International R D & E Investment: Revitalising the Skill Base in Grassland Research and Practice

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Abstract. Grasslands make up about 40.5% of the world's land surface, and almost everywhere they make vital contributions to food supplies, livelihoods, watersheds, conservation of biodiversity and to ameliorating climate change through carbon sequestration. However, grasslands are under-represented in discussions on food security and livelihoods. Despite large investments in building human capacity, improving production systems and in research, grasslands are continuing to degrade and there is no let-up in sight for the consequent strife, famines and conflicts among the pastoral and other communities that depend on them. This review of grassland issues identified many critical skills that are lacking but it also revealed models of public–private partnerships involving educators, entrepreneurs and researchers that could, by enabling the parties to work together, revitalise the skill base in grassland research and practice.

Keywords: Grasslands, research, skill base, investment, partnership.

Introduction

There are a huge number of Indian people who were formerly condemned to blindness because they could not afford to be treated. With innovative thinking it was found that much of the cost was the result of the misapplication of skills. Ophthalmologists could not do the highly skilled work they were trained for because too much of their time was spent on tasks for which more suited cadres had not been trained. However, this has been resolved by the application of a ground-breaking approach to revitalising and applying skills.

Blindness in low income communities can be prevented or cured by melding the practice of medicine, with optical business, ophthalmological training and critical understanding of the required skills. Ensuring that the right people have the right skills enables the surgeons to focus on surgery, which they alone can do, with maximum efficiency. The lesson in this, which is entirely applicable to grassland research and practice, is that when academia, business and research function in concert with each other they are capable of solving the most intractable problems, but they must not forget that, whatever the task, doing good work requires high-level skills.

Grasslands have the biggest footprint on the surface of this planet covering 52.5 million square kilometres or about 40.5% of the world's land surface (excluding Greenland and Antarctica, FAO 2005). Almost everywhere they make vital contributions to food supplies, livelihoods, watersheds, conservation of biodiversity and to ameliorating climate change through carbon sequestration. Without their proper use, there will be no hope of sustainably feeding the 9 billion people who will inhabit planet earth by 2050. Yet, grasslands are under-represented in discussions on food security and livelihoods.

Although people have survived on grasslands since time immemorial, much is still to be discovered. More research must be done to respond to unprecedented demographic challenges, which are causing increasingly severe competition for water and other natural resources. The world must wake up to the consequences of climate change and no meaningful global approach to ameliorate its impacts can ignore grassland management and conservation.

Despite large investments in building human capacity, improving production systems and in research grasslands are continuing to degrade and there is no let-up in sight for the consequent strife, famines and conflicts among the pastoral and other communities that depend on them.

In response to demographic pressures most high quality grasslands have been converted to cropping, mixed farming or artificial pastures. This has resulted in the relegation of grassland producers to less productive areas with more limited scope for investment in research and development. The difficult conditions place a high premium on acquiring the skills required for developing viable grassland business propositions but this is not reflected in capacity building policies.

Universities, businesses and research institutions, especially in respect of grassland issues, tend to be segregated from each other. As a result, universities are imparting knowledge without the urgency, passion and pragmatism that more direct interaction with the issues would generate. This leaves grassland businesses and research institutions short of appropriately trained staff. The consequent inability of the research institutions to deliver high-impact innovations further constrains the direction and rate of grassland development.

A review of grassland issues identified many critical

skills that are lacking but it also revealed models of public–private partnerships involving educators, entrepreneurs and researchers that could, by enabling the parties to work together as indicated in Table 1 revitalise the skill base in grassland research and practice.

Why do we need to revitalise the skill base in grassland research?

Worldwide 45 million people are blind and over 80% of this blindness is needless. It can be prevented or cured (Prahalad 2010). Despite treating most patients free of charge, the Aravind Eye Care System in India has always been financially self-sufficient. An important factor in making this possible is that a surgeon in the Aravind eye hospital averages over 2,000 operations a year, against a national average of 220. An incidental benefit of this high turnover of patients is the scope that it provides for better training of ophthalmology students.

To be able to offer such services, Aravind had to develop innovative businesses in, for example, producing affordable but reliable artificial lenses. They also had to become very effective in deskilling tasks to relieve the scarce ophthalmologists of all the work that could be performed by less highly trained persons, right down to training village women in the skills needed to carry out the patients' pre- and post-operational care. The lesson in this, which is entirely applicable to grassland research and practice, is that ignorance of and lack of attention to ensuring that the different actors in a system have the skills required to perform to their full potential will drastically limit the systems overall impact.

The fact that too little attention has been given to identifying the skills gaps in grasslands research and practice should be a matter of concern for all humanity. It has left grassland communities ill-prepared to deal with the rapid ecological, technical, anthropological, political and economic changes that are impacting grasslands. This paper identifies many skills needed for successful grasslands research and practice which are waning or have not yet even been developed.

Grasslands provide many essential goods and services. They make a very significant contribution to global food supplies by feeding domestic and wild animals that produce meat and milk. They also provide power for traction and transport. The wild animals also support eco-tourism, which is a mainstream economic activity in many countries. Many grassland areas are identified as outstanding examples of diverse ecosystems. In addition to their diverse direct contributions to livelihoods grasslands are also critical in maintaining watersheds, conserving biodiversity and ameliorating climate change through carbon sequestration. Through these services grasslands support over 700 million people directly (Fig. 1) and many more indirectly. Clearly, without their proper use it will be very difficult, if not impossible, to support the 9 billion people who will inhabit planet earth by 2050.

Despite their evident importance, grasslands are very much under-represented in discussions on food security and livelihoods. For example, in the recent report entitled "A New Paradigm for African Agriculture" (The Montpellier Panel 2013) the word grassland appears just once, in the

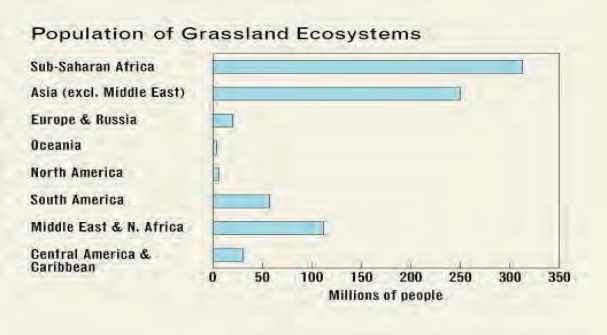

Figure 1. Grassland populations. Source: Reproduced from Bill Moyers reports Earth on Edge, Grasslands Ecosystems Profile http://www.pbs.org/earthonedge/order.html.

definition of sylvo-pasture (p 17). As another illustrative example, when most people think about Kenyan agriculture they envisage lush highlands with high producing dairy cattle and yet, while dairy off take is worth KSh 10 billion per year ($US 125 million), pastoral off take from the dry grasslands is worth over four times that at 44 billion per year ($US 500 million) (Behnke and Muthami 2011).

Even though people have survived on grasslands since time immemorial there is still an urgent need for research to enable grassland communities to respond to the unprecedented demographic changes that are causing increasingly severe competition for land, water and other scarce resources. This competition for resources is aggravated by challenging trends in politics, trade and climate change.

Despite the growing reservoir of knowledge about how grasslands work, what damages them and how they can be restored the evidence affirms that grasslands continue to be degraded leaving no real prospect for a let-up in the consequent inter-communal strife, famines and numbers of displaced persons. Meanwhile grassland-dependent persons such as pastoralists and graziers have, for the most part, had to continue to rely on their own ethnic science to contend with this adverse combination of forces that creates pressures which are beyond the scope of traditional coping mechanisms.

In this review of the state of grassland research and practice, wherever a deficit in a particular skill is identified a reference is made to Table 1 below, which sets out how the academic, business and research communities could work together to redress it.

Most high quality grasslands have been converted to crops, mixed farming or artificial pastures. This limits the amount of investment that can be attracted to develop profitable and sustainable systems of production in the remaining less productive grasslands (FAO 2005) and this makes the dearth of skills needed for grassland research and practice an even more critical constraint (Table 1, addressing skills deficit, Item 1).

Among the most difficult pressures that pastoral people have to contend with is the pernicious loss of opportunities for conveying knowledge and skills to succeeding generations because children are increasingly going to school rather than tending their parents' livestock and grazing lands (Table 1, addressing skills deficit, Item 2).

The weakness of not having a sound grounding in grassland and livestock husbandry is exacerbated by the

Table 1. Revitalising skills through tripartite collaboration. In this table the word 'group' encompasses any form of organisation created for the conduct of business, including but not limited to companies, cooperatives, associations, group ranches *etc*.

Item	Skills deficit in:	Organisational roles in developing skills		
		Academia	Business	Research
1.	developing grassland investment plans	learning in grassland management to include financial analysis and investment planning	provide internships in commercial grassland enterprises	conduct grassland management research with active groups
2.	inculcating basic grassland and livestock husbandry skills	training based on findings of contextually appropriate research	provide jobs with on-the-job training	conduct research to identify deficiencies in actual grassland practices
3.	understanding and appreciating the role and functioning of ethnic science	include teaching of the holistic approach of ethnic science and how to integrated findings of 'modern' reductionist science	apply the best of both approaches to science with a view to creating optimal, long-term sustainable systems	conduct research with rather than for beneficiaries on whole systems; technical, human and economic
4	improving human welfare while maintaining environmental goods and services	factor welfare and environmental services into curricula based on experiential learning in grassland practice	welfare and environmental status metrics included in business plans	welfare and environment assessments part of validation of grassland technology
5	providing pastoral people with high quality information	grassland communities information needs and capacities taught based on experience in promoting gainful aims	informing groups formed for commercial buying, managing, selling purposes	provide contextually relevant content for information systems and assess its impact
6	restoring access to grassland resources, for mobility, flexibility, and system security	grassland curricula include merits and constraints to movement of feed to livestock or livestock to feed as components of livestock systems	grassland groups access to better advice and facilitation in optimising movement of livestock and feedstuffs	expose the fallacy of trying to contain livestock systems and work on policy and legal instruments to facilitate optimal movement of feed or livestock
7	identifying and addressing gaps in knowledge of how grassland systems work and can be improved	expose what is not known through first-hand experience in grassland production	grassland groups are constantly contending with the unknown, especially about the impacts of change over which they have no control	probing the unknown is the essence of research (correct the oxymoronic expression 'it is alright in theory but not in practice')
8	balancing present food security and good nutrition with the well-being of future generations	Include food security, nutrition and well-being issues with practical exposure to appreciate trade-offs between short, medium and long term goals	grassland groups indicators to include food security and nutrition	factor the conflicts between food security, nutrition and well-being should be factored into the design and validation of research products
9	assessing the resilience of agriculture production and food systems and livelihoods, especially to the effects of climate change and economic shocks	tertiary agribusiness education should include periods of first-hand experience in adaptations forced on grassland communities by climate change and economic shocks	production plans should include preparation and adaption to climate change and economic shocks	research should include seeking to understand the impact of climate change on grassland productivity and sustainability in changing economic and demographic contexts
10	applying rights based perspectives	teaching the rights-based paradigm and how to apply it would enhance judgement of grassland researchers and practitioners in how to apply their own specialised disciplines most effectively in improving livelihoods	grassland groups would benefit from advice provided in the knowledge of how changes impact their members' rights to education, health, potable water, shelter etc.	the rights-based paradigm provides a good framework within which to assess the impacts of research products
11	understanding the complex inter linkages and interactions between social protection and food aid	agricultural graduates should be able to assess the real and opportunity costs of food aid and its consequences on social protection	grassland groups would benefit from better advice on how to minimise the negative consequences of food aid on social protection	interactions between food aid and social protection are important topics for research
12	gender analyses	gender analyses should be a part of any curriculum but to teach it appropriately for application in traditional grassland community contexts must be based on first-hand knowledge	business must embed good gender practices and that will be facilitated by recruiting persons who are well trained in gender analyses	research institutions should embed gender analyses in research design and validation

Table 2. Continued.

13	integrating food-based responses with public health interventions	faculty need to understand the health implications of food-based interventions	Groups should be aware of the benefits to productivity members welfare food-based interventions	research should account for health impacts in validating technologies and processes that affect food production and consumption
14	working with and learning from the grassland managers	faculty need to inculcate habits of listening to and working with beneficiaries rather than speaking for and to them	business serving grassland groups will make most rapid progress if their clients work with them as opposed to being passive recipients of their goods and services	research should factor in the need to learn from the 'beneficiaries' to avoid pitfalls and having to relearn
15	understanding the behaviour changes required for innovation	university curricular on innovation should include understanding the behaviour changes that are associated with	groups would benefit from being able to anticipate required behavioural changes	research should factor in the need to learn from the 'beneficiaries' to avoid pitfalls and having to learn what is
16	value Chain analysis	Curricula should address value chains in their full complexity including institutional (rules of the game) issues	groups should be able to recognise value chain constraints and raise awareness of them	researchers need the capacity to work along whole value chains to test and validate their integrity
17	getting innovations adopted	faculty working with groups in decision making will be challenged on both their technical as well as their social skill in ways that are not replicable in class rooms	businesses serving grassland groups and the groups themselves would benefit in getting policies implemented from having staff with both technical and social skills	research should factor in the study of the behavioural changes associated with the innovations they promote
18	building capacity for collaboration in change	faculty working with groups in decision making will be best able to learn what capacities are needed to be effective change agents in different contexts	groups trying to implement change must assure that there is sufficient capacity for implementing the proposed change	the capacity for change should be a factor in determining topics for research and in validating research products
19	establishing trust between advisor and advised	faculty working with groups in decision making will be best able to learn what promotes and what destroys trust	the success of groups and companies is largely determined by the degree of trust in their governance and management	trust is an essential factor in the adoption of research products and therefore building trust should be part of the innovation process
20	providing rural credit	faculty working with groups will be best able to learn what works and what does not work in the provision of credit to remote producers	a prime motivation for forming groups is to access credit without unreasonable transaction costs	credit is an essential factor in the adoption of research products and should be part of the innovation systems in which research is conducted
21	gathering, collating and transforming information so that it can be processed into useful knowledge by the end user	faculty working with groups in decision making will be best able to understand how information is received and processed	groups have much to gain from improving the effectiveness in receiving and transmitting information	researchers have vested interest in how information is received and used
22	crowd sourcing and open-data systems	faculty need to work with groups in decision making to be best able to understand the potential and practices of crowd sourcing	groups have potentially much to gain from contributing to crowd sourcing in gathering and disseminating information	Technology research institutions have the multidisciplinary capacity needed for developing crowd sourcing and open data systems and should be at the forefront of this emerging
23	taking advantage of remote sensing systems	universities including the application modern remote sensing techniques in their curricula	applying remote sensing in the development of business models that benefit from more reliable data	pushing the boundaries of what is possible in increasing the range and reliability of data that can be collected remotely

confusion that is created by introducing unfamiliar imported technologies. The affected communities tend to have little knowledge of the very different scientific and technical traditions from which the new technologies stem.

The most common interface between 'ethnic-holistic' and 'modern-reductionist' science has been in social disciplines. This has been useful, at least in helping 'modern' scientists appreciate the depth of knowledge and skills that have been acquired over the ages by the 'traditional' communities. However, scant regard has been paid to learning how present generations of grassland communities are adapting to the new challenges and opportunities that they are facing. In other words, a lot is known about what ethnic science has delivered by way of accumulated 'traditional' knowledge but very little is known about how it continues to be practised. As a result, researchers and practitioners, who have 'modern' science backgrounds do not appreciate the continued learning of

'non-scientific' producers and have underdeveloped skills in how to learn from their 'ethnic' counterparts (Table 1, addressing skills deficit, Item 3)

Grassland researchers and practitioners who work with 'traditional' communities would have more impact if they revitalised their skills in conducting research with, rather than for, pastoral people and ensuring that research products actually result in improved practices. In other words, ensuring that the theories they propound really do explain the practices in their holistic contexts.

The ongoing changes which are demanding new skills

No system is static and grasslands are no exception even if on the surface many of the communities appear to be following very much in the footsteps of their ancestors. In the case of East Africa Reid *et al* (2005) identified the following changes that are inducing pressures to which the pastoral communities must respond:

- Overgrazing;
- Competition between livestock and wildlife;
- Changes in rangeland burning regimes;
- Rangeland fragmentation and loss of wildlife habitat;
- Expansion of cultivation and settlement;
- Challenges to carbon sequestration;
- Bush encroachment; and
- Rehabilitation of grasslands.

In response to these changes Reid *et al* (2005) suggest the following priority topics for research and development in pastoral lands which will require new skills:

- Human welfare and maintaining environmental goods and services (Table 1, addressing skills deficit, Item 4);
- Providing pastoral people with high quality information (Table 1, addressing skills deficit, Item 5);
- Restoring pastoral access to key resources, increasing mobility and flexibility, and ensuring security (Table 1, addressing skills deficit, Item 6); and
- Addressing gaps in knowledge about how pastoral systems work and how they can be improved (Table 1, addressing skills deficit, Item 7).

Similar lists could be drawn up for grasslands everywhere and together they present a formidable array of challenges that demand diverse skills in research and practice. If the United Nations Secretary General's Zero Hunger Challenge is accepted, these factors should be considered in the formulation of grasslands' contributions to the next set of hunger and nutrition related goals (*The Guardian* 2012).The complexity of these challenges is indicated by the outcome of an online consultation on food security and nutrition that was conducted by the Global Thematic Consultation on Food and Nutrition Security in Post 2015 Development, which provided strong support for prioritising food security and nutrition in the next iteration of global development goals. The complexity of these issues themselves and in their interaction with each other raises concerns about whether grassland researchers and practitioners have the skills needed to cope with them, including:

- Achieving sustainability — that food security and good nutrition should be achieved while ensuring the well-being of future generations (Table 1, addressing skills deficit, Item 8).
- Increasing resilience of agriculture production and food systems and livelihoods, especially to the effects of climate change and (possibly) economic shocks (Table 1, addressing skills deficit, Item 9);
- A stronger emphasis on rights based perspectives, including for food security, land tenure, forestry, fisheries, natural resources, with links to promoting good governance, reducing inequality and establishing a legislative base for action (Table 1, addressing skills deficit, Item 10);
- Linking social protection systems with food assistance (Table 1, addressing skills deficit, Item 11). A much more explicit emphasis on gender equality, which is seen as an important precondition for accelerating progress in reducing hunger and malnutrition (Table 1, addressing skills deficit, Item 12); and
- Integrating food-based responses with public health interventions at all levels (Table 1, addressing skills deficit, Item 13).

It is particularly concerning that, despite their importance and the millennia of human engagement with grasslands, there is still disagreement on what characterises a healthy grassland ecosystem and how to determine the state of grassland ecosystem health (White *et al* 2000). This is disturbing because it raises fundamental questions about the potential for success of grassland research and practice. It is difficult to understand why there is such confusion among the scientific community when the pastoralists and graziers must be well aware of the state of health of their pastures from first-hand experience. This suggests that grassland scientists lack some of the skills they need to work effectively with the grassland managers and that acquiring such skills would enable them to generate more impact through joint learning (Table 1, addressing skills deficit, Item 14).

Innovation is a process of change that results in changed behaviour. Indeed, research has no purpose if it does not result in humans implementing improved practices and this involves the transfer and uptake of research results by the end users. Change involves moving into unknown territory and taking risks and this is particularly threatening to more traditional and poorer communities like those found in many grassland areas. Thus, it would be good to have researchers and practitioners with skills in instigating and managing change who should be able to reduce the debilitating confusion, frustration and downright fear that often accompany change (Table 1, addressing skills deficit, Item 15).

Most grassland regions, especially in Africa, have islands of success where promising technologies have been adopted but failed to spread and scale-up. This is symptomatic of the lack of understanding and skills in value chain analysis that results in breaks along the chain, blocking the progress of the innovation. Proctor and Lucchesi (2012) note that there is a dearth of institutions,

policies and services needed to facilitate value chain development and that there is a shortage of skills in enabling public–private sector dialogue required to address the challenges to value chain development (Table 1, addressing skills deficit, Item 16). This is evidenced by the frequent failure to account for institutional factors such as policies, rules and regulations that significantly impact the functioning of value chains.

Catalysing innovation and going to scale in grassland research and practice requires much more than just a few local successes. The research literature suggests many 'proven' new technologies and processes are waiting to be adopted. However, novel technologies and processes must fit the local context, not just technically, but also in terms of the available financial resources, management, labour, prevailing institutions such as land rights and access to resources. They must also fit the cultural norms which can limit an individual's scope for change but which may also require communal consent for the adoption and implementation of new technologies. Clearly, getting anything adopted in these circumstances requires not only great technical but also well-honed social skills. This is an all too rare combination of skills which must be revitalized (Table 1, addressing skills deficit, Item 17).

Contrary to a common perception that pastoralists and graziers are locked into preferred lifestyle choices evidence shows that they conduct astute businesses. Casual observers tend to mistake pastoralists' acceptance of low levels of production per animal as an irrational fixation on possessing large numbers of animals. However, it has been demonstrated, for example in Kenya and Botswana, that in terms of returns to land they consistently out yield neighbouring commercial ranches, which is entirely rational given that land is their most limiting resource (De Ridder and Wagenar 1984).

Many observers have focused on findings that, in very remote areas pastoralists' response to changes in price may not be high, especially where there are few consumer goods to be bought. However, Sandford (1983), cited in Barton *et al* (2001), explained that in their view pastoralists are economically rational in response to other sources of income from milk, reproduction and blood and there are good reasons to hold on to these assets until their income generating values fall below salvage value during droughts. Despite the evident rationality, Hesse (2009) notes that the enduring misperceptions of pastoralists, as being economically inefficient and pursuing environmentally destructive land-use systems, are still the cause of misguided rangeland and livestock policies.

Hesse (2009) agrees with Sandford (1983 cited in Barton *et al* 2001) that these misperceptions are sustained, in his words, "by ignorance of the dynamics of dryland environments and pastoral livelihood systems, and the absence of an economic valuation framework in which to assess the true contribution of pastoralism to local and national economies. Furthermore, policy design and practice are not sufficiently informed by past failure or designed with the participation of pastoral communities (page 15)". Such false assumptions will continue to blight their lives until the actors in grassland research and practice base their opinions on better evidence and help to build the capacity of pastoral communities to advocate their own causes in local and national decision-making. This is especially true for those grassland systems that depend on being mobile for the good of both their livestock businesses and the environment.

Acceptance that all producers, however poor, are economically rational and astute business persons should not be extrapolated to infer that they have all the necessary business skills. The more remote they are from the market the more likely that they will be unaware of what technologies and markets are available to them or the standards that they must adhere to in applying the technologies and competing in specific markets. Researchers, change agents and business persons operating in these markets must be skilled in dealing with these deficiencies and building the capacity of their trading partners to bring them on to a more equal footing which is essential for sustainable win-win business solutions (Table 1, addressing skills deficit, Item 18).

In every business there is a degree of insecurity and risk but this is more acute when the business involves persons and firms with very different backgrounds and competencies. It is therefore ironic that poorer producers, who need it most, have the least insurance coverage. The traditional systems for mitigating risks such as combining animals from different family members and splitting herds are more difficult to implement in the face of 'modernisation' and increasingly restricted access to resources.

In the absence of enforceable written contracts trade is more or less entirely dependent on trust alone, which is a difficult concept for a commercial firm. This provides openings for agents and business promoters to establish and maintain value chain integrity and create trust between sellers and buyers of the goods or services. However, implementing this role will require uncommon skills. Livestock traders in West Africa traditionally relied on 'landlords' to introduce them to sellers and vouch for the integrity of both parties and studies have revealed that these systems were very intricate requiring very skilled actors (Hill 1966). This is a role that may be taken up by business incubators provided that they are prepared to invest in acquiring the necessary oversight and trading skills. However, skills in establishing trust are not easily acquired especially in cross-cultural settings of educated advisers reaching out to traditional, communities (Table 1, addressing skills deficit, Item 19).

In the past, when human populations were much smaller, competition for grassland resources was far less and far more production and precautionary options were available through movement and exploitation of alternative resources. Grasslands are particularly susceptible to competition for resources because the options for storing or purchasing reserves are very limited. Making hay, for example, requires grazing to be excluded while the grass grows but this is an increasingly untenable practice when all the grazing is needed all the time.

Most businesses use credit to tide over trade and cash flow fluctuations and seize new opportunities when they occur but this is another asset that is not readily available to many grassland producers. Access to credit is improving with the aid of enlightened micro-credit schemes, mobile telephony and innovative insurance schemes (discussed

below) but the lack of experience and shortage of skills in providing rural credit in remote areas is constraining the roll out of such schemes (Table 1, addressing skills deficit, Item 20).

Inadequate infrastructure is a universal problem in developing regions where grasslands predominate. This is a major constraint to efficient marketing and diversification of production systems. The deficiencies are found in roads, storage and handling facilities, water distribution, human and livestock health facilities, electricity supplies and the list goes on. These deficiencies create problems that cannot be wished away and will have to be coped with for the foreseeable future and that will require great skill in marketing and logistics.

One of the main challenges is the lack of market information, which affects the more remote communities more severely. Grassland producers, wherever they are, need information on the demand and prices on offer for the goods and services they wish to sell. These include livestock and livestock products, honey, gum arabic, cochineal, eco-tours, cultural visits, handicrafts and many more. By the same token their clients need information on the availability of their goods and services.

An increasing number of mobile telephone providers can reach remote areas. However, it requires considerable skill to be efficient and effective in gathering, collating and transforming information so that it can be converted into useful knowledge by the end user (Table 1, addressing skills deficit, Item 21). Development of remote areas, especially those with unreliable weather patterns, is constrained by lack of effective insurance. However, remote sensing systems are being tested with the aim of creating insurance systems that are free of the perverse incentives that are inherent in traditional systems that favour the ones who 'apparently' lose the most. Payments based on rainfall and biomass cover rather than numbers of deaths encourage good husbandry and timely sales (Cately *et al* 2012).

Crowd sourcing and open-data systems have demonstrated potential for providing more accurate and more timely data on, for example the state of the grassland and its human and animal inhabitants but the systems and skills needed to apply them have yet to be developed, especially in illiterate communities that depend on voice communication in the vernacular. However, skills in crowd sourcing and open-data systems have not yet been developed for grassland systems (Table 1, addressing skills deficit, Item 22).

The need for knowledge of the status of grasslands is no less than for any other agricultural resource but their vastness, diversity and remoteness bring additional challenges to gathering and handling the information on which to reliably build such knowledge. This infers that grassland researchers and practitioners should be interested and engaged in establishing efficient synoptic monitoring that enables data to be obtained nearly simultaneously over large areas. One of these systems is the Integrated Global Observations of Land (IGOL; http://www.fao.org /gtos/igol/) programme which is assessing the need for enhanced agricultural observations (satellite and in situ). The programme is advising the Group on Earth Observations (GEO; http://www.earthobservations.org/index. shtml) on the requirements for improved observation of the land surface and is addressing a broad range of societal benefit areas, including sustainable agriculture (Becker-Reshef *et al*2009). Other systems include the Global Agricultural Monitoring System (GAMS; http://www.earthobservations.org/cop_ag_gams.shtml) and the Global Earth Observation System of Systems (GEOSS; http://www. earth observations.org/geo ss.shtml) which are also working with national, regional and international systems to provide comprehensive, coordinated Earth observations. GEOSS is specifically intended to help farmers, fishers and policymakers maximise productivity and food security while preserving ecosystems and biodiversity. GEO also aims to support the sustainable management of agriculture by disseminating weather forecasts, early warnings of storms and other extreme events, water pollution, long-term forecasts of likely impacts of climate change, and information on water supplies (http://www.earthobservations.org/geoss_ag.shtmlm). These aspects are all vital to the health and well-being of grasslands and their occupants and, as such, grassland researchers and practitioners should be more interested in acquiring the knowledge and skills needed to take advantage of these remote sensing systems (Table 1, addressing skills deficit, Item 23).

The context for revitalising the skill base in research

Determining that there is a huge and urgent need to revitalise many skills to create a credible basis for grassland development is the easy part. So easy that it is almost trite. However, determining how that can be achieved is much more difficult. It is not even easy to determine where to start the revitalisation processes.

The attrition of traditional skills starts very early in life as more children of pastoralists, graziers and herders attend school rather than herd their parents herds and flocks. This not only deprives them of chances to gain invaluable experience, knowledge and skills but it also tends to promote an active disinterest in acquiring such skills by turning them against following their parents' grassland occupations.

This will have to be addressed in schools by emphasising grassland values in the curricula and extra curricula activities such as field visits that venerate traditional values and practices and confirm not only their merit but also their compatibility with modern practices. For example, any child of the Maasai communities in Kenya and Tanzania should be amazed by the number of livestock diseases that their herdsmen can correctly diagnose and identify with specific Maa names. Their knowledge of the attributes of different grasses and herbs is equally impressive, and this is common to pastoral communities anywhere. This will require changing the mindset of many of the teachers in both primary and secondary schools and of educational authorities who have been taught to disdain traditional occupations.

In tertiary education in developing regions significant misfits between the curricula and the labour markets are common and these are widest in respect of traditional livelihood pursuits. The curricula must be changed but not

by the faculties acting alone. The views of the practitioners and of the students must also be sought. Kruijssen (2009 cited in Percy-Smith and Akkermans 2012) notes that the advantage of enabling young professionals to express their views, aspirations and perception is that they are highly motivated, open and frank, ready to accept change, and at ease with change. Moreover they are inclined to reject traditional hierarchical and inter-institutional relationships. Citing several authors (Urutyan and Litzenberg 2010; Blackie *et al* 2009; Maredia 2007), Percy-Smith and Akkermans (2012) indicate that this is a consequence of weak links between the tertiary institutions and potential employers.

Graduates who will be engaged in agricultural research for development would benefit from exposure to curricula that have had input from practitioners in the industries they propose to enter. This is even more necessary in grass-land industries from which academics tend to be too far removed. This is supported by Ståhl and Hall (2003) who argued that the ambitions to increase agricultural productivity, rehabilitate the environment, create conducive policies and in general reduce poverty, are bound to fail, unless research and development programmes seriously address the question of recruiting a well-qualified and motivated generation into the scientific profession. Temu and Garrity (2003) demonstrate that it is not sufficient to just have trained personnel, which is the product of most capacity building schemes. For the science to contribute to improving livelihoods scientists must be skilled in interacting with the beneficiaries and with those whose decisions and actions affect the uptake of innovations.

Based on this wider view of capacity building training of agricultural scientists, practitioners, businessmen, extension agents and policy makers have some common deficiencies which must be addressed (Kaufmann and Temu 2004). These include:

In human resources:

- Inadequate training: in terms of content and coverage of disciplines (context);
- Attrition of trainers, *e.g.* through retirement, brain drain and disease (especially HIV/AIDS) without replacement;
- Lack of motivation and of participatory skills among scientists; and
- Inadequate incentives for scientists to link up and apply science to development.

In institutional capacity:

- Low establishment levels, not permitting further recruitment of scientists, with the result that very few young scientists are available to take the cue from the ageing senior scientists;
- Inefficient deployment of existing capacity — a weakness in managing research resources (especially human);
- Fiscal stress, often reflected by shortage of operational funds for training and research;
- Inadequate or poorly maintained training and research facilities; and
- Weak links with research and development establishments, *i.e.* the graduates' employers

The consequences of these weaknesses are expressed in the form of low quality, lack of relevance and poor application of scientific products.

The Inter Academy Council (IAC) reports (IAC1, IAC2 2004) are amongst many that have highlighted the importance of universities in developing countries being vibrant centres of excellence capable of propelling their countries into the knowledge economy. It is vital to find mechanisms that will enable university staff to keep up with developments in their subject areas and with changes in training needs and methods, despite their heavy teaching commitments. Watts *et al* (2003) in their paper on institutional learning and change indicate, inter alia, that the rapidly changing context of development entails:

- A more sophisticated understanding of how development occurs, which recognises that innovation has multiple sources and that it results from the actions of a variety of participants;
- The emergence of a large number and range of organisations associated with agriculture and rural development including NGOs, private companies, farmer-operated enterprises and research foundations;
- New working practices involving partnerships and grass-roots participation;
- Globalisation and the increasing influence of international markets on the rate and direction of technological change;
- The increasingly important role of knowledge in the global economy;

Raising the quality of training provided by agricultural universities and colleges will be achieved by developing and implementing scientific upgrading programmes as necessary by:

- Enhancing problem solving skills through short training courses by subject matter;
- Enhancing strategic planning skills through senior fellowships and internships;
- Building skills in the research process, planning, management and resource mobilisation through hands-on work and mentoring;
- Enhancing participatory approaches to research through hands-on project development;
- Enhancing communication skills (scientific and developmental) through short courses with hands-on writing and communication tasks; and
- Establishing programmes of collaboration with organisations that support research and graduate studies by providing opportunities for collaboration in developing course content and training materials.

A common characteristic of most capacity building efforts has been a focus on raising the competency of individuals rather than building the capacity of institutions. Where the effort has focused on institutions it has typically involved high transaction costs and insufficient attention to sustainability after the life of the project. As a result, African training institutes have not been able to sustain

themselves as platforms for launching scientific and technology development.

In view of the complexity of the challenges that have to be addressed in grasslands research and practice and the diversity of required skills a methodical approach to skills building must be developed. Treating skills just like any other input, it is possible to adapt the analysis of Scoones *et al* (2013) which indicates that rethinking is needed about how to revitalise skills in a number of ways, including:

- Challenging inappropriate assumptions about what 'grassland research and practice' is about, and avoid being misguided by simplistic versions of modernisation theory;
- Emphasising the social, political and institutional dimensions of technical change
- Highlighting agro-ecological questions and environmental impacts and influences, including climate change;
- Interrogating 'whose knowledge counts' — not just in disciplinary terms, but by drawing more on local understandings of complex contexts;
- Recognising that technical change, while necessary, is not neutral – it needs to be introduced skilfully because it carries major social and political commitments, and major consequences for governance;

These factors have two major implications for the future:

- The need to revitalise skills in new disciplinary perspectives (beyond agricultural economics and agricultural science) to include social, political, health, environmental and other analysts in technology development and policy assessment;
- The need to highlight the skills needed to address the key challenges of governing change, from upstream design to downstream delivery and regulation

Scoones *et al* (2013) argue that at the core of all solutions are social, cultural and political factors. This demands more than just skills in applying technocratic approaches. It requires skills in implementing more politically sophisticated approaches. A new emphasis is needed on understanding and influencing the processes of innovation, intervention and policy, not just their technical content. This requires skills in implementing cross-disciplinary approaches that will succeed in combining economic and technical analysis in socio-cultural and political frameworks.

The report of the National Academy of Agricultural Sciences (2013) concludes that India's spectacular achievements in the area of food and agriculture have stemmed from a combination of investments in agricultural education, research and government policies. Nevertheless, India's agricultural education still has a long way to go in respect of enabling India to take advantage of new ideas to keep pace with the many environmental, social and economic challenges. University curricula are typically outdated, with quality deteriorating at a time when students urgently need to be taking up agricultural careers. To address this, a roadmap was developed to mobilise cutting edge global knowledge and meet local needs through greater effectiveness and impact of educational institutions and associated research and extension organisations. This requires a clear agricultural education strategy, tuned to the new realities of agriculture and societal needs, with clear deliverables over the short, medium and long term.

The report confirmed that it is essential that universities listen to their customers and foster the new skills required to make agriculture and rural work exciting and attractive to young people. These skills include ICTs, molecular biology, entrepreneurship, nutrition and health, social sciences, ecology, food chain value addition and many others.

Academia, business and research combining in revitalising skills

A 21st century approach to inculcating skills is needed. The process of acquiring skills in grasslands research and practice has no sole proprietor. None of the key institutions involved in imparting skills, *i.e.* universities and colleges, business employers or research institutions can, on their own, develop the myriad of essential skills that have been identified above.

Consultations convened by the Africa Commission (2009) identified two approaches for developing skills that are entirely relevant to revitalising the skill base in grassland research and practice.

Firstly, the Commission advocated the improvement of the skills of young Africans through upgrading existing apprenticeship schemes and developing demand-driven technical and vocational training. For this it recommended that secondary education should pay more attention to skills development in relation to the needs of the private sector where school leavers will seek employment and to the need to equip the labour force with the skills needed to drive productive economies. This is a much neglected area. For example, in most African countries less than 5% of secondary students go on to attend technical and vocational schools. Even where they exist, technical and vocational skills development systems generally suffer from weak links with the job market as well as shortages of qualified staff and ill-adapted programmes. Very few countries emphasise skills development in rural communities, which is essential in the context of grasslands.

Secondly, it recommended linking university education, research and private sector development in agriculture to increase the business skills of graduates and promote innovation in agriculture and agribusiness. It based this on the finding that in most developing countries universities are not sufficiently oriented towards meeting the needs of industry or fostering innovation and entrepreneurship and as a result their potential to promote positive change in society is largely untapped. The relationship between what universities teach and the real challenges that businesses encounter is far too weak.

The Africa Commission noted that universities have particular responsibility to generate and diffuse knowledge into the economy to overcome constraints and open opportunities for innovation. The universities can do this most effectively when they have strong links with research and business. The Commission recognised that achieving such links would require adjustments in the way universities function so that could engage with the private

sector at all scales including smallholders which in the case of grasslands would be livestock keepers. The Commission argued that with such links across the agricultural value chains, locally, nationally and regionally, the universities would be better able to develop effective entrepreneurs and change agents.

The Africa Commission (2009) concluded that an unmet demand exists for more and better educated researchers and practitioners who are equipped with the right skills. With absolute relevance to grasslands, the Commission recommended that the changes needed to achieve this should include developing better links between the education providers and the private sector.

One of the outcomes of the Africa Commission's consultation is the Universities, Business and Research in Agricultural Innovation (UniBRAIN) initiative which, led by the Forum for Agricultural Research in Africa (FARA), is pursuing three main outputs:

- Fostering agricultural innovation;
- Improving agricultural teaching and learning at graduate and postgraduate levels; and
- Exchanging experiences, resources and knowledge for agricultural development.

Fostering agricultural innovation

UniBRAIN is encouraging and facilitating innovation in the private sector by establishing better linkages between universities, research and agribusinesses in addressing constraints and opportunities in agricultural value chains. This will be achieved by establishing agribusiness incubators that will support start-up businesses and small and medium-scale enterprises to help them get established and grow to scale. The agribusiness incubator offices will also be one-stop gateways for firms seeking access to the human and infrastructural assets of the member universities, research institutions and businesses for research and problem solving.

Improving agricultural teaching and learning at graduate and postgraduate levels

UniBRAIN is supporting universities to engage with research institutions and the private sector to develop improved contextually appropriate and up-to-date teaching and learning resources for graduate and postgraduate programmes. The agribusiness incubators main contribution is, however, expected to come from access to hands-on experience in agribusiness for faculty staff and student attachments and internships.

Exchanging experiences, resources and knowledge for agricultural development

The potential to scale up is a key criterion in determining UniBRAIN's priority activities. This will depend on sound value chain analysis to ensure that there are no breaks or institutional blockages that will prevent the businesses promoted by the incubator from succeeding and going to scale. Where breaks occur in the continuity of the value or supply chains they are viewed as potential business opportunities.

The tripartite, universities–academia–research, collaboration being piloted by UniBRAIN is providing lessons that can be applied to overcoming the difficulties that have led to the depletion of skills in grassland research and practice and how to revitalise them. The different but vital roles of each of the parties in revitalising the skills identified in this paper are set out in Table 1. More information on the particular skills deficit can be found through the footnotes.

Conclusion

Skills are usually associated with crafts people but they are in fact needed by everybody in every aspects of their work and indeed personal lives. However, despite everybody's need for them, most people have to acquire most of them almost accidentally in the course of their careers rather than through active education and training in them. Everyone who has worked in grassland research and practice has come across individuals and groups who are very much more effective than others because they seem to possess innate skills for achieving their objectives. Why then is so little attention given to determining what those skills are and learning how to impart them to others who need them?

Research conducted in preparing this paper has revealed that while academic and research institutions are wholly committed to acquiring and imparting knowledge they pay almost no attention to identifying and correcting skills gaps. This is attributed to the physical and, in too many instances, also to intellectual segregation of academia, commerce and research institutions.

Grassland people cannot make persons with whom they have little contact aware of their needs and if they are not aware of them academics cannot address them. Likewise researchers cannot appreciate the context for the adoption of their products unless they work with the adopters. Thus academia, business and research will make most rapid progress only if they work together. This is especially true in respect of identifying, acquiring and inculcating skills and for grasslands research and practice because grasslands tend to be remote from centres of learning and research.

This paper has identified 22 skills, from among potentially many others, that must be addressed and argues that these skills cannot be properly addressed except in collaborations between academia, commerce and research because none of these communities can effectively identify, teach and develop the skills on their own.

The overall conclusion is that revitalising the skill base in grassland research and practice is essential to the proper and sustainable development of grasslands and that this can best be brought about through university, business and research institutions jointly applying their collaborative advantages.

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