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Food Security in Africa Requires More Productive Livestock (1)



Photo credits: Cows of the Maasai, Masai Mara in Kenya

Compared to other continents, Africa experiences a lower level of food security. To feed the fast-growing population much more food must be produced. Not just more calories but also more proteins, partially from meat and milk. This in turn requires more productive livestock. What kinds of livestock systems are viable: traditional pastoral systems, run by people living with and from their animals? Or mixed systems, run by arable farmers who also keep livestock? Or by stockbreeders? How can we increase the productivity of these systems?

Henk Breman and Wouter van der Weijden analyse livestock husbandry's historic and current role in Sub-Saharan Africa (SSA). They focus on pastoral (semi-)nomadic livestock production systems, which lose their mobility-based productivity due to population growth among arable farmers who have been extending their fields. This turned coexistence into

hostility, which caused conflicts in the past, and still does so in the Sahel. In a second article, they will explore options for the future of livestock husbandry in SSA at large.

Food security, defined as "reliable access to sufficient, affordable, nutritious food", is low in SSA. In 2022, the food security index¹, which ranges from 0 to 100, was 47 on average for SSA - far below the 79 of frontrunner North America. One way to improve food security is to import more food. However, this is not the best solution for most SSA countries, as both the costs and the risks are high. This became obvious in the past years when food prices were high due to various factors, including COVID-19, high input costs, and the war in Ukraine. That's why a Pan-African food summit in February 2023 focused on food sovereignty, emphasising that Africa has to reduce its dependency on the world market by increasing domestic food production. In these articles, we explore what the livestock sector can contribute to agricultural development and protein supply in SSA.

Protein scarcity

Food security requires both calories and proteins. Grains contain both but lack sufficient proteins to meet daily human needs, with at least an insufficient supply of one amino acid, lysine.

Only three countries² in SSA have fully used their potential to accelerate the increase of agricultural productivity, by the general adoption of the technology and practices of the Green Revolution, which primarily includes intensification through the use of fertiliser, soil amendments, improved seeds, and crop protection products. But even these countries, though able to produce enough calories for their growing populations, do not yet produce enough proteins.

In the average diet of people in SSA, 80% of the energy needs are met by cereals. Animal products - ruminant meat, dairy, pigs and poultry meat, eggs, and fish - contribute just a few percent, the rest is mainly covered by roots (often cassava), tubers, beans, pulses, and nuts. In normal years, the average diet in African countries covers the energy needs, though to different degrees and partly through imports.

By contrast, the average protein needs are not being met. To achieve this, more beans, pulses, and animal products should be consumed. Animal products have a very high protein content, including some key amino acids. But in plant food, the content is only high in beans and pulses; in grains, it is moderate, in roots and tubers it is low. Yet simply replacing energy crops with protein crops will not improve food security, since protein crops have lower yields. As a result, more land would be required to produce the same amount of food, which may drive food prices up.

Why keep livestock in SSA?

By far the most important livestock in Africa are ruminants: cattle, camels, goats, and sheep. Expressed in kg of live weight, they currently cover 93%, two-thirds of the African livestock. The remaining 7% is shared by poultry and pigs.

Pigs and poultry are mainly kept for meat, but poultry is also kept for eggs.

Cattle, sheep, and goats are kept for meat and dairy, with hides as a by-product. Cattle are also kept for several other purposes:

- as a means to accumulate capital
- as a buffer against risk (drought)
- for transport
- for traction
- to provide manure.

The first two purposes are important for traditional livestock owners. That's why both pastoralists and arable farmers keeping livestock tend to prioritise maximising the number of livestock rather than meat and milk production. This is particularly the case for the latter group, for which manure production and animal traction are key functions for crop production. Pastoralists cannot - and do not - neglect the productivity of their livestock, as is reflected by the high ratio of female animals in their herds. As a result, overgrazing and land degradation are by far the most severe in regions with arable farming.

Whereas animal traction is linked to arable farmers, pack animals for transport serve the mobility of pastoral people.

In this article, we concentrate on meat and dairy production for meeting human protein needs.

The degree to which human protein needs are met largely depends on the suitability of land for livestock. A relatively high protein intake is found in those countries that have large areas of desert borders or high mountains with high-quality rangeland³. This may come as a surprise, but those regions have favourable natural conditions for meat and dairy-producing ruminants. Why? Plants extract as many nutrients as possible from the soil in their early growth stages, but during the short rainy season do not get enough time to dilute them. Such vegetation makes good feed quality, as with each bite the animal ingests quite a few nutrients. Plus - a peculiarity of ruminants - the higher the quality, the higher the food intake! Ruminants cannot compensate for the lack of quality by eating more. On the contrary, the lower the quality, the longer the digestion and the less food is eaten.

However, the differences between climate zones are not just a matter of variation in rainfall and temperature, but also in soil nutrients. As long as average fertiliser use is very low, the availability of soil nutrients – primarily phosphorus and nitrogen - is a key factor for the productivity and quality of crops and rangeland. The availability of nutrients declines from the equatorial rain forests to the desert borders, as does the productivity of natural vegetation and crops. Although it was discovered half a century ago, still few people realize that even in the semi-arid parts of the Sahel, the limited soil nitrogen and phosphate content is often a more limiting factor than is rainfall⁴. Proceeding from the humid zone to the desert border, both soil nutrient contents and the climate become less suitable for arable farming but more suitable for livestock.

Whereas human protein needs are almost met in some Sahel countries, livestock productivity there is far too low to produce sufficient surplus meat and dairy for the people in the savanna and rainforest regions. In the DR Congo, one of the most humid African countries, protein scarcity is extremely serious, in spite of substantial meat imports from the world market⁵. One additional reason is the high disease and parasite burden on livestock in rainforest regions, including trypanosomes, which are transmitted by tsetse flies and cause sleeping sickness among livestock. The other reason is that in SSA, proceeding from the arid zones to the rainforest, soils tend to contain more nutrients, whereas the ratio of nitrogen to phosphate

increases. This reduces the competitive advantage of leguminous species, both in natural rangeland and in non-fertilized farmland.

How much can leguminous plants contribute to protein supply?

The very low availability of phosphorus and nitrogen in soils of (semi-)arid land limits the production of plant biomass. However, it provides some competitive advantage to those plants able to fix atmospheric nitrogen (with the help of rhizobia, root-nodulating bacteria), the so-called leguminous species. As they often have a high protein content, they also contribute to the quality of the fodder in rangeland at desert borders. However, this contribution is small due to the low biomass production.

In (semi-)arid West Africa, for example, the share of leguminous plant species in the production of herbaceous natural vegetation is just about 5%. Among shrubs and trees, it is much higher - about 50% - but the average cover of woody species is only 3%⁶.

Among crops, the share of leguminous species in the total crop production is also very low and of some importance only in the drier parts of the arable regions. Without fertiliser - mainly phosphate - and inoculant of rhizobia (bacteria that can fix nitrogen), these species cannot contribute much to the protein supply⁷.

Today, nearly 15% of the total African arable area is being used for leguminous crops. More than 1/3 of it is used for peanuts, nearly 1/3 for cowpeas, and the rest for various other species including Bambara groundnut, beans, and pulses. Their protein content is c. 25%, which is 2.5 times as high as in grains. Due to fertiliser use, peanut productivity is relatively high, about 1000 kg per hectare, but most peanuts are exported. The other leguminous crops produce less than 500 kg per hectare on average. As for domestic protein supply in SSA, we estimate the current contribution of leguminous crops at about 5%.

Producing animal or plant proteins?

Protein needs can either be met by increased livestock production or increased production of beans and pulses. In case of crop-livestock farms, nitrogen fertiliser is a key input but in case of an arable farm producing beans and pulses, phosphate is key. As the price of phosphate is much higher and volatile than the price of nitrogen, raising meat and milk production can play a key role in meeting protein needs. Today, annual per capita meat consumption in SSA is only one third the world average. For dairy consumption, the ratio is similar, and even declining. One important reason is the low productivity of livestock, which is mainly due to shortages of nutrient-rich feed. Therefore, to improve food protein security, increasing the productivity of both arable and livestock production is desperately needed.

As for arable farming, we need to keep in mind that the natural production potential (NPP)⁸ in Africa is hardly more than half the world average: 630 kg/ha as opposed to 1200 kg/ha. Nevertheless, a Green Revolution approach may more than triple current average yields⁹. Livestock can also benefit, as we shall see later. First, we focus on the role of nomadic and semi-nomadic livestock production systems in the past and present.

Pastoral livestock systems

Until recently, Australia and Africa were (very) sparsely populated continents. This had - and still has - to do with the low NPP. Africa also had to contend with many centuries of slave trade across the Sahara and the Indian and Atlantic Oceans. Worldwide, where space was

abundant and no external means of production were available, arable and livestock farming were relatively separate activities. The reason is that the two systems have different natural resource requirements. Livestock production requires feed of sufficient quality (protein and nutrient content, plus digestibility) to allow ruminants (cattle, camels, sheep, and goats)¹⁰ to a) reach their reproductive age fast enough, b) give birth to enough offspring during their lifetime, and c) have sufficiently low mortality, in order to develop a well-producing herd.

Pastoralists traditionally inhabit regions dominated by low productive herbaceous vegetation with relatively high nutritional value, due to factors such as a short growing season, extreme temperatures, and limited rainfall. The reasons were already explained above.

However, pastoralists usually do not live all year round in these areas as the conditions for vegetation growth differ much between seasons and between years due to variable weather conditions. Therefore, mobility is a "conditio sine qua non". Although some pastoralists (nomads), remain (mostly) in these areas, others move their livestock annually between these areas and regions with better growing conditions for the vegetation and longer growing seasons producing more fodder, though of lower quality. In those regions arable farmers exploit the natural resources and often dominate. The rainy season is long enough to grow cereals and other crops, which have enough time to produce seeds or other edible foods for humans. The annual movements of herdsmen with their herds are called "transhumance". The areas visited in the dry season are savannas or fallen-dry floodplains. In the latter, the mostly clay soils remain moist enough for lush, nutrient-rich vegetation that benefits from fertile silt deposited with each flood.

At low population densities, the moderate overlap between arable and pastoral habitats is an advantage rather than a problem. During the dry season, farmers and herders can live side by side while benefiting from each other. Herders use the villages well, both for themselves and for their livestock. They exchange milk for grain. During the daytime they move their animals to natural pastures outside the village, during the night the livestock feed on harvested fields, depositing their manure. By doing so, they transport nutrients from the pastures to the arable fields¹¹.

High-quality forage during part of the year and sophisticated migration patterns meant that well-functioning traditional pastoral systems could have surprisingly high livestock productions. This was certainly the case in systems that during the dry season were located in areas with arable farming. We could even show that their protein production per hectare was two to eight times as high as that of ranches in the United States and Australia in similar areas¹²! In West Africa, pastoral production systems could supply surplus milk and meat not just to arable farmers, but also to urban populations in the savanna and forest zones¹³.

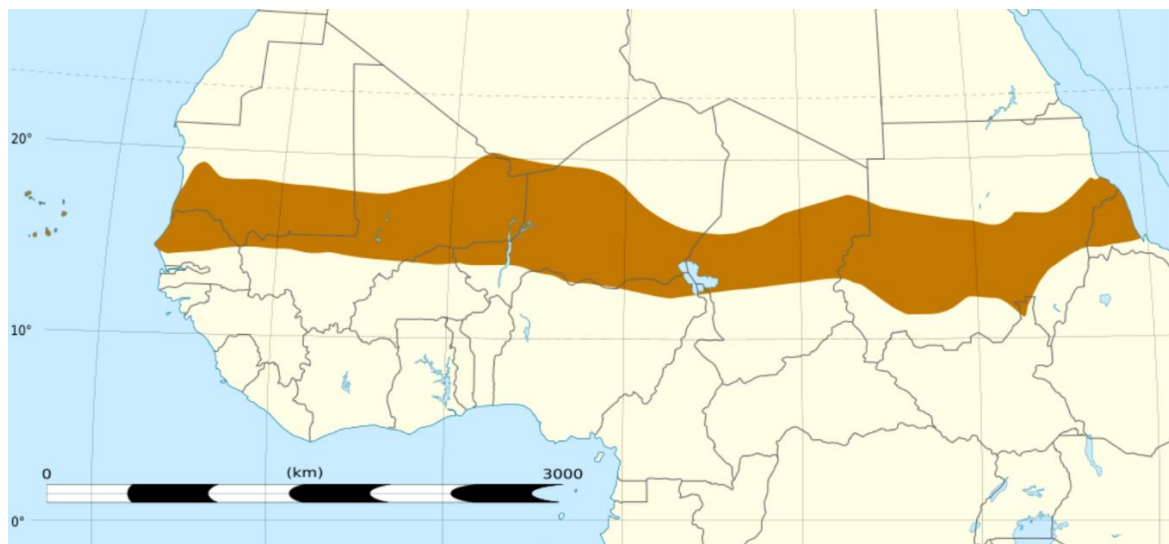
Pastoralism marginalized by increasing population density

As the population grows, the separation of cultivators and herders becomes lost, a process during which pastoralists gradually lose access to grazing areas. Four factors play a role here:

1. as arable farming can feed many more people in a given area than livestock farming, it can benefit more from the increasing demand for food;
2. arable farmers and their livestock will more and more outnumber the pastoralists and their herds¹⁴;

3. during the dry season and in difficult years, the arable area will leave less and less space for herds;
4. this leads to overgrazing of the rangeland, often further compounded by the growth of the pastoralist population as well as their herds¹⁵. As a result, in extreme seasons and/or years, pastoralists have no choice but to sell their livestock for next to nothing or die.

Such tensions have been emerging since half a century in several regions, including the Sahel, the semi-arid transition zone between the Sahara and the Sudanian savanna, which ranges from the Atlantic Ocean all the way to the Red Sea¹⁶. Many pastoralist people used to live there. In West Africa, the Fulani (in French: Peulh) dominate, traditionally semi-nomadic people many of which have since long settled in the arable region. Other pastoralists in West Africa are Tuareg and Moors. Elsewhere, in the heart of Africa, the Tutsi of Burundi, eastern DR Congo, and Rwanda used to be well-known highland pastoralists, whereas Oromo and Somali are pastoralists in the Horn of Africa. Ethiopia, with some 25 mountains peaking beyond 4,000 meters, has the largest livestock population in Africa.



Map of Africa, with the Sahel highlighted in orange. This is roughly the African land area between the lines of 200mm (north) and 600mm (south) mean 20th century annual rainfall. This is limited to land areas directly to the south of the Sahara desert and including the islands of Cape Verde, but not including other areas in Africa with the same rainfall statistics. This is one, but not the only, definition of the Sahel region [Wikimedia](#)

The Fulani and Tutsi are examples of pastoralists who, until recently, had just enough space to effectively practice their livestock raising. In the Sahel, that was partly possible because during half a century before the "great drought" (1970 - 2000), the region experienced a period of higher-than-normal rainfall.

One additional constraint for arable as well as livestock farming, was stiff competition from the "rich West" with its intensive and often subsidised livestock production. In the 1980s, dumping of European meat stocks on the West African market contributed to the decline of pastoralist livestock raising¹⁷. Today, milk powder from Europe makes it difficult to increase animal production. However, the most important factor in the demise of effective pastoralist livestock production has been population growth.

Population growth has made it increasingly difficult for pastoralists to maintain the efficiency

of their system as they were losing access to dry-season rangeland. To make things worse, massive sales - often during droughts - drove prices of livestock down to near zero. The buyers, e.g. during the long drought in the Sahel, were often arable farmers. For them, livestock became increasingly important, and not primarily for meat and milk production:

- sustaining the fertility of the fields by importing nutrients from natural pastures;
- animal traction enabling production at a larger scale;
- savings: accumulation of wealth in good years.

Whereas the pastoral livestock were and still are almost entirely ruminants (cattle, camels, goats, and sheep), farmers traditionally held mainly poultry and – at least in non-Islamic regions - pigs. Chickens used to scavenge seeds and insects, but pigs were largely raised using kitchen waste as feed.

In West Africa, during the dry last quarter of the past century, the centre of gravity of livestock production shifted to the arable region, from the Sahel to the savanna¹⁸. This was partly due to the permanent settlement of pastoralist families. Elsewhere in Africa this process occurred earlier, but there may certainly be niches in SSA, e.g. in Sudan, Ethiopia and Somalia, where it is still proceeding.

Conflicts

The painful loss of power and prestige of pastoralists, due to population growth, particularly among farmers, has led to increasing tensions and even civil war. This holds most in the case of historically very dominant pastoral people¹⁹. At their peak the Fulani had four empires (caliphates), of which Masina in central Mali and Sokoto in northeast Nigeria were the most organised.

Today, the Fulani are deeply divided. Although most of them do not support the jihadists or even oppose them, others - often former herders – have become the main ethnic group among these extremists. Some joined the jihadists after losing their livestock due to diseases or after attacks by militias of Tuareg or arable farmers, or by the Malian army. Although these conflicts have social, ethnic, and religious [components](#), they can also be regarded as the last convulsions of once powerful empires²⁰.

In the regions where most of the cattle are kept today, the natural pastures are of poor quality. Moreover, the same holds for most arable by-products. That is because arable farming on poor soils²¹ without substantial fertilisation, produces low yields of poor quality, whereas by-products such as straw, used as fodder, has an even lower quality than unfertilized grass. The best part of cereal crops, the seeds, are used by humans. Hence cattle have low productivity; from one-half to less than one-tenth that of the pastoral system. As a result, it takes a long time for the animals to reach reproductive age, the numbers of calves and lambs born are low, their mortality is high, the lactation period is short, and milk production per day is low. You are lucky if your cow might produce 4 l/day of milk. This is the main reason, besides the low purchasing power, that meat and milk consumption in SSA is extremely low²². In 2018 it averaged 36 kg of meat and 45 litres of milk per capita per year – much lower than the global averages of 51 kg and 88 litres, respectively.

An almost inevitable outcome is an increasing marginalisation of nomadic and semi-nomadic herders and their herds. They can survive only in those regions where arable farming is

impossible, but even there they may be discouraged or even banned by governments that wish to end trans-border crossings. In that case, nomadism will only survive in countries large enough to allow for within-country transhumance.

In the next article, we will explore options for the future of livestock farming in SSA that can enhance food security, socio-economic development, and a reduction of conflicts in the Sahel region and elsewhere.

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Notes

1. The Global Food Security Index takes account of the core issues of affordability, availability, quality and safety. This [index](#) is yearly published by The Economist. In 2022 the DR Congo had the lowest score of 43.
2. Ethiopia, South-Africa, and Zambia.
3. Combining protein consumption data from a) Z. Abrahams et al. [Diet and mortality rates in Sub-Saharan Africa: Stages in the nutrition transition](#). BMC Public Health 2011 11: 801, with b) the degree of agricultural development data in H. Breman, A.G.T. Schut & N.G. Seligman, 2019. [From fed by the world to food security. Accelerating agricultural development in Africa. Plant Production Systems](#), Wageningen University, p. 96.
4. F.W.T. Penning de Vries & M.A. Djitéye (Eds.), 1982. [La productivité des pâturages sahéliens. Une étude des sols, des végétations et de l'exploitation de cette ressource naturelle](#). Agric. Res. Rep. 918, PUDOC, Wageningen. 523 p.
5. The protein scarcity in the rainforest areas is presumably one of the drivers of wildlife hunting and poaching for bush meat.
6. H. Breman & H. van Reuler, 2003. Legumes, when and where an option? No panacea for poor tropical West African soils and expensive fertilisers. In: B. Vanlauwe, J. Diels, N. Sanginga & R. Merckx (Eds.). Integrated plant nutrient management in sub-Saharan Africa. AB International, 2003. pp. 285 – 298.
7. K.E. Giller & Ronner, E., 2019. [The Story of N2Africa: Putting Nitrogen Fixation to Work for Smallholder Farmers in Africa](#). Wageningen University and Research. <https://doi.org/10.18174/527074>
8. The average level of production of fields and pastures without inputs other than manual labour, generally, expressed in cereal equivalents.
9. [Geopolitical Food Policy: Can Food Security be Achieved for Africa](#).
10. Ruminants are the best animals for efficient livestock production without competing for land with vegetable food for humans.
11. In most regions in SSA, cropland is associated with livestock. Where no fertilizer is applied, the land has to be left fallow periodically. Such fallow land is typically grazed

by ruminants. Most arable land is grazed annually during the dry season for crop residues. So, there are two grazing cycles: a multi-year fallow cycle and a yearly seasonal cycle.

12. [Rangeland productivity and exploitation in the Sahel](#). H. Breman & C.T. de Wit, 1983. Science 221: 1341 - 1347. The field work was mainly done by two of Breman's doctoral students, Abdrahamane Dial and Gaoussou Traoré. For their theses, they walked for 15 months, together with Fulani herdsman and their herds, a distance of 1500 km! Their publications: A. Diallo, 1978. [Transhumance:// comportement, nutrition et productivité d'un troupeau zébus de Diafarabé](#). Centre Pédagogique Supérieur, Bamako. G. Traoré, 1978. [Evolution de la disponibilité et de la qualité de fourrage au cours de la transhumance de Diafarabé](#). Centre Pédagogique Supérieur, Bamako. A film showing the transhumance in question can be viewed on the website [AgroBioAfrica](#).
13. [This trade is still important, but transport is increasingly being done by truck to livestock markets, as far south as southern Nigeria and Ivory Coast. See for example the study conducted by the OECD/SWAC](#)
14. An area suitable for arable farming can feed up to 10 times more arable farmers than livestock can do for pastoralists! H. Breman, B. Fofana & A. Mando, 2007. [The lesson of Drente's 'essen' - Soil Nutrient Depletion in sub-Saharan Africa and Management Strategies for Soil Replenishment](#). In: A.K. Braimoh & P.L.G. Vlek, 2007. Land use and soil resources. Springer Media B.V., pp. 145 – 166.
15. Occasionally, the livestock also start grazing crops, which may trigger violent conflicts.
16. The Sahel includes – from west to east – parts of northern Senegal, southern Mauritania, central Mali, northern Burkina Faso, southern Niger, the extreme north of Nigeria, Cameroon and Central African Republic, central Chad, central and southern Sudan, the extreme north of South Sudan, Eritrea and the extreme north of Ethiopia.
17. “Les subventions d’ exportations européennes sur la viande bovine.” R. Ruben, J. Attema & H. Breman, 1994. Intern. Spectator 48: 599-600.
18. [Agricultural development in the West African Sahelian region: a cure against land hunger](#) H. van Keulen & H. Breman, 1990. Agriculture, Ecosystems and Environment 32: 177-197.
19. In Asia, a classic example of the long dominance of nomads were the Mongols, whose invasions triggered the building of the Great Wall in China. Lead author Breman, who worked with Fulani, Moor and Tutsi livestock breeders, has often wondered where the dominance of pastoral peoples came from in the past, when their population densities were generally much lower than those of arable farmers. Two likely factors may be identified. The first is that their way of life allowed an accumulation of wealth - the herds - while the farmers impoverished the soil and accumulated only poverty. The second is the need to organise and defend oneself and protecting the herds when moving into the domains of others.
20. In 2015-2016, at the request of the Dutch Commission for Environmental Assessment, the lead author coached a team of six Malian researchers, who conducted a strategic environmental study funded by the Netherlands, on the environmental effects of doubling Mali's area of irrigated arable land. They showed that the negative effects on flood reduction in the Central Niger Delta and the related negative effects on the Fulani livestock industry had totally been missed (ignored?). During the assessment, a large group of Fulani representatives visited the governor of the Ségou region. The Fulani had protested the expansion of irrigation, and threatened: "If it will be implemented, we will come with all our herds, being hundreds of thousands of heads of cattle, and

destroy everything. And if that does not help, know that not only Tuareg, but also we have Kalashnikovs!”

21. Soils with low NPP.

22. V. Miller et al., 2022. [Global, regional, and national consumption of animal-source foods between 1990 and 2018: findings from the Global Dietary Database](#). *Lancet Planetary Health* 6: 243–256.