Pastoralists in the 21st century: "lo-tech" meets "hi-tech"

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Introduction

In the 21st century, we live in a hi-tech world. "Hi-tech" is a fuzzy term, at the opposite end of the spectrum to "lo-tech", referring to working mainly with knowledge, skills and simple tools, often hand-made or mechanical. Hi-tech is the most advanced technology available, often involving computer electronics and information and communication technologies (ICT). Examples of currently cutting-edge hi-tech involve mobile phones, satellites, biotechnology, alternative energy or new forms of vehicles, also remotely controlled. Many of these have direct or indirect impact on pastoralism, which is essentially a lo-tech production system.

"Pastoralism" is a form of land use in which grazing livestock make productive use of natural vegetation in marginal areas that are too dry, high, steep and/or infertile for crops. Traditionally, it is labour-intensive, involves diverse animal species and produces diverse outputs: milk, meat, fibre, manure, leather etc. Vegetation growth in the rangelands depends on rainfall and varies greatly between years. Pastoralists capitalise on this poorly predictable heterogeneity over time and space.

In our hi-tech, information-rich world, there is no reliable information about numbers of pastoralists; estimates vary by a factor of ten (Krätli *et al* 2013b). But it is safe to say that well over 90% of the 100–200 million pastoralists in the world live in the Global South. They produce food with few external inputs in areas where other ways of producing food make little economic or ecological sense. To achieve food security with human population growth and climate change, the non-arable areas used for pastoralism will become increasingly important for the world. Here, the pastoralists are used to dealing with high climatic variation – primarily through their mobility – and can continue to produce food.

In the last 2–3 decades, pastoralists even in the most remote areas of Africa are encountering the hi-tech world. In this paper, we look at how hi-tech has impacted on pastoralism and how pastoralists have embraced hi-tech. We focus on Africa, Australia and Central Asia, as these are areas where we have worked and observed and learned.

Some impacts of external hi-tech on pastoralism

Industrialised production marginalises local pastoral products. Hi-tech applied in industrialised livestock systems, such as in Europe or North America, has led to cheaper and more uniform animal products that are transported all over the globe. This marginalises produce coming from more remote areas of extensive livestock production, especially in low-income countries. The industrialised production is costly in terms of fossil energy use and impact on the environment and climate, but – under the current framework conditions – much cheaper than it should be in terms of money.

Hi-tech food-safety control excludes poorer pastoralists from markets. New technologies in animal health and food safety allow tighter control in high-income countries and are doubtless necessary for huge production and processing units so as to decrease risks for human and animal health. However, when the controls required for such mass production are enforced in low-income countries, poor (small-scale) producers cannot access formal markets and poor consumers cannot afford the products on the formal market. This has negative impacts on human nutrition and health, as animal products are vital sources of protein (Roesel & Grace 2015). Intermediate-level technology plus a policy favouring the processing of smaller quantities of pastoral products sold to small-scale butchers and milk processors could bring greater benefits to poor producers and consumers and local workers than applying the highest levels of technology available.

Technological development leads to competing uses of land. New technologies to extract minerals and water have led investors deeper into pastoral areas. Irrigated mechanised farming has expanded into land that was once used only by pastoralists for food production. As demand for energy rises, large solar- and wind-power parks and bio-energy plantations have been set up. Most of this technology consumes non-

renewable resources and requires highly trained external experts to operate it. Hi-tech, when initially applied, usually means high risk, as the chances for success (and impacts) are unknown. However, it can also bring high profits quickly, which is what interests investors. Through such "development", many pastoral groups lost access to land and water resources they had been using for generations. Especially where irrigated farming is introduced in the name of increasing food production, pastoralists are excluded from key grazing and watering sites they need at critical times of the year to be able to maintain their production system. If these vital links in the pastoral seasonal cycle are broken, the drier and more remote areas (unfit for cropping, irrigated or not) can no longer be used at other times of the year to produce animal-based food.

Some impacts of hi-tech within pastoral systems

Pastoralists are not isolated from new technologies. For example, those in Africa have long had market links with cities and other countries, and some have worked abroad for several years, e.g. in the Arab States. They are aware of many new technologies and readily apply those that improve their lives and work. They adopted many of these innovations spontaneously, without donor support, and developed some innovations themselves.

Mobile phones and money. A new technology rapidly welcomed by pastoralists is the mobile phone. Most governments were loath to make the large investments needed to provide landlines for phones and energy supply in the sparsely populated pastoral areas. Mobile phone coverage, coupled with small-scale mobile units to generate electricity using solar or wind power, suits pastoralism well and has brought about a revolution in communications and commerce in the rangelands.

Worldwide, pastoralists now use mobile phones to obtain information about conditions for moving herds: weather, pasture and water availability, disease, conflict along trekking routes. They can stay in touch with family members and herders in their base and mobile camps, and can make herd management and marketing decisions from a distance. Mobile phones help pastoralists grasp new market opportunities, e.g. in camel meat and milk (Debsu *et al* 2016). In Kenya, a study last year found that 93% of Maasai herders rely on cellphones for some aspects of pastoral work (Butt 2015). In Mongolia, about 90% of the herders use cellphones and almost as many have small solar panels to recharge the phones and provide electricity for light, radio and TV. The Mongolian Government supports the spread of such solar power units throughout the rangelands (Hay 2015).

A major technology leap for pastoralists in Kenya was Safaricom's introduction of the electronic money-transfer system M-Pesa (Kiswahili for mobile money). Pastoralists can pay for inputs or be paid for livestock by phone, saving time and money needed to travel to towns and avoiding risks of theft when carrying cash over long distances. They can receive remittances from family members living in towns or abroad. M-Pesa kiosks for depositing and withdrawing money are scattered throughout Kenya, also in towns and settlements in the rangelands. M-Pesa has facilitated money flows for the vast majority of pastoralists in Kenya who do not have bank accounts. It now has more subscribers and transfers more money than do all Kenyan commercial banks together (Reinke & Speradini 2012).

The combination mobile phones + mobile money has widened the pastoralists' scope of commerce and led to an upsurge of micro-enterprises in the rangelands, especially on the initiative of youth with some formal education, selling, repairing and recharging phones and running kiosks to sell SIM cards. Some development projects support this by training youth and women in "solar entrepreneurship" to be able to sell, install and repair solar panels for recharging phones and lighting homes and schools (Obi 2015, Waruru 2013). The cellphone has also raised motivation for literacy, to be able to use SMS, which is less costly than phone calls. Young pastoralists are earning money by teaching older pastoralists how to operate mobile phones and how to use SMS, e.g. in northern Benin (Djohy 2016).

Motor vehicles. In the Americas and Australia, it is common practice to transport animals by vehicle and to use motorbikes to herd stock. With the import of cheap Chinese motorbikes into Africa, now also many African herders use this form of transport – fitting for areas with animal paths but no roads– to check on herds kept in remote areas, to herd animals to seasonal pastures or markets often across national borders, to transport milk-processing equipment between different campsites etc.

Pastoralists in Africa are increasingly using trucks to transport feed and water to animals, or to transport stock to urban markets or ports. Groups of poorer herders combine the proceeds from selling a few

animals to be able to hire a truck to transport the remaining animals to better pasture during drought. Pastoralists in many parts of Africa and Asia often hire tankers to bring water to underground cisterns or containers for their herds where there is good pasture but no natural water source or well. Pastoralists in Sudan use camels to transport large empty rubber containers to grazing sites and then phone a tanker driver to come and fill up the "bladders". These water-related innovations by pastoralists are examples of endogenous solutions that fit the logic of pastoral production. They match access to water with the selective and transient use of pasture, rather than attracting masses of animals to a single static borehole – a standard technological intervention by governments and development projects (Krätli *et al* 2013a).

In high-income countries where the ratio of livestock to pastoralists is high and the ratio of people to land area low, remotely controlled aerial vehicles (drones) with heat sensors are used to find stock and reduce the cost of rounding them up, often done by helicopter in Australia. Drones can also be used to check fences and waterpoints. This technology is still being tested – also by some "techie" livestock owners in high-income countries – but is unlikely to be useful for the majority of the world's pastoralists, who know where their animals are, do not use fences and can use their social networks and cellphones to check on waterpoints at much lower cost.

Animal healthcare. Technological advances related to veterinary drugs and vaccines are highly valued by pastoralists, who will travel long distances to obtain what they need to treat or protect their animals. Some pastoral groups in Africa and Asia operate their own animal health services, through community-based agents linked with government or private veterinary services. However, the easier availability of drugs can lead to widespread inappropriate use and can speed up development of disease agents resistant to the drugs. Especially bacteria resistant to antibiotics are a cause for concern.

The wide popularity of mobile phones among pastoralists in Africa also makes it possible to monitor health and demographic data for both livestock and humans and thus help control diseases. In Chad, for example, groups of pastoralists were contacted regularly by mobile phone to gather information on birth, death and health status of the people and the herds. This surveillance can be combined with One Health services for pastoralists and their livestock (Jean-Richard *et al* 2014).

Computerised market information systems. In Africa, some projects have introduced computerised market information systems. Market data are made available via cellphone and online, can be downloaded and printed for herders without Internet access and are posted at markets. Reports thus far (e.g. Debsu *et al* 2016, Jama *et al* 2006) suggest that, in the rangelands, more traders than herders are using this information, while the main users are urban: project and government staff who track livestock trade and plan interventions. At least in East Africa, all market information systems continue to receive donor funding, in many cases several years after the system was set up (Zoltner & Steffan 2013). Operating costs are too high for governments in low-income countries. Moreover, herders are often wary of the motivations of public bodies trying to collect information. They may have more trust in systems operated by pastoralist organisations, but these systems are not likely to be self-sustainable in terms of raising enough revenue to cover costs.

Satellite-based information systems on pastoral resources. A combination of cellphones and satellite imagery holds potential for pastoralists worldwide to obtain information on pastoral resources. In some cases, such as Kenya, herders collect information on the status of vegetation on the ground using a geo-localised app. Their reports make the satellite-based forage maps more precise (Steele 2015). The data are used primarily by government and development agencies for early-warning and planning purposes.

In the far north of Europe, indigenous herders are exploring these new technologies. The World Reindeer Herders Association approached researchers in Norway to build the herders' competence in using satellite-generated data and GIS as tools for monitoring forage quality, ice and snow features, fire scars and infrastructure development. The herders are integrating their local knowledge with scientific data and developing their own monitoring system so they can adjust herd movements to avoid dangers and take advantage of better pastures along migration routes (Maynard *et al* 2008).

Also in eastern Africa, some NGOs are exploring how herders can use such information systems for their own decision-making. In Ethiopia, Lay Volunteer International Association (LVIA) found that pastoral men and women could easily interpret geo-referenced maps; these, combined with participatory mapping tools, allowed herders to depict their land and water use to support negotiations over resource use with other stakeholders (Rossi & Rizzi 2010). Project Concern International works with herders in Ethiopia

and Tanzania in combining lo-tech scouting and oral communication about pasture conditions with hi-tech satellite-derived vegetation data to help herders decide where to take their herds in different seasons (Maratea 2014). In West Africa, maps based on satellite data are used to identify stock corridors between seasonal grazing areas and across borders to coastal markets; pastoralists are involved in groundtruthing and negotiations with crop farmers to come to agreements about using these corridors (Maxwell 2013).

Another example of hi-tech for local empowerment comes from Tanzania and Kenya, where satellite images are used for a mapping system that enables pastoralists to demonstrate, in a 'language' that policymakers and planners understand, the logic behind the pastoral livelihood strategies. This work, supported by the International Institute for Environment and Development (IIED), takes place in a context of administrative devolution, where district governments now have authority over local planning and development. Pastoralists are using the maps to improve dialogue with their district government so that it will invest in appropriate support to pastoralism as a viable production system (Hill *et al* 2015).

Satellite-based insurance systems. First in Mongolia and now in eastern Africa, some pastoralists are working with donors, researchers and insurance firms to test livestock insurance based on assessment of vegetative cover using satellite data (Chelan'ga *et al* 2015). With remote-sensed data on range conditions over time, groundtruthing and time series of data on stock deaths, mortality rates are predicted (Little & McPeak 2014). The insurance payouts are made on predicted, not actual mortality. Stimulating demand for the insurance is a challenge when herders discover that they may lose stock but not be paid out, since the system did not predict stock mortality. It is still uncertain whether index-based livestock insurance can be a profitable commercial product for private insurance firms or whether it will meet the same fate as market information system projects.

Digital identification of animals. In Botswana, cattle theft has been much reduced since the Government introduced a digital livestock identification system, using a microchip encased in a bolus in the rumen and radio frequency technology (Mooketsi 2013). This system is now being tested elsewhere in Africa. Not only can animals be traced when stolen or lost; the system also traces the provenance of stock, which is useful for penetrating the EU market that requires such data. However, problems in Botswana because of equipment failure and non-visibility of the bolus led the Government to switch to digital eartags.

From the herders' perspective, a disadvantage of digital identification is that it allows the Government to monitor animal holdings and movements. Moreover, such hi-tech systems make herders dependent on equipment, e.g. electronic microchip readers, using hard- and software that only specialists can understand and fix and – if it doesn't work – sell you something new. The costs are prohibitive in the countries where most of the world's pastoralists live, but one government obviously values the benefits of this approach: Uruguay now has a computerised cattle traceability system that covers the whole country, using both numbered and chip-readable eartags. The hi-tech cowboys are said to be as skilled with computers as they are with horses. The Government financed this traceability system to reinforce Uruguay's reputation as an exporter of prime beef (Davies 2014).

Modern weapons. One aspect of technological "advance" that has highly affected herders' lives is the development of high-power weapons, now used in livestock raids and conflicts. The wide availability of small arms has exacerbated conflicts in the African rangelands and led to more stock theft, more human deaths, no-go grazing areas between rival groups and concentration of animals in more secure areas near settlements (Little *et al* 2011). It is an introduced technology that especially large-scale stock traders and rustlers are using to their advantage, obliging herders to carry guns for protection.

Discussion and outlook

Technological threats and potentials

Hi-tech is influencing 21st-century pastoralists in both negative and positive ways. Application of advanced technology in intensive livestock systems elsewhere, together with policies that favour this technology, is changing the framework conditions for pastoralism in low-income countries, above all with regard to marketing. Application of hi-tech in extractive industries and irrigated farming in parts of the rangelands is depleting non-renewable resources and ousting pastoralists from strategic grazing areas, thus threatening the entire pastoral system. Especially in countries with common property regimes for pasture with unclear rights, herders generally have no say over these alternative uses of the land and do not benefit from them. Often, external investors can profit from extractive industries or irrigated farming

for only a short period, until the resources are depleted or the high production cost or environmental damage ends the venture. But in that short time, they can destroy the resource use system that pastoralists have used in the larger area for generations, including the knowledge and skills to continue doing so.

Some pastoral groups have embraced modern technologies that improve their production systems and lives. The potentials of hi-tech must be seen through the lens of pastoralists. The hi-tech world tends to hubris: as if technology can solve all problems. This comes from a mindset of Man's control over Nature – in agriculture: growing food under as highly controlled conditions as possible. This mindset does not fit pastoral logic: making strategic use of dispersed and ephemeral grazing resources. Pastoralism is a form of low-external-input and sustainable agriculture. It makes efficient use of scarce resources – above all, water – with minimal use of fossil-based inputs. It produces nutritious high-protein food from plants that cannot be eaten directly by humans. It is an efficient way of making the existing resources productive for humans. It requires high herd mobility, rapid and flexible reaction to changes in weather and other local conditions, and keeping as many options open as possible. Successful herd mobility relies on collecting current information on pasture and water availability and quality, disease outbreaks, areas of conflict etc, cultivating wide and reliable social networks and engaging in frequent negotiation.

As far as the actual grazing is concerned, the main management options that make economic sense in most of the world's rangelands are lo-tech but highly knowledge intensive: distribution of animals in time and space, use of different types and species of animals, influencing growth and composition of vegetation through grazing, hoof action, fire or mechanical means, e.g. cutting, and applying indigenous knowledge of plant and animal behaviour. Efforts at intensifying this extensive production system make it non-pastoral. However, pastoralists have recognised some hi-tech innovations that can support them in deciding about herd movements, managing animal health and marketing pastoral products. Above all, cellphones make it possible to obtain needed information quickly, especially if communicating with trusted contact persons or scouts. This is a clear technology choice made by pastoralists worldwide, where hi-tech enhances socio-economic networks.

To improve the lives of pastoralists, appropriate and affordable innovations are needed above all to improve the quality of life in the rangelands: providing services that fit the pastoral mode of production rather than attracting people to settle in towns. Here again, mobile technologies are key – to provide safe water for people and livestock, to improve human and animal health, to enable long-distance and life-long learning by children and adults, and to generate renewable energy to support these services.

Beyond technology

Some forms of hi-tech provide useful tools that visualise bio-technical factors, but using, e.g., satellite-based data throws additional light on only some aspects of pastoralism. However, many of the challenges faced by pastoralists are related to policy, economics, insecurity and resource access. Hi-tech is useful if it can support related negotiations, e.g. about land-use rights or stock movement and trade corridors.

Hi-tech does not always lead to economic efficiency, environmental protection or social equity; indeed, many forms of hi-tech in the rangelands work against these. That is why pastoralist development must go beyond physical technologies to explore institutional innovation. For example, this is needed in large parts of Africa to counter tendencies that technical hardware and the political and economic interests behind them lead to greater individualisation and weaken the local institutions that govern the use of rangeland resources, e.g. agreements to rest pastures seasonally or to close large-volume boreholes so as to minimise environmental degradation and socio-economic inequities.

The most important hi-tech contribution for pastoralists has been the revolution in generating, processing and sharing information, but what is crucial for pastoralists is their capacity to use this information and to influence how others are using it. Many ways of using ICT and satellite data in pastoral areas allow governments to track resource dynamics and "manage" the rangelands from afar. It is not the technology that determines how rangelands are used but rather the decision-making systems and institutions of the stakeholders – those who are in the rangelands and those who are not.

In most of Africa, pastoralists have been marginalised ever since colonisation. It was different in the American West and Australasia, where the colonising ranchers once played an important role in national politics and identity. Those days are gone. The Australian station owners are no longer "kings in grass castles"; they now have little political say, and most city dwellers – including new citizens from Asian and Arab countries – do not identify with them (Walker 2015). In terms of their status in their countries,

the "traditional" and "modern" pastoralists now have more in common than before. They need to join forces to show how they contribute to economy and society – not only by producing healthy food but also through environmental protection, carbon sequestration, tourism and security – so as to justify investment in the rangelands. In these efforts, platforms such as WISP (World Initiative for Sustainable Pastoralism), CELEP (Coalition of European Lobbies for Eastern African Pastoralism) and FAO's Pastoralist Knowledge Hub can connect pastoralists and their advocates worldwide. ICT can help pastoralists build new alliances, using websites, blogs, films etc as tools to lobby for recognition of pastoralism as a production system with a future (also in Europe, e.g. Herzog *et al* 2016) and for pastoral resource-use rights. Especially training of youth in ICT could help them use hi-tech for this purpose.

What does the future hold?

The fact remains that, in dry rangelands, pastoralists manage to produce food for themselves and others in their own countries and abroad at low cost and – where they can move their herds – in an ecologically sound way. There are 100–200 million people with these unique skills who live from pastoralism, mainly in low-income countries. On a 10,000 ha property in Australia with 1000 cattle, one family may earn a living; in a similar climate in East Africa, pastoralists may keep twice as many animals on the same area that supports – albeit on a lower level of wealth – 20–30 families. "Development" that ousts these people from the rangelands will push them into urban poverty, aid dependency or overseas migration.

Whether in Africa, Mongolia, Australia or the Americas, ICT and transport innovations make pastoralists much more closely and quickly connected with the rest of the world than in the past. Better connectivity will doubtless lead to further changes in how they organise their life and work. In all pastoral areas, one can see satellite dishes as receivers and solar panels to generate energy for radios, TVs, computers and cellphones. At a petrol station in the southern Ethiopian rangelands, we found ourselves sitting among herders watching a live screening of a World Cup soccer game. ICT brings entertainment, easier communication and more efficient commerce and makes life in the rangelands more attractive, also for youth. Will this reduce rural exodus? Will more people opt to stay in or return to the rangelands to be pastoralists and/or to run businesses to serve local people and perhaps even people in the cities? Or will the flood of information about life elsewhere motivate even higher rural exodus? One observer of the ICT revolution in Mongolia found that pastoralists are enjoying the benefits of "modernity on the move" and claims that widely available cellphones and mobile energy generation are reversing urbanisation: some pastoralists have abandoned the urban congestion and scramble for low-level service jobs and returned to the range, as they now see pastoralism as a viable lifestyle (Hay 2015).

Although today, hi-tech in the North still impacts negatively on the terms of trade for most pastoralists in the South, the economics can change as people and governments become more aware of the health and ecological impacts of "factory animals" versus local grass-grown meat and milk. As more consumers demand healthy and ecologically friendly food, pastoralists in North and South are recognising a niche for selling organic produce. Although pastoralists in many countries are still threatened by hi-tech projects that waste scarce resources, there is growing awareness of the non-sustainability of such interventions. With greater understanding of pastoralists' valuable role in producing nutritious food from ephemeral resources, conserving biodiversity and maintaining society in remote areas, hi-tech options that suit a mobile production system and are applied in a socially responsible way could indeed modernise pastoral life and help ensure its future.

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