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Bioenergy and Pastoralism: Challenging the Wastelands Myth

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Background to Discussion Paper

At present the global biofuel debate is beset by a huge diversity of possible outcomes in terms of the different crops, cropping systems, business models and development trajectories, several of which remain at the experimental stage. More recently, however, international bioenergy developers have focussed upon the expansion of non-edible dryland biofuel crops and the potential exploitation of so-called arid *wastelands* or degraded marginal lands. This has caused alarm among pastoralists who are increasingly experiencing loses of land to biofuel companies and government officials seeking to expand production without competing for food production.

Most agree that the renewed focus on drylands could represent an opportunity for pastoralists to re-emphasize their often underestimated, vital role within the carbon cycle and wider economics of arid lands. Yet, at present, little is known regarding the potential scale of the *wastelands* threat in terms of the business models and dryland crops likely to persist in the long term. NGOs have started to campaign on the *wasteland* issue in order to hold governments accountable for protecting the resource access rights of the rural poor.[1] However, to engage with this new development paradigm effectively, pastoralists and policy makers need better information and greater awareness of the threats and opportunities associated with dryland bioenergy crops such as *Jatropha curcas*.

Drynet commissioned this discussion paper, prepared and researched by SOS Sahel International UK, to clarify the problem and identify the key issues and options for pastoralists and governments. The findings of this work were presented at a special side event at the UNCCD CRIC VII in Istanbul on the 6th November 2008.

SOS Sahel International UK

SOS Sahel UK was established in 1983. It seeks long-term, sustainable solutions to the poverty experienced by millions of people across the semi-arid lands of the Sahel and Horn of Africa. Its vision is that the people of the Sahel will have more influence over the decisions that affect their lives and more control over the resources they need for a secure, sustainable livelihood. Committed to the principle of African-led development, the organisation believes that sustainable change for those living in the Sahel will only come when they are in a position to demand more from others – from governments, donors, NGOs, and their own leaders – and to hold them to account. For over twenty-years the organisation has been working closely with poor people throughout the Sahelian drylands and the strength of these networks enables the organisation to work with pastoralists and their customary institutions; to hear their concerns, problems and future aspirations.

Acknowledgements

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Contents

Executive Summary

Pastoralism is a livelihood system adapted to uncertain, variable environments such as the world's drylands. There are few other livelihood systems able to use mobility and opportunism in such effective ways. Pastoral livelihoods are resilient. They have survived several major threats in recent decades: settlement policies, inappropriate range management policies, drought, armed conflicts. Many attempts have been made to modernize and intensify production in the pastoral drylands or replace extensive pastoralism with alternative land-uses. Without exception these have been a dismal failure wasting vast sums of money and there are few more cost-effective or productive land uses in the drylands. The production biofuel using inedible dryland crops in the pastoral drylands is the most recent threat to pastoral survival.

Recent energy price rises have made agrofuel an economically attractive alternative to fossil fuels. The bioenergy industry is risky, controversial, and dynamic; it relies on political support for preferential trade agreements and markets. There is pressure to avoid presently cultivated land in order not to damage food security. Biofuel industries and governments struggling to meet internationally-agreed biofuel targets are increasingly looking to developing countries for land to expand biofuel production, and within developing countries to land not presently cultivated. To those with little knowledge, dry pastures represent '*wastelands*' apparently without sustained economic use just waiting to be cleared and planted with inedible crops such as *Jatropha curcas*. Yet many of these areas are in fact the grazing lands of extensive transhumant pastoralists and are vital to their food security, as well as providing wider environmental services and economic returns.

Policy makers and pastoralists need greater awareness of the risks and opportunities of bioenergy development before engaging with the industry. This paper asks what the bioenergy boom could mean for pastoralists and their arid rangelands. It explored some of the various development scenarios emerging from the recent focus on inedible dryland crops. Governments and investors are currently rushing to back the expansion of crops such as *Jatropha curcas* onto pastoral rangelands. Yet current understandings regarding the agronomy, economics and environmental risks associated with this plant remain poorly understood. The crop is toxic to livestock and thus the environmental costs of conversion are likely to be far greater than for edible crops.

Pastoral livelihoods could benefit from small-scale bioenergy production, seed sales and seasonal employment in the industry. Social impact assessments for bioenergy development in pastoral areas are currently weak and it is imperative that pastoralists are involved in the search for degraded sites to convert. Developers must recognise that pastoral resource use is notoriously difficult to map and work with pastoralists to determine their energy requirements and how best to integrate bioenergy production into their economy.

We need better information about the environmental impact, economics and agronomy of potential dryland feedstocks in order to critically evaluate the costs of conversion compared to the diverse returns from extensive pastoral use. The political, legal and institutional systems governing biofuel expansion need to be investigated and where energy companies are currently exploiting weaknesses, these must be strengthened to avoid abuse. Debates concerning the carbon debt created from the conversion of degraded pastures totally ignore the complexity of the desertification debate. More research is also required to determine the carbon storage capacity of degraded sites and clarify scientific criteria for identifying where conversions would create least carbon emissions.

keywords

Pastoralism, Biofuels, *Jatropha curcas*, Wastelands.

1. Introduction

In recent years global interest in biofuels has grown rapidly. Driven partly by global concerns over the depletion of oil reserves and the rising price of oil, and partly by the search for ways to mitigate climate change, biofuels are now high on the international agenda. Although the consumption of biofuels in western countries still accounts for a minute share of total global energy consumption - 1 per cent of total fuel for road transport - the contribution is growing rapidly.[2] Global bioethanol production, for example, increased from 29 to 51 billion litres between 2000 and 2006.[3] This year the agrofuel industry is expected to consume 100 million tonnes of grain, an 80 percent increase on consumption eight years ago.[4] The biodiesel sector is also booming, with production increasing nearly fourfold between 2000 and 2005.[5]

As the biofuel industry expands, so do concerns about the positive and negative implications of biofuel crops, and the development scenarios they give rise to. Major issues include links to food price rises and food security, deforestation, restricted resource access for the rural poor, and concerns that fuels produced on cleared land or using intensive processing techniques may produce more carbon than fossil fuels. If biofuels are going to represent even a small share of global energy production, the implications for land use are substantial.

The energy industry is closely regulated and linked to political structures. As scientists and advocacy groups flag social and environmental concerns, the focus moves from one biofuel crop to another. Recently, the debate has concentrated on inedible biofuel feedstocks,[1] such as *Jatropha curcas*. Originating from Central America, the plant grows throughout the drylands of Africa and Asia, where it is often planted as a living fence surrounding fields and houses.

To some, Africa's drylands represent the last agricultural frontier where abundant land and labour provide the conditions for a new green revolution, based on the intensification of arable and livestock production. This view is held by a growing number of investors and governments for whom *Jatropha* represents the answer to the biofuels/food security crisis: a multiple purpose crop able to promote food and energy security, rural development and agricultural exports, based on the use of unproductive arid *wastelands* (Box 1).

Box 1. Jatropha Claims

'The beneficial characteristics of Jatropha could offer a means to address the key social and economic issues of rural unemployment, depopulation, land degradation and fuel security that face many developing countries'

Source: D1-BP Fuel Crops, 2007

'developing countries have millions of hectares of land that is currently classified as marginal, waste or degraded'

'we support the principle that sustainable feedstock production should take place on idle land which is neither existing forest, of high conservation value, nor needed for staple food production in food-stressed areas'

Source: D1-BP Fuel Crops Sustainable Development Statement, September 2008

It is clear that the demand for biofuels and dryland feedstocks such as Jatropha may offer opportunities for pastoralists. Biofuel production could provide pastoralists with new income generating opportunities and new, productive seasonal employment. Yet there are major uncertainties regarding this hypothetical development path. The major question is whether there are indeed vast unproductive wastelands, unused by people or their livestock, and what impact converting these lands to biofuel production would have on livestock keepers and their livelihoods.

[1] Biofuels are made from what are termed biofuel feedstocks. These are the crops grown especially to be pressed or fermented into fuel, or various by-products or wastes that can be processed into fuel.

So far there has been little research on the potential threat to pastoralism. But such research is essential if informed discussion and advocacy are to take place. This discussion paper explores what the current international bioenergy trade boom could mean for pastoralists and arid rangelands. It explores likely development scenarios emerging from the present interest in crops like *Jatropha curcas*. Are there vast *wastelands* devoid of sustained economic use waiting to be exploited? Are these regions the answer to the current global food and energy crisis? Does dryland Africa represent the "green OPEC"?

This discussion paper begins by exploring why so much emphasis is being placed on so-called *wastelands*, and inedible dryland feedstocks such as *Jatropha curcas*.[6] It then seeks to demonstrate the true value and diversity of resource use in such areas. The paper shows how extensive, mobile resource use by pastoralists is difficult to map on the ground and how flexible systems of land tenure leave the resources of such people vulnerable to appropriation. The real threats this development approach presents to pastoral livelihood systems are then exposed before some potential opportunities are evaluated. Finally, a series of research imperatives are listed which are in need of urgent clarity before policy makers and pastoralists can make informed choices about bioenergy production in the pastoral drylands.

2. The Bioenergy Boom: Why *Wastelands*?

While bioenergy is expected to provide much of the fuel required to supply rising demands from developing countries,[7] the present interest in biofuel production comes from developed western nations, many of which have set ambitious targets for bioenergy use. Leading the field is the United States which in 2007 legislated that 36 billion gallons of renewable fuels should be fed into the nation's transport fuel supply by 2022.[8] Earlier this year the European Union revised earlier targets and proposed to source 10 percent of all transport fuels from renewable sources by 2015. When it became clear that domestic production could only provide 5 percent, legislators were forced to reduce their target in the light of fears for global food security and increasing links between agrofuel production and rising global food prices.[9]

As a practical alternative to fossil fuels, biofuels must: (i) offer a net energy gain; (ii) be produced on a large scale without competing with food security; and (iii) not cause social or environmental problems. [10] To date the focus has been on 'first generation' biofuel, most of which is derived from edible crops harvested for their sugar, starch or oil content. However, to produce a significant amount of energy, first generation biofuels would require a significant percentage of the land already used for arable production today. [11] For Europe to fulfil its bioethanol targets, for example, would take 70 percent of its farmland, for the US 43 percent.[12] Thus mandatory targets are clearly impossible without use of land in developing countries.

Africa has long been viewed as the last agricultural frontier; rich in land and labour, a place where the farming potential has barely been scratched.[13] The continent is now termed 'the green OPEC' by biofuel capitalists presently investing heavily in land. For most African governments, biofuels are an attractive way to boost the agricultural sector and intensify production. With 2 million hectares of idle arable land in Mozambique, 3 million in Benin, and 1-2 million in Ethiopia apparently available for agrofuel production, could this be a new green revolution?

In spite of increasing investment, political enthusiasm for first-generation biofuels has waned lately following mounting pressure from scientists and environmental lobby groups. Western governments are increasingly conscious of the global consequences of their agrofuel policies. The debate has

now focussed on the potential of non-edible first or second generation biofuel feedstocks. [14] For example, when the EU reconsidered its bioenergy targets last month and postponed the 10 percent target to 2020, legislators committed to 5 percent by 2015, at least a fifth of which must come from 'new alternatives that do not compete for food production'. [15]

To date few second-generation biofuels have moved beyond the experimental stage, prompting renewed emphasis on non-edible first-generation feedstocks such as *Jatropha curcas*. However, investment in Jatropha has expanded faster than global trade, and the crop still accounts for less than 1 percent of global biodiesel production.[16] Nevertheless, with processing plants established this year in the US and UK,[17] and increasing amounts of land appropriated and pledged in Africa for its export production, a global trade is imminent.

The current and likely future impact of biofuel production on demand for land in developing countries has recently been reviewed. [18] These reports show the impact on the poor. Governments throughout Asia and Africa are under pressure to locate new lands for *Jatropha* cultivation which don't compete for food production, and are identifying idle, abandoned arable lands. However, many are going beyond this and mapping areas of degraded rangeland or forestland. [19] Last year in Ghana, for example, a biofuels corporation appropriated and cleared 38,000 hectares of communal rangeland for *Jatropha* production. Similarly in Ethiopia 10,000 hectares were recently cleared, 86 percent of which were part of an elephant reserve.[20] In the absence of clearly defined land rights, poor marginalised groups are losing access to land for crop farming, herding and the gathering of natural resources.

The biofuels industry is highly risky and controversial, increasingly dependent on political support for market liberalisation and subsidised demand. Clearing rainforest, rangelands, savannas or grasslands to produce biofuels creates a 'biofuel carbon debt' by releasing 17 to 420 times more CO_2 than those biofuels would provide by displacing fossil fuels. [21] Yet alongside claims that inedible dryland feedstocks grown on degraded wastelands can reverse desertification and promote local energy security, some bioenergy companies also maintain such land use changes will improve biodiversity and increase carbon sequestration (Box 2).

Box 2. Biodiversity and Carbon Claims

'where Jatropha is cultivated on land that is not suitable for arable cultivation or has no existing arable use, it can add to the diversity of the local environment'

'where Jatropha is planted on marginal or degraded land containing low carbon deposits, carbon release will be further reduced'

Source: D1-BP Fuel Crops Sustainable Development Statement, September 2008

Uncertainty surrounds the development of biofuels in Africa and so far few studies have evaluated the size of the threat to pastoral production and the pastoral commons. Many claims are made about the performance of dryland feedstocks such as *Jatropha* under large-scale commercial production in drylands, but few of these can be scientifically sustained.[22] We need an unbiased evaluation of the arid *wastelands* issue. Do vast areas of *wasteland* really exist? What is the true cost of such land use changes compared with their present economic use? The following section of this report attempts to explore the real nature of natural resource use in these areas and demonstrates how pastoralists in these areas have become marginalised and are increasingly vulnerable to resource appropriation by sedentary society and outside investors.

3. Challenging the *Wastelands* Orthodoxy

Pastoralism is a livelihood system uniquely adapted to uncertain, variable environments such as the world's drylands. The term refers to livelihood systems where livestock represent 50 per cent or more of the economic income of a smallholder.[23] Globally there are approximately 200 million pastoralists and extensive pastoral production is practiced on 25 per cent of the worlds' land.[24] In African roughly 59 per cent of the continent's ruminant livestock are found in arid and semi-arid areas,[25] and pastoral production takes place on 66 per cent of the continent.[26] The drylands of Africa are therefore essential to the survival of a significant number of its people.

Estimating and predicting the future demand for land in drylands for biofuel production is highly complicated. Some of the increased demand for bioenergy could be met by alternative second-generation biofuels derived from freely available products such as waste or crop residues. More biofuel could also be produced from existing arable lands using new intensive, technical modes of production. However, this is likely to create more carbon emissions and environmental problems in the long term. Estimates vary but some reports predict that between 56 to 166 million hectares of additional land would be required to meet 10 per cent of global petroleum demand by 2020.[27] Thus to avoid competing with food crops for arable land between 4 to 16 per cent of permanent pastures would have to be converted to biofuel cultivation.[28]

Given that the yield potential of dryland feedstocks such as *Jatropha curcas* are poorly understood and expected to be lower on marginal land unless irrigation and fertilizers are used, these estimates could be conservative. Another issue is the likely carbon debt clearing large areas of pastoral land would create. Grasslands contain 2.8 tonnes of carbon per hectare above ground (biomass & litter), 4.4 tonnes per hectare in their roots and 43.6 tonnes per hectare in the top 30cm of soil.[29] 13 per cent of this carbon is lost upon conversion. Thus to expand the production of any biofuel feedstock onto permanent pastures (i.e. rangelands, savannas, grasslands) would release approximately 46 tonnes of CO_2 per hectare.

Supporters claim that this figure is far lower than the carbon debt for tropical forests and that on degraded pastures such a conversion would soon result in greater carbon sequestration. Yet few studies have accurately investigated the carbon sequestration of degraded lands, especially quantities of soil carbon. In September the EU's biofuel policy commitment to avoid expansion onto permanent grasslands was weakened considerably.[30] However, few have considered what role these supposed *wastelands* or *degraded pastures* currently play in sustaining dryland people as sources of fuel, food and grazing. Such considerations give rise to a whole series of important questions. Given that yields are likely to be lower in marginal lands, do we know whether the conversion of these lands into biofuel plantations will improve economic returns relative to their present use? Are the rights of these land users likely to be recognised within national policy frameworks or adequately compensated? Will developers be able to easily determine the nature of natural resource use in these lands so as to avoid competing for prime resource areas?

3.1 Resource Use, Rights and Economics in Pastoral Drylands

Raising livestock in dry environments where erratic rainfall, periodic fires and droughts are common necessitates the use of mobility to cope with the patchy nature of grazing and water resources. There are many types and degrees of pastoral mobility, which vary according to environmental conditions, or the given stage of a household's life cycle. Pastoralism is dynamic, flexible and opportunistic such that it is difficult to categorize into mutually exclusive groups. In

many cases the mobility of livestock can be considered separately to that of people. A pastoral household may be settled for most of the year while family members or contract herders move the livestock several times. Livestock mobility can be seasonal or regular between well defined pastures (e.g. between highlands, lowlands and floodplains); follow fixed transhumant routes or rarely the same from year to year.

Such flexible systems of land-use are highly resilient and allow pastoralists to exploit arid land well beyond the agricultural zone. However, pastoral resource use is not only highly dispersed but notoriously difficult to quantify and map leaving pastoral rangelands open to exploitation by those who misunderstand the system. Existing data of livestock distribution are poor and there are obvious difficulties mapping resource use in such dynamic systems. In developing countries the quality of livestock census data varies considerably depending on economic development.[31] Ground and air mapping techniques also have various drawbacks, not least their failure to account for mobility over time. As ecological conditions are highly variable in space and time, so are most aspects of the pastoral livelihood system (i.e. mobility, livelihoods, tenure). The current mapping of Africa's so-called *wastelands* must seek the input of pastoralists who are the only people who can identify where biofuel production will have the least impact on their key resource areas.[32]

To make matters worse pastoralist communities are often marginalised by society, and are poorly represented within national policy frameworks. Pastoral tenure and land use systems, for example, have been defined by the ecological dynamics of such regions. There are complex, multiple regimes of access and control, ranging from clearly defined privatized patches of land to open access flexible/negotiable communal lands. However, customary land tenure systems in pastoral rangelands afford little protection from abuse by neighbouring sedentary agricultural society or outside investors.[33] Throughout Africa's pastoral drylands, herders have lost vast areas of grazing land to mechanised cash-crop farming, fortress conservation initiatives and privatized fenced ranching schemes. When pastoralists face problems gaining access to their resources their mobility declines, with disastrous consequences for food security, livelihoods and their ability to cope with shocks and disturbances.

One of the beliefs promoting many efforts to modernise pastoralism and appropriate pastoral rangelands is a fundamental misunderstanding regarding the economics of the system. For years policy makers and academics believed that pastoralism was an archaic form of production in need of modernization and intensification. Animal scientists replaced traditional breeds that were resilient to periodic droughts/diseases (after years of drought/disease-induced mortality) with commercially favourable cross-breeds targeted at maximum productivity. Rangeland scientists completely misunderstood the ecological dynamics of arid environments and sought to replace mobile systems of grazing with rationalised, fenced pastures. Both of these changes failed to improve productivity and in fact increased poverty, degradation and vulnerability in pastoral societies throughout the world. However, while better understanding regarding the science of pastoralism has now been achieved, the economics of pastoral rangelands remain poorly understood.

As the pastoral system is undervalued, pastoralists' lands are often ignored or appropriated for alternative uses without evaluating the costs of such changes.[34] More recently, however, sound and precise data on the contribution of pastoralism to national economies in several dryland countries has emerged. These studies have demonstrated that the contribution pastoralists make to national economies is highly significant.[35] However, in most cases the direct contribution of pastoralists to GDP is poorly quantified, reflecting the poor availability of data available in drylands globally. Yet where data is available it clearly demonstrates that pastoralism is 2 to 10 times more productive and

cost-effective that the alternative intensive commercial ranching system policy makers often try to replace it with.[36]

The direct returns from pastoralism vary according to the mix of livestock raised but can include milk, wool, hair, meat, hides and direct livestock sales. With 8.5 per cent of GDP in Uganda, 9 per cent in Ethiopia, 10 per cent in Mali derived from the livestock sector, these products contribute significantly to most African economies.[37] In Central Asia the contribution is higher with pastoralism contributing a massive 20 per cent of Kyrgystan's GDP, for example.[38] The visibility of pastoralism's contribution to national economies varies according to the importance of the livestock sector relative to other export commodities. In industrial and mineral exporting nations economic returns from the pastoral drylands are overshadowed by more lucrative exports. However, policy makers should note that most of the economic returns from pastoralism are gained from marginal lands where other economic activities usually provide lower revenues.

The threat caused by the recent biofuel boom in pastoral drylands is reminiscent of that posed by the large-scale expansion of cash crops in the past. Indeed, the impacts on resource access are likely to be similar to those caused by the spread of commodity cash crops.[39] In the past, pastoralists throughout Africa have been dispossessed of their land when market shifts create a demand for cash crops.[40] Many of these areas were cleared of their perennial vegetative cover, fenced and ploughed. Soon after the economics creating a demand for these crops failed and the land was left abandoned, yet few areas were returned to their rightful owners or regained their diverse vegetative cover.

As well as providing numerous direct economic returns, pastoralism also creates various indirect tangible and intangible values to society. Pastoralism is increasingly being recognised as the linchpin to solving several global environmental problems. Mobile pastoralism can enhance biodiversity, sequester carbon, support wildlife conservation and prevent desertification when properly supported by policies which ensure pastoralists have access to, and effective control over, extensive areas of rangeland.[41] However, when favourable areas of pastoral land are lost (riparian land, forests), an opportunity cost is incurred as the loss of variability in the remaining rangeland causes indirect global environmental services to be lost.[42] Policy makers must consider the total economic cost of replacing extensive pastoralism on permanent pastures with biofuel plantations. Even in the most degraded rangelands minor policy changes can enhance pastoralists' capacity to manage the resources they have supported for generations.

4. Threats to Pastoral Livelihoods

At present the bioenergy debate is focused on the prospects of expanding the production of inedible feedstocks such as *Jatropha curcas* onto areas of *degraded permanent pasture* or *wastelands*. If biofuels are to play a significant role in solving the global energy crisis the demand for new lands for their production will remain; at least until a viable alternative to fossil fuel based transport is found. Thus the focus by bioenergy investors and governments on so-called *wastelands* is likely to persist regardless of the feedstock involved. Inedible feedstocks grown in *wastelands* are supposed to have no impact on food security, yet this argument is fundamentally flawed: these lands are *vital* to the food security of millions of pastoralists. However, producing these crops on rangelands presents many other threats to the future of pastoral livelihoods and raises some searching questions in urgent need of answers.

Inedible crops such as *Jatropha curcas* are toxic to livestock and humans, and unlike edible feedstocks the crop residue and bi-products of production cannot be used as fodder for livestock.

Supporters argue that the seed cake of present varieties grown in Africa can be used as an excellent fertilizer and could be processed into animal feed by removing the toxins.[43] Yet detoxification is likely to be a complicated, expensive and a technical process only conducted on feedstock exported to industrialised nations.

Reports emerging from existing large-scale *J. curcas* plantations reveal that livestock avoid grazing in such areas entirely rendering the land on which the crop is grown useless.[44] As *Jatropha curcas* plants live for up to 50 years, the large scale conversion of pasturelands mean that huge areas of pastoral land are likely to be appropriated with little chance they can be returned to pastoral uses. This is an entirely different scenario from western privatized pastureland where relatively small parcels of land can be cleared and reseeded with ease. Developers must therefore recognise that bioenergy production on permanent pastures in Africa's drylands requires more careful planning and risk assessment than that needed in more agriculturally improved landscapes.

A global trade in biofuel feedstocks could present a more serious threat to dryland pastoralists and agro-pastoralists in the long-term when the technology for second generation feedstocks becomes widespread. These technologies would see the harvesting of perennial grasses, short rotation woody species and crop residues. By removing vast amounts of biomass from grasslands and savannas this raises serious questions regarding nutrient mining from these ecosystems.

Another fundamental problem with the current focus on *wastelands* or *degraded pasturelands* is the highly diverse nature of human-induced vegetation changes in such areas and therefore highly variable carbon emission scenarios upon conversion. Desertification or land degradation in pastoral rangelands manifests in a huge diversity of vegetative changes, far more diverse than the widely accepted, simple notion of advancing deserts pursued in the 1970s. In dryland savannas, degradation from intensive sedentary livestock grazing systems manifests, not in total vegetative removal, but less overt declines in productivity due to the proliferation of shrubs in a process called bush encroachment.[45] In recent years the permanence of desertification has also been challenged and in some areas degraded savannas can in fact retain significant levels of biodiversity in the form of protected ecological niches.[46] Pastoralists also value the proliferation of drought resistant fodder in areas which many western scientists would consider invaded by unpalatable encroaching shrubs.[47]

We therefore require clearer definition of degraded lands in the context of the bioenergy boom and carbon trading. First, far more information about the carbon capacity of degraded rangelands and emissions scenarios upon conversion is required. Next, we need to clarify scientific criteria for determining permanently degraded lands with little biodiversity value, from intensively grazed areas with no permanent soil changes and protected seed banks that could be recovered with minor policy changes. Pastoralists should also be involved in the search for degraded lands where conversion would avoid highly valued drought resistant grazing.

Finally, pastoral livelihoods are threatened by the lack of knowledge regarding the agronomy and business models of biofuel feedstocks currently expanding into their lands. Given the likely permanence of these changes (i.e. toxicity and longevity of inedible biofuel crops) this information is vital to prevent these lands being converted in vain. Commodity crop booms have occurred in the past resulting in the permanent removal of many key areas of pastoral land essential for the wider environmental services these systems provide for the global environment (biodiversity conservation, carbon sequestration). Policy makers need clearer information regarding the diversity of different development scenarios and business models to pursue in remote pastoral drylands. Emphasis must be placed on pro-poor, pro-pastoralists models of development.

5. Livelihood Opportunities

Assuming that satisfactory answers can be found to the questions above, there might be potential for pastoralists to benefit from the cultivation of biofuels on their commons. There are potential livelihood opportunities associated with this development paradigm. As yields from biofuels are low in marginal drylands, rural farmers in Mali earn extra income selling seeds to bioenergy companies. Crop-residues from some feedstocks can be used as fertilizer and some biofuel feedstocks also have alternative medicinal benefits for dryland people to exploit. Second generation biofuels could present an opportunity to deal with invasive species infestations afflicting many pastoral rangelands.

The current large-scale commercial schemes, in which agrofuel corporations take over large areas of '*wastelands*' is only one of several possible models.[48] Before the recent boom in the agrofuel sector there were many small-scale pro-poor bioenergy initiatives in Africa aimed at improving rural poverty and supporting energy self-sufficiency.[49] However, at present energy requirements in pastoral areas are generally low and some argue that pastoralists have little need for biofuel, whereas grazing for livestock is fundamental for survival.[50] Yet some pastoral societies are highly integrated into the carbon economy using fossil fuels to run mechanised boreholes and trucks to transport livestock.

We need to determine the extent of energy use within pastoral society and identify areas where communities could benefit from small-scale energy self-sufficiency projects. Energy requirements in pastoral areas are likely to vary depending on the level of economic marginalisation and in some of the most developed contexts (i.e. southern Africa) water sources are increasingly mechanised and livestock are trucked to export markets. Better understanding is required as to how small-scale biofuel production could be integrated into the pastoral economy. Such projects could offer significant improvements in household incomes. For example, women in Zimbabwe earn supplementary incomes selling soap and fuel for cooking and lighting extracted from *Jatropha*.[51] Similarly, in the drylands of Benin people have exported *Jatropha* seeds to France for soap production since the 1940s.[52] If these projects could be initiated without interfering with livestock management and mobility, significant improvements in pastoral poverty could be gained. In many areas pastoralists have already diversified into agriculture, and with the advent of modern transport men are able to divide their time between kraals and homestead arable lands.[53]

As the climate change debate begins to renew interest in the development of pastoral drylands, there could be opportunities to address many of the social and environmental problems endemic in these regions. Until recently, remote pastoral societies have been marginalised from decision-making processes and were unable to defend their rights to land. Their arid rangelands are often the last to receive investment and when development interventions were made these were usually inappropriate, misunderstanding the complexity of both pastoralism and its dynamic environment. Today, once resilient pastoral societies have become highly vulnerable as their access to resources is constrained by numerous physical limitations (i.e. loss of land to conservation, ranching, cultivation etc.) and economic restrictions (i.e. market integration, out migration to urban markets etc.). Such constraints inhibit the ability of pastoralists to use mobility to cope with droughts and resource scarcity. Given that one of the likely impacts of the biofuel boom is reduced land access in pastoral rangelands, it is clearly time to urgently seek greater security for pastoral land rights. The current focus on pastoral rangelands for bioenergy production represents an excellent opportunity for pastoralists to seek greater recognition for their land rights, especially where weak national laws and policies concerning bioenergy development offer poor protection from exploitation.

The present bioenergy boom also creates an opportunity for pastoralists to reemphasize, their vital, underestimated role in providing wider environmental services. Pastoralists are active managers of their natural resources and have developed some of the most biodiverse habitats in the world supporting CO_2 sequestration and wildlife conservation.[54] Pastoral drylands, which cover more than a quarter of the earth's surface, offer a huge potential sink for greenhouse gasses, second only to tropical rainforests.[55] Poor grazing management, rangeland fires and the clearing of land for agriculture are identified as major causes of C losses and a growing number of scientists are emphasizing the huge potential degraded drylands hold for carbon sequestration.[56] Yet most studies grossly overestimate the extent of degradation in drylands and the subsequent gains for C storage.[57] Some scientists are also sceptical as to the potential for dryland soils to retain organic carbon without intensifying production through the use of irrigation and inorganic fertilizers, itself likely to increase CO_2 emissions elsewhere.[58] Notwithstanding the scientific uncertainty, so far the debate has only focussed on technical suggestions regarding interventions to secure greater carbon storage, and few have considered the many governance obstacles preventing pastoralists from benefiting from carbon trading.[59]

The likely increase in carbon trading and biofuel production in pastoral rangelands could therefore offer opportunities for pastoralists to earn income for the environmental services they have provided for generations. Such schemes may provide far greater reductions in greenhouse gases than the '*greening of deserts*' scenario involving large-scale bioenergy plantations. However, there is also a danger that carbon trading projects will repeat many of the development mistakes made in the past. These were the severely repressive policies associated with the old paradigm for livestock development which completely misunderstood the social and environmental context of pastoral drylands and were responsible for the increasing poverty and land degradation in the first place. Firstly, the CDM of the Kyoto protocol currently emphasizes major land-use changes such as reafforestation rather than minor ecosystem changes, causing much of the present focus on the large-scale expansion of agroforestry plants such as the biofuel feedstock *J. curcas*. Other suggestions for carbon gains include improved grazing management through reduced stocking rates and rotational grazing, and improved fire management.[60] Supporters suggest that if pastoralists were to make only modest improvements in rangeland management, 0.5 tonnes of extra carbon per year would be sequestered per hectare, equating to a 14 per cent increase in income for each pastoralist.[61]

While there may be real opportunities for this revitalized interest in pastoral drylands to offer a new lens to address many of the issues and constraints restricting pastoralism, current suggestions for management improvements appear misplaced. Few of those implementing these schemes understand the social and environmental dynamics of pastoral drylands. For example, only 1 per cent of people providing funds for carbon trading schemes come from pastoral lands,[62] and thus most are unlikely to understand the complex links between poverty and land degradation in such areas. Some suggest that degraded sites should be replanted, often with unsuitable plants, and then fenced to exclude livestock.[63] While this could mean an increase in rangeland in the long-term if degraded arable lands are returned to pastoral use, there is danger that these measures will be focused on grazing areas thus excluding pastoralists from the land they have managed for generations. One major issue is that an ideal rangeland in terms of carbon trading (i.e. maximum CO_2 sequestration) clearly diverges from a pastoralists' view of what such a rangeland should represent in terms of supporting a sustainable pastoral livelihood (i.e. diverse range of herbaceous cover). Thus destocking, privatizing and enclosing communal lands restricts pastoral mobility and the ability to cope with such dynamic environments. Further work is required to reanalyse and stress pastoralists' role in the dryland carbon cycle. Efforts should be made to identify where carbon gains could be achieved without negatively impacting upon pastoral livelihoods and resilience.

After critically analysing the bioenergy development paradigm it is clear that there could be potential to improve pastoral livelihoods but we must learn more about how these feedstocks could be integrated with existing dryland uses. For example, are there opportunities for multiple rangeland uses, such as that experienced by Gum Arabic production in the pastoral drylands?[64] Reports emerging from existing large-scale *Jatropha* schemes suggest that in some cases dryland people have been granted access to intercrop groundnuts for the first few years before the plants mature blocking light to the ground. In India much of the focus has shifted from *Jatropha* to *Pongamia pinnata* as the plant grows taller and thus has a greater potential for intercropping.[65] Could these crops also offer potential for intergrazing with livestock? There are clearly a number of research imperatives in need of urgent clarification before governments and pastoralists can make informed choices regarding bioenergy production in the drylands.

6. Policy and Research Priorities

In parts of dryland Africa the present biofuel boom is causing a land rush as investors take advantage of weak legal, political and institutional frameworks governing bioenergy development. The vast swaths of pastoral lands in Africa appropriated in the past for mechanised farming and now left abandoned are a warning that caution is required before engaging in potential wonder crops. In order for informed choices to be made regarding the development of bioenergy in the drylands we urgently need more research on the following aspects of this new development paradigm:

Policy Frameworks- As with the conversion of pastoral commons for commodity crops and ranching schemes, in today's policy environment pastoralists are unlikely to be among the key actors determining the model and outcome of development. Yet large-scale appropriations of pastoral lands will have a dramatic impact on the productive/adaptive capacity of pastoral systems, intensifying existing problems such as rising poverty, famine and resource conflict. How will the industry be held responsible for these expected consequences? And what realistic plans are in place to avoid or minimise them? Some Africa countries such as Mali have been experimenting with the use of *Jatropha* for small-scale energy self sufficiency projects since the mid-1980s.[66] Mali has banned exports of *Jatropha* until domestic energy requirements are met and has policies that prevent outside investors from legally owning private land. Elsewhere national policy frameworks and land laws are weak allowing powerful investors to appropriate large areas of pastoral rangeland for biofuel plantations. We urgently need to investigate the political, legal and institutional frameworks governing the development of bioenergy in the pastoral drylands. Where weak policy frameworks exist these must be improved. We must also seek to understand and inform international legislation governing the land use implications of bioenergy development.

Agronomy- Biofuel companies claim *Jatropha* doesn't have to be grown in large plantations, suggesting instead that poor farmers could harvest seeds from living fences and hedges to supply the bioenergy market.[67] Indeed, in Mali there are many miles of *Jatropha* hedges surrounding villages and fields, each producing between 2.5 and 3.5 tonnes of seeds per hectare every year for small-scale energy self-sufficiency projects.[68] However, according to a growing number of researchers, if *Jatropha* is in reality to make an impact on the world fuel markets, planting will have to shift from field margins to large-scale monoculture plantations in order to grow sufficient feedstock.[69] There is a scale conflict in the debate over *Jatropha's* benefits. While arguments for pro-poor *Jatropha* development emphasize small-scale production, large-scale and above all *reliable* yields will be required for the plant to make any significant impact on the global energy crisis. If such an approach is technically possible in the drylands, it will undoubtedly require high-

input plantations and an entirely different set of actors. The likely area of permanent grassland required to grow dryland feedstocks thus depends greatly on our understanding regarding their agronomy.[70] If yields are lower on marginal lands under rainfed conditions, producers are likely to require more intensive modes of production such as irrigation and fertilizer. This is likely to compete for already scarce water resources and result in further environmental impacts such as soil salinization and groundwater depletion. Pastoralists and policy makers require better information regarding the agronomy and long-term environmental impacts of dryland agrofuel feedstocks supposedly able to '*green the deserts'*. There are many claims regarding inedible feedstocks such as *Jatropha curcas* but few can be scientifically sustained.[71] Research regarding the agronomy of *Jatropha* in the scientific literature is over twenty years old and more recent work has been rapidly driven by the private sector. Are dryland feedstocks such as *Jatropha* capable of solving the global energy crisis? Will such crops produce the yields required from marginal pastoral lands or is this bioenergy boom really likely to compete for remaining key pastoral resource areas and dry season refuges? Is shared/multiple land use possible with these crops? Could we see dryland people intercropping and intergrazing between rows of biofuel feedstock or judiciously planting feedstocks in their rangelands?

Business/Development Models - At present there are few large-scale commercial *Jatropha* schemes in drylands, but the evidence suggests that oil yields from areas of low soil nutrients and water availability are likely to be poor.[72] Productivity is determined by good management and plantations must be trimmed and pruned annually. Furthermore, in dryland regions with only one wet season per year, only one annual fruiting occurs, compared with up to three possible fruitings if the crop is irrigated and fertilized.[73] This raises questions about whether large-scale *Jatropha* plantations will succeed in the long-term. Bioenergy business models are poorly understood, especially in relation to the energy market. Most data on the economics of dryland feedstocks are held by bioenergy companies and rarely exposed for fear of losing investment. Pastoralists and governments require such information to determine whether large-scale projects will succeed in the long term. Bioenergy has only recently become economically viable since the global price of oil reached a record high of over $100US per barrel. By understanding the economics of dryland biofuel production and its relationship between global energy markets we can determine whether land-use conversions are worthwhile or doomed to failure like so many other cash crop gold rushes. Alongside understanding which development model is likely to persist in long term, we must understand the diversity of development models. Is there a pro-poor/pro pastoralist model of development? What economies of scale are these dependant on?

Total economics of pastoral rangelands- The threat from biofuel cultivation in pastoral drylands is reminiscent of that posed by the large-scale expansion of cash-crops in the past, and the impact on resource access is likely to be similar.[74] Rangelands throughout Africa have been carved out from the pastoral commons and lost to mechanised farming when the demand for cash crops increases.[75] In time the price of many of these cash-crops fell, making the conversion economically unsound and unjustified, but the land was never returned. Many more thousands of hectares of pastoral commons were then set aside for the supposed 'rationalisation' of livestock production through ranching schemes. Most of these schemes were unsuccessful, but again the land was never returned to extensive pastoralists. Whilst in the long run national economies saw little or no benefit from these large-scale conversions of pastoral land, the impact on pastoral economy was seriously negative. Pastoralists faced a significant decrease in grazing land and mobility, with major environmental consequences. This had a severe impact on food security and the overall resilience of the pastoral system. Biofuel feedstock production appears to place yet another blind bid on the pastoral commons, calling for a further wave of large-scale land use change in exchange for the promise of economic growth. Perhaps this time we should be more cautious. Recently, sound and

precise data on the contribution of pastoralism to national economies in several dryland countries has been conducted. However, large-scale conversions of rangeland should not happen in the absence of an informed cost-benefit evaluation of the comparative advantage of such land use changes, compared to the complex economic returns from extensive pastoralism. The '*wastelands*' argument in biofuel literature is particularly alarming in this respect, as it suggests that so far this issue is been ignored altogether. When will the eager self-assured optimism around biofuel feedstock production leave room for a serious consideration of case-by-case, cost-benefit analysis of the total costs of such changes, compared to present dryland uses?

Environmental Impact- There are other environmental concerns regarding the large-scale planting of some inedible feedstocks such as *Jatropha* in drylands. The plant was introduced to Africa from Central America over a century ago. It has since spread from Mozambique throughout the continent mainly in the form of hedges surrounding homesteads and settlements.[76] Some researchers maintain that the species cannot self-propagate,[77] others are increasingly worried that it may become invasive if widely planted in the natural environment.[78] To date both Australia and South Africa have banned the plant for fears that it will become invasive.[79] As an exotic plant toxic to livestock and humans, is Jatropha in danger of becoming an invasive weed? How confident are we that the plant will not become invasive under large-scale intensive cultivation? What studies have been carried out to understand the possible interaction of large concentrations of Jatropha with drylands ecosystems? How will these biofuel crops react to intrinsic characteristics of non-equilibrium dryland ecosystems such as periodic fire and drought events? What will the long-term consequences be if plantations are left abandoned? Will these plantations return to their natural vegetative state?

7. Conclusions

The notion that vast areas of degraded *wasteland* without sustained economic use exist in the world's drylands is a **myth**. This discussion paper has demonstrated that contrary to the belief of a growing number of bioenergy developers and government officials tied to mandatory biofuel targets, 200 million people live in the world's drylands and use mobile, extensive, pastoralism to make the most of a highly risky and variable environment. Being mobile allows pastoralists to exploit patchy resources and deal with inherent risks. No other land-use system is as cost-effective or productive in such harsh environments. Moreover, numerous attempts were made to convert these lands using more intensive modes of production, but without exception these have been a dismal failure wasting vast sums of money. Now scientists fully understand what pastoralists have known all along; that the natural dynamics of these ecosystems necessitates the use of mobility to manage risks and ensure productivity.

Policy makers and pastoralists need to be well informed of the risks and opportunities of bioenergy development if they are to make informed decisions about how to engage with the industry. This paper explored what the bioenergy boom could mean for pastoralists and their arid rangelands. It explored some of the various development scenarios emerging from the recent focus on inedible dryland feedstocks such as *Jatropha curcas*. Given the toxicity of this crop the paper urges caution to policy makers presently rushing to back its development. Current understandings regarding the agronomy and environmental risks associated with the plant are poorly understood and there may be long-term consequences of converting rangelands into plantations making the costs of conversion far higher than for edible cash crops.

Debates concerning the conversion of degraded arid rangelands totally ignore the complexity of the desertification debate. Scientists have raised serious doubts concerning the permanence of some

environmental changes resulting from intensive sedentary grazing in drylands and these areas are far more resilient than expected. Even the most degraded rangelands contain protected seed banks and pastoralists also value some degraded areas for their abundance of drought resistant fodder. Pastoral resource use is notoriously difficult to map and it is imperative that pastoralists are involved in the search for degraded sites to convert.

Finally, while pastoral livelihoods could benefit from small-scale bioenergy production, seed sales and seasonal employment in the industry, this paper also exposed various data deficiencies in urgent need of further understanding before an informed debate can commence. We urgently need more data on the following issues:

(i) **Policy Frameworks**- Which countries have weak policy frameworks and how can dryland people strengthen their rights in these cases? Which international policy mechanisms can be strengthened to ensure an equitable industry (i.e. RSB, EU Land-use change certification)?

(ii) **Agronomy/Environmental Impact**- Capability of plant in different agroecological zones (moving beyond the hype promoted by bioenergy sector). Interactions between plant and dryland ecosystems (fire impact) and long term consequences of plantation abandonment. Prospects for intercropping/intergrazing?

(iii) **Business/Development Models**- Bioenergy business models are poorly understood, especially in relation to energy market. Which model is likely to persist in long term? What is the diversity of models? What economies of scale are these dependant on?

(iv) **Total economics of pastoral rangelands-** Opportunity costs of conversion in terms of wider environmental services lost? Cost-benefit analysis of alternative economic returns compared to extensive pastoral use?

Without such information governments are unlikely to understand the true cost and long-term impact of biofuel development in the pastoral drylands.

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[7] Global energy consumption is expected to increase by 71% between 2003 and 2030 with ¾ of this demand coming from developing nations (cf. von Braun and Pachauri, 2006)

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[15] Kanter, 2008 *op. cit.*

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