Longmans.
- Mason, I. L. (1967). *Sheep Breeds of the Mediterranean*. Rome: Food and Agriculture Organization of the United Nations (FAO).
- Meuret, M., & Provenza, F. (eds.) (2014). *The Art and Science of Shepherding. Tapping the Wisdom of French Herders*. Austin, TX, US: ACRES.
- Molnár, Z., Kelemen, A., Kun, R., Máté, J., Sáfián, L., Provenza, F., Díaz, S., Barani, H., Biró, M., Máté, A., & Vadász, C. (2020). Knowledge co-production with traditional herders on cattle grazing behaviour for better management of species-rich grasslands. *Journal of Applied Ecology*, 57, 1677-1687.
- Mornet, P., & Koné, K. (1941). Le zébu peulh bororo. *Bulletin des Services Zootechniques et des Épizooties de l'Afrique Occidentale Française*, 4 (3-4), 167-180.
- Phillips, C. J. C. (1981). The identification, conservation and effective use of valuable animal genetic resources. In: *Animal genetic resources. Conservation and management. Proceedings of FAO/UNEP Technical Consultation*. Rome: Food and Agriculture Organization of the United Nations (FAO).
- Pretty, J. (2002). *Agri-Culture: Reconnecting People, Land and Nature*. London: Earthscan.
- Prins, H. H. T. (1996). *Ecology and Behaviour of the African Buffalo: Social Inequality and Decision Making*. London: Chapman & Hall.
- Provenza, F. D. (2008). What does it mean to be locally adapted and who cares anyway? *Journal of Animal Science*, 86: E271-E284.
- Reist-Marti, S. B., Simianer, H., Gibson, J., Hanotte, O., & Rege, J. E. O. (2003). Weitzman's Approach and Conservation of Breed Diversity: an Application to African Cattle Breeds. *Conservation Biology*, 17(5), 1299-1311.
- Rischkowsky, B., & Pilling, D. (eds.) (2007). *The State of the World's Animal Genetic Resources for Food and Agriculture*. Rome: Food and Agriculture Organization of the United Nations (FAO).
- Rogerson, A. (1963). Energy utilization of poor-quality roughage by water-deprived steers. *Nature*, 197, 1222.
- Ronga, D., Dal Prà, A., Immovilli, A., Ruoizzi, F., Davolio, R., & Pacchioli, M. T. (2020). Effects of Harvest Time on the Yield and Quality of Winter Wheat Hay Produced in Northern Italy. *Agronomy*, 10 (917). <https://doi.org/10.3390/agronomy10060917>

- Scherf, B. D., & Pilling, D. (eds.) (2015). *The Second Report on the State of the World's Animal Genetic Resources for Food and Agriculture*. Rome: Commission on Genetic Resources for Food and Agriculture Assessments, Food and Agriculture Organization of the United Nations (FAO).
- Scherr, S. J., & McNeely, J. A. (2007). *Farming with Nature. The Science and Practice of Ecoagriculture*. Washington, Covelo, London: Island Press.
- Scialdone, A., & Howard, M. (2015). How plants manage food reserves at night: quantitative models and open questions. *Frontiers in Plant Science*, 6 (204). <https://doi.org/10.3389/fpls.2015.00204>.
- Sharifian, A., Gantuya, B., Wario, H. T. Kotowski, M. A., Barani, H., Manzano, P., Krätli, S., Babai, D., Biró, M., Sáfián, L., Erdenetsogt, J., Qabel, Q. M., & Molnár, Z. (2022). Global principles in local traditional knowledge: a review of forage plant-livestock-herder interactions. *Journal of Environmental Management*, 328 (2023), 116966.
- Shiva, V., Scialabba, N. El Hage, Ceccarelli, S., Masucci, M., Hohenstein, K., Hertoge, K., Cabaleiro, F., Oliveira de Souza, M.M., Pacheco Rodriguez, F., Alvarez Mora, M., Basse, N., Anilkumar, P., Raj Singh, N., Ackerman-Leist, P., Jacob, M., & Latham, J. (2019). *The Future of Food. Farming with Nature, Cultivating the Future*. Rome: Navdanya International.
- UN (1992). *Convention on biological diversity (with annexes). Concluded at Rio de Janeiro on 5 June 1992*. Rio De Janeiro, Brasil: United Nations.
- UNEP (2021). *Making Peace with Nature: A scientific blueprint to tackle the climate, biodiversity and pollution emergencies*. Nairobi: United Nations Environment Programme (UNEP).
- Waiblinger, S., Boivin, X., Pedersen, V., Tosi, M. V., Janczak, A. M., Visser, E. K., & Jones, R. B. (2006). Assessing the human–animal relationship in farmed species: A critical review. *Applied Animal Behaviour Science*, 101 (3-4), 185-242.

Author's Declarations and Essential Ethical Compliances

Author's Contributions (in accordance with ICMJE criteria for authorship)

This article is 100% contributed by the sole author. He conceived and designed the research or analysis, collected the data, contributed to data analysis & interpretation, wrote the article, performed critical revision of the article/paper, edited the article, and supervised and administered the field work.

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Research involving human bodies or organs or tissues (Helsinki Declaration)

The author(s) solemnly declare(s) that this research has not involved any human subject (body or organs) for experimentation. It was not a clinical research. The contexts of human population/participation were only indirectly covered through literature review. Therefore, an Ethical Clearance (from a Committee or Authority) or ethical obligation of Helsinki Declaration does not apply in cases of this study or written work.

Research involving animals (ARRIVE Checklist)

The author(s) solemnly declare(s) that this research has not involved any animal subject (body or organs) for experimentation. The research was not based on laboratory experiment involving any kind of animal. Some contexts of animals are also indirectly covered through literature review. Therefore, an Ethical Clearance (from a Committee or Authority) does not apply in cases of this study or written work. It is because I believe it is also not necessary as I did not 'conduct research on animals', but simply the livestock breeding system of a particular community of pastoralists. As clearly mentioned in the description of methodology, no animal was touched or directly affected by my research in anyway. I asked questions to herders, and that's all. Yet, I have filled in ARRIVE Checklist and been appending it.

Research on Indigenous Peoples and/or Traditional Knowledge

The author(s) solemnly declare(s) that this research has not involved Indigenous Peoples as participants or respondents, with the documentation of their Indigenous Knowledge. Some other contexts of Indigenous Peoples or Indigenous Knowledge are only indirectly covered through literature review. An Ethical Clearance 'to conduct research on indigenous peoples' Indigenous knowledge is also not relevant, because Wodaabe people are not registered or recognised as an 'Indigenous People' in Niger, in Africa, or by the UN. Therefore, an Ethical Clearance (from a Committee or Authority) or prior informed consent (PIC) of the respondents or Self-Declaration in this regard does not apply in cases of this study or written work.

Research involving Plants

The author(s) solemnly declare(s) that this research has not involved the plants for experiment or field studies. The contexts of plants were only indirectly covered through literature review. Thus, during this research the author(s) obeyed the principles of the Convention on Biological Diversity and the Convention on the Trade in Endangered Species of Wild Fauna and Flora.

(Optional) Research Involving Local Community Participants (Non-Indigenous)

The author(s) solemnly declare(s) that this research has involved local community participants or respondents belonging to non-Indigenous peoples. Yet, this study did not involve any child in any form directly. The contexts of different humans, people, populations, men/women/children and ethnic people are also indirectly covered

through literature review. Besides, my research focussed on herders' perception and practices, without resulting in any information of value for marketing purposes (e.g., I did not collect or even investigated animal genetic material). Therefore, an Ethical Clearance (from a Committee or Authority) or prior informed consent (PIC) of the respondents or Self-Declaration in this regard does not apply in cases of this study or written work. A permit issued by Niger for conducting field/social research was obtained.

(Optional) PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses)

The author(s) has/have NOT complied with PRISMA standards. It is not relevant in case of this study or written work.

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To see original copy of these declarations signed by Corresponding/First Author (on behalf of other co-authors too), please download associated zip folder [Ethical Declarations] from the published Abstract page accessible through and linked with the DOI: <https://doi.org/10.33002/pp0101>



The ARRIVE guidelines 2.0: author checklist

The ARRIVE Essential 10

These items are the basic minimum to include in a manuscript. Without this information, readers and reviewers cannot assess the reliability of the findings.

Item	Recommendation	Section/line number, or reason for not reporting
Study design	1 For each experiment, provide brief details of study design including: <ol style="list-style-type: none"> The groups being compared, including control groups. If no control group has been used, the rationale should be stated. The experimental unit (e.g. a single animal, litter, or cage of animals). 	not relevant
Sample size	2 <ol style="list-style-type: none"> Specify the exact number of experimental units allocated to each group, and the total number in each experiment. Also indicate the total number of animals used. Explain how the sample size was decided. Provide details of any <i>a priori</i> sample size calculation, if done. 	2, p2, line 16
Inclusion and exclusion criteria	3 <ol style="list-style-type: none"> Describe any criteria used for including and excluding animals (or experimental units) during the experiment, and data points during the analysis. Specify if these criteria were established <i>a priori</i>. If no criteria were set, state this explicitly. For each experimental group, report any animals, experimental units or data points not included in the analysis and explain why. If there were no exclusions, state so. For each analysis, report the exact value of <i>n</i> in each experimental group. 	2, p2, lines
Randomisation	4 <ol style="list-style-type: none"> State whether randomisation was used to allocate experimental units to control and treatment groups. If done, provide the method used to generate the randomisation sequence. Describe the strategy used to minimise potential confounders such as the order of treatments and measurements, or animal/cage location. If confounders were not controlled, state this explicitly. 	not relevant
Blinding	5 Describe who was aware of the group allocation at the different stages of the experiment (during the allocation, the conduct of the experiment, the outcome assessment, and the data analysis).	not relevant
Outcome measures	6 <ol style="list-style-type: none"> Clearly define all outcome measures assessed (e.g. cell death, molecular markers, or behavioural changes). For hypothesis-testing studies, specify the primary outcome measure, i.e. the outcome measure that was used to determine the sample size. 	not relevant
Statistical methods	7 <ol style="list-style-type: none"> Provide details of the statistical methods used for each analysis, including software used. Describe any methods used to assess whether the data met the assumptions of the statistical approach, and what was done if the assumptions were not met. 	not relevant
Experimental animals	8 <ol style="list-style-type: none"> Provide species-appropriate details of the animals used, including species, strain and substrain, sex, age or developmental stage, and, if relevant, weight. Provide further relevant information on the provenance of animals, health/immune status, genetic modification status, genotype, and any previous procedures. 	not relevant
Experimental procedures	9 For each experimental group, including controls, describe the procedures in enough detail to allow others to replicate them, including: <ol style="list-style-type: none"> What was done, how it was done and what was used. When and how often. Where (including detail of any acclimatisation periods). Why (provide rationale for procedures). 	section 2
Results	10 For each experiment conducted, including independent replications, report: <ol style="list-style-type: none"> Summary/descriptive statistics for each experimental group, with a measure of variability where applicable (e.g. mean and SD, or median and range). If applicable, the effect size with a confidence interval. 	not relevant

Livelihood Transformation among the Borana Pastoralists of Dhas District, Southern Ethiopia

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Abstract

This study intends to examine the triggers of livelihoods transformation among the Borana pastoralists of Dhas district in Borana zone, southern Ethiopia. The Participatory Rural Appraisal (PRA) tools, such as key informant interviews and focused group discussions, were used to explore the perceptions of local communities on the causes of livelihood transformation and its impact on the well-being of pastoralists and their overall survival. Purposive sampling was used to administer key informant interviews and FGDs. The findings of this study indicate that the foremost causes of livelihoods transformation in Dhas district include frequent drought and environmental degradation, pastoralists' sedentarisation policies and conflict over boundary and grazing lands. Previously, pastoralism livelihood system was the most viable strategy in the study area providing sustainable livestock products, while, at the same time, protecting water and rangeland resources and safeguarding environment warrant the Borana pastoralist's well-being. However, with the changing livelihood dynamics, the Borana's pastoral system underwent major upheavals, enfeebling the pragmatism of these practices. Therefore, this study concludes that a comprehensive development strategy for supporting pastoral livelihood becomes the need of the hour to guide the efforts of all relevant stakeholders operating in pastoral areas.

Keywords

Livelihood; Diversification; Drought; Borana pastoralists

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Arushi Malhotra



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1. Introduction

Livelihood diversification among pastoralists in eastern Africa has been common for the past 50 or more years, but has been especially prominent since the regional droughts of 1979-80 and 1984 (Little, 2016). All aspects of pastoral social and economic

life are ordered in relation to livestock and the environment in which they live (Mkutu, n.d.: 11). In pastoralist societies, livestock hold central value and are the basis of association in a complex of social, political and economic institutions. Pastoralist livelihood is practiced predominantly in toughest environments, where resources like grassland and water are erratically available (Alemayehu & Hizekeal, 2022), and usually cannot support other economic activities. In the words of Mkutu (n.d.: 11):

“Some 500-600 million people live in the arid and semi-arid parts of the world, some 30-40 million of them depend entirely on animals. Of these 30-40 million people, 50-60 percent people are found in Africa. The Horn of Africa contains the largest grouping of pastoralists in the world: Sudan has the highest pastoralist percentage globally, while Somalia and Ethiopia rank third and fifth, respectively. In Djibouti, one third of the population is pastoralist. The semi-arid and arid areas in the Horn make up 70 percent of the total land area, which provides an average of 20 to 30 percent of GDP.”

However, pastoralism as a livelihood system is under jeopardy. According to Watson (2006) and Little (2016), the main drivers and threats for pastoralist's livelihoods system were perennial drought, irrelevant resource management policies, frequent conflict, and disputes with neighboring ethnic communities over grazing rights.

Despite the fact that most pastoralists in east Africa still have their flocks and herds of livestock, others have lost all their animals during severe drought and have been unable to re-stock (Little, 2016). In addition, Little (2016) and Avis (2018) argue that conflict has encouraged the securitization of many border areas, alongside the commercialization and appropriation of pastoralists' land by certain vested interests, “resulting in the loss [and] fragmentation of rangelands induced sedentarisation of pastoralists, and a radical reduction in livestock numbers” (Galaty, 2013: 152). The outcome has been an increasing trend of diversification through experimentation with a range of non-pastoral livelihood options to adopt sedentary lifestyles (Avis, 2018; Watson, 2006).

The Borana pastoralists are forced into livelihood diversification due to severe drought and frequent conflicts, alienation of rainy season in ephemeral areas, and the environmental degradations that ensued owing to reduction in rangeland assets. Previously, research and development interventions have been proposed and implemented without adequate knowledge about the pastoralist's livelihood vulnerability to various drivers. The objectives of this study are to assess the causes of livelihood transformation, and to explore the vulnerability of pastoralists' livelihoods and contexts in which they currently function.

2. Methodology

2.1 The Study Area

The study was conducted in Dhas district of Borana zone, southern Ethiopia between November and December of 2021. Dhas district has 7 Pastoralist Associations¹ (PAs) namely: *Borbor*, *Tesso-kalo*, *Gayo*, *Mata-arba*, *Raro*, *Dhaas* and *Gorille* (Alemayehu & Doda, 2020). To be able to collect adequate information of the study area, three PAs were purposively selected for primary data collection i.e., Borbor, Dhaas and Gayo. In these three PAs, the Borana pastoralist's livelihoods have been transforming at an alarming rate as a significant number of pastoralists have evolved to diversify their livelihoods due to various push factors.

¹ Pastoralist Association is the smallest administration division beneath district.

Dhas district is semi-arid district located in eastern Borana zone. The vast majority of the district is unfit for agriculture and most of its population customarily practiced pastoralism. It's just recent that many households have begun to involve in small scale irrigation and other means of livelihoods. Dhas district share borders with Wachille, Miyo, Dire and Dubluk, Guchi district and Somali regional state of Ethiopia in the north, west, southwest, southeast and east, respectively (see Figure 1). Dhas district is the home to pastoral people rearing cattle, goats, sheep and camels. According to Dhas District Pastoralists Development Office (DDPDO, 2019 cited in Alemayehu & Doda, 2020: 112), land use description is revealed as follows: rangeland accounts for 47.3%, bush land 44.37% and bare land 8.33%.

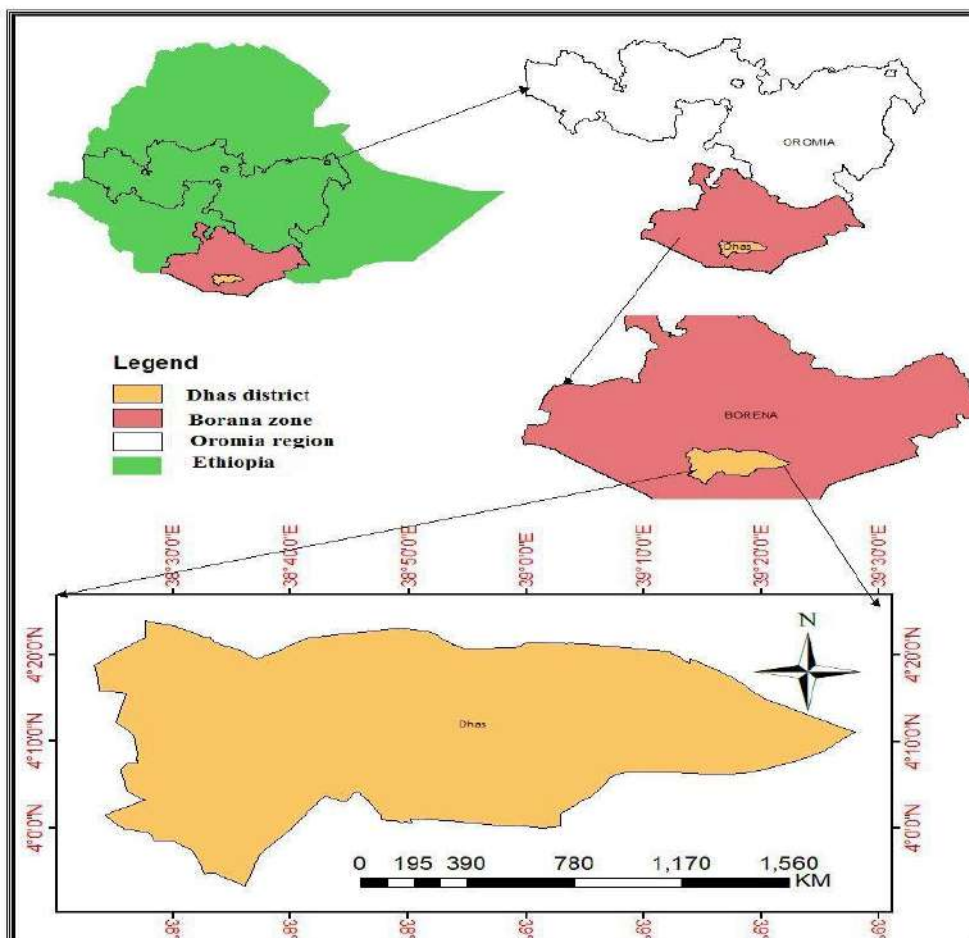


Figure 1: Map of study area [Source: Dhas District Disaster and Risk Prevention, 2021]

2.2 Data Collection

PRA was employed to gather the data. Tools like Key Informant Interviews (KII) and Focus Group Discussions (FGDs) were utilized to explore the perceptions of local communities on the causes of livelihood transformation and its impacts on the subsistence. The PRA tools comprised semi-structured questions that allowed open and flexible exchange of ideas between researcher and informants. Moreover, purposive sampling was used for administering KIIs and the FGDs. A total of 18 key informants were interviewed: three government officials (from administration and security office; Pastoralist and Irrigation Development Office and Disaster and Risk Prevention Office) and 15 from local communities (10 male and 5 female). Moreover, 3 FGDs, having 8 participants in each session, were conducted to attain group's views. Of three FGDs, 1 was conducted with women in Dhaas PA, while two FGDs were conducted with male participants, one in each of the remaining PAs.

2.3 Data Analysis

The data collected from KIIs and FGDs were categorized and interpreted in relation to the research objectives. The collected qualitative data was thematically analysed. Thematic analysis is a method of data analysis utilized for categorizing, investigating and reporting themes within the data to develop categories and sub-themes. These themes encompass the causes of livelihood transformation, the vulnerability of pastoralists' livelihoods and the contexts in which they currently function.

3. Results and Discussion

Results indicate that the following are the main drivers for the Borana pastoralist's livelihood transformation in Dhas district:

3.1 Frequent Drought and Environmental Degradation

The southern lowland of Ethiopia is characterized by recurrent droughts with high livestock mortality that often resulted in frightening the practicality of pastoral livelihood. In Dhas district of Borana zone, frequent drought and unceasing environmental degradation highly bothered the sustainability of Borana pastoralist's livelihood more than any drivers of livelihood transformations. Massive livestock death due to drought, particularly in the last 15 years, has badly affected the livelihoods of the communities and the overall food security in the Dhas district. Dhas district was one of the most affected areas in Ethiopia by the 2011 drought. According to FAO (2014), the total death rate was as much as 60%, 40%, and 25-30% for cattle, sheep and goats, respectively. Likewise, the recent droughts between 2021 and 2022 have provoked catastrophic impacts on the livelihoods of entire Borana communities.



Figure 2: Showing the skeleton of dead cattle in Borbor PA during the 2021-2022 droughts [*Source: Dhas District Disaster and Risk Prevention Office, 2021*]

According to Dhas District Pastoralist and Irrigation Development Office, "approximately 90% pastoralists in Dhas district lost their livestock possessions [the main sources of their subsistence] due to the delay in seasonal rainfalls for two consecutive years [four rainy seasons]. For that reason, the government distributed plot of lands around the traditional deep wells of Borbor, Gorille and Dhas PAs to destitute pastoralists and trained them to establish small scale irrigation at the

expenses of drought prone pastoralism to diversify their livelihoods. Accordingly, prolific results in Borbor and Dhas PAs have been witnessed and the communities started to sell their fruits and vegetable products they produced through irrigation in the proximate districts of Moyale and Wachille.”

The Borana pastoralists were pretty skillful to deal with drought impacts as they were customarily capable to migrate to new productive grassland areas. However, in the past three decades, recurrent drought resulted in precarious environmental degradation and livestock fatalities owing to drought cycles condensation from 10-12 years to 3-4 years (Alemayehu & Doda, 2020; interview with key informants, 2021, Borbor).



Figure 3: Destitute pastoralists settled at *Dhati* camp in Raro PAs [Source: Dhas District Disaster and Risk Prevention Office, 2021]

Nori (2021) corroborated that changes in climatic patterns and environmental uncertainties have accelerated the lengthy droughts that hit the Borana lowland as from the 1970s. In addition to frequent drought and environmental degradation, the partial seizures of Mata-wayama rangeland unit in Dhas district by Garri Somali has deteriorated the customary natural resources management of Borana pastoralists to cope with the impacts of drought through cattle mobility, and, thus, confining them to very limited areas. Overall, environmental dilapidation has prompted significant transformations and reconfiguration in customary environmental management and livelihood patterns. Subsequently, livestock possessions have condensed and, thus, the survival necessities for a large percentage of the Borana pastoralists have diminished. Frequent drought and environmental degradation, predominantly with reference to the enduring reduction and loss of edible grass cover, was repeatedly signposted by informants as a major cause behind livelihood transformation in Dhas district. A key informant unveiled that:

“The Borana pastoralists in Borbor town and surrounding PAs were progressively banked on charcoal selling as a perennial income generating activity, rather than merely during periods of drought torment, as they did in past. The persistent charcoal production was causative factors to the unceasing land degradation besides the drought and invasion of non-palatable bushes on the rangelands at the expense of edible grassland was also an indicator of land degradation with gradually impetus changes in livelihood pattern.”

The Borana pastoralists opted to rely on already wrinkled environments that have been degraded over numerous years and facing increasing pressures from unstable weather patterns. They resort to deleterious coping strategies, such as the collection

and sale of fuel wood and charcoal that undermines long term sustainable livelihoods and natural resources. Overall, frequent drought and environmental degradation dynamics have considerably thwarted the livelihood system of Borana pastoralists. Hence, the climatic inconsistency in Borana Zone and Dhas district in particular has triggered immense challenges for pastoral livelihood system. These signposts that the Borana pastoralist's livelihoods are exceedingly knotted with water and rangeland resources and tenacity in climate change triggers obliteration of natural resources, severe stress on livelihood sectors and an income loss that affects the basic foundation of their pastoral livelihood.

3.2 Pastoralist Sedentarisation Policies

The tenure regime of the natural resources in Ethiopian lowlands experienced deep changes since the end of 19th century and were triggered by a number of factors (Helland, 2006: 29). In formal terms, the legal status of pastoral land is comparable to that of farmland, and the rights of Ethiopia's pastoralists are little different from those of its farmers (Peter et al., 2010). Even if the pastoralist livelihood systems do not correspond with the sedentary lifestyle; they have permanently found themselves at the sympathy of agrarian development policies.

In Dhas district, government-initiated pastoralist development policies have factually marginalized the communal land tenure customs that depict pastoral livelihoods system. To vitalize their sedentarisation strategies, government has implemented development projects that restrict livestock mobility and promote sedentarisation and mixed agro-pastoral system i.e., crop and livestock production as a replacement for pastoralism. According to key informants and FGD participants' elucidations, government rhetoric in the implementation of sedentarisation policy is diligently concomitant to the accessibility of basic infrastructures such as school, water, veterinary post and health station. However, the process by which this is being done is not complementary with pastoralist's means of survival. Abbink et al. (2014) stipulated that the permanent settlement of pastoralists is seen by government as the solution for the perceived problems of water and pasture scarcity in semi-arid areas ill-suited to rain-fed agriculture, despite the often adequate adaptation pattern of pastoralist's vis-à-vis their volatile environment.

In Dhas district, sedentarisation of Borana pastoralists has resulted in overexploitation of rangeland and water resources around the pre-urban settlements of Gayo, Dhaas and Borbor PAs. In the aforementioned pre-urban settlements, a number of basic infrastructures were built by the government and non-governmental organizations (at the request of government) to inspire sedentarisation programs. These changes are anticipated to further encourage the sedentarisation and to reduce significantly the number of livestock being raised by the Borana pastoralists (Degen, 2011). Alemayehu & Doda (2020: 117-118) noted that "the Borana pastoralists have a customary settlement rule (*dongora sera*) that restrict to encamp in dry and wet season grazing reserves. This customary practice is commonly used by the Borana pastoralists to save pasture for the dire time, to broaden grazing land scope, as well as to hinder inflowing of human settlement into the adjoining dry and rainy season grazing land areas."

However, contrary to the customary settlement rule of Borana pastoralists, human settlements and the expansion of basic infrastructures by government in formerly restricted grazing reserves have generated tragic trends for the sustainability of Borana pastoralists' livelihood system. These unfitting sedentarisation policies have restricted pastoral mobility between the wet and dry grazing lands and watering sites, which is the paramount response and adaptation strategy within the dry-land milieu. Hence, this study argues that the classical paradigm for pastoral development in Ethiopia based on sedentarisation is ineffective. A new paradigm based on mobility

of livestock, communal property management and all-embracing production systems are thus vital to sustain the pastoralists' livelihood.

3.3 Conflict over Boundary and Grazing Lands

Even though sporadic conflicts between the Borana and neighbouring pastoralist communities have been part of the history of inter-community relations in the past, the frequency and severity of inter-community conflicts has increased in recent years (Solomon, 2006; Odhiambo, 2012). The politics of ethnicity-based federalism has generated permanent and inflexible boundaries between different ethnic groups and has contributed to limiting the massive lands that pastoralists used to cross in search of pastures and water resources for their livestock. Abdulahi (2005) recounted that Borana and Garri resided in one administrative region in the pre-federal Ethiopia and lived in peace for many years; nevertheless they experienced sporadic conflicts over the access to resources. In their long-lasting relationship, they developed a common approach to shared resources, culture and governance systems (Abdulahi, 2005: 7). However, the introduction of such uncompromising restrictions has ascended perpetual tensions among various ethnic groups. In addition, the regional state boundary demarcations established in 1991 has also augmented disputes between the Borana and Garri people. According to Temesgen (2010), the two rival communities are in discrepancy over the south eastern border of Oromia region (which is also the border of Borana lowlands and the adjacent Somali region).

As of 1991, conflict over boundary has exposed the mobility of Borana pastoralists' livestock to severe pressures. Consistently, Odhiambo (2012) and Pavanello & Levine (2011) reported that the implementation of ethnicity-based federalism has disrupted nomadic grazing movement patterns and restricted the Borana pastoralist coping strategies against adversity and drought, thereby, increased their exposure to shocks. Due to periodic conflicts in 2019-2020 between Borana and Garri Somali, rainy season grazing areas in Mata-arba and Rarro PAs and other vital rangeland transitory areas and water points were abandoned. This has exaggerated the scarcity of pasture and water as well as overgrazing in other PAs of Dhas district. In addition, numerous families have been displaced and exposed to starvation. Thus, the flow of displaced people and livestock have contributed to the obliteration of the hitherto insubstantial natural resources.

For centuries, pastoralists have ignored national borders and have engaged in activities, such as transhumance, related to their livelihoods being characterized by high levels of trans-border mobility. The rights of ethnic groups to self-administration, as enshrined in the 1994 Ethiopian Constitution, have provoked a contest towards control over land, as territorial gains at the PA, district as well as regional levels transform into more administrative power, land and potentially food relief. This means that pastoralist rangeland and water utilization system is no longer capable to respond to the environmental and climate variability triggering environmental degradation.

In sum, the conflict between the two groups has not only led to the death of many Borana and Garri, but it has also intimidated the livelihood security of the Borana pastoralists as multiple seasonal grazing areas such as *boji*, *dhaka-wata*, *cari-ilu*, *dida har-heddu*, *tuma*, *udet* and *kojjiya*, have been acquired by the Garri (demarcated within Somali region).

4. Conclusion

In conclusion, push factors such as frequent drought, conflict, sedentarisation policies and environmental degradation were found to be the major threats to the sustainable practice of pastoralism in Dhas district. Paradoxically, there also existed a general consensus that pastoralism remains the most viable livelihood and production

system for the toughest environmental conditions. Yet, it is transforming and adapting to the severe drought and environmental stress resulting in declining pastoral practices. To conclude, we propose that there is a necessity for more deepened and sympathetic understanding of the drivers causing pastoralists' livelihood transformation in order to design supportive strategies that address their concerns.

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6. References

- Abbink, J., Kelly, A. Dereje, D., Elliot, F., Echi, G., John, G., Shauna, L., Jean, L., Hussein, A., John, M., Günther, S., Ivo, S., & David, T. (2014). Lands of the Future: transforming pastoral lands and livelihoods in eastern Africa. Working paper no. 154.
- Abdulahi, M. (2005). The changing nature of pastoral conflicts in south-eastern Ethiopia: The case of the Borana and Dogodi pastoralists. Africa Peace Forum. Retrieved from <https://www.files.ethz.ch/isn/124861/Changing%20nature%20of%20pastoralist%20conflicts%20in%20SE%20Ethiopia.pdf> [accessed on 23 January 2023]
- Abdulahi, M. (2007). The Legal Status of the Communal Land Holding System in Ethiopia: The Case of Pastoral Communities. *International Journal on Minority and Group Rights*, 14 (1), 85-125.
- Alemayehu, D., & Doda, Z. (2020). Indigenous Environmental Knowledge of Borana Pastoralists. *Grassroots Journal of Natural Resources*, 3 (4), 110-131. <https://doi.org/10.33002/nr2581.6853.03047>
- Alemayehu, D., & Hizekeal, Y. (2022). The Relevance and Practices of Indigenous Weather Forecasting Knowledge among the Gabra Pastoralists of Southern Ethiopia. *Journal of Agriculture and Environment for International Development*, 116 (1), 59-76 <https://doi.org/10.36253/jaeid-12295>
- Avis, W. (2018). Rebuilding pastoralist livelihoods during and after conflict. K4D Helpdesk Report 421. Brighton, UK: Institute of Development Studies. Retrieved from <https://opendocs.ids.ac.uk/opendocs/handle/20.500.12413/14259> [accessed on 23 January 2023]
- Dhas District Pastoralist Development Office (2019). Unpublished annual Report. Dhas, Ethiopia.
- Degen, A. A. (2011). Transformation of Borana from nomadic pastoralists to agropastoralists and shift of livestock from cattle to include more goats, camels and sheep in Southern Ethiopia. *International Journal of Business and Globalisation*, 6 (3-4), 292-312. <https://doi.org/10.1504/IJBG.2011.039389>
- FAO (2014). Pastoralism in Africa's dry lands. Food and Agriculture Organization of the United Nations (FAO), Rome. 52 pp.
- Galaty, J. (2013). The Collapsing Platform for Pastoralism: Land Sales and Land Loss in Kajiado County, Kenya. *Nomadic Peoples*, 17 (2). Retrieved from <http://www.ingentaconnect.com/content/whp/nomp/2013/00000017/00000002/art00004> [accessed on 23 January 2023]
- Helland, J. (2006). Pastoral Land Tenure in Ethiopia. Colloque international 'Les frontières de la question foncière — At the frontier of land issues'. IRD, Montpellier. Retrieved from <https://www.mpl.ird.fr/colloquefoncier/Communications/PDF/Helland.pdf> [accessed on 23 January 2023]

- Little, P. D. (ed.) (2016). Resilience and risk in pastoralist areas: Recent trends in diversified and alternative livelihoods. USAID/East Africa Resilience Learning Project, Nairobi. Retrieved from: http://www.agri-learning-ethiopia.org/wp-content/uploads/2016/07/TUFTS_1610_Risk_Pastoralist_V3_online1-2.pdf [accessed on 23 January 2023]
- Mkutu, K. (n.d.). Pastoralist Conflict, Governance and Small Arms in North Rift, North East Africa. Bradford University, UK. Retrieved from <https://core.ac.uk/download/pdf/46810305.pdf> [accessed on 23 January 2023]
- Nori, M. (2021). The evolving interface between pastoralism and uncertainty: reflecting on cases from three continents. Robert Schuman Centre for Advanced Studies Global Governance Programme-435. Working Paper RSC 2021/16, European University Institute (EUI), Florence, Italy.
- Odhiambo, M. (2012). Impact of Conflict on Pastoral Communities' Resilience in the Horn of Africa: Case Studies from Ethiopia, Kenya and Uganda. FAO RECONCILE, Rome, Italy.
- Pavanello, S. (2009). Pastoralists' Vulnerability in the Horn of Africa: Exploring Political Marginalization, Donors' Policies, and Cross-Border Issues. Humanitarian Policy Group (HPG), Overseas Development Institute, London, UK.
- Pavanello, S., & Levine, S. (2011). Natural resources management in Kenya-Ethiopia border areas. Working Paper, Humanitarian Policy Group (HPG), Overseas Development Institute, London, United Kingdom.
- Peter, L., Roy, B., John, M., & Getachew, G. (2010). Future Scenarios for Pastoral Development in Ethiopia, 2010-2025. Report Number 2 Pastoral Economic Growths and Development Policy Assessment, Ethiopia. Retrieved from <https://jomcpeak.expressions.syr.edu/wp-content/uploads/Rpt2ScenariosPastoralDevelopFINALNov-2010vers9.pdf> [accessed on 23 January 2023]
- Solomon, D. (2006). Pastoralism and Development in Ethiopia. Ethiopian Economic Association, the Vision 2020 Forum.
- Temesgen, A. K. (2010). Climate change to conflict. Lessons from Southern Ethiopia and Northern Kenya. Fafo Report, 9.
- Watson, D. (2006). Life beyond pastoralism: Livelihood diversification opportunities for pastoralists in Turkana District, Kenya. International Livestock Research Institute, Nairobi, Kenya. Retrieved from <https://hdl.handle.net/10568/580> [accessed on 23 January 2023]
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Author's Declarations and Essential Ethical Compliances

Author's Contributions (in accordance with ICMJE criteria for authorship)

<i>Contribution</i>	<i>Author 1</i>	<i>Author 2</i>	<i>Author 3</i>	<i>Author 4</i>
Conceived and designed the research or analysis	Yes	Yes	No	No
Collected the data	Yes	No	No	No
Contributed to data analysis & interpretation	Yes	Yes	Yes	Yes
Wrote the article/paper	Yes	No	No	No
Critical revision of the article/paper	Yes	Yes	Yes	Yes
Editing of the article/paper	Yes	Yes	Yes	Yes
Supervision	No	Yes	No	No
Project Administration	Yes	Yes	No	No
Funding Acquisition	No	No	No	No
Overall Contribution Proportion (%)	40	30	20	10

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Research involving human bodies or organs or tissues (Helsinki Declaration)

The author(s) solemnly declare(s) that this research has not involved any human subject (body or organs) for experimentation. It was not a clinical research. The contexts of human population/participation were only indirectly covered through literature review. Therefore, an Ethical Clearance (from a Committee or Authority) or ethical obligation of Helsinki Declaration does not apply in cases of this study or written work.

Research involving animals (ARRIVE Checklist)

The author(s) solemnly declare(s) that this research has not involved any animal subject (body or organs) for experimentation. The research was not based on laboratory experiment involving any kind animal. Some contexts of animals are also indirectly covered through literature review. Therefore, an Ethical Clearance (from a Committee or Authority) or ethical obligation of ARRIVE does not apply in cases of this study or written work.

Research on Indigenous Peoples and/or Traditional Knowledge

The author(s) solemnly declare(s) that this research has involved Indigenous Peoples as participants or respondents, with the documentation of their Indigenous Knowledge. Some other contexts of Indigenous Peoples or Indigenous Knowledge are indirectly covered through literature review. Therefore, a Self-Declaration in this regard is filed by the researcher and first author to support this study or written work.

Research involving Plants

The author(s) solemnly declare(s) that this research has not involved the plants for experiment or field studies. The contexts of plants were only indirectly covered through literature review. Thus, during this research the author(s) obeyed the principles of the Convention on Biological Diversity and the Convention on the Trade in Endangered Species of Wild Fauna and Flora.

(Optional) Research Involving Local Community Participants (Non-Indigenous)

The author(s) solemnly declare(s) that this research has involved local community participants or respondents belonging to non-Indigenous peoples. Yet, this study did not involve any child in any form directly or indirectly. The contexts of different humans, people, populations, men/women/children and ethnic people are also indirectly covered through literature review. Therefore, prior informed consent (PIC) of the respondents was taken under this study before the face-to-face interviews and interactions.

(Optional) PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses)

The author(s) has/have NOT complied with PRISMA standards. It is not relevant in case of this study or written work.

Competing Interests/Conflict of Interest

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To see original copy of these declarations signed by Corresponding/First Author (on behalf of other co-authors too), please download associated zip folder [Ethical Declarations] from the published Abstract page accessible through and linked with the DOI: <https://doi.org/10.33002/pp0102>

SELF-DECLARATION FORM

Research on Indigenous Peoples and/or Traditional Knowledge

1. Conditions of the Research

1.1 Was or will the research (be) conducted on (an) Indigenous land, including reserve, settlement, and land governed under a self-government rule/agreement or?

Yes/No

1.2 Did/does any of the criteria for participation include membership in an Indigenous community, group of communities, or organization, including urban Indigenous populations?

Yes/No

1.3 Did/does the research seek inputs from participants (members of the Indigenous community) regarding a community's cultural heritage, artifacts, traditional knowledge, biocultural or biological resources or unique characteristics/practices?

Yes/No

1.4 Did/will Aboriginal identity or membership in an Indigenous community used or be used as a variable for the purposes of analysis?

Yes/No

2. Community Engagement

2.1 If you answered "Yes" to questions 1.1, 1.2, 1.3 or 1.4, have you initiated or do you intend to initiate an engagement process with the Indigenous collective, community or communities for this study?

Yes/No

2.2 If you answered "Yes" to question 2.1, describe the process that you have followed or will follow with to community engagement. Include any documentation of consultations (*i.e., formal research agreement, letter of approval, PIC, email communications, etc.*) and the role or position of those consulted, including their names if appropriate:

⇒ During the progression of this project I have consulted the Borana pastoralist's customary leaders to attain authorization and to select proficient informants that would abetted me to attain comprehensive data/ information from the target communities.

3. No Community Consultation or Engagement

If you answered “No” to question 2.1, briefly describe why community engagement will not be sought and how you can conduct a study that respects Aboriginal/ Indigenous communities and participants in the absence of community engagement.

Not Applicable

⇒ Name of Principal Researcher: **Dejene Alemayehu**

⇒ Affiliation of Principal Researcher: Institute of Indigenous Studies, Dilla University, Dilla Ethiopia

Signature: *D Alemayehu*

Declaration: Submitting this note by email to any journal published by The Grassroots Institute is your confirmation that the information declared above is correct and devoid of any manipulation.

**INFORMATION AND CONSENT FORM FROM RESPONDENTS
(Non-Indigenous or Indigenous Respondents)**

This form was translated into local language for the respondents

**Title of the Research: Livelihood Transformation among the Borana
Pastoralists of Dhas District, Southern Ethiopia**

Principal Researcher: Dejene a Alemayehu
Dilla University, Dilla/Ethiopia

Research Supervisor: Yetebarek Hizekeal
Dilla University, Dilla/Ethiopia

A) INFORMATION TO PARTICIPANTS

1. Objectives of the research

The objectives of this study are to assess the causes of livelihood transformation, and to explore the vulnerability of pastoralists' livelihoods and contexts in which they currently function in Dhas district of Borana zone in southern Ethiopia

2. Participation in research

The researcher will ask you several pertinent questions. This interview will be recorded in written form and should last about 50-60 minutes. The location and timing of the interview will be determined by you, depending on your availability and convenience.

3. Risks and disadvantages

There is no particular risk involved in this project. You may, however, refuse to answer any question at any time or even terminate the interview.

4. Advantages and benefits

You will receive intangible benefits even if you refuse to answer some questions or decide to terminate the interview. You will also contribute to a better understanding of the causes for Borana pastoralists' livelihood transformation.

5. Confidentiality

Personal information you give us will be kept confidential. No information identifying you in any way will be published. In addition, each participant in the research will be assigned a code and only the researcher will know your identity.

6. Right of withdrawal

Your participation in this project is entirely voluntary and you can at any time withdraw from the research on simple verbal notice and without having to justify your decision, without consequence to you. If you decide to opt out of the research, please contact the researcher at the telephone number or email listed below. At your request, all information concerning you can also be destroyed. However, after the outbreak of the publishing process, it is impossible to destroy the analyses and results on the data collected.

B) CONSENT

Declaration of the participant

- ⇒ I understand that I can take some time to think before agreeing or not to participate in the research.
- ⇒ I can ask the research team questions and ask for satisfactory answers.
- ⇒ I understand that by participating in this research project, I do not relinquish any of my rights, including my right to terminate the interview at any time.
- ⇒ I have read this information and consent form and agree to participate in the research project.
- ⇒ I agree that the interviews be recorded in written form by the researcher: Yes () No ()

Signature of the participant : _____ Date : _____

Surname : _____ First name : _____

Researcher engagement

I explained to the participant the conditions for participation in the research project. I answered to the best of my knowledge the questions asked and I made sure of the participant's understanding. I, along with the research team, agree to abide by what was agreed to in this information and consent form.

Signature of the researcher : *D Alemayehu*

Date : 03-11-2022

Surname: Dejene

First name: Alemayehu

- ⇒ Should you have any questions regarding this study, or to withdraw from the research, please contact Mr. Yetebarek Hizekeal or by e-mail at yetebarek-h.zekareas@connect.polyu.hk
- ⇒ If you have any concerns about your rights or about the responsibilities of researchers concerning your participation in this project, you can contact the Director of Institute of Indigenous Studies by email at petrostesfatsion@gmail.com

Biocultural Diversity and Culture Animals in Mobile Pastoralism: Cattle-Culture of Pastoralists of Telangana State, India

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Abstract

The concepts of culture animals and biocultural diversity do exist since the time immemorial; however, they made inroads into scientific research relatively recently. Indigenous livestock breeding communities have a tradition of assigning social and cultural meaning to the livestock they breed. In this regard, an attempt is made to review the term 'biocultural diversity' and to define tentatively the term 'culture animals' with reference to the Indigenous Poda Thurpu cattle breed reared by pastoralists inhabiting the Telangana state of India. Indigenous livestock breeds, such as the Poda Thurpu cattle, represent the collective heritage of communities they are associated with, and cannot be conserved in isolation. Such breeds will survive only when the Indigenous knowledge and production systems, which they are a part of, would also survive.

Keywords

Culture animals; Biocultural diversity; Pastoralism; Poda Thurpu; Deccan Plateau; Banjara; Golla

1. Introduction

Biocultural diversity and the concept of culture animals have been around since the time immemorial, however, it made inroads into scientific research and discourse relatively recently. The term biocultural diversity is gaining significance in science, practice and policy. Maffi (2007) defines biocultural diversity as "the diversity of life in all its manifestations - biological, cultural, and linguistic - which are interrelated (and possibly coevolved) within a complex socio-ecological adaptive system." Further, Maffi (2012) elucidates that biocultural diversity can be understood as "the diversity of life is made up not only of the diversity of plants and animal species, habitats and ecosystems found on the planet, but also of the diversity of human cultures and languages."

With reference to the concept of 'culture animals', Kohler-Rollefson (2015) defines (animal cultures) as "Indigenous livestock breeding communities that have a tradition of livestock breeding and for whom their animals have social and cultural meaning. This is reflected in an identity based on the community's association with animals, and a myth of origin linking community to a particular breed or species. Animals represent social currency, and they are given as dowry or bride wealth. Animals are shared within the community, while exchange with outsiders is restricted."

With the above background, an attempt was made to refer to the term biocultural diversity, to propose and define tentatively the term 'culture animals'. Present findings of the study conducted on biocultural diversity of mobile pastoral communities of the Deccan Plateau region of India discuss Poda Thurpu cattle breed as the 'culture animal' of mobile pastoralist communities of Nagarkurnool district of the Telangana state of India.

2. Methodology

2.1 About the Study

A study on mobile pastoralism of the Deccan Plateau region was initiated by Sahjeevan-Center for Pastoralism based in the Indian state of Gujarat, in collaboration with the Watershed Support Services and Activity Network (WASSAN) and Revitalizing Rainfed Agriculture Network (RRAN), based in Telangana, India, during July-December 2018. The objective of the study was to develop new insights on the biocultural diversity of mobile pastoralism and explore the concept of culture animals with regards to the indigenous Poda Thurpu cattle breed reared by the traditional pastoralist communities of Telangana state.

2.2 About the Study Area

Nagarkurnool district was the study area, which is geographically located at 16.4833° N and 78.3333° E, at an elevation of 576 m in Telangana state of India (Government of Telangana, 2020). The Amrabad plateau of Nagarkurnool district was selected to conduct this study. It is one of the mandals (sub-division) in Nagarkurnool district of the once undivided Mahabubnagar district in Telangana state of the Deccan Plateau region of India. The topography of the area is highly undulating and hilly, covered in savannah type grasslands with tall grasses. The mandal has an area of 727 sq. miles, comprising 14 villages and a total population of 45,589 (Census of India, 2011).

2.3 Sampling and Data Collection

Following the ethnographic approach (Cresswell, 2013), this study was conducted in 7 villages of 2 mandals of Nagarkurnool district. A total of 50 resource persons belonging to the Indigenous pastoralist communities were recruited for collection of data. Resource persons have been selected by following purposive sampling technique (Cresswell, 2013) and prior oral consent of the respondents was taken by the authors before collecting the data. Primary data, predominantly qualitative in nature, was collected through personal interviews and focus group discussions (FGDs) with the resource persons. Data collected through personal interviews and FGDs was transcribed. Transcripts were carefully coded and inductive coding method (Leech & Onwuegbuzie, 2007) was adopted to initiate the coding process. Codes were generated by identifying 'shared beliefs' (i.e. words or terms mentioned by two or more participants/FGDs with reference to a particular context/thing), (Francis *et al.* 2010). Codes such as beliefs, traditional festivals involving cattle, importance of cattle in pastoralist weddings, and the relationship of pastoralists with wildlife have emerged naturally from the data itself. It helped in breaking the transcripts into

smaller chunks necessary for interpretation and writing the report (Fereday, Muir-Cochrane, 2006; Leech & Onwuegbuzie, 2007).

3. Results and Discussion

3.1. The Mobile Pastoralist Communities of the Study Area

There are three major traditional pastoralist communities found in the study are the sheep rearing Kuruma community (known also as Dangar in Maharashtra and Kuruba in Karnataka states), the cattle rearing Lambadi community (known also as Banjara) and the cattle and buffalo rearing Golla community (known also as Yadava), besides few other non-traditional pastoralist communities actively engaged in mobile pastoralism at a very small scale.

The Lambadi community of the study belongs to the sub-sect called Gora/Goramaati Banjara, they are categorized as a nomadic tribal community in the official categorization of tribes and other Indigenous communities of India. They are known to have migrated from the North Indian state of Rajasthan to the study area more than four centuries ago. The Golla (belongs to OBC¹) are the dominant traditional mobile pastoralist communities of the study area. Both the communities practice mobile pastoralism, and Lambadi communities usually travel further and longer than the Golla communities during their annual seasonal migration. In addition, few families of Maala (SC²) have been maintaining large herds of this cattle breed for generations (Siripurapu et al., 2020).

The local pastoralist communities rear a unique Indigenous cattle breed called as Poda Thurpu cattle breed (Siripurapu et al., 2019). From the oral narratives of the local communities, Poda Thurpu cattle breed is reared by the local communities for over 400 years now. Oral narratives suggest that both the Poda Thurpu cattle breed and the pastoralists have been around this area for over 400 years. And the documental evidence (cattle grazing permits issued by Nizams³ and forest department) suggests that cattle breed and the breeders have been here since 1836 (India Code, 2021).

About 101 households have been maintaining large herds (more than 100 cattle heads) and about 30 – 40 households have been maintaining less than 50 cattle heads of Poda cattle breed in the study area. The Poda Thurpu cattle breeders of the study area formed a group and registered into an association named “Amrabad Poda Lakshmi Govu Sangham” (APLGS) in 2018. There are about 101 members in the APLGS. Among the 101 members, the major communities are Lambadi (52%), Golla (23%), Maala (11%). Other communities include Chenchu (2%), Kuruva (4%), Maadiga (2%), Doodekula-Muslim (3%), Vaddera (2%) and Yerra-Golla (1%). The three major communities engaged in rearing of Poda Thurpu cattle breed in Nagarkurnool district are Lambadi/Banjara, Golla and Maala, (Siripurapu et al., 2020).

3.2. Biocultural Diversity of Poda Thurpu Cattle Breed

Poda Thurpu is a small-compact sized Indigenous cattle breed belonging to the draught power group of cattle breeds. Local communities identify the cattle breed as Poda edlu (locally the term Poda means spotted/speckles/blotches); the cattle usually has speckled/blotched coat (brown spots on white coat or white spots on brown). The cattle breed is commonly known as Thurpu edlu in the western parts of Mahbubnagar and Nagakurnool districts and western parts of Telangana. Farmers

¹ Other Backward Caste, as notified under Constitutional provisions and differently in different states.

² Scheduled Caste, as notified under Constitutional provisions and differently in different states.

³ https://en.wikipedia.org/wiki/Nizam_of_Hyderabad

who use bullocks of the breed for draught purposes call them as Thurpu (means East, in local language Telugu), because they are believed to have come from the eastern side of the state. There are an estimated 15076 (approx.) cattle heads of this cattle breed present in the native breeding tract (Siripurapu et al., 2019).

The Indigenous Gora/Goramaati Banjara community (Lambadi) of the study area rear cattle because their spiritual guru, Santh Sevalal Maharaj (believed to be the incarnation of Lord Shiva) who was also a cattle herder (Naik, 2009). He took care of his father's 7,000 cows and led the life of a cattle herder. Being his disciples, the Goramaati Banjaras also rear cattle and continue his legacy. Cattle occupy a very significant place in their traditions, culture and economy (Siripurapu et al., 2020). Malaya Ramavath, an elderly Goramaati Banjara (Lambadi) pastoralist says that "*those who serve the cow will attain nirvana and reach the heaven and those who serve the cattle would die a natural and peaceful death.*"

Similarly, Golla (also known as Yadava/Yaduvanshi) the other dominant traditional mobile pastoralist community of the study area rear cattle due to the belief that they belong to the same lineage into which Lord Krishna was born. The name Golla is derived from the Sanskrit word, 'Gopal', which means caretaker/protector of cows (Joshua Project, 2019; Yaadav, 2010). Cattle are extremely important for the community as it is a huge part of their culture and traditions. The animal is a part of every ceremony, ritual and festival of the Golla community.

Every year both the pastoralist communities celebrate their own traditional festivals during Diwali, which are especially observed to celebrate their intimate relationship with their cattle. The element of conservation is deeply embedded within their culture; perhaps, it was a combination of the culture, traditions and economy, in other words biocultural diversity that may have played an important role in the evolution and conservation of the Poda Thurpu cattle breed in the study area.

3.2.1. Traditional Festivals of Lambada Community involving Cattle

The two major traditional festivals of Lambadi community are *Aavula panduga* (cow festival celebrated during Diwali festival) and *Seetala panduga* (celebrated during Holi festival). *Aavula panduga* and *Seetala panduga* are celebrated during the month of October and March, respectively. During *Aavula panduga*, the entire village congregates at temples of the forest goddesses *Mantralamma* and *Peddamma*. Both the forest goddesses are worshipped, and traditional rituals are performed to appease them. The entire community cooks and feasts together at the site. *Aavula panduga* involves the procession of cattle of each pastoralist household. Usually, 9 – 16 cows are tied in a sequence to the sacred rope, locally known as *Avula tadulu / Damara tadulu* (rope made of neem⁴ fiber) and brought to the temple of the goddess *Mantralamma*. Local people believe that blessings of the goddess will double the number of strings (which means the number of cows will be doubled the next season).

Rice porridge cooked in cows' milk and curd are offered to satiate the goddess *Mantralamma*. The goddess is said to have born out of cows' milk and curd and the symbol of bounty of milk and curd; therefore, cow milk and curd are very sacred for the Lambadis'. Lambadis' of the study area abstain from eating non-vegetarian foods along with milk and curd because of the belief that the goddess *Mantralamma* lives in them.

The most powerful goddess of the Lambadi community of the study area is *Peddamma* (symbolically represented as the Tiger). She is offered lambs and chicken to protect the cattle herders as well as the cattle herders from predators and other

⁴ *Azadirachta indica*

wildlife during their stay inside the forest. Although *Lambadis'* of the study area seldom milch the cattle; however, cows with only female calves are milked during Diwali festival, and the milk is used for cooking rice porridge and make curd. Perhaps this is the only festival of Lambadi's where rice porridge is cooked in cow's milk and consumed along with non-vegetarian dishes.

Another major traditional festival of the Lambadis' is *Seetala panduga*, which is celebrated during Holi festival. Like any other traditional festival, it also involves sacrifice of lambs and chicken and offering of rice porridge cooked of cow milk to the goddesses. During the festival, *Jaju* (red colour) is applied to horns of the cattle and the owner of the cattle herd brings seven bones, known as *Kamani* and women of his family bring punnets/pots of *Molakalu* (nine day old wheat seedlings) to the ritual site. *Kamani* ritual is performed by men (considered masculine) and *Molakalu* ritual is performed by women (considered feminine). A large pit is dug in the ground (at least ten feet away from the goddess) and filled with cooked *Bobbarlu* (horse gram), beans, feathers and innards of the chicken and lambs sacrificed during the festival. After filling the pit, cattle herds are made to pass by the pit. Either one or two people toss the rice porridge at the passing shepherds, which the shepherds catch and eat as they move on. Cooked *Bobbarlu* (horse gram), feathers and innards of chicken are scooped from the pit and toss at the passing by cattle herd, it is believed to protect the cattle from wild animals during their stay inside the forest. Cattle herds are often taken to the village in a procession during the festival. Local communities consider cattle entering into the village as a good omen and believe that they bring wealth and good fortune to the village.

3.2.2. Traditional Festivals of Golla Community involving Cattle

One of the major traditional festivals of *Golla's* in the study area is *Ligamayya jatara*, which is celebrated during Dassehra, a major Hindu festival celebrated in the month of October. The festival is observed in the honour of the forest god *Lingamayya* (believed to be the incarnation of Lord Shiva) and his five sisters *Pedamma*, *Elamma*, *Mahishamma*, *Pochamma*, and *Mantramma*. The temple of *Lingamayya* is usually located at a sacred spot inside in the forest and the entire family of the cattle herders visit the temple and offers lambs or chicken to satiate *Lingamayya*.

The festival also includes a ritual called "*poli challadam*", which involves tossing hot porridge cooked in milk at shepherds and herds taking procession through the sacred place. The shepherds catch the porridge thrown at them and move ahead eating it. It was believed that it brings good luck and protects the shepherds and the herd from dangers (bad spirits, predators, wildlife, etc.) lurking inside the forest. The ritual is observed once in every 3 – 5 years.

3.2.3. Cattle in the Wedding of the Lambadi Community

Traditionally, parents of the Lambadi and Golla communities give cattle as wedding gifts to their daughter at her wedding. Usually, pedigree of the cattle is also drawn from such traditional transferences and exchanges. The Lambadi community even performs ritual involving cattle (especially bull) during weddings. The new bride is made to sit on the bull and she sings to the bull, reminding him how she took care of him and requests the bull to move to her in-laws house along with her as her parents and siblings may not join her. The bull and few cattle accompany the new bride to her in-laws place.

3.2.4. Traditional Pastoralist Communities and their Relationship with Wildlife

The traditional pastoralist communities of the sub-continent share a unique relationship with wildlife. As mentioned earlier, the Lambadi community of the study area reveres and worship the tiger. It is considered as the manifestation of

“*Peddamma*”, the most powerful goddess, and believed to be the creator of the universe. Similarly, the sheep rearing, Kuruma/Kuruba/Dangar, pastoralist communities of the Deccan plateau region of India, are known for their mythological and cultural connection with wolves. They revere wolves and refer to them as their maternal uncle/aunt, and do not resort to killing them even if wolves lift off their livestock (Vishwanadha, 2017; Bhardwaj, 2020; Kohler-Rollefson, 2015; Ghotge and Ramdas, 2010). According to them meat of the sheep is tastier when wolves are around, due to adrenaline rush; therefore, the presence of wolves is tolerated. Surprisingly, they often support conservation and protection of wolves in the Deccan plateau region (Bhardwaj, 2020). Similarly, the Changpa herders of Ladakh of the Himalayan region also share a special mythical and cultural relationship with wolves and often tolerate their presence (Bijoor, 2020). One of the most fascinating is the relationship shared by the Indigenous Bishnoi community of the Indian state of Rajasthan with the wildlife. The Bishnois are known for their dedication to protect blackbucks and the environment. Bishnoi women take wildlife conservation altogether to a different level, they are known to breastfeed the young and orphaned blackbuck fawns along with their own babies (Humairah, 2017; Menon, 2012).

3.3. The Terms ‘Cultural Animals’, ‘Animal Cultures’ and ‘Culture Animals’

The notion of human beings as the cultural animals refers to the idea that human beings differ from other animals in the extent to which they create, sustain, and participate in culture (Aronson, 2004; Baumeister, 2005; IResearch.net, 2020). Borrowing the term ‘animal cultures’ from Kohler-Rollefson (2015), it is preferred to use the term “*culture animals*” over “*cultural animals*” and “*animal culture*”, as the former has a different definition and the later has a different connotation (Ramsey, 2017). ‘Animal culture’ as defined by Bekoff (2019) is, “animal culture as information or behaviours shared within a community, which is acquired from conspecifics through some form of social learning.” It is suggested that understanding the rich social lives and preserving animal cultures are quintessential for biodiversity conservation (Whitehead, 2010; Balter, 2013; Whitehead, and Rendell, 2015; Bekoff, 2019; also see Avital & Jablonka, 2001; Bennett, 2010).

In the context of pastoralism, the term “culture animal” refers to the livestock species that prefer living in groups, tolerate and prefer human companionship. They are organized and maintained not by an individual human being but by a community, where the knowledge and information pertaining to the breed, breeding, management and animal husbandry are usually generated, accumulated and shared not only among a particular community but is also passed down to the next generation through traditions, customs, beliefs, rituals, songs, myths, stories, folktales, crafts, and other folklores by placing the animal at the centre of culture and traditions (Kohler-Rollefson, 2015; Tripathi & Rajput, 2006). Further, such animals/livestock usually rely on the community to get what they need to survive and procreate in return of the products and services derived from them by their human counterparts.

There are however, many other wild fauna revered and considered sacred among different cultures of the human society. And many wild fauna are a part of traditions, customs, beliefs, rituals, songs, myths, stories, folktales, crafts, and other folklores of human societies around the world. That leads to the question whether such wild fauna should also be considered as culture animals? Perhaps the answer is no, because, such fauna may not live in groups, may not tolerate and prefer human companionship. They are not organized and maintained by an individual human being or a community. And the knowledge and information pertaining to the breed, breeding, management and animal husbandry is usually neither generated nor shared among a particular community or passed down to the next generation. Most importantly, such fauna do not rely on humans for their survival and procreation in return of providing goods and services.

3.4. The Concept of Culture Animals in Mobile Pastoralism in India

Pastoralist communities are often closely associated with a particular livestock breed/species by the myth of origin, drawing their descent to an ancestor who was created by God to take care of these animals (Kohler-Rollefson, 2015; Sharma et al., 2003). Indigenous livestock breeds such as the Poda Thurpu cattle represent the collective heritage of communities. They are associated with, and cannot be conserved separately. Such breeds will survive only when the indigenous knowledge and production systems of which they are a part of are also conserved (LPPS & Köhler-Rollefson, 2005; Marsoner et al., 2018).

The Indigenous cow-herding and semi-nomadic Nanda Gawli pastoralist community is a sub-group of the Gawli community, which is predominantly found in the Indian state of Maharashtra. The three sub-groups of the Gawli community, the Yadav Gawli, Ahir Gawli, and Ligayat Gawli, are divided on the basis of the territory which they inhabit (Singh et al., 2004). Perhaps the name 'Nanda' was derived from Lord Krishna, the Hindu God, who was raised by a cow-herding family. The Nanda-Gawlis believe that they are the descendants of Lord Krishna (Kalokar & Siripurapu, 2020; Siripurapu et al., 2021).

Nanda-Gawli community rears a unique Indigenous cattle breed called as Gaolao cattle breed. Legend has it that Nanda-Gawli ancestors brought the Gaolao cattle along with them when they arrived from the ancient mythical city of Mathura. Since then, Nanda-Gawlis' continue to nurture and conserve the Gaolao cattle breed. Perhaps, the name Gaolao may have been given after the Gawli community, which rears it. There is a traditional practice among the Nanda-Gawli community, locally known as '*Jani*' (translates as origin/life). *Jani* as a practice is to maintain few selected animals as sacred (elite) animals and they are revered. Animal products and calves produced by '*Jani*' are considered holy and sacred (Siripurapu et al., 2021).

Gaolao cattle are extremely important for the Nanda-Gawli community and it is a part of their culture, traditions, identity and economy. It is an integral part of every traditional ceremony, ritual and festival of the Gawli community. It is gifted as a wedding gift to the new bride by her parents at the wedding and pedigree of the cattle is traced accordingly. Both men and women of the community share the responsibility of taking care of the cattle and women usually keeps a record of the pedigree of the cattle.

Likewise, both sheep and wool are intricately woven into customs, traditions, culture and social fabric of the Indigenous Dangar/Kuruma/Kuruba pastoralist communities of the Deccan plateau region (Patil, 2009). The Dangar/Kuruma/Kuruba pastoralist communities share a special bond especially with the Deccani sheep breed, found in the Deccan Plateau region of India. There are many myths and stories celebrating the relationship between the Deccani sheep breed and the Dangar/Kuruma/Kuruba pastoralist communities. The Dangar pastoralist communities revere Sri. Santh Balumama, their spiritual guru, a shepherd himself, who had handed over his Deccani sheep flock to the Admapur Panchayat at the time of his "jeevasamadhi" (soulful meditation). Therefore, the progeny of his flock is considered sacred and taken care of by the Balumama Trust of Admapur, Maharashtra (Shri Balumama Trust, 2019). Similarly, the Kuruma community of Telangana keep idols of both sheep and dog at shrines of their deity Beerappa (believed to be the incarnation of Lord Shiva) (Patil, 2009).

Similarly, camels have an important place in the traditions, culture, identity and economy of the Rabari community of Gujarat and the Raika community of Rajasthan states of India. Camels are not only central to their culture, rituals, customs, traditions and ceremonies but also influence their lifestyle to a large extent. The relationship of

these communities with camels is believed to be more spiritual than economic (Patel, 2018; The Raika Samaj Panchayat, 2009; Tripathi & Rajput, 2006).

Cattle, especially the Burugur cattle breed is an important part of the life, culture and traditions of the indigenous Lingayat community of the Indian state of Tamil Nadu. They consider themselves as the proud custodians of the indigenous Burugur cattle and *Malai Erumai* buffalo (hill buffalo) breeds. Both the breeds are said to have co-evolved with the Barugur forest ecosystem. One can notice a picture of the Burugur cattle on the roof of every Lingayat temple in the state (Swamigal, 2009).

Van Gujjar of Himachal and Uttarakhand is a Muslim, vegetarian and nomadic pastoralist community sharing a unique bond with their buffalos (Benanav, 2015; Gooch, 2004). Equally, the indigenous Toda communities, the oldest inhabitants of the upper Nilgiri Plateau of Tamil Nadu state rear buffaloes and they are an integral part of their life, traditions, culture and economy. Traditionally, Todas divide their buffalo herds into six hierarchical grades and maintains special dairy temples for each grade (Chhabra, 2018). Similarly, Nagpur buffalo breed occupies a very special place in the life, culture and economy of the Nanda-Gawli community, a semi-nomadic pastoralist community of Maharashtra. Curd prepared from Chilika buffalos' milk is offered to Lord Jagannath of Puri, Odisha. As per the mythology, Manika, a milkmaid offered some curd to Lord Jagannath and his elder brother Lord Balabhadra at the village named Dahikhia, and both the brothers relished the curd. As a tradition, offering of curd made from Chilika buffalo milk continues to this day at the famous Puri shrine (Mishra, 2022; Nanda *et al.*, 2013).

4. Conclusion

The traditional pastoralist communities of the study area have a rich and vibrant biocultural diversity, which they share with their livestock, the Poda Thurpu cattle breed. Poda Thurpu cattle as a culture animal, is central to the biocultural diversity of the Lambadi and Golla communities. Cattle is the genesis of folklore and folksongs of the traditional pastoralist communities of the study area. It is evident that indigenous livestock is crucial for keeping the socio-cultural fabric of the traditional pastoralist societies intact, sustain their livelihoods, traditions, culture, art and crafts, folklore, music, ecology and economies, vis-à-vis the biocultural diversity and socio-cultural fabric of the traditional pastoralist communities. There are endless such examples of biocultural diversity depicting the intimate and intricate relationship between the livestock and the indigenous traditional pastoralist communities of India and around the world, which need further exploration.

6. References

- Aronson, E. (2004). *The social animal* (9th ed.). New York: Worth.
- Avital, E., & Jablonka, E. (2001). *Animal Traditions, Behavioural Inheritance in Evolution*. Cambridge: Cambridge University Press. Retrieved from: https://www.researchgate.net/publication/233820364_Animal_traditions [accessed on 11 January 2023]
- Balter, M. (2013). Strongest Evidence of Animal Culture Seen in Monkeys and Whales. Science. American Association for the Advancement of Science, blog. Retrieved from: <https://www.sciencemag.org/news/2013/04/strongest-evidence-animal-culture-seen-monkeys-and-whales> [accessed on 11 January 2023]
- Baumeister, R. F. (2005). *The cultural animal: Human nature, meaning, and social life*. Oxford: Oxford University Press. <https://doi.org/10.1093/acprof:oso/9780195167030.001.0001>
- Bekoff, M. (2019). Conservation Depends on Preserving Animal Cultures. Understanding the rich social lives of animals' benefits conservation efforts. *Psychology Today*, 12 December 2019. Retrieved from:

- <https://www.psychologytoday.com/us/blog/animal-emotions/201912/conservation-depends-preserving-animal-cultures#:~:text=Animal%20culture%20can%20be%20defined,some%20form%20of%20social%20learning.&text=Social%20learning%20can%20be%20particularly,to%20changes%20in%20the%20environment> [accessed on 11 January 2023]
- Benanav, M. (2015). *Himalaya Bound: An American's Journey with Nomads of India*. New Delhi: Harper Collins Publishers India. ISBN: 9351770915.
- Bennett, G. G. (2010). Animal Traditions: Experimental Evidence of Learning by Imitation in an Unlikely Animal. *Current Biology*, 20(13), 555-56. Retrieved from: <https://www.sciencedirect.com/science/article/pii/S0960982210005634> [accessed on 11 January 2023]
- Bhardwaj, M. (2020). Wolf at the Door – You won't find a little Red Riding Hood and the Big Bad Wolf here. *The New Indian Express*, 19 January 2020. Retrieved from: <https://www.newindianexpress.com/cities/bengaluru/2020/jan/19/wolf-at-the-door-2091501.html> [accessed on 11 January 2023]
- Bijoor, A. (2020). Finding the middle ground with the Changpa herders in Ladakh. *The New Leam*, 18 May 2020. Retrieved from: <https://thenewleam.com/2020/05/finding-the-middle-ground-with-the-changpa-herders-in-ladakh/> [accessed on 11 January 2023]
- Census of India (2011). Amrabad Mandal – Mahbubnagar. *Population Census 2011*. Government of India. Retrieved from: <https://www.census2011.co.in/data/subdistrict/4578-amrabad-mahbubnagar-andhra-pradesh.html> [accessed on 21 January 2023]
- Chhabra, T. (2018). Todas: The Naturalistic People. Environment and Ecology. *VikalpSangam Alternatives India*. Retrieved from: <http://www.vikalpsangam.org/article/todas-the-naturalistic-people/#.XSChA-gzbiU> [accessed on 23 January 2023]
- Cresswell, J. W. (2013). *Qualitative Inquiry and Research Design, Choosing Among Five approaches*. California, CA: Sage.
- Fereday, J., & Muir-Cochrane, M. (2006). Demonstrating Rigor Using Thematic Analysis: A Hybrid Approach of Inductive and Deductive Coding and Theme Development. *International Journal of Qualitative Methods*, 5(1). Retrieved from: https://sites.ualberta.ca/~iiqm/backissues/5_1/PDF/FEREDAY.PDF [accessed on 18 January 2023]
- Francis, J. J., Johnston, M., Robertson, C., Glidewell, L., Entwistle, V., Eccles, M. P., & Grimshaw, J. M. (2010). What is an adequate sample size? Operationalising data saturation for theory-based interview studies. *Psychology & Health*, 25(10), 1229-1245. <https://doi.org/10.1080/08870440903194015>
- Ghotge, N.S., & Ramdas, S. (2010). Black Sheep and Grey Wolves. *Anthra*. Retrieved from: <http://www.anthra.org/publications/research-papers/black-sheep-gray-wolves/> [accessed on 12 January 2023]
- Gooch, P. (2004). Van Gujjar: The Persistent Forest Pastoralists. *Nomadic Peoples*, 8(2), 125-135.
- Government of Telangana (2020). About the District – Nagarkurnool. Retrieved from: <http://nagarkurnool.telangana.gov.in/> [accessed on 13 January 2023]
- Humairah, I. (2017). The Bishnois, India's original environmentalists, who inspired the Chipko movement. *Ecologise.in*, 28 May 2017. Retrieved from: <https://www.ecologise.in/2017/05/28/the-bishnois-indias-original-environmentalists-who-inspired-the-chipko-movement/> [accessed on 31 January 2023]
- India Code (2021). *The Telangana Land Revenue Act, 1317 F*. India Code, Govt. of India. Retrieved from: https://www.indiacode.nic.in/bitstream/123456789/8668/1/act_8_of_1317_f.pdf [accessed on 19 January 2023]
- IRResearch.net (2020). Cultural Animal – Cultural Animal Definitions. Cultural Psychology. *IRResearch.net*. Retrieved from:

- <http://psychology.iresearchnet.com/social-psychology/cultural-psychology/cultural-animal/> [accessed on 17 January 2023]
- Joshua Project (2019). Yadav (Hindu Traditions) in India. Joshua Project, a ministry of Frontier Ventures. Retrieved from: https://joshuaproject.net/people_groups/16187/IN [accessed on 15 January 2023]
- Kalokar, P., & Siripurapu, K.K. (2020). Is Our Environment for Taking From or for Giving To? A Young Indigenous Economist Finds Answers in His Own Culture. "The Other Extinction Rebellion: Countering the Loss of Biocultural Diversity." *Langscape*, 9(1).
- Kohler-Rollefson, I. (2015). Animal Cultures – *the future of livestock keeping and the survival of pastoralists and small-scale livestock keepers*. A blog. Retrieved from: <https://ikrweb.wordpress.com/animal-cultures/> [accessed on 01 January 2023]
- Leech, N. L., & Onwuegbuzie, A. J. (2007). An Array of Qualitative Data Analysis Tools: A Call for Data Analysis Triangulation. *School Psychology Quarterly*, 22(4), 557–584.
- LPPS (LokhitPashu-PalakSansthan), & Köhler-Rollefson, I. (2005). *Indigenous Breeds, Local Communities, Documenting Animal Breeds and Breeding from a Community Perspective*. LokhitPashu-PalakSansthan (LPPS), Rajasthan, India. ISBN: 81-901624-1-1.
- Maffi, L. (2012). *Biocultural Diversity Conservation*. London, UK: Earthscan, p.5.
- Maffi, L. (2007). Biocultural Diversity and Sustainability. Jules Pretty et al. (eds.). *The SAGE Handbook of Environment and Society*, p. 269. ISBN 9781446250082.
- Marsoner, T., Vigl, L.E., Manck, F., Jaritz, G., Tappeiner, U., & Tasser, E. (2018). Indigenous livestock breeds as indicators for cultural ecosystem services: A spatial analysis within the Alpine Space. *Ecological Indicators*, 94(2018), 55–63.
- Menon, G. (2012). The Land of the Bishnois – Where Conservation of Wildlife is a Religion! *The Better India*. Retrieved from: <https://www.thebetterindia.com/5621/the-land-of-the-bishnois-where-conservation-of-wildlife-is-a-religion/> [accessed on 11 January 2023]
- Mishra, G.R. (2022). *Beyond Food and Fitness for Indians Milk is a Faith*. Editorial, *The Kalinga Chronicle*. 10(175), 31 May 2022.
- Naik, L. (2009). *Banjara Hejje gurutugalu*. Bangalore: Karnataka Rajya Patragarallakhe, pp. 42–84. ISBN: 978-8190843812.
- Nanda, D. K., Singh, R., Tomar, S.K., Dash, S. K., Jayakumar, S., Arora, D. K., Chaudhary, R., & Kumar, D. (2013). India Chilika curd – A potential dairy product for Geographical Indication registration. *Indian Journal of Traditional Knowledge*, 12(4), 707-713. Retrieved from: <http://nopr.niscair.res.in/bitstream/123456789/22195/1/IJTK%2012%284%29%20707-713.pdf> [accessed on 16 January 2023]
- Patel, H. H. R. (2018). The Rabaris: The Nomadic Pastoral Community of Kutch. *Sahapedia*. Retrieved from: <https://www.sahapedia.org/the-rabaris-the-nomadic-pastoral-community-of-kutch> [accessed on 10 January 2023]
- Patil, P. (2009). Recent Habitat Management in Great Indian Bustard Sanctuary. GAHIVAR Foundation, India. Retrieved from: <http://www.indiaenvironmentportal.org.in/files/GIB%20Report%20Final.pdf> [accessed on 11 January 2023]
- Ramsey, G. (2017). What is Animal Culture? In: K. Andrews and J. Beck (eds.), *Routledge Companion to the Philosophy of Animal Minds*. London: Routledge. Retrieved from: http://philsci-archive.pitt.edu/12456/1/Ramsey_Animal_Culture.pdf [accessed on 15 January 2023]
- Sharma, V. P., Kohler-Rollefson, I., & Morton, J. (2003). Pastoralism in India. A Scoping Study. DFID, New Delhi. Retrieved from: <https://assets.publishing.service.gov.uk/media/57a08ce2e5274a31e00014fa/ZC0181b.pdf> [accessed on 10 January 2023]

- Shri Balumama Trust (2019). *Shri Balumama Mandir*. Shri Sant Balumama Devalaya, Admapur, India, 2019. Retrieved from: <https://www.balumamamandir.org/> [accessed on 11 January 2023]
- Singh, K. S., Bhanu, B. V., Bhatnagar, B. R., Bose, D. K., Kulkarni, V. S. & Sreenath, J. (eds.) (2004). *People of India - Maharashtra, Part Three, Volume XXX*. Anthropological Survey of India. Mumbai: Popular Prakashan Pvt. Ltd.. ISBN 81-7991-102-0 (3848).
- Siripurapu, K. K., Iyengar, S., Saberwal, V., & Das, S. (2020). An Overview of Mobile Pastoralism in Andhra Pradesh and Telangana States of the Deccan Plateau Region of India. Center for Pastoralism, WASSAN and RRAN. Retrieved from: <https://www.rainfedindia.org/wp-content/uploads/2020/07/Siripurapu-et-al-2020-Mobile-Pastoralism-in-Andhra-Pradesh-and-Telangana.pdf> [accessed on 19 January 2023]
- Siripurapu, K. K., Das, S., Sharma, S., Akinepalli, V. R., Reddy, M. & Yadav, V. (2019). Characterization of Poda Thurpu Cattle: A Native Livestock Population of Telangana State. *Journal of Livestock Biodiversity*, 9(1).
- Siripurapu, K. K., Kulkarni, S., & Das, S. (2021). Understanding the Indigenous Socio-cultural, Economic and Ecological Systems of Indigenous Livestock Breeds for Designing Appropriate Extension Services and Delivery Systems. *Journal of Livestock Biodiversity*, 10.
- Swamigal, A. R. (2009). *Lingayat Bio-Cultural Protocol*. Donagiri Mutt, Bargur, Thamaraikekarai Post, AnthiyurViaBhavani taluk, Erode district, Tamil Nadu, India.
- The Raika Samaj Panchayat (2009). *Raika Bio-Cultural Protocol*. The Raika Samaj Panchayat, c/o LokhitPashu-PalakSansthan, Butibagh, Rajpura, Via Sadri 306702, Distt. Pali, India.
- Tripathi, H., & Rajput, D.S. (2006). Customs and beliefs of Raika pastoralists of Rajasthan associated with camel husbandry. *Indian Journal of Traditional Knowledge*, 5(2), 284-286.
- Vishwanadha, A. (2017). In our love for the tiger, are we losing the soul of the Deccan grasslands – the Indian grey Wolf? Wildlife Conservation. *Scroll*, 28 September 2017. Retrieved from: <https://scroll.in/magazine/849645/in-our-love-for-the-tiger-are-we-losing-the-soul-of-the-deccan-grasslands-the-indian-grey-wolf> [accessed on 11 January 2023]
- Whitehead, H. (2010). Conserving and Managing Animals that Learn Socially and Share Cultures. *Learning and Behavior*, 38(3), 329–336. Retrieved from: <https://link.springer.com/article/10.3758/LB.38.3.329> [accessed on 13 January 2023]
- Whitehead, H., & Rendell, L. (2015). *The Cultural Lives of Whales and Dolphins*. Chicago: University of Chicago Press. ISBN: 9780226325927.
- Yaadav, R. (2010). *Yadav History – Great Yadavas*. Yadava History. Retrieved from: http://yadavhistory.com/short_history [accessed on 10 January 2023]

Authors' Declarations and Essential Ethical Compliances

Authors' Contributions (in accordance with ICMJE criteria for authorship)

<i>Contribution</i>	<i>Author 1</i>	<i>Author 2</i>
Conceived and designed the research or analysis	Yes	Yes
Collected the data	Yes	No
Contributed to data analysis & interpretation	Yes	Yes
Wrote the article/paper	Yes	No
Critical revision of the article/paper	Yes	Yes
Editing of the article/paper	Yes	Yes
Supervision	No	Yes
Project Administration	No	Yes
Funding Acquisition	No	No
Overall Contribution Proportion (%)	70	30

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Research involving human bodies or organs or tissues (Helsinki Declaration)

The author(s) solemnly declare(s) that this research has not involved any human subject (body or organs) for experimentation. It was not a clinical research. The contexts of human population/participation were only indirectly covered through literature review. Therefore, an Ethical Clearance (from a Committee or Authority) or ethical obligation of Helsinki Declaration does not apply in cases of this study or written work.

Research involving animals (ARRIVE Checklist)

The author(s) solemnly declare(s) that this research has not involved any animal subject (body or organs) for experimentation. The research was not based on laboratory experiment involving any kind animal. Some contexts of animals are also indirectly covered through literature review. Therefore, an Ethical Clearance (from a Committee or Authority) or ethical obligation of ARRIVE does not apply in cases of this study or written work.

Research on Indigenous Peoples and/or Traditional Knowledge

The author(s) solemnly declare(s) that this research has involved Indigenous Peoples as participants or respondents, with the documentation of their Indigenous Knowledge. Some other contexts of Indigenous Peoples or Indigenous Knowledge are indirectly covered through literature review. Therefore, a Self-Declaration in this regard is filed by the researcher and first author to support this study or written work.

Research involving Plants

The author(s) solemnly declare(s) that this research has not involved the plants for experiment or field studies. The contexts of plants were only indirectly covered through literature review. Thus, during this research the author(s) obeyed the principles of the Convention on Biological Diversity and the Convention on the Trade in Endangered Species of Wild Fauna and Flora.

(Optional) Research Involving Local Community Participants (Non-Indigenous)

The author(s) solemnly declare(s) that this research has involved local community participants or respondents belonging to non-Indigenous peoples. Yet, this study did not involve any child in any form directly or indirectly. The contexts of different humans, people, populations, men/women/children and ethnic people are also indirectly covered through literature review. Therefore, prior informed consent (PIC)

of the respondents was taken under this study before the face-to-face interviews and interactions.

(Optional) PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses)

The author(s) has/have NOT complied with PRISMA standards. It is not relevant in case of this study or written work.

Competing Interests/Conflict of Interest

Author(s) has/have no competing financial, professional, or personal interests from other parties or in publishing this manuscript. There is no conflict of interest with the publisher or the editorial team or the reviewers.

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To see original copy of these declarations signed by Corresponding/First Author (on behalf of other co-authors too), please download associated zip folder [Ethical Declarations] from the published Abstract page accessible through and linked with the DOI: <https://doi.org/10.33002/pp0103>

SELF-DECLARATION FORM

Research on Indigenous Peoples and/or Traditional Knowledge

1. Conditions of the Research

1.1 Was or will the research (be) conducted on (an) Indigenous land, including reserve, settlement, and land governed under a self-government rule/agreement or?

Yes

1.2 Did/does any of the criteria for participation include membership in an Indigenous community, group of communities, or organization, including urban Indigenous populations?

Yes

1.3 Did/does the research seek inputs from participants (members of the Indigenous community) regarding a community's cultural heritage, artifacts, traditional knowledge, biocultural or biological resources or unique characteristics/practices?

Yes

1.4 Did/will Aboriginal identity or membership in an Indigenous community used or be used as a variable for the purposes of analysis?

Yes

2. Community Engagement

2.1 If you answered "Yes" to questions 1.1, 1.2, 1.3 or 1.4, have you initiated or do you intend to initiate an engagement process with the Indigenous collective, community or communities for this study?

Yes

2.2 If you answered "Yes" to question 2.1, describe the process that you have followed or will follow with to community engagement. Include any documentation of consultations (*i.e., formal research agreement, letter of approval, PIC, email communications, etc.*) and the role or position of those consulted, including their names if appropriate:

Before initiating the field work and investigations, the consents were obtained from the village heads of Kuruma, Lambadi, Golla and Maala communities. The groups discussions and

informal interactions were conducted after these consents. While interviewing the individual respondents, a PIC document was shared and got signed bilaterally between each respondent and the researcher. No personal data was gathered with the approval and consent of the individual owner of the knowledge or information.

3. No Community Consultation or Engagement

If you answered “No” to question 2.1, briefly describe why community engagement will not be sought and how you can conduct a study that respects Aboriginal/ Indigenous communities and participants in the absence of community engagement.

Not Applicable

⇒ Name of Principal Researcher: Kanna Kumar Siripurapu

⇒ Affiliation of Principal Researcher: South Asia Consortium for Interdisciplinary Water Resources Studies, Plot No. 164, Road No. 6, Vayupuri, Sainikpuri, Secunderabad - 500094, Telangana, India.

Signature:



Declaration: Submitting this note by email to any journal published by The Grassroots Institute is your confirmation that the information declared above is correct and devoid of any manipulation.

INFORMATION AND CONSENT FORM FROM RESPONDENTS
(Non-Indigenous or Indigenous Respondents)

This form was translated into local language for the respondents

Title of the Research: Biocultural Diversity and Culture Animals in Mobile Pastoralism in Telangana of India

Principal Researcher: Kanna Kumar Siripurapu
South Asia Consortium for Interdisciplinary Water
Resources Studies, Plot No. 164, Road No. 6, Vayupuri,
Sainikpuri, Secunderabad - 500094, Telangana, India

Research Supervisor: Sushma Iyengar
Sahjeevan, Hospital Rd., Jalaram Society, Vijay Nagar, Bhuj
370001, Gujarat, India

A) INFORMATION TO PARTICIPANTS

1. Objectives of the research

The objectives of this study were to investigate on biocultural diversity of mobile pastoral communities of the Deccan Plateau region of India in context of Poda Thurpu cattle breed as the 'culture animal' of mobile pastoralist communities of Nagarkurnool district of the Telangana state of India

2. Participation in research

The researcher will ask you several pertinent questions. This interview will be recorded in written form and should last about 50-60 minutes. The location and timing of the interview will be determined by you, depending on your availability and convenience.

3. Risks and disadvantages

There is no particular risk involved in this project. You may, however, refuse to answer any question at any time or even terminate the interview.

4. Advantages and benefits

You will receive intangible benefits even if you refuse to answer some questions or decide to terminate the interview. You will also contribute to a better understanding of the causes for pastoralists' livelihood transformation.

5. Confidentiality

Personal information you give us will be kept confidential. No information identifying you in any way will be published. In addition, each participant in the research will be assigned a code and only the researcher will know your identity.

6. Right of withdrawal

Your participation in this project is entirely voluntary and you can at any time withdraw from the research on simple verbal notice and without having to justify your decision, without consequence to you. If you decide to

opt out of the research, please contact the researcher at the telephone number or email listed below. At your request, all information concerning you can also be destroyed. However, after the outbreak of the publishing process, it is impossible to destroy the analyses and results on the data collected.

B) CONSENT

Declaration of the participant

- ⇒ I understand that I can take some time to think before agreeing or not to participate in the research.
- ⇒ I can ask the research team questions and ask for satisfactory answers.
- ⇒ I understand that by participating in this research project, I do not relinquish any of my rights, including my right to terminate the interview at any time.
- ⇒ I have read this information and consent form and agree to participate in the research project.
- ⇒ I agree that the interviews be recorded in written form by the researcher: Yes () No ()

Signature of the participant : _____ Date : _____

Surname : _____ First name : _____

Researcher engagement

I explained to the participant the conditions for participation in the research project. I answered to the best of my knowledge the questions asked and I made sure of the participant's understanding. I, along with the research team, agree to abide by what was agreed to in this information and consent form.

Signature of the researcher :



Date : 12-09-2022

Surname: Siripurapu

First name: Kanna

- ⇒ Should you have any questions regarding this study, or to withdraw from the research, please contact Mr. Kanna Kumar Siripurapu by e-mail kanna.siripurapu@gmail.com
- ⇒ If you have any concerns about your rights or about the responsibilities of researchers concerning your participation in this project, you can contact the Sahjeevan, Hospital Rd., Jalaram Society, Vijay Nagar, Bhuj - 370001, Gujarat, India by email sushmasiyengar@gmail.com

Technological Strategies Implemented by Livestock Farmers Specialized in Goat Breeding in the Mountain Region of San Juan, Mendoza and La Rioja Provinces in Argentina

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Open Access

Abstract

The goat farming is of great relevance in the mountain ranges of San Juan, La Rioja and Mendoza Provinces in Argentina. Out of the three, Mendoza province has the highest number of goats in the country. This system of production is majorly managed by the family members making it an integral part of the Family Farming sector. This type of production generates work in a pauperized sector and at such places that are distant from the urban centres where possibility of alternative occupations is scarce or almost nil. The animal rearing activity focuses on primary production with little value addition, high seasonality, and informal and rudimentary marketing strategies. These activities primarily employ tacit knowledge acquired over the years by trial-and-error method. Transhumance, as a strategy for the use of the natural environment, reveals the existence of a thorough knowledge of the seasonal productivity of the grasslands of the mountain valleys. Research and extension organizations develop projects aimed at improving these production systems through the implementation of contemporary technologies. The objective of this paper is to identify the technological strategies implemented by the Family Farming sector specialized in goat breeding in the mountain region of the provinces of Mendoza, San Juan and La Rioja, with specific focus on their origin, specific problems they face, and strategic similarities and differences to propose recommendations for the research and extension organizations.

Keywords

Family farming; Pastoralism; Goat production; Rural extension

Executive Chief Editor
Dr. Hasrat Arjjumend
Associate Editor
Arushi Malhotra



This article is edited by Arushi Malhotra and Dr. Hasrat Arjjumend

1. Introduction

Goat farming is of great relevance in the mountain area of the provinces of the Cuyo region in the western part of Argentina.

According to SENASA¹ data, collected in 2020, Mendoza with 742,413 heads, has the second highest number of goats in the country, after Neuquén (SENASA, 2020). In accordance with the Article 5 of Law No. 27,118 of Argentina, a family farmer is defined as the one who carries out agricultural, livestock, forestry, fishing and aquaculture activities in rural areas and meets the following requirements: a) management of the productive enterprise is exercised directly by the producer and/or a member of their family; b) Owns all or part of the means of production; c) Work requirements are covered mainly by family labour and/or supplementary contributions from employees (Ministerio de Justicia y Derechos Humanos, Presidencia de la Nación Argentina, 2015). Javier Balsa proposes that a central defining feature of family farming is that the family forms a work team (Balsa, 2012).

The principal contribution to goat pastoralist production is provided by the families involved, so it is limited, almost exclusively, to the family farming (FF) sector. This type of production generates work for the population that is characterized by low income, informality and located at places distant from urban centers, where there are very scarce or no alternative occupations, so the opportunity cost is very low or zero.

Goat feeding is based on wild grassland species, including rotational grazing in some cases, as is the practice of transhumance and punctual supplementation when the forage supply does not cover the animal's dietary needs. Goat husbandry in this region is the means of primary production because of high seasonality and informal and rudimentary marketing strategies. The distance to the urban centers where production is marketed, and the high freight costs involved both in the sale of products and in the supply of inputs, limit the potential competitiveness within this production system. The production activities are dictated by ancestral traditions that use tacit knowledge acquired over generations by trial-and-error method and constitute symbolic capital for the people of the region. Transhumance, as a strategy for the use of the natural environment, reveals the existence of a practical and meticulous knowledge base to manage the seasonal productivity of the grasslands in the mountainous valleys.

Development projects implemented by research and extension organizations are, and historically have been, aiming at improving these production systems by implementing thoroughly researched and experimented technologies. It leads to a confrontation between different approaches to knowledge acquisition that on many occasions create unexpected misunderstandings. Therefore, the main objective of the present work is to clearly identify and understand the technological strategies implemented by the livestock farmers specialized in goat breeding in the mountain regions of San Juan, Mendoza and La Rioja Province.

2. Methodology

This work adheres to a descriptive exploratory framework. We begin by analysing secondary data presented in six projects in the program portfolio of the National Institute of Agricultural Technology of Argentina (INTA), that address goat production in the mountain regions of the provinces of Mendoza, San Juan and La Rioja. This preliminary analysis allowed us to identify the analytical categories that were subsequently investigated in in-depth interviews with 26 family producers. These interviews were conducted to understand the technologies applied in different situations. The work was therefore carried out in two stages: first, a literature review and second, personal in-depth interviews.

The authors interviewed four producers in the department of San Rafael and two in the department of Malargüe, both in the province of Mendoza; six producers in the

¹ National Service of Food Health and Quality of Argentina

department of Jáchal and six in the department of Iglesia, both located in the province of San Juan; four producers in the department of Felipe Varela, two in the department of Villa Castelli and two in the department of Vinchina in the province of La Rioja.

The proposals analyzed for this study were those implemented as extension intervention strategies by the Instituto Nacional de Tecnología Agropecuaria (INTA) units present in the area. The project "Strengthening the Production of Small Ruminants in the Andean Valleys of San Juan and Mendoza" (Instituto Nacional de Tecnología Agropecuaria (INTA) Centro Regional Mendoza - San Juan, 2020) of the INTA², as part of the program portfolio of the Cuyo region and projects previously developed by the Federal Program for Sustainable Rural Development (PROFEDER) of INTA at a national level including the following:

- "Integrated Territorial Development, Malargüe, Mendoza" (Instituto Nacional de Tecnología Agropecuaria (INTA) AER Malargüe, 2004).
- "Regional Development Project through the Use of Special Fibers" (Instituto Nacional de Tecnología Agropecuaria (INTA) AER Malargüe, Mendoza).
- "Integrated Territorial Development, Carrizalito, Agua Botada, La Salinilla, Agua Nueva" (Instituto Nacional de Tecnología Agropecuaria (INTA) AER Malargüe, Mendoza).
- "Promotion of Value-Added to Local and Tourism Production of the Bermejo Valley Region, La Rioja province" (Instituto Nacional de Tecnología Agropecuaria (INTA) AER Valle del Bermejo).
- "Support for the Socio-Productive Development of the Bermejo Valley" (Instituto Nacional de Tecnología Agropecuaria (INTA), AER Valle del Bermejo).

The distribution of interviews by department and province was determined based on accessibility of the producers by the local extension professionals. A set of questions (Table 1) was created as a guide based on our professional experience and the categories of topics extracted from the analyzed projects.

Table 1: Questions asked from the respondents

<i>Category</i>	<i>Thematic area</i>	<i>Guiding Questions</i>
Management	Food, nutrition	How is the grazing managed? What plant species are consumed by animals? What is the carrying capacity? Is rotation of grazing areas practiced? Is supplementation done at any time of the year? To what category of animals? Are there times of lack of pasture, when do they occur and what strategies are implemented for them?
	Facilities	What is the design of the corrals, what materials are used? Why are they made in a certain way? What facilities are present? What is the origin of the model used? How old are the facilities? Who made them?
	Health	What are the health problems present? What practices are carried out to address them? How often? Is the producer in charge of the sanitary practices or does someone from outside the establishment?
	Logistics	Is transhumance practiced? How are animals managed during winter and summer? How are the animals moved, with herder on a horse, by truck? Do they have

² National Institute of Agricultural Technology of Argentina

<i>Category</i>	<i>Thematic area</i>	<i>Guiding Questions</i>
		vans? How far do the animals have to move? How many days does the transfer take? How do they organize the feeding of the people who are in charge during the summer? What activities do they need to do when they arrive at the summer post? How long do they stay at the post? Are the people who are caring for the animals rotated in the summer stall?
Marketing		To whom do they sell the produce? Do they sell all the produce to the same buyer? At what times of the year do they sell? Do they always sell to the same buyer? Is the commercial relationship long standing?
Scale		Are they part of any formal association / organization of producers? Do they work in association with any other producer? For what activities do they associate with others?

3. Results and Discussion

The principal problems identified were organized into three categories depending on the degree of governance exercised by the producing families. According to Fernando Guzmán, we consider those situations of reality as problems with which we do not conform but we have the capabilities that allow us to modify them (Guzmán, 2019). There is agreement in the analysis of the different projects on these problems, which acquire different nuances according to the area.

In this way, the first group of problems that was identified was the ‘management’ of production systems. It involves decisions related to food, health, genetics, reproduction and facilities. All these aspects are characterized by a high degree of governance exercised by the producing families and, therefore, manifest themselves as an internal scope to the productive system. A second group of problems is related to ‘commercial’ aspects having poor governance exercised by the producing families manifesting as an area external to the productive system. The third group of problems can be classified as ‘scale’ having intermediate governance exercised by the producing families. It is manifested in a space external to the scope of decisions of the individual productive system.

3.1 Main Problems identified and described in the Extension Projects

Extension projects address family farming (FF) including the goat production, with varying degrees of specificity. Some, such as those implemented in the department of Malargüe of the province of Mendoza, highlight goat breeding as the central axis, analyze their specific problems, and propose technological strategies for their resolution. Other projects, such as those carried out in the Bermejo Valley of the province of La Rioja, set objectives of integral territorial development among which goat farming is one of the productive activities. These projects do not do in-depth analysis of the restrictions or problems that arise within these production systems, nor do they propose any specific technological strategies that could enhance these production systems.

3.1.1 Management Related Problems

The following 'management' problems are described in the projects:

- a) *Producers have a quantity of animals that exceeds the capacity of forage supply, so there is overgrazing and degradation of natural grassland. Old and unproductive animals are not disposed of in time.*

This analysis is recurrent in all the projects. Reference is made to the impoverishing conditions of the natural pastures. The main cause of this impoverishment is attributed to overgrazing, which the resource has been subjected to over many years due to the maintenance of a number of animals that exceeds the forage supply. This animal overload is linked to the cultural problems of FF where the producers sustain an excess of animals because of the irrationality in their management practices. They consider their social prestige to be associated with the large number of animals reared by them.

As an example, we can cite the project "Integrated Territorial Development, Malargüe, Mendoza" (Instituto Nacional de Tecnología Agropecuaria (INTA) AER Malargüe, 2004), where the following stands out:

"On the other hand, due to the idiosyncrasy of local producers, where the number of animals owned by a producer within a community is a sign of social importance, it is difficult to reduce the number of unproductive goats, to which is added the impact on the natural pasture made by all these animals, with the consequent degradation of the resource."

- b) *Genetics. There is a great heterogeneity of animals due to indiscriminate crossing that causes low quality of the product they offer.*

Though this topic is under scrutiny and remains controversial, it persists as a prominent problem discussed in all the projects. It is notable that in most of herds, the Creole breed is predominant with crossbreeding over a time. Breeds such as the Anglo Nubian, Boer, Saanen and others, have been introduced when the economy of the producers permits and through programs that have encouraged the incorporation of other breeds.

In the project "Integrated Territorial Development, Carrizalito, Agua Botada, La Salinilla, Agua Nueva" (Instituto Nacional de Tecnología Agropecuaria (INTA) AER Malargüe, Mendoza) it is stated that:

"The predominant goat breed is Creole, which is characterized by great rusticity and adaptation to the local environment, and in smaller numbers crosses with Anglo Nubian and Angora. There is not a single type of animal as a consequence of indiscriminate crossings, which determines a great heterogeneity and low quality of the product offered."

It is important to note that these additions have generally not followed an orderly plan of genetic improvement or considered adaptation to the natural environment. In cases where crosses introduced larger breeds to the Creole, for example, the Anglo Nubian or Boer, the animals had greater weaning weights, but also greater food demand.

- c) *Not locking the animals in the pen daily nor handling them by a shepherd*

This problem has been highlighted in the southern area of Mendoza, where it is common for producers not to lock up the animals every afternoon, so they remain in

the pasture for 2-3 days without supervision, thus exposing them to risks. Permanent accompaniment by a shepherd is not a common practice anywhere in the region and there is a growing loss of animals due to predators.

d) Low proportion of males used in service

It is common to find a lower percentage of males than recommended, noting that they do not exceed 3% in most establishments. In the project "Integrated Territorial Development, Carrizalito, Agua Botada, La Salinilla, Agua Nueva" (Instituto Nacional de Tecnología Agropecuaria (INTA) AER Malargüe, Mendoza), this problem is described as:

"The proportion of males used in the service is very low and the presence of old females that produce weak kids consuming low milk production means that the productivity indices are low."

e) There are a few health controls

It is noted that in most cases health controls are not conducted beyond traditional treatments. These are not based on a diagnosis by a qualified professional but on the tacit knowledge of the producers. It may also include some inappropriate practices having poor impact on the health of the animals.

3.1.2 Commercial Problems

The 'commercial' problems highlighted in the projects include:

a) Atomized sale of production directly on the spot

This is the traditional way of selling through which most of the produce is marketed. However, in production systems that are close to cities or on important communication routes, a large proportion of produce is sold for slaughtering directly to the consumers for higher prices. This is done, however, without complying with current sanitary standard legislation.

The problems linked with the competitiveness of the production systems clearly stand out in the project "Support for the Socio-Productive Development of the Bermejo Valley" (Instituto Nacional de Tecnología Agropecuaria (INTA), AER Valle del Bermejo).

"High percentage of informal marketing, with productive areas isolated from the commercial circuit, do not present marketing strategies and hence lack quality controls."

b) Low profitability caused by low prices obtained from production, which causes decapitalization of producers.

It is highlighted in most of the projects that the prices paid by the intermediaries, which are the merchants buying the majority of the production, are low or insufficient. This situation erodes the capacity for maintenance and growth of the productive systems. In the project "Integrated Territorial Development, Carrizalito, Agua Botada, La Salinilla, Agua Nueva" (Instituto Nacional de Tecnología Agropecuaria (INTA) AER Malargüe, Mendoza), the following stands out:

"The situation raised together with other problems leads to a low profitability of the farms due to the low prices obtained and, consequently, to a progressive decapitalization of the sector, which motivates social phenomena such as the rural exodus and school failure."

c) There are no agro-industries allowing the production of products with added value at origin

Frequently highlighted is the lack of strategies to add value to the production at a local level, so that farmers get more revenue on the final product. Further analysis indicates that there is little or no presence of agro-industries in the areas of production, which can add value to the products, and that there is poor processing of by-products and handicrafts.

d) Scarcity of commercial alternatives

This problem is related to the previous one and focuses on the need for diversification of production in the face of the limitation of income due to the sale of a primary product. However, there may be many other ways to generate income by adding value to the production at origin.

3.1.3 Scale Related Problems

A third group of issues is related to 'scale', which means that only a few organizations and producers are working in a coordinated way. These problems are frequently mentioned in the description of the situation analysis of the projects. Cooperative and coordinated work is considered to improve the economic results of the productive system. This is possible through lower purchase prices (of inputs), higher product prices, and joint sale to the distributors avoiding wholesale intermediation.

In some cases, the producers' association notices gender issues, highlighting the lack of women's associations. In the project "Integrated Territorial Development, Carrizalito, Agua Botada, La Salinilla, Agua Nueva" (Instituto Nacional de Tecnología Agropecuaria (INTA) AER Malargüe, Mendoza), it is underscored that women play an important role in production activity as they perform fundamental tasks during the calving season. Women are also in charge of the animals that remain in the lowlands during the summer season in areas where transhumance is practiced and the men go up the Andes mountain range with rodeos. There is no organization of rural women allowing for social leadership in this sector of goat rearing.

There is also frequent mention in the projects of the scarce use of appropriate technologies, without going into further detail regarding what technologies and the evidence are missing.

3.2 Summary of the Principal Technological Strategies Applied and Identified

Considering the breadth of the area considered for analysis, a variety of technological practices are employed in accordance with the natural characteristics of the environment, the customs of family producers, and the requirements of the destination markets.

The technological practices are organized in accordance with the thematic divisions of the interviews, and are described as under:

a) Feeding

Grazing, in most cases, happens in the open fields with notable differences between different fields under study. In the southern Mendoza, transhumance is the norm with shepherds moving the animals every December. In many cases, they cover the distances as far as 100 km or more to reach the outposts in the mountain range where they remain until the end of May before the snowfall begins. These transfers of animals take an average of approximately 7 days.

According to a producer, who visited the department of San Rafael in the province of Mendoza, he moves the animals every year in December covering a journey of 105 km that lasts 7 days until the source of the Atuel river in the Andes Mountains. There they graze in natural pastures until the end of May when they return to the lowlands taking a 5-day journey. The outposts in the mountain range are usually leased fields as part of a long-standing business relationship, in many cases more than 20 years old, although the contracts are annual. The remainder of the year the animals are pastured in fields in lower areas that are usually owned by the family producers. In most cases, they do not have legal deeds to these pastures, which is a problem manifested on a recurring basis.

This way, the productivity of the pasture is rotated through different areas and times of the year. The respondents highlighted the decrease in forage supply in recent years in which rainfall has decreased considerably and water sources, which were previously abundant, have dried up. To address this, in some cases, animals are supplemented during the winter months with corn or bales bought from a nearby agricultural area under irrigation. For example, a producer that we visited in the Iglesia department of the province of San Juan buys lucerne (*Medicago sativa* L.) bales from farmers who produce in the area having irrigation.

In the Andean departments of San Juan, some producers practice transhumance with moving the animals to outpost in the Andes, spending the summer months in the mountain range, while others keep animals in the low fields all year round. It is very common for the same producer to have irrigated lots in the low areas where they grow lucerne (*Medicago sativa* L.), which is preserved "encastillada" (stacked in the field), and corn is used to supplement during the months of scarcity usually at the end of winter. In the Bermejo Valley of La Rioja, where transhumance is less practiced, the animals remain all year-round on the same property and usually do not receive supplementation.

When analyzing the restrictions of the forage supply over the years, producers relate the scarcity of forage with the dry years, and the abundance with periods of greater rainfall without considering the importance of the stocking of forage. This is due to the fact that it is hard to track because of the difficulty involved in analyzing it in open farms and with movements of animals between different fields during winters and summers. To compound this, none of the producers graze only goats and their rodeos are usually composed of cows, goats, sheep and horses, which make a differential use of the forage supply.

b) Facilities

The facilities are constructed of materials available in the area such as sticks, straw, and stone. Although it is also very common to find constructions made from pallets and wire in the areas closer to cities. The use of enclosures dates back many years. They are used to enclose and shelter the animals with coverings on the southern side having roofed space to protect animals from the rain. In the mountainous area of San Juan, the main protection necessary for animals is on the west side since the prevalence of the Zonda wind³ is high.

It is common that the facilities are not properly maintained. It contains a marked accumulation of manure that previously was sold as a fertilizer to farmers owning vineyards in the provinces of San Juan and Mendoza. In recent years, this practice has decreased due to higher freight costs, the infestation of weed seeds, and replacement by chemical fertilizers.

³ Strong, hot and dry wind that comes from the west. This wind phenomenon originates in the Pacific Ocean where it is initially full of humidity. As it crosses the Andes mountains, it discharges snow on the peaks, and moves down the mountains into Argentina mainland, while increasing temperatures and decreasing humidity as it descends.

The practice of locking up animals varies according to the area. In the southern Mendoza, once the number of animals is controlled with no registered health problems, it is very common that animals are not confined every day but only every three or more days. In the province of La Rioja, however, the animals are released every morning to graze and in the afternoon they return back to where they are locked up until the next day. Very few pens have water troughs as the animals typically drink from streams or watercourses available in the field.

c) Health

Sanitary practices are very basic, usually managed by the producers themselves and based on knowledge acquired informally and transmitted generationally. The presence of "corrocho" (*Fasciola hepatica*) is common, and it affects the animals mainly during "la veranda" when their principal water source are the natural mountain streams. In the southern part of Mendoza, the producers mention that the animals suffer from diarrhea when they return to the lowlands from the outpost in the Andes mountains and consume the water from the lower fields. In many cases, these water sources have an origin in shallow perforations and undergo process of increased salinization during periods of drought. While the water is suitable for animal consumption, it is of a lower quality than what they have available in the outposts of the mountain range.

The presence of "mascadera"⁴ is frequently mentioned, due to the consumption of the fruits of "Algarroba" (*Prosopis alpataco*). In the province of San Juan, the poisoning of animals through the consumption of toxic plants is recorded. However, the respondents were not able to identify the toxic plants and what kind of poisoning they cause. The mastitis and abortions are also common, yet not exceeding 10% of the herd.

d) Logistics

Different animal management practices are employed in the different locations of this study. As highlighted above, transhumance is common in the southern part of Mendoza, taking advantage of the high-altitude pastures during the months of December till the first days of May. This involves the movement of animals over considerable distances and is done with shepherds on horseback or in some cases, with trucks. This practice is common in all three areas under study, however, its frequency decreases going from south to north i.e., being very common in Malargüe and very rare in La Rioja.

Agreements are usually made between producers to move the animals together each taking his turn during the stay of animals in the outposts up in the Andes mountains. It is the men who travel up to the mountains, stay approximately 15 days in the outpost from where they return to the lower fields. While the mountain outposts have precarious constructions, it is necessary that while herding the men carry with them all the necessary utensils in addition to food stuff, which is then supplemented with frequent slaughters practiced during the season. In the southern zone mating is concentrated from May to June. The bulk of the births occur in the months of October to November. This allows the producers to take advantage of greatest demand for kids at the end of the year.

The "Castrones" (males) are kept separate from the females from October to April, a period in which it is common for them to be in the care of "Castroneros" who charge for the service approximately equal to the value of a kid. In San Juan and La Rioja, mating is continuous; the males are kept together with the females throughout the year, and thus births also occur year-round. In some instances, as in San Juan, this can

⁴ "Mascadera" is a chronic emaciating neuropathy affecting goats.

cause inconveniences with high kid mortality due to births in the cold season, when there is a lack of fodder and mothers are in poor body condition. While in the Bermejo Valley in the province of La Rioja, kid births taking place all year round is a productive strategy, as the forage supply is greater. There is also a growing year-round tourism due to the proximity of two national parks and they can sell directly to restaurants and hotels, achieving substantially higher prices than selling through intermediaries.

An issue that is present in all the producing areas is mortality by predators. The most common are pumas and condors. In production near the inhabited areas, the presence of dogs can also cause serious damage to the herds.

4. Conclusion

A variety of situations were documented in the project areas across the mountains of the Cuyo. The technological practices implemented by the goat producers in the region have influence over the situations. On the one hand, a joint construction with the producers was recorded in long-standing projects such as those carried out in the Malargüe department in the province of Mendoza and those in the Bermejo Valley in the province of La Rioja. On the other hand, in areas where animal husbandry projects have not been carried out, as in the western departments of San Juan province, production is aligned to a greater extent with traditional productive practices.

Considering that extension projects were developed after identifying problems using participatory methodologies where the producers were consulted, there is a logical relationship between the activities proposed and the current problems. A notable inconsistency, where the relationship is not clear, is related to the overgrazing and degradation of natural grassland as highlighted in the projects. Additionally, the animal overload is linked to the cultural factors of the family producers. Having more animals is considered prestigious from socio-cultural perspectives. This is not an isolated observation confined to this productive area but is observed across other regions with a pastoral livestock culture and family production patterns.

As observed in this study, these animal management strategies that come into conflict with the forage capacity are more closely linked to the maintenance of capital and the ability to use pasture production in times of greater growth than to hold prestige identification by the producers. However, the frequent animal mortality due to the lack of pasture is evident, and is highlighted in the observations of this study. Along the same lines, Oba (2012: 34) argues that:

“For dryland ecosystems, the effect of biotic factors, such as grazing intensity, on plants has been overemphasized; while the effects of abiotic influences, independent of livestock densities, notably spatial and temporal variability in rainfall, have been ignored.”

The producers relate to a greater extent the restrictions of forage supply with periods of scarce rainfall, without mentioning variations in the number of grazing animals. Another point of merits is the profitability of goat production. Although most of the projects underscore that the low profitability is achieved, yet no demonstrative analysis is presented quantifying the capital at stake. Considering that most producers correspond to the category of family farming, which is characterized by a lack of capital and the presence of a labour force, the profitability analysis would be irrelevant since the capital invested is minimal and has low liquidity, making it difficult to analyze the investment alternatives.

The projects address the goat husbandry with different levels of granularity, but in all cases, the bulk of the proposed activities exceed the scope of the primary system of

goat husbandry incorporating activities aimed at vertical advancement in the production chain, adding value and using by-products, promoting associative forms between producers, both for economic benefits and gender issues, and the incorporation of rural tourism activities. This approach is supported by the intentionality of the programmatic tool. In the case of PROFEDER⁵, the strategy was to move beyond the productive chains approach and towards a systems approach in proposals for rural development, in a context where the resilience strategy is oriented to the reduction of risk levels, rather than the maximization of economic results.

Analysis of the projects demonstrate that while the primary activity of goat husbandry yields an acceptable productive performance, the activity by itself is not enough to satisfy family necessities or the aspirations of family members. Therefore, the focus is on increasing income through aggregate activities. According to Ian Scoones, a central characteristic of the way in which pastoralist producers respond to uncertainty is by relying on different sources of knowledge (Scoones, 2022). On this basis, we can consider that goat producers capitalize on both their knowledge from the exercise of production through trial and error, the knowledge inherited from generations of goat husbandry, and the knowledge acquired from the technicians in the extension projects. Engagement and openness to varied knowledge sources demonstrates a pragmatic perspective in an environment that imposes difficult working conditions. As a result of this innovative stance, new life strategies are developed reaching beyond the scope of goat or agricultural production without neglecting this basic activity, which provides security in its strategy of social reproduction.

5. References

- Balsa, J. (2012). Agricultura familiar, caracterización, defensa y viabilidad. [*Family farming, characterization, defense and viability*] *Revista Interdisciplinaria de Estudios Agrarios*, (pp. 5 - 28). Retrieved from: <https://www.ciea.com.ar/revista-interdisciplinaria-de-estudios-agrarios/revista-num-36/> [accessed on 17 January 2023]
- Catley, A., Lind, J., & Scoones, I. (2012). *Pastoralism and Development in Africa: Dynamic Change at the Margins (1st ed.)*. London: Routledge. <https://doi.org/10.4324/9780203105979>
- Guzmán, F. D. (2019). El rol problematizador de la extensión rural. [*The problematizing role of rural extension*] Mendoza: Facultad de Ciencias Agrarias - UNCuyo. Retrieved from: https://www.academia.edu/43705060/El_rol_problematizador_de_la_extensi%C3%B3n_rural [accessed on 19 January 2023]
- Instituto Nacional de Tecnología Agropecuaria (INTA) AER Malargüe. (2004). *Proyecto de desarrollo territorial integrado. Malargüe, Mendoza* [*Integrated Territorial Development, Malargüe, Mendoza*]. Malargüe, Mendoza.
- Instituto Nacional de Tecnología Agropecuaria (INTA) AER Malargüe, Mendoza. (n.d.). *Desarrollo Territorial Integrado, Carrizalito, Agua Botada, La Salinilla, Agua Nueva*. [*Integrated Territorial Development, Carrizalito, Agua Botada, La Salinilla, Agua Nueva*]. Malargüe, Mendoza.
- Instituto Nacional de Tecnología Agropecuaria (INTA) AER Malargüe, Mendoza. (n.d.). *Proyecto de desarrollo regional a través del aprovechamiento de fibras especiales*. [*Regional Development Project through the Use of Special Fibers*]. Malargüe, Mendoza.
- Instituto Nacional de Tecnología Agropecuaria (INTA) AER Valle del Bermejo. (n.d.). *Fomento del agregado de valor a la producción local y turística de la región*

⁵ Federal Sustainable Rural Development Program of INTA

- del Valle del Bermejo, Provincia de La Rioja. [Promotion of Value-Added to Local and Tourism Production of the Bermejo Valley Region, La Rioja province].* Villa Unión, La Rioja.
- Instituto Nacional de Tecnología Agropecuaria (INTA) Centro Regional Mendoza - San Juan. (2020). *Fortalecimiento de la producción de rumiantes menores en los Valles Cordilleranos de San Juan y Mendoza.* Mendoza: INTA.
- Instituto Nacional de Tecnología Agropecuaria (INTA), AER Valle del Bermejo. (n.d.). *Apoyo al desarrollo socio-productivo del Valle del Bermejo.* [Support for the Socio-Productive Development of the Bermejo Valley]. Villa Unión, La Rioja.
- Ministerio de Justicia y Derechos Humanos. Presidencia de la Nación Argentina. (2015). Law: Historical repair of family farming for the construction of a new rurality in Argentina. *InfoLEG Información Legislativa.* Retrieved from: <http://servicios.infoleg.gob.ar/infolegInternet/anexos/240000-244999/241352/norma.htm> [accessed on 11 January 2023]
- Oba, G. (2012). The sustainability of pastoral production in Africa. In: A. L. Catley (Ed.), *Pastoralism and development in Africa. Dynamic Change at the Margins* (1st ed., pp. 29-36). London: Routledge. <https://doi.org/10.4324/9780203105979>
- Scoones, I. (2022). What pastoralists know. S. Haselby (Ed.), *Aeon.* Retrieved from: <https://aeon.co/essays/what-bankers-should-learn-from-the-traditions-of-pastoralism> [accessed on 17 January 2023]
- SENASA (2020). *Existencias caprinas por provincia. [Goat stocks by province].* Buenos Aires: Ministerio de Economía / Agricultura, Ganadería y Pesca / Senasa. Retrieved from: <https://www.argentina.gob.ar/senasa/caprinos-sector-primario> [accessed on 17 January 2023]

AUTHORS' DECLARATIONS AND ESSENTIAL ETHICAL COMPLIANCES

Author's Contributions (in accordance with ICMJE criteria for authorship)

<i>Contribution</i>	<i>Author 1</i>	<i>Author 2</i>
Conceived and designed the research or analysis	Yes	No
Collected the data	Yes	Yes
Contributed to data analysis & interpretation	Yes	Yes
Wrote the article/paper	Yes	No
Critical revision of the article/paper	Yes	Yes
Editing of the article/paper	Yes	No
Supervision	Yes	No
Project Administration	Yes	No
Funding Acquisition	No	No
Overall Contribution Proportion (%)	70	30

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Research involving human bodies or organs or tissues (Helsinki Declaration)

The author(s) solemnly declare(s) that this research has not involved any human subject (body or organs) for experimentation. It was not a clinical research. The contexts of human population/participation were only indirectly covered through literature review. Therefore, an Ethical Clearance (from a Committee or Authority) or ethical obligation of Helsinki Declaration does not apply in cases of this study or written work.

Research involving animals (ARRIVE Checklist)

The author(s) solemnly declare(s) that this research has not involved any animal subject (body or organs) for experimentation. The research was not based on laboratory experiment involving any kind animal. Some contexts of animals are also indirectly covered through literature review. In general terms ARRIVE does not correspond to our study because we have been analysing technologies applied by farmers, and their relation with the technological proposals originated from the science and technology sector and their extension programs, and not conducting studies with animals. Therefore, an Ethical Clearance (from a Committee or Authority) or ethical obligation of ARRIVE does not apply in cases of this study or written work. Yet, we are appending the filled-in ARRIVE Checklist just for further clarifications.

Research on Indigenous Peoples and/or Traditional Knowledge

The author(s) solemnly declare(s) that this research has NOT involved Indigenous Peoples as participants or respondents, with the documentation of their Indigenous Knowledge. Some other contexts of Indigenous Peoples or Indigenous Knowledge are indirectly covered through literature review. Therefore, an Ethical Clearance (from a Committee or Authority) or prior informed consent (PIC) of the respondents or Self-Declaration in this regard does not apply in cases of this study or written work.

Research involving Plants

The author(s) solemnly declare(s) that this research has not involved the plants for experiment or field studies. The contexts of plants were only indirectly covered through literature review. Yet, during this research the author(s) obeyed the principles of the Convention on Biological Diversity and the Convention on the Trade in Endangered Species of Wild Fauna and Flora.

(Optional) Research Involving Local Community Participants (Non-Indigenous)

The author(s) solemnly declare(s) that this research has involved local community participants or respondents belonging to non-Indigenous peoples. Yet, this study did not involve any child in any form directly or indirectly. The contexts of different humans, people, populations, men/women/children and ethnic people are also indirectly covered through literature review. Therefore, a sample copy of the prior informed consent (PIC) of the respondents was taken under this study before the face-to-face interviews and interactions.

(Optional) PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses)

The author(s) has/have NOT complied with PRISMA standards. It is not relevant in case of this study or written work.

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To see original copy of these declarations signed by Corresponding/First Author (on behalf of other co-authors too), please download associated zip folder [Ethical Declarations] from the published Abstract page accessible through and linked with the DOI: <https://doi.org/10.33002/pp0104>



The ARRIVE guidelines 2.0: author checklist

The ARRIVE Essential 10

These items are the basic minimum to include in a manuscript. Without this information, readers and reviewers cannot assess the reliability of the findings.

Item	Recommendation	Section/line number, or reason for not reporting
Study design	1 For each experiment, provide brief details of study design including: <ol style="list-style-type: none"> The groups being compared, including control groups. If no control group has been used, the rationale should be stated. The experimental unit (e.g. a single animal, litter, or cage of animals). 	
Sample size	2 <ol style="list-style-type: none"> Specify the exact number of experimental units allocated to each group, and the total number in each experiment. Also indicate the total number of animals used. Explain how the sample size was decided. Provide details of any <i>a priori</i> sample size calculation, if done. 	
Inclusion and exclusion criteria	3 <ol style="list-style-type: none"> Describe any criteria used for including and excluding animals (or experimental units) during the experiment, and data points during the analysis. Specify if these criteria were established <i>a priori</i>. If no criteria were set, state this explicitly. For each experimental group, report any animals, experimental units or data points not included in the analysis and explain why. If there were no exclusions, state so. For each analysis, report the exact value of <i>n</i> in each experimental group. 	
Randomisation	4 <ol style="list-style-type: none"> State whether randomisation was used to allocate experimental units to control and treatment groups. If done, provide the method used to generate the randomisation sequence. Describe the strategy used to minimise potential confounders such as the order of treatments and measurements, or animal/cage location. If confounders were not controlled, state this explicitly. 	
Blinding	5 Describe who was aware of the group allocation at the different stages of the experiment (during the allocation, the conduct of the experiment, the outcome assessment, and the data analysis).	
Outcome measures	6 <ol style="list-style-type: none"> Clearly define all outcome measures assessed (e.g. cell death, molecular markers, or behavioural changes). For hypothesis-testing studies, specify the primary outcome measure, i.e. the outcome measure that was used to determine the sample size. 	
Statistical methods	7 <ol style="list-style-type: none"> Provide details of the statistical methods used for each analysis, including software used. Describe any methods used to assess whether the data met the assumptions of the statistical approach, and what was done if the assumptions were not met. 	
Experimental animals	8 <ol style="list-style-type: none"> Provide species-appropriate details of the animals used, including species, strain and substrain, sex, age or developmental stage, and, if relevant, weight. Provide further relevant information on the provenance of animals, health/immune status, genetic modification status, genotype, and any previous procedures. 	
Experimental procedures	9 For each experimental group, including controls, describe the procedures in enough detail to allow others to replicate them, including: <ol style="list-style-type: none"> What was done, how it was done and what was used. When and how often. Where (including detail of any acclimatisation periods). Why (provide rationale for procedures). 	
Results	10 For each experiment conducted, including independent replications, report: <ol style="list-style-type: none"> Summary/descriptive statistics for each experimental group, with a measure of variability where applicable (e.g. mean and SD, or median and range). If applicable, the effect size with a confidence interval. 	

**INFORMATION AND CONSENT FORM FROM RESPONDENTS
(Non-Indigenous or Indigenous Respondents)**

This form was translated into local language for the respondents

**Title of the Research: Technological Strategies Implemented by Livestock
Farmers Specialized in Goat Breeding in the Mountain Region of San Juan,
Mendoza and La Rioja Provinces in Argentina**

Principal Researcher: Fernando Diego Guzmán
Area of Research and Technological Development for
Family Farming, CR Mendoza – San Juan, National Institute
of Agricultural Technology of Argentina, Argentina

Research Supervisor: Self

A) INFORMATION TO PARTICIPANTS

1. Objectives of the research

The objectives of this study were to clearly identify and understand the technological strategies implemented by the livestock farmers specialized in goat breeding in the mountain regions of San Juan, Mendoza and La Rioja Province.

2. Participation in research

The researcher will ask you several pertinent questions. This interview will be recorded in written form and should last about 50-60 minutes. The location and timing of the interview will be determined by you, depending on your availability and convenience.

3. Risks and disadvantages

There is no particular risk involved in this project. You may, however, refuse to answer any question at any time or even terminate the interview.

4. Advantages and benefits

You will receive intangible benefits even if you refuse to answer some questions or decide to terminate the interview. You will also contribute to a better understanding of the causes for livelihood transformation of livestock keepers.

5. Confidentiality

Personal information you give us will be kept confidential. No information identifying you in any way will be published. In addition, each participant in the research will be assigned a code and only the researcher will know your identity.

6. Right of withdrawal

Your participation in this project is entirely voluntary and you can at any time withdraw from the research on simple verbal notice and without having to justify your decision, without consequence to you. If you decide to opt out of the research, please contact the researcher at the telephone number or email listed below. At your

request, all information concerning you can also be destroyed. However, after the outbreak of the publishing process, it is impossible to destroy the analyses and results on the data collected.

B) CONSENT

Declaration of the participant

- ⇒ I understand that I can take some time to think before agreeing or not to participate in the research.
- ⇒ I can ask the research team questions and ask for satisfactory answers.
- ⇒ I understand that by participating in this research project, I do not relinquish any of my rights, including my right to terminate the interview at any time.
- ⇒ I have read this information and consent form and agree to participate in the research project.
- ⇒ I agree that the interviews be recorded in written form by the researcher: Yes () No ()

Signature of the participant : _____ Date : _____

Surname : _____ First name : _____

Researcher engagement

I explained to the participant the conditions for participation in the research project. I answered to the best of my knowledge the questions asked and I made sure of the participant's understanding. I, along with the research team, agree to abide by what was agreed to in this information and consent form.

Signature of the researcher :



Date : 02-12-2022

Surname: Guzmán

First name: Fernando

- ⇒ Should you have any questions regarding this study, or to withdraw from the research, please contact Fernando Diego by e-mail guzman.fernando@inta.gob.ar
- ⇒ If you have any concerns about your rights or about the responsibilities of researchers concerning your participation in this project, you can contact the Area of Research and Technological Development for Family Farming, CR Mendoza – San Juan, National Institute of Agricultural Technology of Argentina by email guzman.fernando@inta.gob.ar

The Traditional Sheep Penning System: An Exploratory Study on Farmers' Preferences, Farmer-Pastoralist Relationships and Economics of Sheep Penning in Telangana, India

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Abstract

Penning of livestock especially in the southern Indian peninsula can be traced back to the Neolithic age. The presence of 'Ashmounds' across most parts of the southern Indian peninsula indicates a complex agro-pastoral economy flourishing since the Neolithic era. Contemporary studies on sheep penning in India, however, remain mainly focused on its contribution to soil fertility and relevance to organic farming and economics, but very few studies have focussed on the farmers' preference for sheep penning, farmer-pastoralist relationships and sheep penning economy in the backdrop of a rapidly changing agriculture landscape in the Telangana state of India. Observations of the study indicate that changes in agricultural practices and decrease in commons have led to changes in the sheep flock size, seasonal migration pattern of pastoralists and farmers' preference for sheep penning in the study area. Participant farmers of the study, who practice both penning and application of synthetic fertilizer, reported to have incurred relatively lesser input costs than the farmers who exclusively rely on synthetic fertilizers. Penning was reported to be the second major source of household income for the pastoralists who participated in the study, next to the sale of live animals.

Keywords

Penning; Sheep; Pastoralism; Deccan Plateau; Telangana; Exploratory study

1. Introduction

India has an estimated 535.78 million livestock population (Government of India, 2019). About 80 per cent of which is reared by the rural and pastoralist communities and maintained under extensive livestock management systems (Phand et al., 2021). Penning of livestock is an ancient and the most common practice in the extensive livestock management and pastoralist systems across the world. Penning of livestock especially in the southern Indian peninsula can be traced back to the southern Indian Neolithic age (Korissettar et al., 2001a; Krishna & Morrison,

2009; Murthy & Sontheimer, 1980; Southworth, 2006). The presence of 'Ashmounds' (the remnants of large mounds or heaps of highly-fired cattle dung) across most parts of the southern peninsula indicate existence of a complex agro-pastoral economy flourishing since the Neolithic era (Allchin & Allchin, 1982; Kennedy, 2000; Korisettar et al., 2001b; Morrison, 2007; Murthy & Sontheimer, 1980).

The study by Sekhar (2015) indicates that during the pre-colonial period, despite the availability of permanent village pastures, livestock (cattle and sheep) were regularly driven inside forests for fodder and water, especially during the periods of scarcity. However, dung was never collected from forests, which was the possible reason for improved soil fertility of forests in the region. The pens/corrals were known as *patti* in the regional Tamil language. They were called either as "*maattupatti* (or) *thondupatti*"¹ based on the type of livestock enclosed in the penn/corral. There is also a frequent reference to *patti* in the old Tamil literature (Sekhar, 2015). However, scholars have a divided opinion about the specific relevance of heaping and burning such large piles of dung, as it holds both social and ritual importance (Johansen, 2003; Allchin, 1963) as well as the utilitarian economic value (Paddayya, 1992, 1974).

A few significant geo-ethno-archaeological studies in Africa have shed many interesting insights on the ecological functions of ancient penning sites of pastoralists (Eguez et al., 2017). A study by Marshall et al. (2018) suggests that African grasslands have been enriched, restructured and diversified by the penning and herding activities of the pastoralist communities of Africa. The study by Donihue (2013) on Savannas of Kenya found relatively larger and fast growing trees and higher densities of *Lygodactylus keniensis*, a native gecko species at the edges of glades, suggesting that dung deposits of the ancient penning sites of pastoralists could be the reason behind the presence of large, fast growing trees and higher densities of geckos at the edges of the glades.

Sheep is one of the earliest domesticated animals (Daly et al., 2021; Nomura et al., 2013) and nomadic sheep rearing till today remains one of the dominant ways of rearing. Traditionally, sheep rearing was the primary occupation of a few specific pastoralist communities of the sub-continent (Somvanshi, 2006). The *Dhangars* of Maharashtra, *Kuruma* of Andhra Pradesh and Telangana, *Kuruba* of Karnataka (of the Deccan Plateau region) (Aerukala, 2020; Murthy & Sontheimer, 1980), the *Konar* of Tamil Nadu, the *Bakarwals* of Jammu and Kashmir, the *Gaddis*, *Kanets*, *Kaulis* and *Kinnauras* of Himachal Pradesh, the *Bhotias* of Uttarakhand, the *Raikas* of Gujarat and Rajasthan are particularly associated with sheep and goat rearing in India and are well known for sharing an intricate socio-cultural, religious, spiritual, and economic relationship with them (Koller-Rollefson, 1994; Patil, 2009; Sharma et al., 2003).

Livestock in India produces more than 2600 million tons of dung per year (Kaur et al., 2017). Penning of sheep and other livestock provides a regular supply of dung that is used for manure, fuel and building material (Portillo et al., 2015) and also has cultural and ritualistic significance (Notermans, 2019; Udayavani, 2020; Vedas Resources, 2012). However, contemporary studies on sheep penning in India remain mainly focused on its contribution to soil fertility and relevance to organic farming (Nandhini & Suganthi, 2018; Sriveda & Srihitha, 2020) and economy (Kolay, 2007; Shivkumara & Kiran, 2019); but very few studies have focused on the farmers' preference for sheep penning, farmer-pastoralist relationships and sheep penning economy in the backdrop of the rapidly changing agriculture landscapes in India in general and Telangana in particular.

¹. Cattle/buffalo are called *Mattu*, and livestock is called *Thondu*, in Tamil, the regional Language mainly spoken in the Indian state of Tamil Nadu.

The Telangana Socio Economic Outlook report of Government of Telangana (2022) suggests that the overall gross irrigated area in the state has increased by 119% (6.2 million acres in 2014 to 13.6 million acres in 2020), since bifurcation of the state from the former undivided Andhra Pradesh in 2014. The state also moved away from cultivation of the traditional dryland food crops of pulses and millets, and adopted cultivation based on more water intensive paddy (increase by 378%) and synthetic fertilizer intensive commercial crops of cotton (increase by 61%) (Government of Telangana, 2022). Sheep pastoralists do not prefer to graze their flocks among damp and inundated farmlands as sheep have evolved in dry and arid conditions and naturally averse to dampness.

Telangana is now the second largest producer of cotton and paddy in India (Government of Telangana, 2022). It was assumed that the changing agriculture landscapes and shift in crop choices may have some impact on the farmers' preference for sheep penning, farmer-pastoralist relationships and sheep penning economy in Telangana. In this background, an exploratory study was commissioned by Sahjeevan - Center for Pastoralism (Cfp)² during 2019-20 to examine famers' preference for sheep penning, farmer-pastoralist relationships and economics of sheep penning tradition in Telangana state (part of the Deccan plateau region of India).

2. Methodology

The study adopted an exploratory study design (Fusch et al., 2017) for scientific inquiry. Adopting the exploratory study design was appropriate for the present study for the following reasons. There were a lot of ambiguity surrounding farmer-pastoralist relationships, negotiations, and economics of sheep penning in Telangana due to lack of similar detailed studies. The objective of the study was to discover new findings and ideas for further research (Kurt et al., 2011). Furthermore, the finances were extremely meagre, and the study coincided with the outbreak of the COVID-19 pandemic in the study area, which greatly limited the sample size and rigour of investigation.

The study area is geographically located in the Telangana state situated in the semi-arid Deccan plateau region of India. It experiences a hot and dry tropical weather. Based on the weather and climatology and soils, the state is broadly divided into three major agro-climatic zones – the Northern Telangana Zone (NTZ), the Central Telangana Zone (CTZ), and the Southern Telangana Zone (STZ) (TSDPS & DES, 2021).

The NTZ comprises of 10 districts, the CTZ comprises of 12 districts and the STZ comprises of 11 districts. Two agro-climatic zones and one district from each agro-climatic zone were selected following the random sampling technique (Bartlett II et al., 2001; Bryman, 2012). Kamareddy district represents the NTZ and Vikarabad district represents the STZ of the state. Both the study districts represent different agro-ecological zones with different precipitation rates, soil and crop profiles and densities of sheep population. It was assumed that such diversity would provide an opportunity to investigate the soil fertility management practices and penning choices of farmers of the study area.

Criterion sampling, a variant of the purposive sampling technique (Cresswell, 2013), was adopted for selection of research participants. Pastoralists involved in mobile sheep pastoralism, and two types of farmers were considered as research participants – farmers who prefer for both penning and synthetic fertilizers and farmers who prefer only synthetic fertilizers for improving soil fertility.

² Sahjeevan is a grassroots organisation based in Bhuj, Gujrat, India. 'Sah' means together and 'Jeevan' is living, implying harmonious-living. The organization envisions a world where pastoral communities will continue their traditional livelihoods living in harmony with nature. The Centre for Pastoralism is an initiative of Sahjeevan, with an objective to promote understanding of Indian pastoralism through action-research and advocacy.

Data was gathered by conducting personal interviews and focus group discussions (FGDs) (Mukherjee, 2003). As a protocol of an exploratory study, it is necessary to learn from the communities themselves. In an exploratory study, data collection is a kind of learning process than collection of evidence for predetermined set of questions. Therefore, a semi-structured questionnaire with predominantly open-ended questions was used for data collection (Fusch et al., 2017). Data was collected through personal interviews and focus group discussions (FGDs) while strictly adhering to the COVID-19 protocols issued by the Government of India during the pandemic. Data was mixed but predominantly qualitative in nature, consisting of anecdotes, personal stories and experiences of farmers and pastoralists.

A two phase data collection strategy was adopted to ensure data saturation (Francis et al., 2010). The two phase sampling strategy comprises of an 'initial analysis sample' and 'stopping criterion' (Francis et al., 2010) to achieve data saturation. The assumption was that data saturation occurs when no new information emerges from the research subjects. As assumed, data related to farmer-pastoralist interpersonal relationships, price negotiations related to penning, farmers' crop choices and soil management practices reached saturation with the initial analysis sample of 24 respondents and further new information hardly emerged thereafter.

Qualitative data collected through interviews and FGDs was transcribed. Transcripts were subjected to inductive coding to initiate the coding process (Leech & Onwuegbuzie, 2007). Codes such as mode of communication between pastoralists and farmers, choice of farms for penning, terms and conditions for penning, and change in interpersonal relationships have emerged naturally from the data itself (Leech & Onwuegbuzie, 2007; Fereday & Muir-Cochrane, 2006). Report was developed by collating the coded information found to be common among the transcripts. Quantitative data related to the size of land, size of sheep flock, fee paid for penning, amount of fertilizer used is analyzed using cross-tabulation for descriptive purposes (Miles et al., 2019).

3. Results

3.1. Profiles of the Pastoralists and Farmers of the Study

The sheep pastoralists of the study predominantly belong to the Kuruma community (known also as Dhangar in Maharashtra and Kuruba in Karnataka). The other community found to have been engaged in sheep pastoralism is Yerra Golla (a sub-set of the Golla/Yadava community). Both the communities belong to the other backward caste³ (OBC) category (Table 1). The average age of the participating pastoralists in the study is 43.5 years. The average duration for which they were involved in pastoralism is 24.5 years. Literacy rate among the pastoralists participated in the study was only 35.7% with 64.3% illiterates. Nuclear family is the common family structure among the study participants with the average family size of 4 persons.

Table 1: Details of the Communities Involved in Sheep Pastoralism

<i>Name of the Pastoralist Community</i>	<i>Community Category</i>	<i>Number of Households (n = 14)</i>	<i>Percentage of Households</i>
Kuruma	OBC	10	71.4
Yerra Golla	OBC	4	28.6

³ https://en.wikipedia.org/wiki/Other_Backward_Class

Participant farmers of the study belong to the small and medium landholder category. The average age of the participant farmers is 43.8 years. The average number of years they are involved in farming is 18.4 years. Participant farmers of the study belong to Kuruma, Telugu Mudiraj Matsya and Yerra Golla communities belonging to the other backward castes (OBC) and Reddy community belongs to the general category (GN) (Table 2).

Table 2: Details of the Communities Involved in Agriculture

<i>Name of the Community</i>	<i>Category of the Community</i>	<i>Number of Households (n = 10)</i>	<i>Percentage of Households</i>
Kuruma	OBC	2	20
Reddy	GN	3	30
Telugu Mudiraj Matsya	OBC	3	30
Yerra Golla	OBC	2	20

Similar to pastoralists, farmers of the study also have nuclear families and the average size of the family is 4 members. Only 40% of the farmers are found to have primary level education with 60% illiterates. The average landholding size (own land) of the studies farmers is 7.4 acres. However, it was found that there is a difference in the average landholding size (own land) of farmers who are practicing both penning and chemical fertilizers and farmers who are using only chemical fertilizers to maintain soil health and enhance productivity.

The average landholding (own land) of the participant farmers who are practicing both penning and chemical fertilizers is 9.3 acres (rainfed 7 acres and irrigated 2.3 acres). The average landholding (own land) of farmers applying only chemical fertilizers is 4.5 acres (rainfed 3.5 acres and 1 acre irrigated). In addition to the own land, farmers relying exclusively on chemical fertilizers were found to lease-in land and the average size of lease-in land is 4.2 acres (rainfed) (Table 3). The crops cultivated by the participant farmers was found to be quite narrow and the major crops reported were paddy, pigeon pea, cotton, sugarcane and peanut.

Table 3: Profiles of the Pastoralists and Farmers of the Study

<i>S.No.</i>	<i>Variables</i>	<i>Pastoralists (n = 14)</i>	<i>Farmers (Penning and Chemical Fertilizers), (n = 6)</i>	<i>Farmers (Only Chemical Fertilizers), (n = 4)</i>
1.	Primary occupation	Sheep pastoralism	Rainfed agriculture	Rainfed agriculture
2.	Average age	43.5	42.6	43
3.	Average years involved	24.5	17.6	19.5
4.	% with primary education	35.7	50	25
5.	Average family size	4	4	4
6.	Average size of own flock (sheep)	139	0	0
7.	Average size of own land holding (in ac)	2.5	9.3	4.5
8.	Average size of lease in land (in ac)	1	0	4.2

Although results of the present study allude to a positive correlation between the small landholding size and exclusive use of chemical fertilizers (Figure 1), but observations of the present study remain inconclusive for two reasons: extremely small dataset and the lack of detailed inquiry in that direction. Further, studies on the

relationship between farm size and the use of chemical fertilizers or adoption of organic agriculture practices also remain inconclusive.

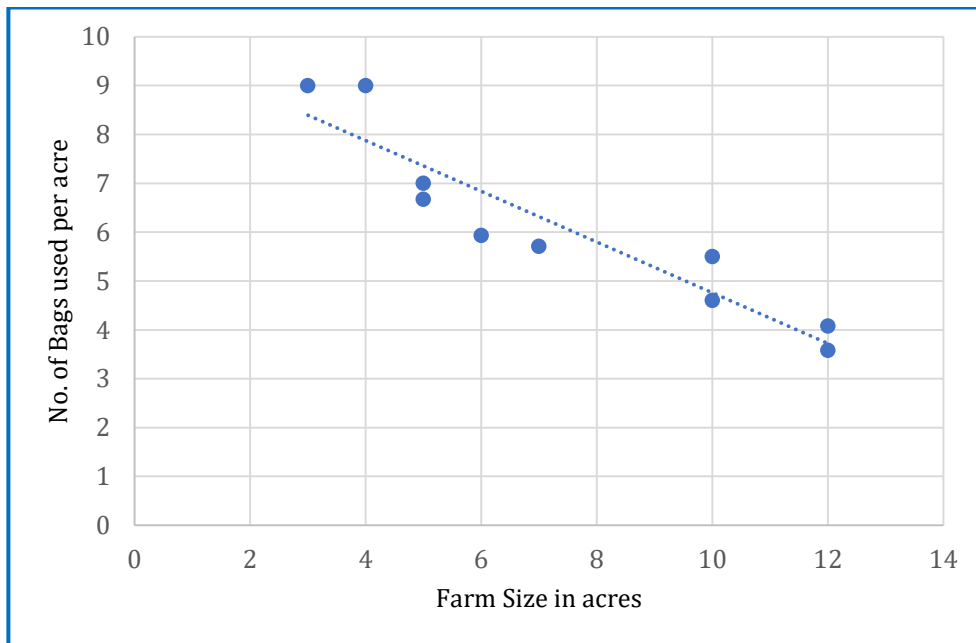


Figure 1: The Correlations Between the Land Size and Number of Synthetic Fertilizer Bags Used Per acre

3.2. The Major Livestock Species found in Sheep Pastoralism

The major livestock species maintained by pastoralists under the study is sheep. The average flock size of sheep of the study is 139 animals. The pastoralists also keep a few goats among the sheep and the average number of goats kept in the flock is 8 animals. Pastoralists under the study have reported to leave a few sheep (usually sick/injured) back home and the average number of such sheep is 28. Pastoralists under the study also lease in sheep from neighbours/others of their native villages and the average number of such lease in sheep is 21. The owners of such sheep pay an agreed amount (cash and kind) to pastoralists for taking care of their sheep.

Poultry also forms an important part of the livestock kept by the pastoralists under the study and the average number of chicken maintained by pastoralists is 8 birds. Traditionally, dogs have always been associated with pastoralism and enjoy a very special place in the culture and traditions of the Kuruma community. They are kept for herding and guarding the livestock and also as a regular companion to humans. The average number of dogs kept by pastoralists under the study is 2. In addition, pastoralists were also found to keeping a few other livestock, usually pony/bullock kept as pack animals and the average number of such other livestock is 2.

Earlier (some 25–30 years ago), the average size of the sheep flock was 312 animals (55.4% larger than the present flock size). Traditionally, other livestock of goats, poultry, pack animals and dogs have been a part of sheep pastoralism in the study area. Like today, goats were kept among sheep earlier too and the average number of goats was 42 animals (81% more animals than the present number). Chicken were kept earlier too and the average number of chicken was 13 birds (33% more birds than present). The average number of sheep herding/guardian dogs kept earlier was 2. The average number of other livestock kept for pack animals earlier was 3. Similar to today, sheep were leased in earlier too and the average number of sheep leased in was 40 (46.2% higher than present) and the average number of goats leased in earlier was 14.

3.3. Seasonal Migration Patterns and the Penning Season

The inception of seasonal migration in the study area is usually during the month of November–January. However, pastoralists often linger around their native villages till the end of November and leave for seasonal migration during the month of December–January. It was observed that pastoralists of the two study districts prefer different routes of seasonal migration. For instance, pastoralists of Vikarabad district migrate south-west towards Sedam in Karnataka, about 100 km from their native villages. Pastoralists of Kamareddy district tend to migrate north-west towards Nanded in Maharashtra, about 200 km from their native villages.

The penning season in the study area usually commences during the month of December–January and concludes during the month of April–June. The average duration of penning season during the year 2020 was 106.8 days (3.5 months) and the average number of days spent on penning at each farm was 5.2 days.

A sheep flock is referred to as *gumpu* or *manda* in Telugu, the regional language of the study area. It was reported that two to three pastoralists, usually of the same village, come together to form a group, which is called locally as “*Melam*”. A *Melam* consists of both pastoralists and their livestock. They stick together throughout the migration season – they graze, pen, cook and eat together. The few main reasons for pastoralists coming together to form *Melam* are – security during migration, sharing of labour (usually one of them goes out in search of potential farms for grazing and penning), and to increase the size of the flock as farmers in the study area usually prefer to pen a flock having more than 500 sheep. Further, pastoralists (both sheep and cattle) of the study area usually hire one or two labourers for taking care of the livestock (Siripurapu et al., 2020; Siripurapu, 2021).

3.4. Hiring of Penning Services in the Study Area

The average number of farmers hiring penning services was observed to have been increasing steadily over the past five years in Telangana study area. For instance, the average number of farmers hiring penning services in the year 2019 was 43.7 (68% increase) compared to 26 number of farmers hired the same in the year 2016 (Figure 2). The year 2020 has shown a 66% dip in the number of farmers hiring penning services in the study area and it can be attributed to the COVID – 19 induced lockdown (Siripurapu, 2021).

Farmers in the study area pay both in cash and kind (food grains) to pastoralists in return for penning at their farms. The average penning fee per night collected from farmers was INR 985.7 (USD 9.55) for an average flock size of 600-800 sheep during the year 2020. On an average, pastoralists in the study area charge INR 1.5–2 per sheep for penning per night. Author’s personal observations of penning economy of cattle pastoralists in four districts of Kamareddy, Nagarkurnool, Nizamabad and Rajanna-sircilla of Telangana also indicate that cattle pastoralists charge between INR 8-10 per animal per night for penning (Siripurapu et al., 2020). It was observed that there has been a steady increase in the average penning fee per night in the study area. For instance, the average fees collected from farmers for penning a flock of the size between 600-800 sheep per night during the year 2016 and 2020 were INR 535.7 (USD 6.51) and INR 985.7 (USD 9.55), respectively (Figure 3). There has been 84% increase in the average penning fee per night from the year 2016 to 2020. As per the response of the participant farmers and pastoralists, one of the major drivers behind the increase in penning fee is the increase in the demand for organic farm inputs and agriculture area and the decrease in number of households rearing livestock (both large and small ruminants). However, further in-depth studies are required to ascertain this.

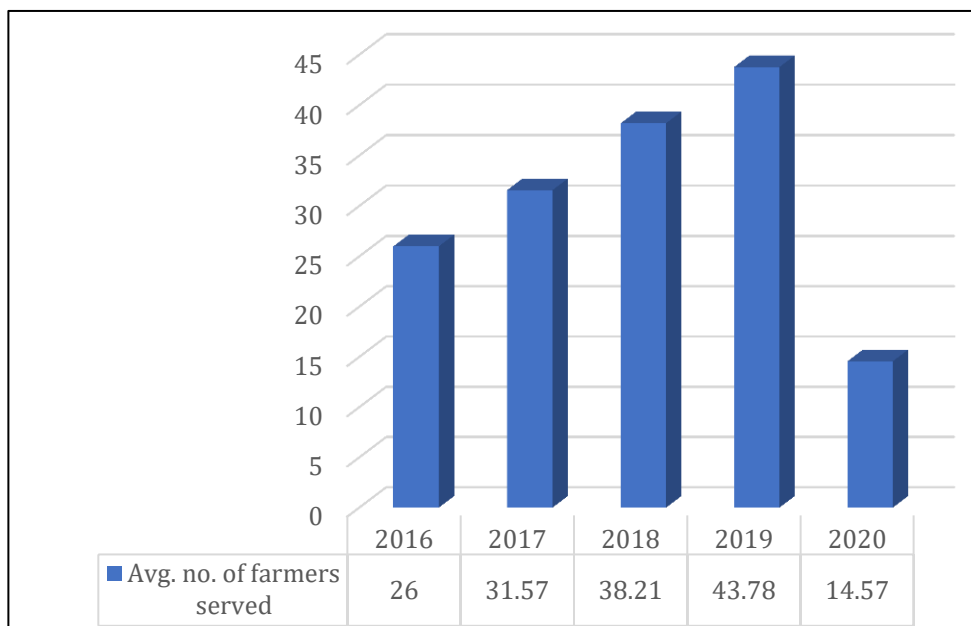


Figure 2: The Average Number of Farmers Hiring Penning Services for the Past Five Years in the Study Area

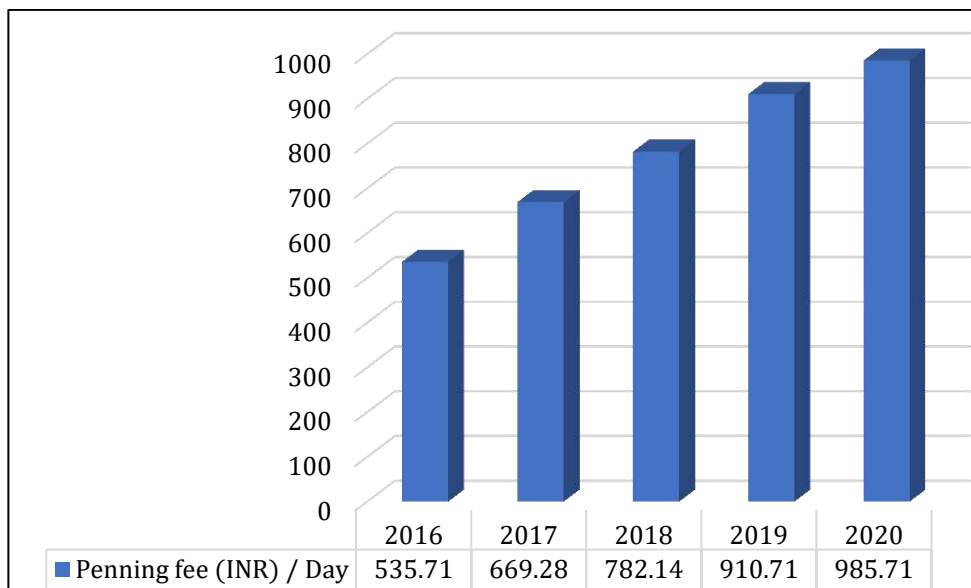


Figure 3: Sheep Penning Fee (INR) /night in the Study Area

Payment in kind (known locally as *Bettam*) by farmers to pastoralists in the study area includes 5-8 kg of food grains (usually rice). Traditionally, food grains were paid in kind to both the pastoralists and their guarding dogs. It was reported that during the period 2016 – 2019 pastoralists were paid mainly 5-6 kg of rice in kind, and only 7% of the respondents have reported to also have received vegetables during 2016 - 2019. However, there is not only an increase in the amount of rice (5-8 kg) but even vegetables (100% HHs) have made their way into *bettam* since the year 2020. It was reported that farmers in the study area have started vegetable cultivation on small-scale on a few decimals of land for domestic consumption, since the advent of borewells at individual farms. Farmers usually share a few vegetables from their gardens with pastoralists as a part of *bettam*. However, it is unclear whether COVID-19 induced lockdown has played any role in the inclusion of vegetables in *bettam* during the year 2020.

3.5. Contribution of Penning to the Pastoralist Household Income

Pastoralism is the mainstay of pastoralists of the study area. The household (HH) income of pastoralists is derived from multiple sources that include the sale of livestock, penning, sale of dung, agriculture and others (usually wage labour and occasional sale of small quantities of wool and wool-based products). The mainstay of pastoralist HH income however is the sale of livestock. The average annual pastoralist HH income from the sale of livestock in the year 2020 was INR 199,143 (USD 2,420). It was observed that the average annual HH income from penning in the year 2020 was INR 99,357 (USD 1,207), accounting to the second major source of the pastoralist HH income in the study area (Figure 4).

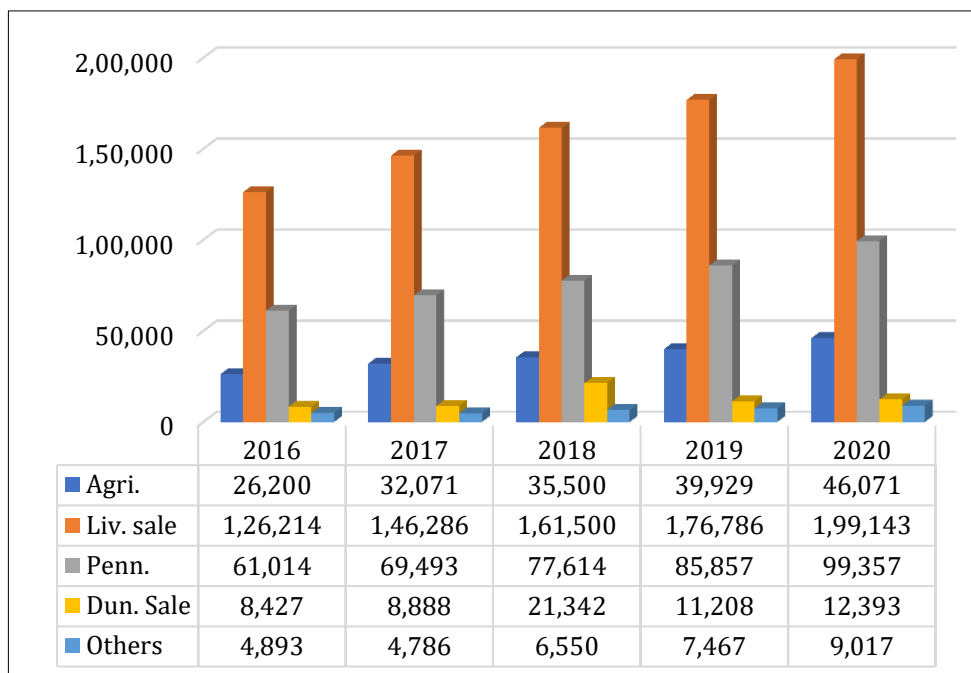


Figure 4: The Different Sources of Annual Pastoralist Household Income in the Study Area

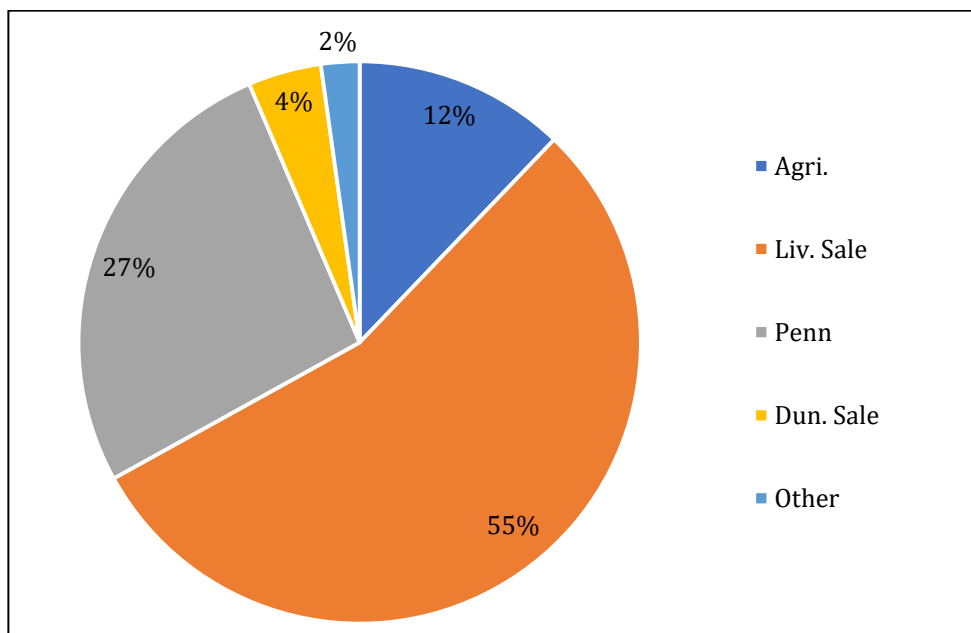


Figure 5: The Share (in %) of Sources of Income of Pastoralist Households in the Study Area (Year 2020)

It was observed that the percentage share of penning, sale of dung and other sources of pastoralist’s annual HH income remains fairly static in the financial year 2016 and 2020. However, a slight (1%) variation was observed in the percentage of share of pastoralist annual HH income from agriculture and livestock. The percentage share of annual HH income from agriculture has increased by 1% and the percentage share of livestock of the HH income has decreased by 1% during the period 2016 – 2020 (Figure 6).

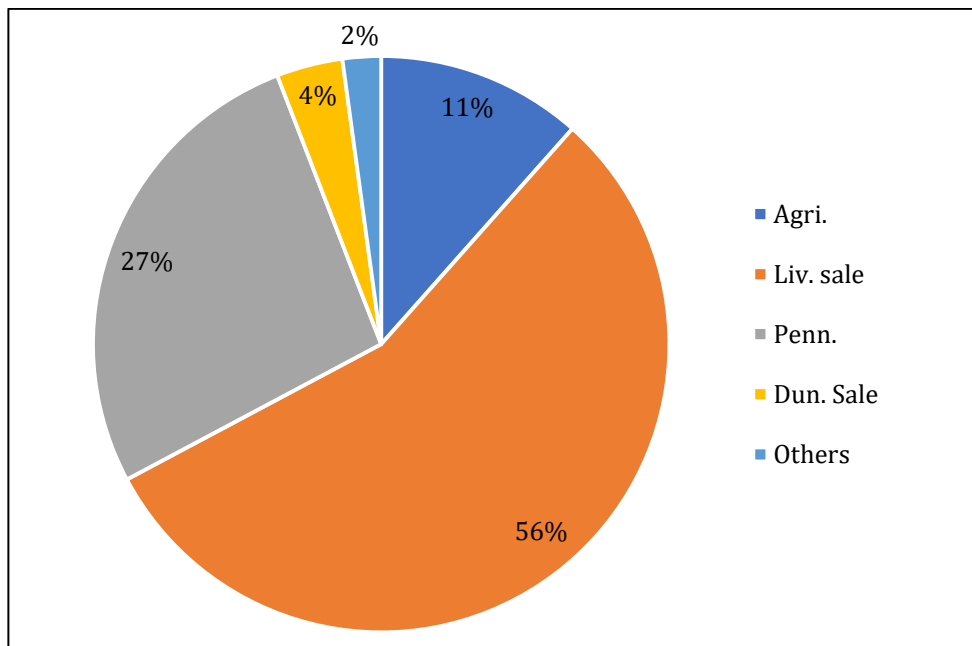


Figure 6: The Share (in %) of Sources of Income of Pastoralist Households in the Study Area (Year 2016)

3.6. Investment of Farmers on Penning in the Study Area

On an average, farmers have been practicing in penning for 20 years in the study area. Farmers of the study area have reported that pastoralists charge anywhere between INR 500 (USD 6.08) and INR 1,450 (USD 17.62) for penning for a night. On an average, a farmer pays INR 850 (USD 10.33) for penning for a night. Farmers in the study area usually prefer a flock with more than 500 sheep and an ideal flock should have anywhere between 600 and 800 sheep. The average number of days farmers hire penning services is 5.2 days; however, a few farmers would not mind having the flocks at their farms for a bit longer.

The average investment on penning per acre is INR 2,465 (USD 29.96) in the study area. However, penning is usually practiced in a three year cycle, which means, farmers would invite flocks for penning on the same piece of land only once in three years. Farmers reported that approximately 60% of farmers of the studied villages apply chemical fertilizers as well as practice penning to maintain soil health and enhance yields. It was also reported that approximately 40% of farmers of the studied villages almost exclusively rely on chemical fertilizers for the same. It was found that farmers of Vikarabad district seem to have a strong preference for sheep penning while the farmers of Kamareddy district have shown interest in both penning the cattle and sheep.

3.7. The Impact of Penning on the use of Chemical Fertilizers in the Study Area

Observations of the study indicate that the average amount (in INR) spent per acre on chemical fertilizers by farmers practicing penning and applying chemical fertilizers is

relatively lower (47.6%) than the average amount spent by farmers applying only chemical fertilizers (Figure 7). While the average amount spent on chemical fertilizers per acre by farmers practicing penning and applying chemical fertilizers and farmers using only chemical fertilizers in the year 2020 was found to be INR 4,900 (USD 59.55) and INR 7,472 (USD 90.81), respectively. It was however, observed that there is no significant difference in the amount spent on application of pesticides between both the groups. The amount spent per acre on pesticides by farmers practicing penning and applying chemical fertilizers and farmers using only chemical fertilizers in the year 2020 were found to be INR 1,352 (USD 16.43) and INR 1,340 (USD 16.29), respectively. Farmers who practice penning have reported that dung and urine deposited by sheep (or cattle) enriches soil fertility (Immanuel et al., 2010). The fertility of the soil treated with penning usually lasts for three years (or three cropping seasons), because of which the need for application of chemical fertilizers decreases considerably. Farmers in the study area usually treat a piece of land with dung or penning once in three years (or three cropping seasons) to maintain soil fertility.

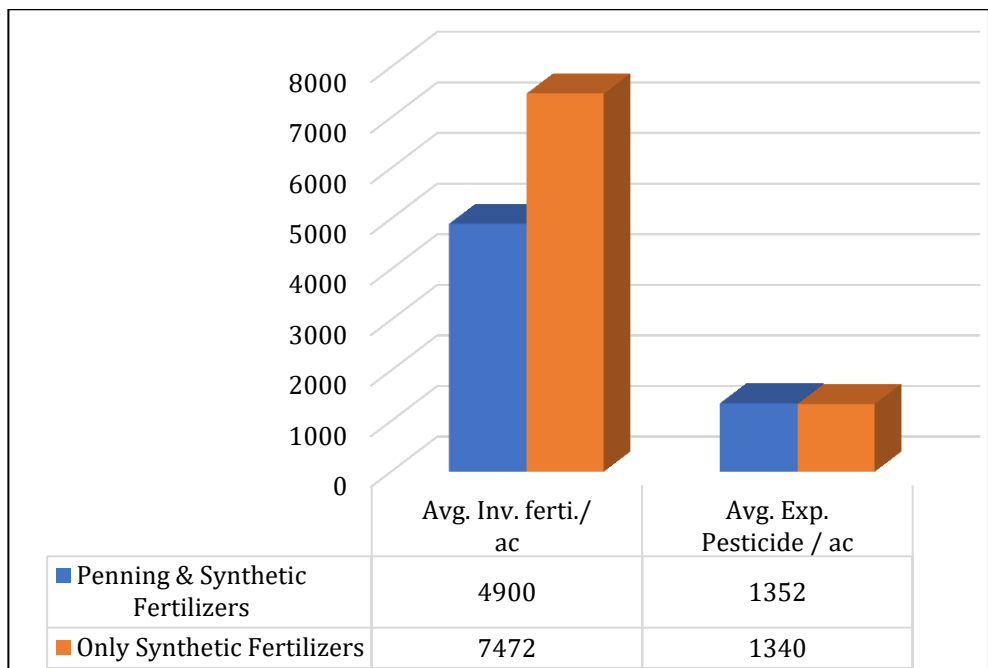


Figure 7: Difference in the Amount Spent (in INR)/per acre on Synthetic Fertilizers and Pesticides by Farmers Practicing Penning and Synthetic Fertilizers and Farmers Applying only Synthetic Fertilizers in the FY 2020

It was evident from observations of the study that both the groups of farmers use chemical fertilizers and pesticides for maintenance of soil health and control pests and diseases. It was however noticed that the average number of bags of urea + DAP (di-ammonium phosphate) used by both the groups vary. Farmers practicing penning and applying chemical fertilizers seem to be applying 60% less number of bags when compared with the farmers using only chemical fertilizers. The average number of bags of chemical fertilizers per acre by farmers practicing penning and applying chemical fertilizers and farmers using only chemical fertilizers in the year 2020 was found to be 5 and 8, respectively (Figure 8).

3.8. Communication between Farmers and Pastoralists over Penning

Usually, one of the members of the pastoralist group (*Melam*) or a family member goes out in search of potential farms for grazing and penning. Likewise, farmers also go out in search of pastoralists and invite them to stop by their farmlands for

penning. Farmers and pastoralists keep in touch and communicate with each other over the phone or social networks. It was found that farmers and pastoralists of the study area are acquainted with each other for over 20 years, on an average.

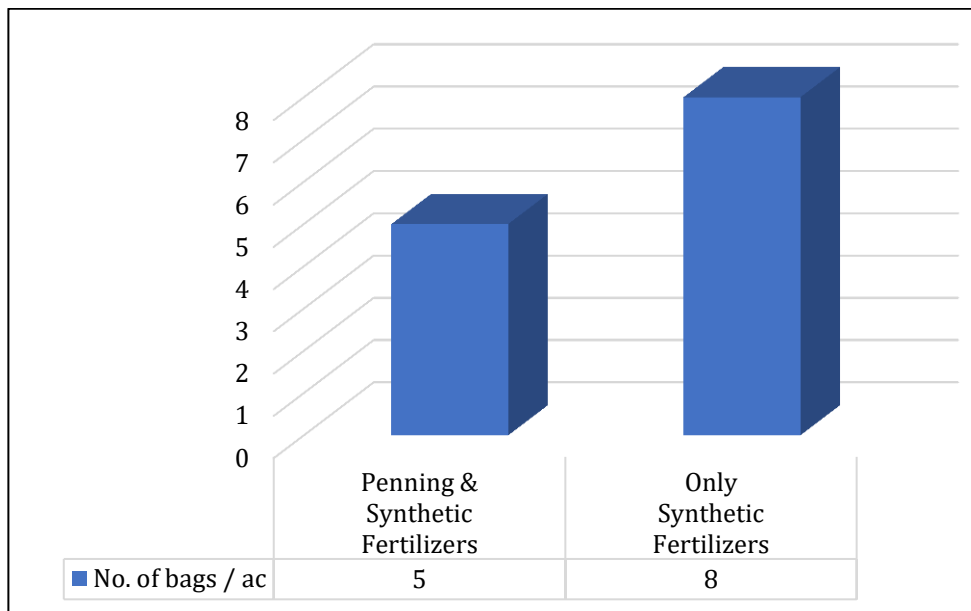


Figure 8: Difference in the No. of Bags (Urea + DAP) used per acre by Farmers Practicing Penning and Synthetic Fertilizers and Farmers Applying only Synthetic Fertilizers

3.9. Criteria used by Pastoralists for Choosing a Farm for Penning

It was noticed that pastoralists use an elaborate set of criteria for choosing a potential farm for penning. The criteria used by pastoralists include availability of sufficient fodder and water for their livestock, potential duration of their stay at a farm, existing crops both at the farm chosen for penning and the adjacent farms, character of the farmer and their history of payment for penning, safety of the livestock, presence and convenience of route that they may use for onward journey, safety of the route, and presence of other flocks along the way on the onward journey to avoid any potential competition or conflict among the pastoralists.

3.10. Terms and Conditions of Pastoralists to Penn at a Farm

Pastoralists under the study have reported to have a few unwritten terms and conditions for penning at a farm. They would confirm the number of days of stay at a farm and the amount paid by a farmer for penning for a night. They would confirm whether a farmer expects a goat/sheep ram in exchange to allow grazing and staying at a farm. They would also consider the availability of enough fodder and water for the flock. Usually nothing takes place in written form and pastoralists often get into oral agreement with farmers in the presence of a third person (mediator/witness). The oral agreements over penning include payments in cash and kind from farmers and donation of a lamb (goat or sheep) to farmers by the pastoralists.

3.11. Terms and Conditions of Farmers to Allow Penning at Their Farms

Farmers in the study area decide the penning fee based on the size of the flock/herd. Farmers usually prefer a flock having about 600 – 800 sheep and do not find a flock with less than 500 sheep desirable for penning. In case of cattle, farmers prefer a herd with 200-400 cattle heads. The average cycle of penning at the farm in the study area is 3 years. In addition, farmers of the study area often lay down a few conditions to allow flocks for grazing and penning at their farms. Pastoralists are asked to prevent

their flocks from going astray and raid crops on their own farm or the neighbouring farms. Pastoralists are asked to take their flocks for drinking water at water bodies of the village without letting out their livestock into farms along the route and prevent any potential crop raiding. Pastoralists are asked to use water from the bore-well and straw heaps at a farm judiciously. Pastoralists are asked not to cut or pollard trees at the farm or neighbouring farms to feed their flocks. Farmers often make it clear that in case of any crop raiding by the flock, either on own farm or neighbouring farms, the compensation will be borne by the pastoralists.

3.12. Changes in Interpersonal Relationships and Terms and Conditions over Time

The changes in cropping pattern, increase in area under agriculture, and decrease of commons, among others have brought quite a few changes not only in the livestock population and seasonal migration, but also in the interpersonal relationships between farmers and pastoralists in the study area. It was said that the area under cultivation has increased and livestock has decreased in the study area. This shift has led to farmers actively pursuing pastoralists to pen at their farms in exchange for money.

Unlike earlier, pastoralists are now migrating further away from their native villages and relatively spending very little time at each farm, leading to disruption of long-term relationships that they have enjoyed traditionally. Penning has now become more of a commercial activity than a co-dependent relationship. Earlier, money was not a part of the penning tradition, but now it has turned into a major income generation activity for pastoralists of the study area. Agreements over payment or exchange of livestock are made first before entering a farm for grazing or penning.

Earlier, pastoralists used to give a goat or sheep ram voluntarily as a present on family functions and festivals of landowners but such practices have now become a part of the formal agreements of grazing and penning. Pastoralists have started procuring fodder from market in case of need, a practice which was uncommon earlier.

4. Discussion

Factors influencing farmers' fertilizer input behaviour with regards to farmers' own characteristics, land size, land tenure, education, gender, neighbouring effect, resource endowment, cropping structure, among others, have been discussed extensively in the existing literature (Brunelle et al., 2015; Takeshima & Liverpool-Tasie, 2015; Takeshima et al., 2017; Yanggen et al., 1998). Most studies on land size suggest that the intensity of chemical fertilizer application decreases as land size increases without any impact on the yield, as large-scale farms are more likely to substitute advanced farm machinery and agricultural technologies for chemical fertilizer use (Ju et al., 2016). However, Aryal et al. (2021) in the study on the factors affecting farmers' use of organic and inorganic fertilizers across the Indo-Gangetic Plains in India, Nepal, and Bangladesh found that large farm size is positively associated with the amount of application of both urea and DAP in paddy cultivation. The study suggests that wealthier households (HHs) and HHs with more livestock in all study locations, except the Indian state of Haryana, were found to apply more of the same. The same study also found that the likelihood of application of manure has increased with the increase in land size, but the rate of application was inversely related.

Similar to observations of the present study, a study by Rapsomanikis (2015) in Kenya found that small landholding farmers use seeds and chemical fertilizers more intensively than large landholder farmers. Wu et al. (2021a) in the study on farmers of Northern China found that the deviation from optimal use of chemical fertilizers of

small-scale farmers is significantly higher than that of the large-scale farmers. The general notion is that small farmers are usually resource poor, therefore, cannot afford to buy sufficient amount of chemical fertilizers, and also more likely to apply less or an unbalanced use of chemical fertilizers (Singh et al., 2014). However, studies have also found that chemical fertilizer use efficiency is inversely proportional to farm size i.e., the smaller the farm size, the higher the fertilizer use efficiency (Hu et al., 2019).

Wu et al. (2021b) in the study on the impact of land transfer on the intensity of chemical fertilizer application in China found that men farmers with smaller arable land, and long years of farming experience, as well as younger farmers and farmers with higher awareness of low-carbon agriculture or membership in specialized farmer cooperatives tend to apply less amounts of chemical fertilizers (Chen et al., 2011).

Land ownership rights and tenure security also play a major role in farmers' choices and behaviour. The property rights theory suggests that a stable, clear, and long-term land rights will encourage farmers to make responsible investments, such as the application of organic fertilizer that can lead to soil improvement in the long term (Bungau et al., 2021; Liang et al., 2020; Ya-Hui et al., 2019). Conversely, short and unclear tenures and unstable land rights can provoke predatory short-term production behaviour of farmers Wu et al. (2021) submit that farmers may apply more fertilizer on the transferred land, especially when the contract duration and stability are unclear and apply more chemical fertilizer on the transferred land (Otsuka et al., 2001).

Kolay (2007) found that a sheep produces about 0.5 kg of droppings and 1.2 litres of urine every day. The nitrogen, potassium and phosphorus (NPK) content of sheep droppings is N= 0.7%, P=0.51% and K=0.29 % and that of urine is N=1.5%, P=0.05% and K=1.96%. Studies suggest that penning of 100 sheep for 6 nights can fertilize around 2.5 acres of farmland (Nandhini & Suganthi, 2018). Telangana has 17.4 million sheep, providing about 9 million kg of manure and about 21 million litres of urine every day. Farmers of the study area reportedly pay an average INR 1.5 – 2.0 per sheep for penning per night, which could generate a revenue of an estimated INR 26 million (USD 316,843) per day in the state (Nandhini & Suganthi, 2018; Sriveda & Srihita, 2020). The average duration of sheep penning in Telangana state is 107 days and the estimated revenue generated from sheep penning alone could be approximately INR 2.7 billion (USD 327,240) within a span of 3.5 months (107 days). If the revenue generated from the sale of dung of sheep, goat, cattle and buffalo and penning of cattle is calculated, then the figure would be even higher.

Personal observations at Salkapuram village, Kallur Mandal, in Kurnool district of Andhra Pradesh, found that the panchayat (village council) usually auctions the village farmlands and commons for grazing. Pastoralists of the surrounding villages usually participate in a bid to gain access to the village grazing lands. The bidding fee would be anywhere between INR 50,000–100,000 (USD 609-1218) per individual to gain access to grazing at the village.

Nandhini & Suganthi (2018, p.371) hypothetically put forward the “penning theory”, which elucidates that “.....the sheep get their feed from field and field is enriched with nutrients and loads of microorganisms act on them to turn the soil more fertile than before”. It may open new research opportunities to investigate how this hypothetical theory behaves in the different and dynamic socio-cultural, economic, agricultural, land tenure regimes and climate change settings.

5. Conclusion

Penning and sale of dung accounts to the second major source of HH income of pastoralists who participated in the study. Results of the study indicate a steady increase in the average HH income of pastoralists from penning during the period 2016 - 2020. However, it is seldom considered as an important livelihood and income generation activity, therefore, remains out of the purview of the Telangana state machinery. Perhaps, the promotion of penning and dung sale should be institutionalized as "*manure economy*" and included as a mandate of both the state agriculture and animal husbandry departments. The Government of India and few Indian states like Chhattisgarh, have already initiated schemes for institutionalization and streamlining of the dung economy.

Godhan Nyay Yojana is the flagship scheme of the Indian state of Chhattisgarh (Pandey et al., 2022). The objective of the scheme is to "facilitate rapid strengthening of the rural economy" by giving "a boost to the dairy business and organic farming" while improving the rural environment. Chhattisgarh is the first state in the country to procure cattle dung and establish a system for procurement in a profit oriented approach. Currently, cattle dung procured under the scheme is used for the production of vermi-compost. GOBARdhan⁴, a centrally sponsored scheme by the Government of India, supports the villages in safely managing the livestock and agriculture waste and converting them into bio-gas and manure through rural enterprises. Similarly, the Ministry of Petroleum and Natural Gas (MoPNG) has already launched the "Sustainable Alternative towards Affordable Transportation" (SATAT)⁵, to boost the renewable energy sector and technologies. The SATAT provides the necessary opportunities for effective management of bio-waste and conversion of the same into economically viable models such as the production of compressed-biogas and manure. The Ministry, under this scheme promotes marketing of bio-compressed natural gas (Bio-CNG) in the country.

With regards to farm input costs, observations of the present study indicate that farmers who are practicing penning tend to incur relatively lower expenses on chemical fertilizers when compared with the farmers who rely exclusively on chemical fertilizers for enhancement of soil fertility and production. However, results of the study assume that land ownership rights and tenure security may also play a major role in farmers' interest in more environmental friendly choices like sheep penning.

Agricultural expansion, disappearance of commons and unavailability of labour were cited as the major constraints of mobile pastoralism. Furthermore, pastoralists of the study indicate that acquiring immovable assets such as agriculture land and a more settled lifestyle is the future. However, more studies are necessary to understand the future of pastoralism in the study area.

Other services of sheep and other livestock include trampling of soils and application of manure directly to farmlands without any transportation and application costs, free services for rejuvenation of commons, pastures, and forests, control of weeds, recycling of nutrients, seed dispersal, among others, in-lieu of grazing throughout the year, are not even accounted. Such dimensions of penning in the context of India need further investigation.

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⁴ GOBARdhan: <https://sbm.gov.in/gbdw20/>

⁵ SATAT: <https://mopng.gov.in/en/pdc/investible-projects/alternate-fuels/sustainable-alternative-towards-affordable-transportation>

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7. References

- Aerukala, S. (2020). The Kurumas of Telangana and Andhra Pradesh States, India: An Anthropological Study. International Conference of the Royal Anthropological Institute (RAI), London, UK, 14-16 September 2020.
- Allchin, B., & Allchin, F.R. (1982). *The rise of civilization in Pakistan*. Cambridge: Cambridge University Press, pp.244.
- Allchin, F.R. (1963). *Neolithic cattle keepers of South India and Deccan Ashmounds*. Cambridge: Cambridge University Press, pp.183.
- Aryal, J. P., Sapkota, T. B., Krupnik, T. J., Rahut, D. B., Jat, M. L., & Stirling, C. M. (2021). Factors affecting farmers' use of organic and inorganic fertilizers in South Asia. *Environmental Science and Pollution Research*, 28, 51480–51496. Retrieved from: <https://link.springer.com/content/pdf/10.1007/s11356-021-13975-7.pdf> [accessed 12 March 2023]
- Bartlett II, J. E., Kotrlik, J. W., & Higgins, C. C. (2001). Organizational Research: Determining Appropriate Sample Size in Survey Research. *Information Technology, Learning and Performance Journal*, 19(1), 43-50. Retrieved from: <https://www.opalco.com/wp-content/uploads/2014/10/Reading-Sample-Size1.pdf> [accessed 12 March 2023]
- Brunelle, T., Dumas, P., Souty, F., Dorina, B., & Nadaud, F. (2015). Evaluating the impact of rising fertilizer prices on crop yields. *Agric. Econ.*, 46, 653–666. <https://doi.org/10.1111/agec.12161>.
- Bryman, A. (2012). *Social Research Methods*. Offord: Oxford University Press. ISBN 978-0-19-958805-3.
- Bungau, S., Behl, T., Aleya, L., Bourgeade, P., Aloui-Sossé, B., Purza, A. L., Abid, A., & Samuel, A. D. (2021). Expatriating the impact of anthropogenic aspects and climatic factors on long-term soil monitoring and management. *Environ. Sci. Pollut. Res.*, 28, 30528-30550. <https://doi.org/10.1007/s11356-021-14127-7>.
- Chen, X., Wu, K., & He, Y. (2011). The impact of farmland circulation on farmers' productivity: An empirical analysis based on DEA Method. *J. Agrotech. Econ.*, 8, 65–71.
- Cresswell, J.W. (2013). *Qualitative Inquiry and Research Design, Choosing among Five Approaches*. California: Sage.
- Daly, K. G., Mattiangeli, V., Hare, A.J., Davoudi, H., Fathi, H., Doost, S. B., Amiri, S., Khazaeli, R., Decruyenaere, D., Nokandeh, J., Richter, T., Darabi, H., Mortensen, P., Pantos, A., Yeomans, L., Bangsgaard, P., Mashkour, M., Zeder, M. A., & Bradley, D. G. (2021). Herded and hunted goat genomes from the dawn of domestication in the Zagros Mountains. *PNAS*, 118(25), e2100901118. <https://doi.org/10.1073/pnas.2100901118>
- Donihue, C. (2013). *Traditional Ranching Practices Enhance African Savanna*. Yale School of the Environment, USA. Retrieved from: <https://environment.yale.edu/news/article/traditional-ranching-practices-enhance-african-savanna/> [accessed 12 March 2023]
- Eguez, N., Zerboni, A., & Biagetti, S. (2018). Microstratigraphic analysis on a modern central Saharan pastoral campsite. Ovicaprine pellets and stabling floors as, ethnographic and archaeological referential data. *Quaternary International*, 483, 180-193.
- Fereday, J., & Muir-Cochrane, M. (2006). Demonstrating Rigor Using Thematic Analysis: A Hybrid Approach of Inductive and Deductive Coding and Theme Development. *International Journal of Qualitative Methods*, 5(1).
- Francis, J. J., Johnston, M., Robertson, C., Glidewell, L., Entwistle, V., Eccles, M. P., & Grimshaw, J. M. (2010). What is an adequate sample size? Operationalising

- data saturation for theory-based interview studies, *Psychology & Health*, 25(10), 1229-1245. <https://doi.org/10.1080/08870440903194015>.
- Fusch, P. I., Fusch, G. E., & Ness, L. R. (2017). How to conduct a Mini-Ethnographic Case Study: A guide for novice researchers. *The Qualitative Report*, 22(3).
- Government of India (2019). 20th Livestock Census. Ministry of Fisheries, Animal Husbandry & Dairying, Government of India. Retrieved from: <https://pib.gov.in/PressReleasePage.aspx?PRID=1588304>; <https://vikaspedia.in/agriculture/agri-directory/reports-and-policy-briefs/20th-livestock-census> [accessed 12 March 2023]
- Government of Telangana (2020). About the District – Kamareddy. Retrieved from: <https://kamareddy.telangana.gov.in/history/> [accessed 12 March 2023]
- Government of Telangana (2022). Telangana Socio Economic Outlook (2022). Planning Department, Government of Telangana, Hyderabad, India. Retrieved from: https://ecostat.telangana.gov.in/PDF/PUBLICATIONS/Socio_Economic_2022.pdf [accessed 12 March 2023]
- Government of Telangana, (2021). About the District – Vikarabad. Retrieved from: <https://vikarabad.telangana.gov.in/> [accessed 12 March 2023]
- Hu, L. X., Zhang, X. H., & Zhou, Y. H. (2019). Farm size and fertilizer sustainable use: An empirical study in Jiangsu, China. *J. Integr. Agric.*, 18, 2898-2909. [https://doi.org/10.1016/S2095-3119\(19\)62732-2](https://doi.org/10.1016/S2095-3119(19)62732-2).
- Immanuel, R. R., Imayavaramban, V., Elizabeth, L. L., Kannan, T., & Murugan, G. (2010). Traditional farming knowledge on agroecosystem conservation in Northeast coastal Tamil Nadu. *Indian Journal of Traditional Knowledge*, 9(2), 366-374.
- Johansen, P. G. (2003). Landscape, monumental architecture, and ritual: a reconsideration of the South Indian ashmounds. *Journal of Anthropological Archaeology*, 23, 309-330.
- Ju, X., Gu, B., Wu, Y., & Galloway, J.N. (2016) Reducing China's fertilizer use by increasing farm size. *Glob. Environ. Chang.*, 41, 26-32. <https://doi.org/10.1016/j.gloenvcha.2016.08.005>.
- Kaur, G., Brar, Y. S., & Kothari, D. P. (2017). Potential of Livestock Generated Biomass: Untapped Energy Source in India. *Energies*, 10(7), 847.
- Kennedy, K. A. R. (2000). *God Apes and Fossil Men: Palaeoanthropology in South Asia*. Ann Arbor, USA: University of Michigan Press, pp.480.
- Kim, Y. J., Oh, Y., Park, S., Cho, S., & Park, H. (2013). Stratified sampling design based on data mining. *Healthcare informatics research*, 19(3), 186-195. <https://doi.org/10.4258/hir.2013.19.3.186>.
- Kolay, A. K. (2007). *Manures and Fertilizers*. New Delhi: Atlantic Publishers.
- Koller-Rollefson, I. (1994). *Pastoralism in Western India from a Comparative Perspective: Some Comments*. AGRIS, the Food and Agriculture Organization, United Nations. Retrieved from: <https://agris.fao.org/agris-search/search.do?recordID=GB2013200761> [accessed 12 March 2023]
- Korisettar, R., Joglekar, P. P., Fuller, D. Q., & Venkatasubbaiah, P. C. (2001a). Archaeological re-investigation and archaeozoology of seven southern Neolithic sites in Karnataka and Andhra Pradesh. *Man and Environment*, 26, 47-66.
- Korisettar, R., Venkatasubbaiah, P.C., & Fuller, D.Q. (2001b). Bramhagiri and beyond: The Archaeology of Southern Indian Neolithic. In: Settar, S. & Korisettar, R. (Eds.), *Indian Archaeology in Retrospective Prehistory*. New Delhi: Manohar Publishers, pp.151-356.
- Krishna, K. R., & Morrison, K. D. (2009). *History of South Indian Agriculture and Agroecosystems*. University of Chicago, Illinois, USA. Retrieved from: <http://paleoecology.uchicago.edu/storage/Krishna%20Morrison%20-%202009%20-%20History%20of%20South%20Indian%20Agriculture%20and%20Agroecosystems.pdf> [accessed 12 March 2023]
- Kurt, D., Inman, J. J., & Argo, J.J. (2011). The influence of friends in consumer spending: The role of agency – community orientation, and self-monitoring.

- Journal of Marketing Research*, 48, 741-754.
<https://doi.org/10.1509/jmkr.48.4.741>
- Leech, N. L., & Onwuegbuzie, A. J., (2007). An Array of Qualitative Data Analysis Tools: A Call for Data Analysis Triangulation. *School Psychology Quarterly*, 22(4), 557-584.
- Liang, Z., Zhang, L., & Zhang, J. (2020). Land inward transfer, plot scale and chemical fertilizer reduction: An empirical analysis based on main rice-producing areas in Hubei province. *China Rural Survey*, 5, 73-92.
- Marshall, F., Reid, R. E. B., Goldstein, S., Storozum, M., Wreschnig, A., Hu, L., Kiura, P., Shahack-Gross, R., & Ambrose, S. H. (2018). Ancient herders enriched and restructured African grasslands. *Nature*, 561, 387-390.
<https://doi.org/10.1038/s41586-018-0456-9>
- Miles, M. B., Huberman, A. M., & Saldana J. (2019). *Qualitative Data Analysis: A Methods Sourcebook*. Fourth Edition. California: SAGE Publications, Inc.
- Morrison, K. D. (2007). Foragers and Forager-Traders in South Asian Worlds: some thoughts from the last 10,000 years. In: M.D. Petraglia & B. Allchin (eds.), *The Evolution and History of Human Populations in South Asia*. Dordrecht: Springer.
- Mukherjee, N. (2003). *Participatory Appraisal of Natural Resources. Studies in Rural Participation- 3*. New Delhi: Concept Publishing Company.
- Murthy, M. L. K., & Sontheimer, G. D. (1980). Prehistoric background to pastoralism in the Southern Deccan in the light of oral traditions and cults of some pastoral communities. *Anthropos*, 75(1/2), 163-184.
- Nandhini D. U., & Suganthi, S. (2018). Role of Sheep Penning in Organic Farming. *Approaches in Poultry, Dairy and Veterinary Sciences*, 4(5).
- Nomura, K., Yonezawa, T., Mano, S., Kawakami, S., Shedlock, A. M, Hasegawa, M, & Amano, T. (2013). Domestication process of the goat revealed by an analysis of the nearly complete mitochondrial protein-encoding genes. *PLoS One*, 8(8), e67775. <https://doi.org/10.1371/journal.pone.0067775>
- Notermans, C. (2019). Prayers of Cow Dung: Women Sculpting Fertile Environments in Rural Rajasthan (India). *Religions*, 10, 71.
<https://doi.org/10.3390/rel10020071>
- Otsuka, K., Suyanto, S., Sonobe, T., & Tomich, T.P. (2001). Evolution of land tenure institutions and development of agroforestry: Evidence from customary land areas of Sumatra. *Agric. Econ.*, 25, 85-101. <https://doi.org/10.1111/j.1574-0862.2001.tb00237.x>
- Paddayya, K. (1974). Investigations into the Neolithic sites of Shorapur Doab, South India. *Bulletin of the School of Oriental and African Studies*, 37(3), 707-708.
- Paddayya, K. (1992). *The Ashmounds of South India and Possible implications*. Bulletin of the Deccan Graduate College and Research Institute, Pune, 51-52: 573-626.
- Pandey, S., Patel, M., Wasnik, S. B., Parte, J., & Chandra, M. (2022). A Review of Gothan and Godhan Nyay Scheme in Chhattisgarh. *Economic Affairs*, 67(02): 137-142.
- Patil, P. (2009). Recent Habitat Management in Great Indian Bustard Sanctuary. GAHIVAR Foundation, India. Retrieved from: <http://www.indiaenvironmentportal.org.in/files/GIB%20Report%20Final.pdf> [accessed 12 March 2023]
- Phand, S., Jaya, G., & Gummagolmath, K. C. (2021). Livestock Extension Services: Time to Think Beyond Treatment and Breed. MANAGE Knowledge Series, No. 2/21. Institute of Agricultural Extension Management, Hyderabad. Retrieved from: <https://www.manage.gov.in/publications/knowledgeseries/livestock.pdf> [accessed 12 March 2023]
- PJTSAU (Professor Jayashankar Telangana State Agricultural University) (2020). Regional Agricultural Research Stations and Agricultural Research Stations of PJTSAU. Retrieved from: <https://pjtsau.edu.in/ntz.html> [accessed 12 March 2023]
- Portillo, M., Belarte, M. C., Ramon, J., Kallala, N., Sanmarti, J., & Albert, R. M. (2011). An ethnoarchaeological study of livestock dung fuels from cooking installations in

- northern Tunisia. *Quaternary International*, 431, 133-144. Retrieved from: <https://core.ac.uk/download/pdf/77066962.pdf> [accessed 12 March 2023]
- Rapsomanikis, G. (2015). The economic lives of smallholder farmers - An analysis based on household data from nine countries. Food and Agriculture Organization of the United Nations, Rome. Retrieved from: <https://www.fao.org/3/i5251e/i5251e.pdf> [accessed 12 March 2023]
- Sekhar, T. (2015). Forest Management in Tamil Nadu – A Historical Perspective. Tamil Nadu Forest Department. Retrieved from: <https://www.forests.tn.gov.in/tnforest/app/webroot/img/document/Innerpages-Part1.pdf> [accessed 12 March 2023]
- Sharma, V. P., Kohler-Rollerfson, I., & Morton J. (2003). Pastoralism in India. A Scoping Study. DFID, New Delhi. Retrieved from: <https://assets.publishing.service.gov.uk/media/57a08ce2e5274a31e00014fa/ZC0181b.pdf> [accessed 12 March 2023]
- Shivkumara, C., & Kiran, S. (2019). Economics of Sheep and Goat Rearing under Extensive, Semi-intensive and Intensive Methods of Rearing. *Economic Affairs*, 64(3), 553-561.
- Singh, R. K. P., Kumar, A., Singh, K. M., & Kumar, A. (2014). Agricultural Production performance on Small farm holdings: Some Empirical Evidences from Bihar, India. MPRA Paper No. 59680. Retrieved from: https://mpra.ub.uni-muenchen.de/59680/1/MPRA_paper_59680.pdf [accessed 12 March 2023]
- Siripurapu, K. K. (2021). Telangana – Mobility in Immobility: Mobility – A pastoralist Perplexity! In: *Impact of COVID – 19 Lockdown on Pastoralists of India*. Centre for Pastoralism, New Delhi, India.
- Siripurapu, K. K., Iyengar, S., Saberwal, V., & Das, S. (2020). An Overview of Mobile Pastoralism in Andhra Pradesh and Telangana States of the Deccan Plateau Region of India. Center for Pastoralism, WASSAN and RRAN, India.
- Somvanshi, R. (2006). Veterinary Medicine and Animal Keeping in Ancient India. *Asian Agri-History*, 10(2), 133-146. Retrieved from: <https://www.asianagrihistory.org/pdf/volume10/veterniray.pdf> [accessed 12 March 2023]
- Southworth, F. C. (2006). *Proto-Dravidian Agriculture*. University of Pennsylvania, Pennsylvania, USA, pp.1-5. Retrieved from: <http://ccat.sas.upenn.edu/~fsouth/proto-Dravidianagriculture.pdf> [accessed 12 March 2023]
- Sriveda, B., & Srihita, B. (2020). Sheep penning: Need to sustain this unique practice. *LEISA India* Blog. Retrieved from: <https://leisaindia.org/sheep-penning-need-to-sustain-this-unique-practice/> [accessed 12 March 2023]
- Takeshima, H., & Liverpool-Tasie, L. S. O. (2015) Fertilizer subsidies, political influence and local food prices in sub-Saharan Africa: Evidence from Nigeria. *Food Policy*, 54, 11-24. <https://doi.org/10.1016/j.foodpol.2015.04.003>
- Takeshima, H., Adhikari, R. P., Shivakoti, S., Kaphle, B. D., & Kumar, A. (2017). Heterogeneous returns to chemical fertilizer at the intensive margins: Insights from Nepal. *Food Policy*, 69, 97-109. <https://doi.org/10.1016/j.foodpol.2017.03.007>.
- TSDPS (Telangana State Development Planning Society), & DES (Directorate of Economics & Statistics) (2021). Weather and Climatology of Telangana. Government of Telangana, Hyderabad, India. Retrieved from: https://tsdps.telangana.gov.in/Weather&Climatology_of_telangana.pdf [accessed 12 March 2023]
- Udayavani (2020). Gore Habba: Festival Celebrated with Cow Dung Play fights. *Udayavani*, 16 November 2020. Retrieved from: <https://www.udayavani.com/english-news/gore-habba-festival-celebrated-with-cow-dung-playfights> [accessed 12 March 2023]
- Vedas Resources (2012). Bhogi Panduga – The Most Important Festival of Andhra Pradesh. Vedas Resources, the Home of Knowledge. Retrieved from:

- <https://www.chivukulas.com/2012/01/bhogi-important-festival-of-andhra-pradesh.html> [accessed 12 March 2023]
- Wu, H., Hao, H., Lei, H., Ge, Y., Shi, H., & Song, Y. (2021a). Farm Size, Risk Aversion and Overuse of Fertilizer: The Heterogeneity of Large-Scale and Small-Scale Wheat Farmers in Northern China. *Land* 2021, 10, 111. <https://doi.org/10.3390/land10020111>
- Wu, J., Wen, X., Qi, X., Fang, S., & Xu, C. (2021b). More Land, Less Pollution? How Land Transfer Affects Fertilizer Application. *Int. J. Environ Res Public Health*, 18(21), 11268. <https://doi.org/10.3390/ijerph182111268>
- Ya-Hui, W., Xiu-Bin, L., & Liang-Jie, X. (2019). Characteristics of cropland fragmentation and its impact on agricultural production costs in mountainous areas. *J. Nat. Resour.*, 34, 2658–2672. <https://doi.org/10.31497/zrzyxb.20191214>.
- Yanggen, D., Kelly, V. A., Reardon, T., & Naseem, A. (1998). Incentives for fertilizer use in Sub-Saharan Africa: A review of empirical evidence on fertilizer response and profitability. Food Security International Development Working Paper 54677, Michigan State University, Department of Agricultural, Food, and Resource Economics. <https://doi.org/10.22004/ag.econ.54677>.

Author's Declarations and Essential Ethical Compliances

Author's Contributions (in accordance with ICMJE criteria for authorship)

This article is 100% contributed by the sole author. He conceived and designed the research or analysis, collected the data, contributed to data analysis & interpretation, wrote the article, performed critical revision of the article/paper, edited the article, and supervised and administered the field work.

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Research involving human bodies or organs or tissues (Helsinki Declaration)

The author(s) solemnly declare(s) that this research has not involved any human subject (body or organs) for experimentation. It was not a clinical research. The contexts of human population/participation were only indirectly covered through literature review. Therefore, an Ethical Clearance (from a Committee or Authority) or ethical obligation of Helsinki Declaration does not apply in cases of this study or written work. Yet, a Declaration is appended.

Research involving animals (ARRIVE Checklist)

The author(s) solemnly declare(s) that this research has not involved any animal subject (body or organs) for experimentation. The research was not based on laboratory experiment involving any kind animal. Some contexts of animals are also indirectly covered through literature review. Therefore, an Ethical Clearance (from a Committee or Authority) or ethical obligation of ARRIVE does not apply in cases of this study or written work. Yet, the ARRIVE checklist is appended.

Research on Indigenous Peoples and/or Traditional Knowledge

The author(s) solemnly declare(s) that this research has not involved Indigenous Peoples as participants or respondents, with the documentation of their Indigenous Knowledge. Some other contexts of Indigenous Peoples or Indigenous Knowledge are indirectly covered through literature review. Therefore, a Self-Declaration in this regard is filed by the researcher and first author to support this study or written work. Ethical Clearance Certificate is also appended.

Research involving Plants

The author(s) solemnly declare(s) that this research has not involved the plants for experiment or field studies. The contexts of plants were only indirectly covered through literature review. Yet, during this research the author(s) obeyed the principles of the Convention on Biological Diversity and the Convention on the Trade in Endangered Species of Wild Fauna and Flora.

(Optional) Research Involving Local Community Participants (Non-Indigenous)

The author(s) solemnly declare(s) that this research has involved local community participants or respondents belonging to non-Indigenous peoples. Yet, this study did not involve any child in any form directly or indirectly. The contexts of different humans, people, populations, men/women/children and ethnic people are also indirectly covered through literature review. Therefore, a sample copy of prior informed consent (PIC) of the respondents was taken under this study before the face-to-face interviews and interactions.

(Optional) PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses)

The author(s) has/have NOT complied with PRISMA standards. It is not relevant in case of this study or written work.

Competing Interests/Conflict of Interest

Author(s) has/have no competing financial, professional, or personal interests from other parties or in publishing this manuscript. There is no conflict of interest with the publisher or the editorial team or the reviewers.

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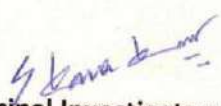
To see original copy of these declarations signed by Corresponding/First Author (on behalf of other co-authors too), please download associated zip folder [Ethical Declarations] from the published Abstract page accessible through and linked with the DOI: <https://doi.org/10.33002/pp0105>

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ETHICAL CLEARANCE CERTIFICATE ANIMAL RESEARCH DECLARATION FORM

Declaration by the Principal Investigator


I certify that the study titled: "The Traditional Sheep Penning System: An Exploratory Study on Farmers' Preferences, Farmer-Pastoralist Relationships and Economics of Sheep Penning in Telangana, India", (ref: pp010105), **does not involve** capture, confinement, and use of any animals (either living or dead), collection of their body parts, tissues or genetic material for the purpose of the present study. **No animal** was harmed either physically or subjected to any type of stress in any form for the purpose of the present study. The study fully complies with the legislation and the general principles of the Committee for the Purpose of Control and Supervision of Experiments on Animals (CCSEA), of the Ministry of Fisheries, Animal Husbandry and Dairying, Department of Animal Husbandry and Dairying (DAHD), Government of India, laid down for the Practice, Care and Use of Animals for Scientific Purposes. I hereby declare the same and confirm that all personnel associated with the present study have read this application and have agreed to comply with procedures described and any conditions imposed by the CCSEA.


Principal Investigator:

10/4/23
Date:

Declaration by Head of the Organization/ Research Committee

I have read this application and am satisfied that the study **does not involve** capture, confinement, and use of any animals (either living or dead), collection of their body parts, tissues or genetic material for the purpose of the present study. **No animal** was harmed either physically or subjected to any type of stress in any form for the purpose of the present study. The study fully complies with the legislation and the general principles of the CCSEA.


Head of Organization/ Research Committee:



Date: 10.04.2023



The ARRIVE guidelines 2.0: author checklist

The ARRIVE Essential 10

These items are the basic minimum to include in a manuscript. Without this information, readers and reviewers cannot assess the reliability of the findings.

Item	Recommendation	Section/line number, or reason for not reporting
Study design	1 For each experiment, provide brief details of study design including: <ol style="list-style-type: none"> The groups being compared, including control groups. If no control group has been used, the rationale should be stated. The experimental unit (e.g. a single animal, litter, or cage of animals). 	
Sample size	2 <ol style="list-style-type: none"> Specify the exact number of experimental units allocated to each group, and the total number in each experiment. Also indicate the total number of animals used. Explain how the sample size was decided. Provide details of any <i>a priori</i> sample size calculation, if done. 	
Inclusion and exclusion criteria	3 <ol style="list-style-type: none"> Describe any criteria used for including and excluding animals (or experimental units) during the experiment, and data points during the analysis. Specify if these criteria were established <i>a priori</i>. If no criteria were set, state this explicitly. For each experimental group, report any animals, experimental units or data points not included in the analysis and explain why. If there were no exclusions, state so. For each analysis, report the exact value of <i>n</i> in each experimental group. 	
Randomisation	4 <ol style="list-style-type: none"> State whether randomisation was used to allocate experimental units to control and treatment groups. If done, provide the method used to generate the randomisation sequence. Describe the strategy used to minimise potential confounders such as the order of treatments and measurements, or animal/cage location. If confounders were not controlled, state this explicitly. 	
Blinding	5 Describe who was aware of the group allocation at the different stages of the experiment (during the allocation, the conduct of the experiment, the outcome assessment, and the data analysis).	
Outcome measures	6 <ol style="list-style-type: none"> Clearly define all outcome measures assessed (e.g. cell death, molecular markers, or behavioural changes). For hypothesis-testing studies, specify the primary outcome measure, i.e. the outcome measure that was used to determine the sample size. 	
Statistical methods	7 <ol style="list-style-type: none"> Provide details of the statistical methods used for each analysis, including software used. Describe any methods used to assess whether the data met the assumptions of the statistical approach, and what was done if the assumptions were not met. 	
Experimental animals	8 <ol style="list-style-type: none"> Provide species-appropriate details of the animals used, including species, strain and substrain, sex, age or developmental stage, and, if relevant, weight. Provide further relevant information on the provenance of animals, health/immune status, genetic modification status, genotype, and any previous procedures. 	
Experimental procedures	9 For each experimental group, including controls, describe the procedures in enough detail to allow others to replicate them, including: <ol style="list-style-type: none"> What was done, how it was done and what was used. When and how often. Where (including detail of any acclimatisation periods). Why (provide rationale for procedures). 	
Results	10 For each experiment conducted, including independent replications, report: <ol style="list-style-type: none"> Summary/descriptive statistics for each experimental group, with a measure of variability where applicable (e.g. mean and SD, or median and range). If applicable, the effect size with a confidence interval. 	

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ETHICAL CLEARANCE CERTIFICATE

Research involving Indigenous Peoples and Traditional Knowledge

Declaration by the Principal Investigator


I certify that the study titled: "The Traditional Sheep Penning System: An Exploratory Study on Farmers' Preferences, Farmer-Pastoralist Relationships and Economics of Sheep Penning in Telangana, India", (ref: pp010105), **does not involve** collection of data or information on (an) Indigenous land, including reserve, settlement, and land governed under a self-government rule/agreement; the study **does not involve** any of the criteria for participation, including membership in an Indigenous community, group of communities, or organization, including urban Indigenous populations; the study **does not seek** inputs from participants (members of the Indigenous community) regarding a community's cultural heritage, artifacts, traditional knowledge, biocultural or biological resources or unique characteristics/practices; and the study **does not involve** Aboriginal identity or membership in an Indigenous community used or be used as a variable for the purposes of analysis. The present study involves farmers and pastoralists and none of the research participants belong to the Indigenous communities, classified as "the Scheduled Tribes" by the Ministry of Tribal Affairs – The Government of India. I hereby declare the same and confirm that all personnel associated with the present study have read this application and have agreed to comply with procedures described and any conditions imposed by the World Intellectual Property Organization (WIPO), Geneva, with regards to research on Indigenous Peoples and/or Traditional Knowledge.


Principal Investigator:

10/4/23
Date:

Declaration by Head of the Organization / Research Committee

I have read this application and am satisfied that the study **does not involve** capturing and collection of data or information of the indigenous community's cultural heritage, artifacts, traditional knowledge, biocultural or biological resources or unique characteristics/practices. The study fully complies with the legislation and the general principles of the World Intellectual Property Organization (WIPO), Geneva.

 JAYATI
Head of Organization / Research Committee:



Date: 10.04.2023

SELF-DECLARATION FORM

Research on Indigenous Peoples and/or Traditional Knowledge

1. Conditions of the Research

1.1 Was or will the research (be) conducted on (an) Indigenous land, including reserve, settlement, and land governed under a self-government rule/agreement or?

No

1.2 Did/does any of the criteria for participation include membership in an Indigenous community, group of communities, or organization, including urban Indigenous populations?

No

1.3 Did/does the research seek inputs from participants (members of the Indigenous community) regarding a community's cultural heritage, artifacts, traditional knowledge, biocultural or biological resources or unique characteristics/practices?

No

1.4 Did/will Aboriginal identity or membership in an Indigenous community used or be used as a variable for the purposes of analysis?

No

2. Community Engagement

2.1 If you answered "Yes" to questions 1.1, 1.2, 1.3 or 1.4, have you initiated or do you intend to initiate an engagement process with the Indigenous collective, community or communities for this study?

No Applicable

2.2 If you answered "Yes" to question 2.1, describe the process that you have followed or will follow with to community engagement. Include any documentation of consultations (*i.e., formal research agreement, letter of approval, PIC, email communications, etc.*) and the role or position of those consulted, including their names if appropriate:

Not Applicable.

3. No Community Consultation or Engagement

If you answered “No” to question 2.1, briefly describe why community engagement will not be sought and how you can conduct a study that respects Aboriginal/ Indigenous communities and participants in the absence of community engagement.

The present study titled: “The Traditional Sheep Penning System: An Exploratory Study on Farmers’ Preferences, Farmer-Pastoralist Relationships and Economics of Sheep Penning in Telangana, India”, involves community participation, however, the research participants of the present study does not belong to any Aboriginal/ Indigenous communities, which were officially classified and identified as the “Scheduled Tribes”, by the Ministry of Tribal Affairs – The Government of India.

-
- ⇒ Name of Principal Researcher: Kanna Kumar Siripurapu
 - ⇒ Affiliation of Principal Researcher: South Asia Consortium for Interdisciplinary Water Resources Studies, Plot No. 164, Road No. 6, Vayupuri, Sainikpuri, Secunderabad - 500094, Telangana, India.

Signature:



Declaration: Submitting this note by email to any journal published by The Grassroots Institute is your confirmation that the information declared above is correct and devoid of any manipulation.

**INFORMATION AND CONSENT FORM FROM RESPONDENTS
(Non-Indigenous or Indigenous Respondents)**

This form was translated into local language for the respondents

Title of the Research: The Traditional Sheep Penning System: An Exploratory Study on Farmers' Preferences, Farmer-Pastoralist Relationships and Economics of Sheep Penning in Telangana, India

Principal Researcher: Kanna Kumar Siripurapu
South Asia Consortium for Interdisciplinary Water
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Sainikpuri, Secunderabad - 500094, Telangana, India

Research Supervisor: Sushma Iyengar
Sahjeevan, Hospital Rd., Jalaram Society, Vijay Nagar, Bhuj
370001, Gujarat, India

A) INFORMATION TO PARTICIPANTS

1. Objectives of the research

The objectives of this study were to to examine famers' preference for sheep penning, farmer-pastoralist relationships and economics of sheep penning tradition in Telangana state

2. Participation in research

The researcher will ask you several pertinent questions. This interview will be recorded in written form and should last about 50-60 minutes. The location and timing of the interview will be determined by you, depending on your availability and convenience.

3. Risks and disadvantages

There is no particular risk involved in this project. You may, however, refuse to answer any question at any time or even terminate the interview.

4. Advantages and benefits

You will receive intangible benefits even if you refuse to answer some questions or decide to terminate the interview. You will also contribute to a better understanding of the causes for pastoralists' livelihood transformation.

5. Confidentiality

Personal information you give us will be kept confidential. No information identifying you in any way will be published. In addition, each participant in the research will be assigned a code and only the researcher will know your identity.

6. Right of withdrawal

Your participation in this project is entirely voluntary and you can at any time withdraw from the research on simple verbal notice and without having to justify your decision, without consequence to you. If you decide to

opt out of the research, please contact the researcher at the telephone number or email listed below. At your request, all information concerning you can also be destroyed. However, after the outbreak of the publishing process, it is impossible to destroy the analyses and results on the data collected.

B) CONSENT

Declaration of the participant

- ⇒ I understand that I can take some time to think before agreeing or not to participate in the research.
- ⇒ I can ask the research team questions and ask for satisfactory answers.
- ⇒ I understand that by participating in this research project, I do not relinquish any of my rights, including my right to terminate the interview at any time.
- ⇒ I have read this information and consent form and agree to participate in the research project.
- ⇒ I agree that the interviews be recorded in written form by the researcher: Yes () No ()

Signature of the participant : _____ Date : _____

Surname : _____ First name : _____

Researcher engagement

I explained to the participant the conditions for participation in the research project. I answered to the best of my knowledge the questions asked and I made sure of the participant's understanding. I, along with the research team, agree to abide by what was agreed to in this information and consent form.

Signature of the researcher :



Date : 15-02-2020

Surname: Siripurapu

First name: Kanna

- ⇒ Should you have any questions regarding this study, or to withdraw from the research, please contact Mr. Kanna Kumar Siripurapu by e-mail kanna.siripurapu@gmail.com
- ⇒ If you have any concerns about your rights or about the responsibilities of researchers concerning your participation in this project, you can contact the Sahjeevan, Hospital Rd., Jalaram Society, Vijay Nagar, Bhuj - 370001, Gujarat, India by email sushmasiyengar@gmail.com

Camel Systems and Pastoralists' Lifestyle in Semi-Deserts and Mountains: Constraints and Challenges

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Abstract

Camels are vital to the daily life of all desert dwellers, especially Bedouins, for whom they form a source of food, a means of transportation and recreation. To appreciate the unique contribution that Arabian camels make towards the community life and the history of the desert lands, in this paper, the pastoral production systems observed across three major regions - Butana, Kordofan and Darfur - are discussed. The field survey based study was conducted from August 2011 to May 2014 using structured interview method to determine the limitations and challenges faced by camel pastoral community in main camel production regions of Sudan. The results revealed that the average of calving interval was 30 months; male camel is rutting for 3 months during rainy season. She-camel gives birth to 6-8 calves throughout the life. The average milk yield was 3 liters per day with the lactation period extended to more than 10 months. The calf is weaned for 10 months or more. Social prestige and continuity of traditional heritage are the major reasons for keeping animals rather than economic revenue. However, it was found that the security issues are limiting camel breeding practices and pastoralists' movement in the semi-desert and mountain regions. Internal conflicts between farmers and pastoralists that often develop into tribal wars also affected pastoral production systems. Such constraints in addition to the lack of government support and favorable policies present major challenges to camel pastoral system in the region.

Keywords

Challenges; Camel; Mountain; Pastoralist; Pastoralism; Sudan

1. Introduction

The camel is an important species uniquely adapted to hot and arid environments (Schwartz, 1992) and contributes significantly to the food security of nomadic pastoral households. This unique adaptability makes this species ideal for human use in the arid

and semi-arid land conditions. The contributions of camels to the human welfare in the developing countries are generally obscured by several factors, which tend to underestimate their true value. Firstly, the estimates of camel populations are usually inaccurate due to the lack of a periodical census. Secondly, their products seldom enter a formal marketing system; thus, their contribution to subsistence and the national economy is rarely realized (Njiru, 1993).

Ahmed & Iqbal (2012) stated that the productivity of the animal depends on genetics, health status, and management. Proper management and health practices ultimately lead to improved production and reproduction. The existing traditional management practices of camel production require interventions for the improvement of camel productivity. Increasing human population pressure and declining per capita production of food in Africa precipitated an urgent need to develop previously marginal resources, such as the semi-arid and arid rangelands, and to optimize their utilization through appropriate livestock production systems among which camel production is certainly the most suitable (Schwartz, 1992). Despite the camel's considerable contribution to food security in semi-dry and dry zones, and existence as a major component of the agro-pastoral systems in vast pastoral areas in Africa and Asia, little is known about its production potential and production systems compared to other domestic animals. Most of the previous research conducted on camels stresses on diseases, reproductive physiology, and characterization (Mohammed, 2000). The available information on camel production potential and production systems, especially in Sudan, remains inadequate. Pastoral camel production is under pressure because of multiple changes in the production environment. Increasing human population pressure on pastoral grazing areas and the economic implications resulting from diseases and lack of veterinary services are some of the factors that adversely affect traditional camel production. Additionally, reproductive performance is low in camels due to late first parturition, long parturition intervals, and high calf mortality. Improvement in reproductive performance and reduction of animal losses by management measures that apply to a mobile system, appear to offer possibilities of increasing camel productivity and capacity to support the increasing human population. An adequate understanding of traditional camel production practices forms the foundation on which improvements and innovations could be based (Farah et al., 2004). In line with this objective, current study was carried out in three main regions of camel production in Sudan. The main aim is to clarify the camel management systems, husbandry practices, and camel's constraints and challenges. Additionally, we also identify the socio-economic values of camel, and contribution of camel products to the improvement of overall household incomes.

2. Methodology

2.1 Study Areas

The study was conducted in major camel production regions of Sudan, which comprise Butana, Kordofan, and Darfur. Description of the regions is as follows.

The Butana region

Butana lies in the Sahel zone of Sudan, surrounded with mountains in the east, center, and south. It is bounded by the river Nile and Blue Nile from the west, River Atbara from north and Geddarif railways on the eastern and southern boundaries (Map 1). It covers an area of approximately 12,000 square kilometers (Abusin, 1990). The Butana is located at the cusp of climatic and ecological transition zone that has Savannah in the south and Sahara in the north. Based on the long-term average precipitation, Sahel is marked by annual precipitation of up to 100 mm in the North and 600 in the South. Duration of the rain varies from 2 to 5 months (June to

September/October). The extreme spatial and temporal variability of rainfall resulting from the inter-annual fluctuations in the north-ward drift of the Inter-Tropical Convergence Zone (ITCZ) leads to unpredictability in the rainy season, and thus, to the recurring drought events at an irregular interval.

According to Al-Khouri & Majid (2000), inter-annual variability of the rainfall with the severe drought events leads to a natural shift in the vegetation pattern across several hundred kilometers. The temperature in the Butana is generally considered high all-round the year, with a drop in July and August as a result of moisture and cloudiness. It rises again by September, and then drops to a minimum with the advance of cool Northern winds during November. Highest temperature is recorded in April, while January remains the coldest month (Abusin, 1990).

There are three main types of natural vegetation found across Butana. *Acacia* trees form the major perennial vegetation, including *Acacia terbilus*, *Acacia seyal*, and *Acacia mellifera*. The shrubs are the second perennial vegetation found in Butana and it includes bushy grasses scattered all over the region. The third type includes the annual grasses and herbs. These herbaceous plants are dominant during the wet season and only a few species sustain during the dry season. During the rainy season, the low areas that remain covered in water for a long time become less vegetated due to the spoilage of seeds. The variation in the rainfall in addition to the variations in relief, drainage, and parent material produce a clear local difference in the Butana soil.

The Kordofan region

Kordofan region is located in an arid and semi-desert ecological zone that is surrounded by the mountains both in the north and south. It is located between 12°: 25' - 13°: 45' N and longitudes 24°:45' - 30°:30' E. The rainy season in this zone is shorter and only extends from July to October with August being the wettest month. The average annual rainfall estimated in this region was 298 mm with uniform relative humidity ranging between 22-25% in the dry season and 75% during the rainy season. Wind velocity is usually less than 8 km/hour. The vegetation cover which is a reflection of that climatic zone and soil type range from a sparse growth of drought-resistant grasses and dwarf scrub in the north through a belt of open wood and grass in semi-arid central region to open forest in the well-watered south. The common trees belong to the species of genus *Acacia*. Whereas, the vegetation covers includes grasses, herbs, shrubs, and small trees. Livestock and its product form the primary source of income for over 60% of the population in this region. A traditional system of cropping in combination with animal husbandry predominates the state (MARF, 2007). Total animal units in the state are estimated at 6 million. The animals raised mainly include sheep, goats, cattle and camel. In the northern part of the state, land use is characterized by a mobile pastoral system practiced by different nomadic tribes where each tribe has its predefined territory. In the southern part of the state, land use is characterized by a sedentary agro-pastoralist system. There are three main types of soil are widely distributed in Kordofan state: sandy soil in the northern, clay soil in the southern part, and Guarded soil distributed all over the state as stated by MOARF (2004).

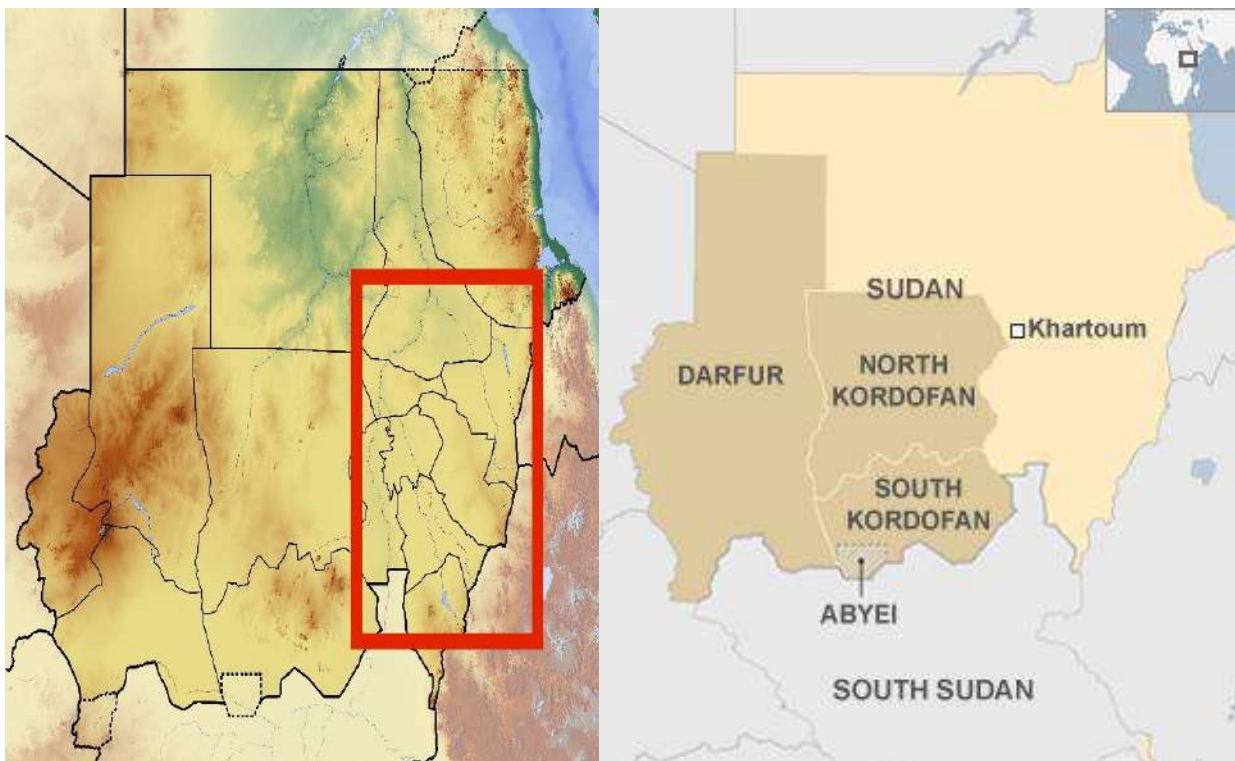
Darfur region

Darfur is a hilly area that has rich natural resource base with fertile land suitable for grazing pasture, forest, and water sources. Relatively better rainfall and existing seasonal rivers make the region fertile and less prone to droughts (Abusin, 1990). The samples were collected from the area in the Darfur region, which lies between latitude 14.45° - 11° N and longitude 22° - 24° E. Topographically, Darfur has basement rocks and is covered with a thin layer of sandy soil. Basement rock is too infertile to be farmed but provides sporadic forest cover that can be grazed by animals. Another feature of Darfur is the Marrah Mountains i.e. the volcanic plugs

created by a massif that rise up to a peak at Deriba crater where there is a small area observing temperate climate, high rainfall, and permanent springs of water (MOARF, 2004). The vegetation covering the rangeland includes grasses, shrubs, and trees (Map 2).

2.2 Survey Protocol

Data was collected through a survey that helped in identifying camel pastoralists and their views regarding the aspects including herd composition, milk production, calving management, restriction methods of calving suckling, milking times and methods, socio-economic value of camel, production and reproduction limitations, breed ecotypes, and breeding in dromedary camels under traditional management systems and nutritional evaluation of natural pasture across all the study sites. The survey was carried out using different methods as described below.



Map 1: Darfur and Kordofan regions

Questionnaire and data collection

Data was collected from 170 camel pastoralists¹, camel herders², and camel owners³ in the Butana, Kordofan, and Darfur regions using structured questionnaire. The questionnaire was prepared to inquire about various aspects of camel management systems, and related constraints faced by the pastoralists. A detailed structured questionnaire was used to collect information from camel herders and owners in different regions. Simultaneously, interviews were also conducted during the field visits (Table1). The questionnaire was pre-tested to check the clarity and appropriateness of the questions.

¹ Camel pastoralist: The pastoralist is the person who rear camel herd against monthly wage from owner of the herd.

² Camel herder: The herder is the person who owns a herd of camels and rearing of them himself.

³ Camel owner: The owner is the person who owns a herd of camels and does not rear himself, but hires someone to rearing it.

Direct communication and field visits

Some of the information collected during interviews was supported by field visits and meeting with chairmen of pastoralists unions in study areas. All visits and communications were carried out during the wet and dry seasons from August 2011 to May 2014.

Table 1: The regions selected for the survey of the camel management system

<i>Region</i>	<i>Number of Interviewees</i>
Butana	50
Kordofan	60
Darfur	60
Total	170

In addition, the samples of straws and stoves from residues of agricultural rain-fed production crops were also collected to identify their applicability in satisfying the nutritional requirements of camels and their feasibility in formulating desirable feed concentrates.

Data analysis

The professional version of Statistics 10 analytical software was used to develop comparison between the three study areas. Results are represented mainly in the form of descriptive statistical summaries.

3. Results

3.1 General Information

All the pastoralists interviewed were males. The majority of respondents (76%) were illiterate followed by those who completed primary school (21%), followed by those who completed secondary school (2.5%). There were fewer university graduates (0.5%) (Table 2).

Table 2: General information about interviewers

<i>Regions</i>	<i>N</i>	<i>Level of Education (%)</i>				<i>Interviewees (%)</i>		
		<i>Illiterate</i>	<i>Primary</i>	<i>Secondary</i>	<i>Graduates</i>	<i>Owner</i>	<i>herder</i>	<i>Owner herder</i>
Butana	50	68	22	8	2	26	40	34
Kordofan	60	78	22	0	0	1	23	76
Darfur	60	80	20	0	0	28	27	45
Total	170	76	21	2.5	0.5	21	29	50

The majority of respondents were both owner and herders of the camels, followed by those who only owned a camel and then who is working as a herder of camel (Table 2). Most of the camel herders and owners (56%) were of young age ranging between 25 and 45 years, followed by below 25 years old (22%) and above 45 years old (22%). Whereas, the majority of camel herders and owners were 83% married, but fewer (14%) were single and divorced (3%) (Table 3).

Table 3: Age and marital status of interviewers

<i>Regions</i>	<i>N</i>	<i>Age (%)</i>			<i>Marital status of interviewees (%)</i>		
		<i>< 25years</i>	<i>25-45 years</i>	<i>> 45 years</i>	<i>Single</i>	<i>married</i>	<i>divorced</i>
Butana	50	18	66	16	12	88	0
Kordofan	60	32	47	21	8	87	5
Darfur	60	16	57	27	23	73	4
Overall	170	22	56	22	14	83	3

3.2 Herd Composition and Structure

The result revealed that the size of the camel herd varies from region to region. The wide proportion of participants in Butana (60%) and Darfur (47%) held bigger herd size (more than 50 heads) compared to Kordofan region, while majority of participants in Kordofan had middle herd size (20-50 heads) compared to other regions. Generally, majority of participants (49%) had biggest herd size exceeding 50 heads of camel. Whereas, Arabi camel breed are most dominant camel herds (66%) in Sudan followed by Anafi and Bushari breed. The result of the survey (Table 4) reflects that Arabi camel breed is highly preferable breed in main camel production regions of Sudan.

Table 4: The herd size

Regions	N	Herd size (%)			Camel breeds (%)			
		< 20heads	20-50 heads	>50 heads	Anafi	Bishri	Arabi	others
Butana	50	0	40	60	12	12	76	0
Kordofan	60	13	47	40	8	17	75	0
Darfur	60	18	35	47	35	15	47	3
Total	170	10	41	49	18	15	66	1

In this survey, it was recorded that female camel formed a higher percentage (46%) in the herd. Clearly, the female camel acquired highest proportion (58%) of the herd in the Butana region compared to Kordofan and Darfur. Whereas the number of male camels recorded the highest percentage (55%) of the herd in Kordofan region followed by Darfur region (45%), and very few males camels were present in the herds of Butana region. It was only one male camel in the herd as shown in table 5.

Table 5: The percentage of matured male and she-camel in the herd

Regions	N	No. of females (%)			No. of males (%)		
		< 15 heads	15-40 heads	> 40 heads	1	2-3	>3
Butana	50	0	42	58	54	40	6
Kordofan	60	20	40	40	15	30	55
Darfur	60	23	37	40	18	37	45
Total	170	14	40	46	28	35	37

The majority of respondents (70%) from Darfur region have seen an increase in the camel population. In contrast, the highest percentage of respondents (52%) from the Butana region said that camel population has decreased. Generally, the results of this study reveal the increasing trend in camel population (Table 6). The preferable color of camel was asked; and respondents indicated that red camel is the most preferable among majority (50%) of respondents in the three regions followed by dark brown camel (18%), yellow camel (17%) and white camel (12%), which is least preferred by the herders in three regions. The yellow camel is also rarely preferred in the Butana region.

Table 6: The status of the camel population and preferred color

Regions	N	Status of camel population (%)			Preferred color (%)				
		Increasing	Decreasing	Fixed	Black	Dark brown	Yellow	Red	White
Butana	50	20	52	28	8	10	0	64	18
Kordofan	60	55	28	17	0	8	28	47	17
Darfur	60	70	17	13	0	35	18	44	3
Total	170	50	31	19	3	18	17	50	12

3.3 Camel Husbandry Practices

The findings of the study revealed that (80%) of the camel herders prefer grazing in natural pastures (Table 7). The majority of the pastoralists (56%) provide camels with fodder from crop residues in specially rainfed agricultural areas of Butana

region. Generally, the result revealed that the majority of participants (58%) depend on water sources from the annual river in rainy season. Majority of the herders (42%) in Butana depend on the river water and there is no irrigation canal available in Kordofan and Darfur region.

Table 7: Feeding and watering system of camel

Regions	N	Feeding of camel (%)			Watering of camel (%)				
		Pasture	fodder	Pasture & fodder	River	Annual river	Half year river	Irrigation canal	Groundwater
Butana	50	36	8	56	42	4	16	32	4
Kordofan	60	26	18	33	18	20	12	0	2
Darfur	60	46	18	3	0	36	23	0	1
Total	170	80	26	64	40	58	43	16	5

The majority of camel herders and owners (45%) were found to be adapted to the semi-nomadic management system in all regions (Table 8). 70% of the respondents were engaged in nomadic camel rearing system in Darfur followed by Kordofan and the low percentages (14%) were observed in Butana. Additionally, data also suggest that the majority of camel owners and herders (91%) do not prefer crossbreeding within their herd (Table 8).

Table 8: The camel breeding systems

Region	N	Management system (%)				NBH cross-breeding (%)	
		Transhumant	Nomadic	Semi-nomadic	Sedentary	yes	No.
Butana	50	0	14	66	20	18	82
Kordofan	60	0	42	48	10	7	93
Darfur	60	0	70	23	7	5	95
Total	170	0	43	45	12	9	91

This survey indicates that 55% of the camel owners do not have a clear purpose for rearing camels. It is only because they have inherited the herd from their parents they continue their traditional occupation (Table 9). However, for 33% of the respondents, camel rearing was economically profitable from trade point of view. For only 8% of them, camels were integral part of household food security and livelihood.

Table 9: The purposes of camel breeding in the traditional system (%)

Regions	N	Inherited	Livelihood	Profit and export	Social
Butana	50	60	8	28	4
Kordofan	60	58	5	35	2
Darfur	60	48	12	33	7
Total	170	55	8	32	5

3.4 Camel Production and Reproduction Traits

The results of the current study revealed that the majority (75%) of the female camels attain puberty at the age of 4-5 years (Table 10). The data revealed that majority of participants (60%) confirmed that a high sexual ability of Sudanese male camels; the male camel can mate more than 8 females during rutting season. Highest percentage (65%) of male camel sexual ability was recorded in Darfur region followed Butana region.

Evidently, majority of the participants (80%) confirmed 1-5% of abortions happening among their camels in base year in the Butana region. In general, wide proportion of

participants (62%) had stated that 1-5% of abortions occur annually in all regions (Table 11).

Table 10: The puberty age of female camel and the ability of male

Region	N	Puberty age (%)			No. of female camel mated by male camel (%) in a rutting season		
		<4 yrs	4-5 yrs	>5 yrs	3-5	6-8	>8
Butana	50	8	86	6	16	26	58
Kordofan	60	28	62	10	0	25	35
Darfur	60	13	80	7	17	18	65
Total	170	17	75	8	11	29	60

Table 11: The percentage of abortion among camel herds per year

Regions	N	0 %	1 - 5%	> 5%
Butana	50	4	80	16
Kordofan	60	30	53	17
Darfur	60	33	55	12
Total	170	23	62	15

During the period of this study, the majority of camel herders (57%) began milking the female camels on the third day of calving, especially in Kordofan (77%). 40% herders started milking on the first day immediately (Table 12). The result of the survey indicates that a high percentage of camel (89%) lactate for more than 9 months in all the study regions.

Table 12: The start of milking and the length of the lactation period

Regions	N	Start of milking after calving (%)			Long lactation period (%)	
		1 st day	2 nd day	3 rd day	6-9 month	>9 month
Butana	50	40	36	24	14	86
Kordofan	60	11	12	77	5	95
Darfur	60	22	17	61	15	85
Total	170	23	20	57	11	89

The data shown in table 13 reflects that the majority of female camels (53%) produced 8-10 calves during the productive life in the pastoral system prevalent in all regions.

Table 13: The number of calving during the reproductive age of she-camel (%)

Regions	N	5-7 calves	8 - 10 calves	>10 calves
Butana	50	36	40	24
Kordofan	60	25	58	17
Darfur	60	13	60	27
Total	170	24	53	23

The results show a high percentage (46%) of camels produce a milk yield of less than 3 liters per day in all regions. In the Kordofan region, it was recorded that around 57% camels produced milk of 3-6 liters/day/head (Table 14). Many factors including type of breed, season, availability of feeds, and water sources were found to be affecting the milk yields

Table (15) shows the majority of calves (84%) were weaned off within 10 months postpartum in all regions. However, calves in the pastoral system were allowed a direct contact during the daylight with the dam even up to 2 years.

Table 14: The camel milk yield in free range (%)

Region	N	<3 litres	3 - 6 litres	> 6 litres
Butana	50	60	28	12
Kordofan	60	36	57	7
Darfur	60	45	38	17
Total	170	46	42	12

Table 15: The percentage of calf age at weaning

Regions	N	6-7 months	8 - 10 months	>10 months
Butana	50	0	16	84
Kordofan	60	0	9	91
Darfur	60	11	12	77
Total	170	4	12	84

The camel herders practiced traditional methods for calve weaning and restricted suckling throughout the day such as *Sawrar*, *Shomal*, *Hasaka*, as shown in table 16. The majority (50%) of camel herders practiced *Sawrar* method, followed by *Shomal* method, and little number of herders used *Hasaka* method. Very few herders just used pen to restrict calves from suckling. The *Sawrar* method is considered the main method for calve weaning in Kordofan region.

Table 16: The traditional methods of calf weaning and restricted suckling (%)

Regions	N	<i>Sawrar</i> ⁴	<i>Shomal</i> ⁵	<i>Hasaka</i> ⁶	Restricted to pens
Butana	50	46	48	2	4
Kordofan	60	73	5	21	1
Darfur	60	30	23	5	42
Total	170	50	23	10	17

In the table 17, the results revealed that the majority (81%) of camel herders are allowing calf to suckling their dam before the beginning of the milking procedure. This method is traditional adopted in all camel regions. On the other hand, the highest percentage of participants (68%) said that lactating she-camel can be milked twice a day. This method is practiced more in Kordofan than in Darfur. Whereas camel herders in Butana milk a she-camel three times a day.

Table 17: The methods of milk letdown and milking times (%)

Regions	N	Suckling of calf	Without calf	Both methods	1 time	Twice	3 times
Butana	50	80	12	8	0	56	44
Kordofan	60	93	6	1	0	68	32
Darfur	60	71	20	9	28	58	16
Total	170	81	13	6	10	61	29

The highest percentage (58%) of respondents confirmed that the rutting season of a male camel is about 2-3 months in Kordofan (Table 18). While, almost 56% of camel herders in Butana, believed that the length of the rutting season of a male camel is more than 3 months. It was found that the majority of male camels were rutting in the rainy season rather than the winter across all the study regions.

⁴ *Sawrar*: Traditional method use to cover udder teats by camel feces to restrict suckling by calve.

⁵ *Shomal*: Traditional method where udder teats are covered by a piece of cloth or plastic bag to prevent calve suckling.

⁶ *Hasaka*: Traditional method where a chunk of wood is put in the calve's mouth to restrict it from suckling the dam.

Table 18: The percentage of rutting season length and season of rutting

Regions	N	Long of rutting season			The main season of rutting	
		<2 months	2-3 months	> 3 months	Rainy	Winter
Butana	50	4	40	56	68	32
Kordofan	60	16	58	26	88	12
Darfur	60	36	33	30	71	28
Total	170	20	44	36	76	24

Generally, majority of the respondents (55%) confirmed that the calving interval of she-camels ranged from 20-30 months postpartum (Table 19). On the other hand, majority of Darfur camel herders confirmed that the period between calving ranged from 15 to 20 months.

Table 19: The percentages of calving interval in the pastoral system

Regions	N	<15 months	15-20 months	20-30 months	>30 months
Butana	50	0	14	64	22
Kordofan	60	0	30	62	8
Darfur	60	0	46	42	12
Total	170	0	31	55	14

The majority of the respondents from Butana (74%) and Kordofan (41%) said that the main sign of the estrus cycle is the swelling of the vulva (Table 20). In contrast, the highest percentage of camel herders confirmed that the main sign of estrus cycle is seeking male in Darfur. On the other hand, the highest percentage of herders (93%) believed that the raising of tails is the main sign of pregnancy among the camels in Kordofan, followed by Butana and Darfur region. Moreover, the highest percentage (53%) of camel pastoralists have seen a swelling of the udder is the main sign of parturition in Kordofan followed Butana region.

Table 20: The reproduction signs among the camels identified by the herders (%)

Reproduction signs	Butana	Kordofan	Darfur	Total
<i>Sign of estrus cycle:</i>				
Frequent urination	12	6	20	13
Swelling of vulva	74	41	13	45
Seeking male	14	53	67	42
<i>Sign of parturition:</i>				
Isolation	6	33	22	20
Swelling of udder	44	53	7	35
Restlessness	36	9	53	33
Swelling of vulva	14	5	18	12
<i>Detection of pregnancy</i>				
Raise-up tail and coil	90	93	90	91
Refuse male	10	7	10	9

In the table 21, the result of the survey revealed that the highest percentage of herders (44%) in Butana mentioned more than 5% of the calving mortality ratio in their herds. The highest percentage of herders (73%) reported the ratio of mortality ranged from 1 to 5% in the herd in Kordofan.

The majority of camel herders mentioned the main constraints of camel production as shown in table 22. The highest percentage of herders (78%) reported the shortage

of pasture and feeding as the main problem in Butana followed by Kordofan. Similarly, the highest percentage of camel herders (50%) mentioned lack of security as the most pressing challenge for camel production in Kordofan than in Darfur.

Table 21: The percentage of calve mortality per year

<i>Regions</i>	<i>N</i>	<i>Zero</i>	<i>1-5%</i>	<i>>5%</i>
Butana	50	0	56	44
Kordofan	60	18	73	9
Darfur	60	52	36	12
Total	170	24	55	21

Table 22: The problems facing the rearing of camels in the pastoral system

<i>Problems</i>	<i>Butana (%)</i>	<i>Kordofan (%)</i>	<i>Darfur (%)</i>	<i>Total (%)</i>
Lack of veterinary services	12	5	36	18
Shortage of pasture and feeding	78	23	12	35
Shortage of water	4	18	4	9
Lack of security	0	50	43	33
Taxes	6	4	5	5

4. Discussion

Herd composition and structure

Camels play an important role in the local economy of the pastoral community and are central to the survival of pastoralists in the desert, and semi-desert regions in Sudan. The current survey emphasizes on the camel rearing practices in three main regions of Sudan.

It was found that the average herd size in the region is around 50 heads. This finding is in tune with Bakhiet's (2008) findings, who reported that the average camel herd size in Sudan is 75.3 heads. Also, it was mentioned that female camels constitute around 74% of the total herd size. The insights gathered from the camel herders explain that the size of camel herds largely depend on the availability of water and food and high veterinary care rather than the changing lifestyle of pastoralists. The majority of camels in Sudan belong to the pack type (Arabi and Rashaidi camels); the Arabi camel has a wide geographic distribution in Sudan because it produces high quality meat and milk. Finding of the present study agrees with a study stating that the camel breeds in Sudan, which produced high quality of meat, are highly integrated into the regional market (Al-Khoury & Majid, 2000).

The result of the current survey highlights a decline in the camel population. This finding contradicts the finding of Faye et al. (2011), who stated that the camel population growth in Sudan is higher than the world growth i.e., 2% per year on an average. However, this growth is not regular. Observations from three time periods substantiate this claim. It was observed that from 1961 to 1978, a medium growth (1.3%) was recorded, from 1979 to 2000 a low growth (0.95) was recorded, and from 2001 onwards a rapid growth of 5.14% per year was recorded. These differences could be attributed to the impact of drought and flaws in the livestock census data. Additionally, the factors like lack of security, prevalence of diseases, shortage of pasture, and illegal export of female camel also impact the camel population and its growth in Sudan.

In Nigeria, the majority of the camel pastoralists prefer camel of dark brown phenotype breed (Abdelrahman et al., 2011). The result of the current study coincides with the finding of Abdelrahman et al. (2011). The preference of camel differs according to the difference of participants' visions. They believed that good camel traits are the productivity of milk and meat. Other traits were considered insignificant. Generally, the dark brown camel is preferred by some herders, while red camel is preferable by almost all herders in camel production regions of Sudan.

Management and husbandry practices

In the current study, most of the camel herders were depended on natural rangelands for grazing their herds. The findings of current study are similar to those reported by Idriss (2003). Bakheit et al. (2008) mentioned that the decrease in available range land and pastures is a result of agricultural activities on natural pasture. As a result, most of the income of camel owners goes in purchasing crop residues in the Butana region. Whereas the camel owners in Kordofan solve the shortage of feed and water supply by adopting long migration routes towards the south.

The nomadic and semi-nomadic systems are well adopted systems for camel production in Sudan. The finding of current study agrees with Al-Khouri & Majid (2000) study. They reported that three camel production systems were mainly found in Sudan: Nomadic, transhumant, and sedentary system. No description for the transhumant system was mentioned in the current study as the transhumant camel herders remained unapproachable because of their long-term migrations. It was also found that crossbreeding of camels is not appreciated among all herders in the study regions as it helps them to maintain their camel traits and avoid undesirable traits. In the long run such management style can lead to a decline in positive production traits among the camels unless awareness about the benefits of crossbreeding are introduced.

The majority of participants had inherited their camel population from their parents and they were not looking forward to develop their system to be more profitable and economically dependable. The findings of this study agree with Bakheit et al. (2008) who mentioned about the low cost of keeping a camel. As camels are drought-tolerant animals, they are able to survive in adverse conditions compared to other livestock. This also remains one of the primary reasons for the people to rear camels.

Camel production and reproduction traits

Almost the age of female camels at first gestation ranges 4 to 5 years. This is similar to the finding of Abdelrahman et al. (2011), who stated that camel bull and heifer mean ages at first mating were 5.63 and 3.85 years, respectively. The maturity age of a female camel may depend upon many factors such as nutrition status, breed, ecotype, health condition, and husbandry practices. According to Wilson (1989), sexual maturity in camels may be correlated not only with absolute age and condition but also with other factors affecting the onset of the breeding season such as nutrition and climate. In addition, he reported that the mean ratio of camel cows to a camel bulls during the mating season was 47.8 cows per bull. A high percentage of the female camel mating in the rutting season of the male camel is within the range as mentioned by the author.

The percentage of abortion was high in the pastoral traditional system, especially in the Butana region, which may be attributed to lack of veterinary care, more stress among the camels that move long distances to cover nutrition requirements by grazing and browsing mostly on acacia species or grazing on unidentified poisoning plants. The findings of the present study agree with the finding of Farah et al. (2004) who reported that the pastoral camel production is under pressure because of multiple changes in the pastoral environment, economic implications and traditional

factors of pastoral system. In current study, the lactation period is more than 9 months. Farah et al. (2004) found that lactation period ranged between 9 to 18 months. Our findings do not match with that of the Tezera's (1998), who stated that the lactation period was 13-15 months for Ethiopian camels. On the other hand, finding of current study indicates longer period than that of the finding by Alemayehu (2001) who reported 6 to 8 months of lactation period. This variation might have emanated from ecotype, nutrition, management practices and differences in the production system.

The findings of this study regarding the high percentage of calving range during the productive age of female camel agrees with Farah et al.'s (2004) findings. According to them, under normal conditions, a female camel giving birth every other year will have 8 and 10 calves in her breeding life of around 25–30 years. Contrarily, these findings do not match with the findings of Raziq et al. (2008) where they reported that a she-camel produces up to 12 calves in her whole life span.

The amount of milk yield was found to be affected by many factors among different regions of camel production. These factors might include breeds, health conditions, type of pasture, stage, and season of lactation. The results revealed that the high percentage of yield in Butana and Kordofan is lower than the finding of Zeleke (2007) who observed that the mean daily milk yield of a camel in pastoral system was 3.75 liters. However, this fact is in line with Ali & Majid (2006) who reported that the amount of milk declines to 1.38 litre/day in Butana area, whereas it was found to be 2.36 litre/day under nomadic management system in Western Sudan. Furthermore, the stage of lactation of camels and parity significantly affected their daily milk yield in Ethiopia camel. Despite a high percentage of milk yield in the Darfur region, this study agrees with Bakheit (2008) who states that the average daily milk yield obtained from camel under the traditional system is 3.14 litre/day. Traditionally, there are cultural restrictions on the sale of camel milk, and it is not sold in the core camel production areas. Therefore, pastoralists were not interested in milk production to get cash.

The age of calving at weaning is slightly different between areas in this study. Overall weaning age is more than 10 months. This finding is in agreement with Abdelrahman et al. (2011), who reported that the dromedary calf was weaned between 12 and 16 months with a mean of 12.4 months in a traditional pastoral system in Nigeria. The result of this study disagreed with the finding of Farah et al. (2004). His findings suggest that the weaning of calves happen at the age of 8–18 months, depending on the browsing situation, milk production of the dam, growth of the calf, and ultimate use of the calf. Delay separation and weaning of calves have coincided with poor management in the traditional pastoral system, which possibly is the main reason for an increasing interval between calving. According to Khorchani et al. (2004), productivity could be improved by new techniques including early separation and artificial nursing of calves by reducing the interval between calving.

The traditional methods of calving and weaning are different across the regions in this survey. These variations can be attributed to the cultural diversity among the tribes of camel breeding. Some of the weaning methods in this study are also practiced in Somalia as mentioned in the study by Farah et al. (2004). They have described that several different systems of weaning are practiced by the Somali camel herders, of which the most prominent are: tying the dam's teats with a softened bark (maraq); making a small incision in the skin of the calf's nose-tip and inserting Acacia thorns that will prick the dam whenever the calf tries to suckle, and making a small incision at the top of the calf's tongue and inserting a piece of wood that will hurt the calf when it tries to suckle.

The majority of pastoralist in this study practiced suckling the calf few minutes before milking. It is a good process for milk letdown. This finding agreed with Farah

et al. (2004) and Eisa & Mustafa (2011), who reported that sucking process is adopted by camel herders in camel dairy production in Sudan. While milking frequency ranged from 1-3 times, most of the respondents emphasized on 2 times of milking per day in a pastoral system. This result was in accordance with the finding by Eisa & Mustafa (2011).

Most of the pastoralists considered the rainy season to be the main rutting season of male camel, and the length of rutting periods ranged from 2-3 months in this study. This finding is similar to Abdelrahman et al. (2011) who mentioned that the male camel exhibits rutting during the early-dry season between October and December coinciding with the cold period of the year. In this study, the calving interval is not less than 15 months; moreover, the majority of pastoralist respondents mentioned the parturition period ranging between 20 and 30 months. This finding agrees with the facts reported by Abdelrahman et al. (2011), that the mean calving interval was 23.8 months, and by Farah et al. (2004) who mentioned that the mean calving interval in the traditional pastoral system is 27.4 months.

The main signs of the estrus cycle, parturition, and pregnancy detection are carried out in this study; these are different among pastoral communities from one region to another. However, swelling of the vulva, swelling of the udder, and raise-up tail are common signs to identify the estrus cycle, parturition, and pregnancy in female camels respectively. This finding is in agreement with Abdelrahman et al. (2011), who recorded some prominent signs of estrus in the female camel including frequent urination, vulval discharge, vulval swelling, male seeking, bleating, foul vulval odour, tail raising, in appetite, grouping of camel cows, and cows mounting one another. According to Yagil (2006), a pregnant camel will show it by lifting and curving her tail (tail "cocking") when a male camel advances toward her. The male then moves away looking for another receptive female. This is the method used by nomads to determine pregnancy in she-camels.

The result reveals a high calve mortality rate ranging 1 to 5% in herds yearly. Death of calves before weaning is a critical problem in the traditional pastoral system. This finding is in agreement with Wilson (1986) who reported that in nomadic herds of dromedaries, the pregnancy losses are due to early embryonic death and abortions that vary from 3% to 33%.

Constraints in camel movement and nomadism

In this survey, many constraints were observed that limit the camel production in the study areas. First and foremost is the issue of the security in Kordofan and Darfur regions where internal conflicts between the farmers and pastoralists often lead into tribal wars. Such findings are in line with the data reported by Helen et al. (2009) where they found the camel-pastoralism to be under threat because of mounting insecurity inhibiting their movement patterns. Additionally, lack of desirable development efforts that could support the pastoralist lifestyles (for example, lack of water facilities on the routes), unfavorable and biased policies, pressures to settle down, and the economic incentives of maladaptive strategies make livestock rearing a less desirable and more challenging livelihood choice. At the same time, finding from the camel production system as observed in the Butana region is in agreement with the findings of Darosa (2005) where he reported the shortage of natural pasture and fodder in the region. According to him, expansion of mechanized agricultural activities is diminishing the availability of natural fodder making the herders highly dependent on crop residues. As a result of it, camel owners and herders have to bear a high price of purchasing crop residues from the farmers making the production system most competitive out of the three types discussed above.

5. Conclusion

Camel pastoral traditional system holds tremendous socio-economic potential because of its high productivity. However, that is only possible if this system is able to garner attention from the government authorities and organizations that could help them overcome the production related constraints. Based on the findings of this study, it can be concluded that the government needs to adopt appropriate policies that help in controlling the conflicts between pastoral tribes, securing their main routes of migration and spreading awareness regarding desirable camel management practices to boost the productivity of camel pastoral practices in the region.

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7. References

- Abdelrahman, Y. M., Eisa, M. O., Mustafa, A. B., & Salih, A. M. (2011). Constraints of Camel pastoralists in Gadaref State, Eastern Sudan. *Research Opinion of Animal and Veterinary Sciences*, 3, 174-177. Retrieved from: https://www.academia.edu/34249785/Constraints_of_camel_pastoralists_in_Gedarif_state_eastern_Sudan [accessed on 11 January 2023]
- Abusin, M. E. (1990). Literature survey of baseline information and Profile of central. UNDP, Khartoum, Sudan.
- Ahmed, M. Y., & Iqbal, A. (2012). Farmers' Attitude towards Interventions Regarding Camel Calf Health Care and Management Practices Under Pastoralists Conditions, Proceeding of 3rd ISOCARD International Conference, Muscat, Oman, pp.158-159. Retrieved from: www.isocard.net [accessed on 11 January 2023]
- Alemayehu, G. (2001). Breeding program and evaluation of semen characteristics of camels in the central rift valley of Ethiopia. MSc. Thesis, the School of Graduate Studies, Alemaya University, Ethiopia.
- Al-Khouri, F., & Majid, A. M. (2000). Camels in Sudan: Ecology, Production Systems, Characterization and Herd Dynamics. The Camel Applied Research and Development Network, CARDN/ACSAD/Camel/P96/2000, Damascus, Syria.
- Ali, Y. H., & Majid, M. A. (2006). Epidemiology of camel calf diarrhea in Sudan: seroprevalence of camel rotavirus infection. *J. of Animal and Veterinary Advance*, 4(3), 393-397. Retrieved from: <https://medwelljournals.com/abstract/?doi=javaa.2005.393.397> [accessed on 17 January 2023]
- Aljammah, R. S., Almutari, F. A., Alsayied, I., & Ayadi, M. (2012). Effect of the production system, breed, parity, and stage of lactation on milk composition of dromedary camel in Saudi Arabia. *J. of Animal and Veterinary Advance*, 11(1), 141-147. <https://doi.org/10.3923/javaa.2012.141.147>
- Bakheit, S. A., Majid, A. M. A., & Nikhala, A. M. (2008). Camels (*Camelus dromedarius*) under pastoral systems in North Kordofan, Sudan: Seasonal and parity effects on milk composition. *Journal of Camelid Sciences*, 1, 32-36. <https://doi.org/10.3167/082279402782311202>
- Darosa, A. E. M. (2005). Studies on Some Camel Production Traits and Health in Butana Area, Sudan. Ph.D. Thesis. University of Khartoum, Sudan.
- Eisa, M. O., & Mustafa, A. B. (2011). Production Systems and Dairy Production of Sudan Camel (*Camelus dromedarius*): A Review. *Middle-East Journal of Scientific Research*, 7(2), 132-135. [https://idosi.org/mejsr/mejsr7\(2\)11/1.pdf](https://idosi.org/mejsr/mejsr7(2)11/1.pdf)

- Farah, K. O., Nyariki, D. M., Ngugi, R. K., Noor, I. M., & Guliye A. Y. (2004). The Somali and the Camel: Ecology, Management, and Economics. *Kamla-Raj Anthropologist*, 6(1), 45-55. <https://doi.org/10.1080/09720073.2004.11890828>
- Faye, B., Abdelhadi, O. M. A., Ahmed, A. I., & Bakheit, S. A. (2011). Camel in Sudan: future prospects. *Livestock Research for Rural Development*, 23(10), 1-11. Retrieved from: https://agritrop.cirad.fr/561298/1/document_561298.pdf [accessed on 19 January 2023]
- Helen, Y., Osman, A., Abusin, A. M., Asher, M., & Egemi, O. (2009). Livelihoods, Power, and Choice: The Vulnerability of the Northern Rizaygat, Darfur, Sudan. *Feinstein International Center, Tufts University, Suite 4800 Medford, USA*, p.91. Retrieved from: https://wikis.uit.tufts.edu/confluence/download/attachments/21931179/Darfur_livelihoods.pdf?version=1 [accessed on 21 January 2023]
- Idriss, B. (2003). Marketing of camels in the Soudan, 1st Ed. Camel Applied Research and Development Network, Damascus, Syria.
- Khorchani, T., Hammadi, M., & Moslah, M. (2004). *An effective technique for calve safeguards and improving herd productivity*, 1st Ed. Ashgabat: IOS Press.
- MARF (2007). Statistical report of Sudanese livestock. Ministry of Animal Resources and Fisheries, Sudan.
- MOARF (2004). Estimates of animal population (2000-2004). Ministry of Animal Resources and Fisheries, Sudan.
- Mohammed, I. (2000). *Study of the integration of the dromedary in the smallholder crop-livestock production systems in northwestern Nigeria*, 1st Ed. Goettingen, Germany: Cuvillier Verlag.
- Njiru, G. K. (1993). Economics of camel production. In: S.P. Simpkin (ed.), *Camel Production. A series of lectures given by FARM-Africa*, Nairobi University, Nairobi, Kenya.
- Raziq, A., Iqbal, M. Y., & Khan, M. S. (2008). Role of camel in the pastoral economy of marri tribe in balochistan, Pakistan. *Journal of Camel Practice and Research*, 15(1), 131-138. Retrieved from: https://www.researchgate.net/publication/200164015_Role_of_camel_in_the_pastoral_economy_of_Marri_tribe_in_Balochistan_Pakistan [accessed on 23 January 2023]
- Schwartz, H. J. (1992). Productive performance and productivity of dromedaries (*Camelus dromedarius*). *Anim. Res. Dev.*, 35, 86-89.
- Tezera, G. (1998). Characterization of camel husbandry practices and camel milk and meat utilization in Jijiga and Shnlie zone, Somali region. An MSc Thesis, School of Graduate Studies, Alemaya University, Ethiopia.
- Wilson, R. T. (1989). The nutritional requirements of the camel. CIHEAM Options Méditerranéennes, Série Séminaires, No. 2, 171-179.
- Yagil, R. (2006). Reproductive processes in camels (*Camelus dromedarius*). *Israel J. of Veterinary Medicine*, 61(2), 1-6. Retrieved from www.scribd.com/document/142326289/ [accessed on 21 January 2023]
- Zelege, Z. M. (2007). Non-genetic factors affecting milk yield and milk composition of traditionally managed camels (*Camelus dromedarius*) in Eastern Ethiopia. *Livestock Research for Rural Development*, 19(6). Retrieved from: www.irrd.org/irrd19/6/zelege_19085.HTML [accessed on 29 January 2023].

Author's Declarations and Essential Ethical Compliances

Authors' Contributions (in accordance with ICMJE criteria for authorship)

<i>Contribution</i>	<i>Author 1</i>	<i>Author 2</i>
Conceived and designed the research or analysis	Yes	Yes
Collected the data	Yes	No
Contributed to data analysis & interpretation	Yes	Yes
Wrote the article/paper	Yes	Yes
Critical revision of the article/paper	Yes	Yes
Editing of the article/paper	Yes	Yes
Supervision	Yes	No
Project Administration	Yes	No
Funding Acquisition	No	No
Overall Contribution Proportion (%)	75	25

Funding

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Research involving human bodies or organs or tissues (Helsinki Declaration)

The author(s) solemnly declare(s) that this research has not involved any human subject (body or organs) for experimentation. It was not a clinical research. The contexts of human population/participation were only indirectly covered through literature review. Therefore, an Ethical Clearance (from a Committee or Authority) or ethical obligation of Helsinki Declaration does not apply in cases of this study or written work.

Research involving animals (ARRIVE Checklist)

The author(s) solemnly declare(s) that this research has not involved any animal subject (body or organs) for experimentation. The research was not based on laboratory experiment involving any kind animal. Some contexts of animals are also indirectly covered through literature review. Therefore, an Ethical Clearance (from a Committee or Authority) or ethical obligation of ARRIVE does not apply in cases of this study or written work. Yet, we are appending the filled-in ARRIVE Checklist just for further clarifications.

Research on Indigenous Peoples and/or Traditional Knowledge

The author(s) solemnly declare(s) that this research has involved Indigenous Peoples as participants or respondents, with the documentation of their Indigenous Knowledge. Some other contexts of Indigenous Peoples or Indigenous Knowledge are indirectly covered through literature review. Therefore, a Self-Declaration in this regard is filed by the researcher and first author to support this study or written work.

Research involving Plants

The author(s) solemnly declare(s) that this research has not involved the plants for experiment or field studies. The contexts of plants were only indirectly covered through literature review. Yet, during this research the author(s) obeyed the principles of the Convention on Biological Diversity and the Convention on the Trade in Endangered Species of Wild Fauna and Flora.

(Optional) Research Involving Local Community Participants (Non-Indigenous)

The author(s) solemnly declare(s) that this research has involved local community participants or respondents belonging to non-Indigenous peoples. Yet, this study did not involve any child in any form directly or indirectly. The contexts of different humans, people, populations, men/women/children and ethnic people are also

indirectly covered through literature review. Therefore, because the consent of the Chairman of Pastoralists Union in Butana region was taken, a prior informed consent (PIC) of the individual respondents was not taken under this study before the face-to-face interviews and interactions.

(Optional) PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses)

The author(s) has/have NOT complied with PRISMA standards. It is not relevant in case of this study or written work.

Competing Interests/Conflict of Interest

Author(s) has/have no competing financial, professional, or personal interests from other parties or in publishing this manuscript. There is no conflict of interest with the publisher or the editorial team or the reviewers.

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To see original copy of these declarations signed by Corresponding/First Author (on behalf of other co-authors too), please download associated zip folder [Ethical Declarations] from the published Abstract page accessible through and linked with the DOI: <https://doi.org/10.33002/pp0106>



The ARRIVE guidelines 2.0: author checklist

The ARRIVE Essential 10

These items are the basic minimum to include in a manuscript. Without this information, readers and reviewers cannot assess the reliability of the findings.

Item	Recommendation	Section/line number, or reason for not reporting
Study design	1 For each experiment, provide brief details of study design including: <ol style="list-style-type: none"> The groups being compared, including control groups. If no control group has been used, the rationale should be stated. The experimental unit (e.g. a single animal, litter, or cage of animals). 	
Sample size	2 <ol style="list-style-type: none"> Specify the exact number of experimental units allocated to each group, and the total number in each experiment. Also indicate the total number of animals used. Explain how the sample size was decided. Provide details of any <i>a priori</i> sample size calculation, if done. 	
Inclusion and exclusion criteria	3 <ol style="list-style-type: none"> Describe any criteria used for including and excluding animals (or experimental units) during the experiment, and data points during the analysis. Specify if these criteria were established <i>a priori</i>. If no criteria were set, state this explicitly. For each experimental group, report any animals, experimental units or data points not included in the analysis and explain why. If there were no exclusions, state so. For each analysis, report the exact value of <i>n</i> in each experimental group. 	
Randomisation	4 <ol style="list-style-type: none"> State whether randomisation was used to allocate experimental units to control and treatment groups. If done, provide the method used to generate the randomisation sequence. Describe the strategy used to minimise potential confounders such as the order of treatments and measurements, or animal/cage location. If confounders were not controlled, state this explicitly. 	
Blinding	5 Describe who was aware of the group allocation at the different stages of the experiment (during the allocation, the conduct of the experiment, the outcome assessment, and the data analysis).	
Outcome measures	6 <ol style="list-style-type: none"> Clearly define all outcome measures assessed (e.g. cell death, molecular markers, or behavioural changes). For hypothesis-testing studies, specify the primary outcome measure, i.e. the outcome measure that was used to determine the sample size. 	
Statistical methods	7 <ol style="list-style-type: none"> Provide details of the statistical methods used for each analysis, including software used. Describe any methods used to assess whether the data met the assumptions of the statistical approach, and what was done if the assumptions were not met. 	
Experimental animals	8 <ol style="list-style-type: none"> Provide species-appropriate details of the animals used, including species, strain and substrain, sex, age or developmental stage, and, if relevant, weight. Provide further relevant information on the provenance of animals, health/immune status, genetic modification status, genotype, and any previous procedures. 	
Experimental procedures	9 For each experimental group, including controls, describe the procedures in enough detail to allow others to replicate them, including: <ol style="list-style-type: none"> What was done, how it was done and what was used. When and how often. Where (including detail of any acclimatisation periods). Why (provide rationale for procedures). 	
Results	10 For each experiment conducted, including independent replications, report: <ol style="list-style-type: none"> Summary/descriptive statistics for each experimental group, with a measure of variability where applicable (e.g. mean and SD, or median and range). If applicable, the effect size with a confidence interval. 	

SELF-DECLARATION FORM

Research on Indigenous Peoples and/or Traditional Knowledge

The nature and extent of community engagement should be determined jointly by the researcher and the relevant community or collective, taking into account the characteristics and protocols of the community and the nature of the research.

If your research involved/involves the Indigenous Peoples as participants or respondents, you should fill in and upload this Self-Declaration and/or Prior Informed Consent (PIC) from the Indigenous Peoples. [Please read carefully <https://grassrootsjournals.org/credibility-compliance.php#Research-Ethics>]

1. Conditions of the Research

1.1 Was or will the research (be) conducted on (an) Indigenous land, including reserve, settlement, and land governed under a self-government rule/agreement or?

Yes

1.2 Did/does any of the criteria for participation include membership in an Indigenous community, group of communities, or organization, including urban Indigenous populations?

Yes.

What kind of membership?

Groups of communities

1.3 Did/does the research seek inputs from participants (members of the Indigenous community) regarding a community's cultural heritage, artifacts, traditional knowledge, biocultural or biological resources or unique characteristics/practices?

Yes

1.4 Did/will Aboriginal identity or membership in an Indigenous community used or be used as a variable for the purposes of analysis?

Yes

2. Community Engagement

2.1 If you answered "Yes" to questions 1.1, 1.2, 1.3 or 1.4, have you initiated or do you intend to initiate an engagement process with the Indigenous collective, community or communities for this study?

Yes

2.2 If you answered “Yes” to question 2.1, describe the process that you have followed or will follow with respect to community engagement. Include any documentation of consultations (*i.e., formal research agreement, letter of approval, PIC, email communications, etc.*) and the role or position of those consulted, including their names if appropriate:

Researcher consulted the chairman of pastoralists union in Butana region. Researcher took some pictures with pastoralists and their animals in free range, and those pictures are included in the text of the article.

3. No Community Consultation or Engagement

If you answered “No” to question 2.1, briefly describe why community engagement will not be sought and how you can conduct a study that respects Aboriginal/ Indigenous communities and participants in the absence of community engagement.

Not Applicable.

Name of Principal Researcher: Ayman Balla Mustafa (PhD)

Affiliation of Principal Researcher: Associate Professor, Therapeutic Nutrition Department, Faculty of Health Sciences, Misurata University, P. O. Box: 2478, Misurata, Libya

Signature:



Declaration: Submitting this note by email to any journal published by The Grassroots Institute is your confirmation that the information declared above is correct and devoid of any manipulation.

PASTURES & PASTORALISM

Background

Subsistence pastoralism is a sustainable strategy of livelihood and ecosystem conservation in the rangelands. By means of changing land use, exclusion of indigenous herder communities, fragmentation of habitats and militarization of territories, the enclosure of rangelands has affected the sustainability of both the rangeland ecosystem services and viable pastoralism and transhumance. Ecological, social and economic impacts on rangeland ecosystems, pastoralists' livelihoods, livestock productivity and, ultimately, national economy are visible in many agrarian countries. Such impacts need to be revisited, reviewed and, to an extent, investigated afresh in order to compare the economic, social and environmental gains obtained from conserved rangeland ecosystems and pastoralism, and from converted/enclosed/fragmented rangelands (including other land use). It is expected to build a strong case for pursuing inclusive policies of conserving the landscapes integrating rangelands and pastoralism as a sustainable livelihood practice.

Despite awareness of the critical roles of rangelands in sustaining livelihoods of pastoralists and ecological safeguarding, rangelands have felt the pressure of habitat fragmentation, land use change, industrialization, enclosure, privatization, militarization, and ecosystem devastation. Gradually, rangelands are being converted into other land uses or enclosed for exclusive uses under various national laws or policies. Worldwide, there is a common trend of governing bodies increasingly declaring rangelands unproductive, waste or under-productive lands and term the pastoralist lifestyles outdated and obsolete. Thereafter, with the help of weak rangeland or pastures related laws/policies and by using powerful land acquisition or conversion laws/policies, countries either have given up massive rangeland territories to other forms of land uses or enclosed tenures or have restricted/ circumvented the grazing activities of pastoralist herders.

It is believed that subsistence pastoralism is a sustainable strategy of livelihood and ecosystem conservation in the rangelands. Fading fast all over the world, the (most sustainable) livelihoods and lifestyles of nomadic pastoralists can, therefore, only sustain/conservate the rangeland commons, which are most productive ecosystems on planet (even more productive than forests). Many studies have been undertaken to demonstrate that the nomadic pastoralist way (on rangelands) of livestock production with hardly any economic investment produces some of the most nutritive foods as well as other sustainable products. Unfortunately, such products have not been desirably priced in modern markets, and the nomadic grazing (which is helpful to biodiversity, not detrimental) is perceived by ecologists and policy makers as a threat to conservation. Hence, pastoralists as well as the rangeland ecosystems have suffered as a result.

Resilience of indigenous pastoralist communities to the changing environments – ecological, economic and political – has great potential to protecting and conserving the rangeland landscapes or waterscapes. Such resilience is more talked in context of climate change and its impact on the herder communities surviving in marginal environments. Still the deep understanding of ecological aspects of the impacts of climate change on nomadic pastoralists and their livestock is lacking. Similarly, amid plenty of documentation of adaptation strategies coping the climate variability, the scientific rationale is not established by the scientists and researchers.

PASTURES & PASTORALISM

In the view of widespread regional and national policy failures and modernity-catalyzed societal rejection of transhumance and nomadic pastoralism, International Year of Rangelands and Pastoralists 2026 declared by the United Nations General Assembly is a grand opportunity for all to revitalize the least-external-input driven systems of livestock raising and mobility across the continents. This international blind peer-review journal, 'Pastures & Pastoralism', will contribute to the science, policy and practice across the world by providing a novel platform to seasoned, budding and young scientists, experts and practitioners, including the pastoral community members.

Scope of the Journal

Any topic having emanated from **biology, geography, agriculture, economics, animal science, anthropology, sociology, ecology, law, policy, political science, public administration, management, or other allied discipline** will be considered for publishing in this journal. However, the topic should fall in the ambit of pasturelands, transhumance and pastoralism, especially in the following broader areas:

- Rangelands and Grasslands
- Pastures & Pasturelands
- Meadows and Alpine Meadows
- Grazing Commons
- Pastoralism and Pastoral Cultures
- Agro-Pastoral Communities
- Nomadic or Mobile Pastoralists
- Transhumance and Heritage
- Shepherds and Ethnic Groups
- Animal Centric Cultures
- Animal Husbandry
- Livestock and Economics
- Indigenous Knowledge
- Animal Based Livelihoods
- Production of Livestock Products
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