Is Water the Hidden Agenda of Agricultural Land Acquisition in sub-Saharan Africa?

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Abstract

The many headlines focusing on 'land-grabbing' have distracted attention from the role that access to water plays in underpinning the projected productivity of foreign direct investment in acquisition of agricultural land in developing countries. This paper will review the explicit and implicit requirements for access to water for irrigation in planned agricultural projects on land that is subject to such foreign investment deals. It will focus particularly on land acquisition in sub-Saharan Africa (SSA), where, for savanna ecosystems that cover some two thirds of the area, rainfall uncertainty is the principal constraint to increased agricultural productivity. To the extent that foreign investment 'land grab' deals result in the expansion of irrigation in SSA, it is therefore arguable that they may accelerate significantly the development of water infrastructure that will reduce uncertainty and risk inherent in much of African agriculture. For this to be the case, the benefits of such water resource development will need to be broadly distributed. There is, however, some evidence that foreign investment may compete with existing water use, given that land deals have in some instances included provisions for priority access to water in cases of scarcity. Using available secondary sources, the paper will assess the extent to which impacts on water use may constitute a significant hidden agenda of land deals.

Introduction: Land Grab and water requirements

Availability of adequate moisture is a fundamental requirement for agricultural use of land. Designation of exclusive rights to use land provides prior rights to 'green' water (rainfall and plant transpiration) on that land. However, in many contexts it also implies a demand on 'blue' water resources (rivers, lakes and aquifers), since agriculture typically accounts for 70-80 percent of such water 'abstracted' (pumped, stored or diverted) in less industrialised economies (UNDP, 2006). However, in current debates about the impact of foreign investment in agricultural land, the consideration of water has been peripheral. In part, this may be due to the more or less purposive construction of water as a distinct 'sector', notably since the International Conference on Water and the Environment in Dublin in 1992 (Young et al. 1994), and the subsequent establishment of the 'World Water Council' and the high-profile World Water Forums it has convened every three years since. The consolidation of water as a domain of separate professional and academic concern has been further reinforced by the political importance of access to water for drinking and hygiene as a 'basic need' or 'human right'. While often accounting for relatively small percentages (typically ten to twenty percent) of the total water resource use, failure to invest sufficiently to provide adequate access to water for drinking and washing has become emblematic of wider development failure and immiseration, as indicated by the prominence of drinking water and sanitation improvement among the Millennium Development Goals. It is not to detract from the importance of this 'water and sanitation services' agenda to observe that 'the water sector' has come to be primarily associated with it, and the identification of water as integral to land use correspondingly weakened.

As a consequence, headlines about 'land deals' do not automatically lead to a discussion of water requirements. Yet it is clear that water scarcity is a major driver of international flows of investment in agricultural land. This is not because there is any 'global' scarcity of water, but local scarcity of water for agricultural use is emerging in economies that are expanding particularly quickly, such as India and China (de Fraiture et al, 2010), and where renewable water resources are particularly limited, such as the Gulf countries (Woertz *et al*., 2008). In such contexts, a variety of options will include improving efficiency of water use (recycling wastewater, improved irrigation etc) and investing in expanding supply (inter-basin transfers, desalination etc), but all will tend to be expensive, at least in the short term. Consequently, simply displacing agricultural water demand to areas with less intensively-used (and therefore cheaper) water resources has an economic logic. This logic is arguably stronger than that for increased agricultural land area, most evidently in cases such as that of Saudi Arabia where policy is to halt irrigation using non-renewable 'fossil' water from aquifers that are no longer recharged by rainfall. Instead, Saudi investment in agricultural production is to focus on production in other countries with renewable water resources, notably in Africa, as exemplified by the successful export of rice from Ethiopia (Reuters, 2009) a seven-year plan to produce 7 million tons of rice annually under irrigation on a total of 700,000 ha to be acquired in Niger, Mali, Senegal, Uganda and Sudan (GRAIN, 2010).

This paper explores the extent to which water constraints are addressed in land deals involving foreign direct investment. It focuses particularly on sub-Saharan Africa because this is the region in which a majority of land deals are being made (World Bank, 2010a), and which has been promoted internationally as having an abundance of under-utilised land and water for agricultural development: a 'sleeping giant' ready to be awakened by commercial agriculture (World Bank, 2010b). The paper argues that this perception of abundance, and the investment strategies it fosters among both African governments and foreign investors, fails to address the specific ways in which water underpins land productivity in the semi-arid and sub-humid African savannahs. As a consequence, the land deals risk underestimating not only the water management needs of agricultural production, but also the impacts upon existing local water resource users. The paper first reviews the logic of the current round of foreign investment in agricultural land in Africa from the point of view of African governments and foreign investors. It assesses the extent to which the planned investments have implications for 'blue' water use and then explores the type of mechanisms through which impacts may be felt by other water users.

Water use in African agriculture

A recurrent emphasis in reports of 'land grab' land deals is that these constitute a major change in international relationships, with international capital investment being deployed in African contexts in which regulatory and legal frameworks are ill-equipped to defend the interests of existing land users or the wider public interest of the country concerned (World Bank, 2010a). According to the World Bank report on the subject, some foreign investment has in fact targeted countries with weak regulations, although this needs to be seen in the context of the Bank's own pursuit of financial, land ownership and trade liberalisation to improve the climate for agricultural investment (World Bank, 2009). There seems little doubt that land deals in Africa have involved new types of foreign investors, and we shall review below why this is so, but it is also important to recognise the proactive role played by African governments, for many of whom these land deals are only the latest initiative in a long-running search for capital investment to raise agricultural productivity. For the most part, this search has been guided by ideas of 'modernisation', either through mechanisation and creation of large-scale production units along the lines of North American farms, or through transformation of small-scale 'subsistence' producers into small-scale commercial farmers, following an 'Asian' model. In each case the goal has been to raise the amount of marketed agricultural output either for export or for local food markets.

For both models of modernisation, water management has played a role. This was to be expected since for the two thirds of sub-Saharan Africa that lies outside the equatorial humid zone, water is the key constraint to agricultural production. These areas are characterised by 'savanna' vegetation – grassland with a tree density that varies according to prevailing rainfall levels. Annual rainfall may vary from as little as 400mm in Sahelian zones to 1200mm in 'Guinea savanna', but in all cases is strongly seasonal, being restricted to 4-5 months in a year. Moisture constraints for agriculture are caused not only by the long dry season. High inter-year variability of total rainfall, including significant rainfall deficits ('meteorological' drought) once or twice a decade, and high probability (two out of three years) of dry spells at critical crop growth stages during the rainy season mean that significant risk attaches to all other investments in agriculture if crops are dependent on rainfall alone (Rockstrom, 2003; Rockstrom et al., 2010). African agriculture includes many different 'indigenous soil and water conservation' approaches to reducing risks associated with low and unreliable rainfall (Reij et al. 1996), including methods to retain rainfall and prevent soil erosion through devices such as terraces, trenches and pits, and stone or earth barriers across fields. Indigenous technology also includes stream diversion for crop irrigation in the East African highlands (Adams, 1992: 89), and construction of drainage ditches and cultivation of raised beds in low-lying wetlands, such as in the Nyanga highlands of Zimbabwe (Soper, 2006). More generally, agricultural production seeks to exploit retained moisture in lower-lying wetland areas during the dry season or following a receding flood. Even where such valley bottoms may be of limited extent, cultivation is commonly split so as to occupy a variety of topographical positions and thus spread risk associated with rainfall: floods in lower lying sites in wet years, drought on higher, better-drained sites in drier years (Richards, 1985).

Government efforts to modernise African agriculture began under colonial administration in the 1920s, with large-scale irrigation schemes at Gezira on the Nile in Sudan, and on the Niger in Mali, both designed to produce cotton for export. Productivity on such schemes proved disappointing, however, and a major stimulus to new irrigation investment came only in the 1970s, in response to a rainfall reduction of about 30 percent in much of the West African savanna that began with a severe drought in 1972-3. However, development of formal irrigation in Africa made relatively little headway, when compared to developments in South Asian countries such as India and Bangladesh. Irrigated agriculture is estimated (UNDP, 2006: 177) to account for less than five percent of African agriculture, compared to nearly 40 percent in South Asia. Consequently, although agriculture accounts for 85 percent of all water withdrawals for economic activity in Africa, this represents only 2-3 percent of African internal renewable water resources, compared to 25-35 percent in South Asia (FAO, 2009). Part of the explanation is found in reviews undertaken in the 1980s, which make clear that state-managed irrigation systems, in which African cultivators were typically tenants of the state, suffered from a number of specific design problems. These included physical design failures, such as cost-cutting measures that omitted adequate drainage and led to waterlogging and salinization after the schemes were put into operation, or inappropriate dimensions of reservoirs or pumping stations due to designs based on inadequate river flow records. Other problems resulted from inadequate budgets for supporting infrastructure such as roads, resulting in poor market access, or for compensating and re-settling populations displaced from sites of reservoirs or new irrigation areas (Moris and Thom, 1985; Hocombe et al., 1986; Adams, 1992).

Growing disillusion with formal irrigation schemes prompted both a retreat from irrigation investment by development funders, and also a recognition of, and interest in, ‘informal’ or indigenous irrigation water management among African farmers. Subsequently, data for irrigation in Africa discriminated between a ‘formal’ irrigation sector, equipped for full or partial water control, and ‘informal’ or ‘non-equipped’ cultivation of lowland areas. ‘Formal’ irrigation is typically state-funded and uses standard engineering structures (dams, canals, pumps) to store and distribute water on the floodplains of major river systems. ‘Informal’ or ‘non-equipped’ lowland cultivation typically uses indigenous technology to achieve a measure of water management, for example through stream diversion into irrigation furrows, drainage of wetlands, or planting crops following a receding flood. Taken together, these categories have been estimated (FAO, 2005) to constitute a total of 15.4 million ha of “areas under water management” in Africa. However, nearly half of this is in North Africa and Madagascar. The remaining 8 million ha in sub-Saharan Africa is split between some 6 million ha of formal (full or partial control) irrigation and 2 million ha of areas under informal water management. These figures quite explicitly omit any mention of ‘dryland’ water management, such as rainwater harvesting or other techniques for retaining and conserving rainfall, such as terraces, pits, contour ridges and stone lines, and so on (Reij et al, 1996; Rockstrom et al., 2003). Such techniques are widely used in cultivation of drier savannas and their exclusion must evidently underestimate the extent of water management used in African agriculture.

It is important here to note that water management has underpinned much of the most dynamic elements of African agriculture over the past two decades. In particular the production of fresh fruit and vegetables for growing urban markets by small-scale producers in peri-urban areas or on major transport corridors has exploited wetland resources to allow year-round production, and in some cases involved significant infrastructure construction by farmers themselves (Southgate and Hulme, 2000; Bolding et al, 2010). While covering significant areas, informal irrigation may often be contingent on water availability, expanding in years of high rainfall and runoff and contracting in drier years (Lankford, 2004). Despite the significance of water management, both in historic indigenous agricultural production strategies and in contemporary instances of entrepreneurial agricultural growth, formal investment in water management has largely stalled. Estimates in the mid-1980s put formal irrigation in sub-Saharan Africa at 2.64 million ha, with an additional 2.38 million ha of informal water management (Hocombe et al., 1986). In 1994, FAO estimated 5 million ha of formal irrigation, rising to 6 million in 2004, and about 2 million ha of informal water management, which remained unchanged across the decade (FAO, 2005). If we ignore for the moment the obvious questions about accuracy of estimates of areas subject to informal water control, which we noted above, these figures reflect a halt to public investment in irrigation in Africa for a decade from the mid-1990s, and some sources estimate that loans for irrigation and drainage in Africa were lower in 2002-5 than they had been in 1978-81 (CAWMA, 2007: 73). It should be noted that these figures relate to the extent of 'areas equipped for irrigation' through water storage and distribution infrastructure. In many cases lack of maintenance and operational budgets resulted in low proportions of these areas being harvested. Thus, while in Mali cropping intensity figures of 171 percent indicated that the irrigated area was not only fully cultivated but much of it was cultivated with more than two crops per year, in contrast in Senegal only 73 percent of the 'equipped' irrigation area was actually harvested . Elsewhere, even lower rates of usage of areas equipped with irrigation infrastructure are recorded, such as 43 percent in Sudan, and 11 percent in Congo (FAO, 2005: 36-37).

This current context reflects not only a legacy of declining investment, but also the withdrawal of state agencies from irrigation management as part of structural adjustment measures to reduce government budget deficits. Contrasting impacts are evident in two Sahelian examples. In the Senegal River Valley, the winding down of the state agency (SAED –Société d'Aménagement et d'Exploitation des terres du Delta du fleuve Sénégal) coincided with the completion of two dams (at Manantali and Diama) designed to regularise the flow of the river and control its annual flood and thus provide year-round irrigation on 300,000ha in the river valley, of which 224,000 ha on the left, or Senegalese, bank. The expectation under Senegal's New Agricultural Policy of 1984 was that much of the expansion of irrigation from its existing extent of around 31,500ha in 1988 would come from investment by commercial entrepreneurs, while existing irrigation infrastructure would be managed by farmers' associations. By 2003, the total area of irrigation recorded by the river basin authority (OMVS) on the Senegalese bank was 94,000ha. However, of this only 35,000 – 40,000ha were estimated to be in production (OMVS, 2003) – that is, little more than in 1988. Behind this failure to expand irrigated agriculture during 15 years of market-based reform lie the effects of raised cost of inputs such as fertiliser previously subsidised by the government. Farmers on the many smaller village-run irrigation schemes of the 'Middle Valley', more distant from the coastal cities of Dakar and Saint Louis (hence with higher transport costs) and producing mainly for household consumption, had little marketed output with which to cover increased production costs and most of such schemes were simply abandoned (Adams, 2000).

Two further factors have markedly worsened conditions for many inhabitants of the Senegal River Valley. Firstly, the restriction of the annual flood has meant the loss of some 100,000 ha of crops previously planted under indigenous water management (flood-recession) in the valley (Adams, 2000). Secondly, the association of irrigation with *de facto* permanent occupation of land undermined existing customary land rights that were largely seasonal, following the annual flood regime that transformed land successively into fishing-ground, cultivated field, and then pasture. This transition to more exclusive land occupation, coupled with a political discourse of entrepreneurial investment by 'outsiders' resulted in heightened tensions over land rights that in 1989 precipitated violent confrontations between villages on both Senegalese and Mauritanian sides of the valley. These escalated into communitarian violence in Dakar and Nouakchott and the 'repatriation' of hundreds of thousands of people, many of whom had to be resettled as refugees within the valley (Horowitz, 1989).

In contrast, the Office du Niger, in Mali, describes a trajectory of incremental reform of state management that has been interpreted as producing more positive outcomes (Aw and Diemer, 2005). As with the SAED, productivity on the Office du Niger was declining by the early 1980s, but rather than rapid disengagement the government agency was encouraged to undertake a series of technical improvements in water management to raise yields and also to devolve certain areas of management (notably initial processing of the rice crop) to farmers' organisations. Successive reforms have raised the role of farmers' representatives in governing the management of the scheme. Average productivity of the principal (rice) crop trebled between the mid 1980s and 2002 and an increasing area cultivated during the dry season for higher value crops, such as fruit and vegetables, has added a further 46 percent to the value of the scheme output in 2002. Higher levels of productivity have enabled higher fees to be charged for water and financing of further expansion of the irrigated area. Conversely, an estimated one third of those cultivating on the Office du Niger in 2002 struggled to achieve more than subsistence income (Aw and Diemer, 2005: 68), and rising water fees threaten such households with eviction. In this instance of comparatively successful irrigation, therefore, there is evidence that the higher potential productivity afforded by irrigated farming may introduce demands to meet increased costs that may force out the less able or poorer farming households. Moreover, such pressures are liable to be intensified, as the Malian government seeks to expand the irrigated area using further investment from commercial partners, as will be explored further below.

From the perspective of many African governments, the pursuit of a major increase in agricultural productivity involves a modernisation of farming that depends on bringing in investment. This perception is reinforced by calls for a rapid expansion of irrigation in Africa (Commission for Africa, 2005). Yet African governments face challenges to water infrastructure projects for agriculture, from both environmental and financial considerations, that governments in earlier episodes of state-led development have not. Two decades of neo-liberal policy has restricted public sector funding of agriculture, not only by African governments themselves, but also by many multilateral funding agencies, reflecting also a broader decline in the relative importance of agriculture in development funders' policies. Lending for agricultural development slipped from 30 percent of World Bank loans in 1980 to 7 percent in 2000, a trend only recently reversed by a rise to 12 percent in 2010 as a result of the rise in food prices in 2007-8 (IPS, 2010).

The above review has highlighted the significance of water as a constraint to improving farm productivity in the savanna (semi-arid and sub-humid) environments that predominate in sub-Saharan Africa, and the role water management plays in both indigenous agricultural strategies and in state efforts to bring about an increase in productivity through modernisation. The frequent failure of agricultural modernisation in Africa, particularly where it has involved large-scale mechanised production systems, has not given rise to a widely-recognised alternative model of productive farming, despite evidence of dynamic responses to new markets and technologies (Wiggins, 2000; Woodhouse, 2003). A widely-shared perception of stagnation of agricultural productivity in sub-Saharan Africa thus creates a climate in which African governments more or less actively solicit foreign investment in agriculture. In the Sahelian examples of Senegal and Mali, briefly reviewed above, rainfall is low enough for irrigation to be an obvious pre-requisite for commercial agriculture, and past and present agricultural investment has focused on the major river floodplains. However, even in the higher rainfall 'sub-humid' savanna zones – foreign investment tends to cluster around major rivers and the production of crops with high water requirements. In the following section we review the factors driving this pattern of investment.

Water use in planned FDI projects

If the search for investors in agriculture has been a long-standing concern of African governments, the interest of international investors is relatively recent. It has arisen from an international context characterised by perceptions of rising insecurity of energy and food supply and concomitant volatility in energy and food commodity prices. While these perceptions are linked to narratives of climate change, it is important to recognise that it is the policy responses to climate change concerns, not the biophysical effects of climate change, that have the most immediate impact. Thus, while predicted climate change impacts are often characterised in terms of changing rainfall patterns, typically in terms of increasing frequency of extreme events (greater concentrations of rainfall in fewer and more intense storms), leading to higher runoff and greater risks of both floods and soil moisture deficits (Arnell et al., 2001), the modelling of such predictions at regional or national scales relevant to agricultural policy is at a relatively early stage, and effects on flood patterns in African river basins are as yet unclear (Conway et al., 2009; Goulden et al., 2009). Significant determinants of inter-year rainfall variation have only recently been identified, such as the relationship between rainfall intensity in East Africa and atmospheric circulation patterns resulting from changes in ocean surface temperature differentials in the Indian Ocean (Conway et al., 2007). The most that may be said about climate change impacts on moisture availability in African agriculture is that it is likely to be subject to extreme fluctuation. In many respects, this suggests that the constraint of rainfall uncertainty that confronts the majority of African farmers cultivating savanna areas today will continue to be the main constraint to farming in future, if in more intense form, and water management will continue to be a primary factor in agricultural productivity.

Yet climate change concerns are linked to policies with important impacts on investment in agricultural land. Specifically, biofuels constitute the nexus through which a number of strands of energy policy have become linked with agricultural production, with major implications for land and water use in Africa. The principal driving force is a combination of environmental and security concerns that have diverted agricultural output from food to biofuel production (FAO, 2009). Thus, from 2004 the perception of rising oil prices as indicating diminishing oil stocks and insecurity of future energy supply prompted governments in the USA and EU to fund subsidies – estimated at over US$10 billion in 2006 alone - for the production of biofuel from agricultural crops. In 2007, this diverted some 30 percent of US maize output or 12 percent of world maize output into ethanol production (FAO, 2009), reducing cereal availability for food supply and thus driving up food prices. Speculative activities further reinforced a short-lived food price 'spike' in 2007-8 during which some prices rose by as much as 100 times (Imai et al., 2008; Ghosh, 2010), before dropping back again.

The political climate favouring production of biofuel was reinforced by environmental arguments that they constitute a renewable energy source that can substitute fossil fuel (petroleum), and thus reduce net carbon emissions as part of a strategy to mitigate climate change. Biofuels are therefore the link through which growing concerns with climate change reinforce and accentuate the rise in agricultural commodity prices that may already reflect rising fossil fuel costs, particularly in nitrogen fertiliser. It has been estimated that biofuel production is uneconomic in the US and EU when crude oil prices are below US$50 and US$70 respectively (Dufey, 2006). While the economic recession in late 2008 caused oil prices to fall below this level for six months, they generally exceeded it for the period 2006-2011 (US EIA, 2011), thus reinforcing the incentive for governments to promote biofuel production, despite claims that in certain cases (notably ethanol production from maize) biofuel does not necessarily produce a net reduction in carbon emissions (Pimental and Patzek, 2005). This suggests policy decisions favouring biofuel production on grounds of climate change mitigation and energy security are likely to be a long-term factor driving up agricultural commodity prices, and as a consequence, promoting competition for control of land, water and other inputs to agricultural production. The dimensions of this impact on international agriculture can be gauged from projected increases in land areas dedicated to biofuel production. Whereas de Fraiture et al's (2005) estimates projected a global total of 42.2 million hectares devoted to biofuels in 2030, more recent projections for 2030 claim increases, in Brazil alone, from 20 million ha to 60million ha in the case of sugarcane (ethanol), and from 6 million ha currently to 30 million ha in the case of soya bean (bio-diesel). Similarly Indonesian oil palm production for biodiesel is planned to rise from its current 6 million ha to 30 million ha by 2030 (Brand, 2010).

Whatever the accuracy of such projections, the prospect of rising food commodity prices has had the effect of galvanizing interest of international finance capital in agricultural production, prompting acquisition of large areas of agricultural land in Africa, Latin America and South-East Asia by a variety of international commercial investors (Cotula et al, 2009; Mann and Smaller, 2010, World Bank, 2010). It is the transactions in Africa, accounting for about 75% of the 45 million ha of deals reported in 2009 (World Bank, 2010a), typically involving land acquired as 40-99 year leases agreed between commercial companies and African governments, that have aroused the greatest controversy. Concern centres partly on the use of land for biofuel in countries subject to food shortages, and partly on the perception that some investors, notably those from high-income food importing countries in the Middle East, plan to use the land (particularly that acquired through agreements with the Ethiopian government) to produce food destined exclusively for export to the investor's domestic market. In the case of Saudi Arabia's 'AgroGlobe 7x7' scheme to produce 7 million tons of rice in Africa, GRAIN (2010) reports that 70% of the output is designated for export to Saudi Arabia.

With the exception of some of the large Sahelian projects, relatively little of the commentary on these investment deals has addressed the implications for water use. Mann and Smaller (2010) are among the few who identify water scarcity as one of the long-term drivers of land acquisitions for agriculture: "..a critical motivation in the current trend towards large-scale land acquisitions is the water factor. Agriculture trade specialists have long recognised the notion of trade in virtual water to account for the water needed to grow different crops. Today we see investment in water rights in foreign states, through the purchase or lease of land with associated water rights and access, as a critical part of the new process of securing long-term farming investments."(Mann and Smaller, 2010: 6). A recent review of land deal contracts by Cotula (2011) also observes that land leases in semi-arid countries would be worthless if they did not ensure access to sufficient water for agricultural use. In contrast, a review undertaken by the World Bank (2010a) explicitly states that its estimates of farmland 'available' for investment are based on suitability for rainfed production alone. This is a questionable stance where commercial agriculture in sub-Saharan Africa is concerned, as indicated by another recent World Bank study on agricultural development potential: "Irrigation may not be as critical in the Guinea Savannah as in other more arid production environments, but the potential contribution of irrigation to African agriculture should not be underestimated. Commercial farmers in southern Africa have long known that even a single preplanting irrigation can make an enormous difference in enabling timely planting and ensuring that crops get off to a vigorous start, which can significantly affect eventual yields and reduce risks." (World Bank, 2010b: 119). This underlines the point made in the previous section that water management is needed in much of African agriculture to compensate for irregular and unpredictable rainfall, not necessarily for a lack of total rainfall.

In practice, where information is available, the choice of crops to be grown financed by foreign direct investment suggests a high likelihood of production that demands ‘blue’ water (irrigation), not just ‘green’ water (rainfall). Sugarcane and rice, both of which have a high demand for water and a long growing season, would usually require irrigation in all but the most humid climatic zones of sub-Saharan Africa. However, wheat is a cool (i.e. dry) season crop in the tropics and thus also requires irrigation in sub-Saharan Africa, except in the Ethiopian highlands. The available data may not be accurate, retrieved as they are from press sources. Nonetheless, where reports specify the crops to be grown and their location, they do indicate a preponderance of projects with high water demand. It may be argued that Jatropha, introduced as a biofuel (biodiesel) crop that can grow on poor soils and with low water demand, departs from this pattern. It has been proposed as means by which small-scale producers can gain access to the growing market for biofuel by growing a crop that does not compete with food crops for land with better fertility and moisture availability. However, a number of sources indicate that commercial yields of biofuel will require good soils and no moisture constraint. Aston-Lloyd’s prospectus for investors in jatropha plantations in Indonesia (ref Aston Lloyd) highlights the importance of irrigation to maximise yields. Schut et al. (2010) cite research indicating yields of 2.72 tonnes of Jatropha oil per hectare (t oil ha^{-1}) under optimal growing conditions, including no limitations of water or nutrients. They observe that the average yield of 2.64 t oil ha^{-1}, given as the planned production level in 12 Jatropha projects in Mozambique, would be “extremely difficult, if not impossible” to achieve (Schut et al. 2010: 5157). This conclusion can only be strengthened by the fact that Jatropha projects are promoted as enabling the exploitation of ‘marginal land’ not used for food crops. Indeed, Nhantumbo and Salomão (2010: 10) report that an existing Jatropha project in central Mozambique had switched to forestry due to soil quality considerations. The same authors also observe that even where biofuel projects plan to grow crops with low water demand, such as sorghum, project design includes irrigation and the construction of dams.

Country	Investors	crop	Area indicated (1000 ha)	source
Angola	Local + Portugal investor+ US multinational	Banana	3	http://www.angoladigital.net/digitalnews/index.php?option=com_content&task=view&id=5310&Itemid=41; *passionfruit.cirad.fr/index.php/download/(id)/3684/(langue)/eng/.../article)* Cancelled: http://www.reuters.com/article/2009/09/23/angola-chiquita-idUSLN11462220090923)
Angola	UK	Rice	25	http://www.lonrho.com/Press/News_%28RNS%29/RnsNews.aspx?id=779&rid=2066343 http://business.timesonline.co.uk/tol/business/industry_sectors/industrials/article6956373.ece,
Cameroon	Local?	Sugarcane	11,9	http://farmlandgrab.org/post/view/15236
DRC	Canada	Palm oil	101,4	http://www.newswire.ca/en/releases/archive/September2010/14/c9790.html?view=print
Ethiopia	Local +Saudi	rice	At least: 10 +130	http://www.ft.com/cms/s/0/bc1e4974-0906-11de-b8b0-0000779fd2ac.html#axzz1IGz8nFWT http://farmlandgrab.org/post/view/18344
Ethiopia	India	Rice: 35 Maize: 10 Sorghum: 10 [Sugar+palm oil: 20		http://farmlandgrab.org/post/view/18271
Kenya	S Africa	sugarcane	6 (total)	http://www.miga.org/projects/index_sv.cfm?pid=722
Kenya	US	rice	17	http://www.rtfn-watch.org/uploads/media/Land_grabbing_in_Kenya_and_Mozambique.pdf
Mali	Local +Netherlands	Jatropha	2	www2.gtz.de/wbf/.../gtz2010-0060en-foreign-direct-investment-dc.pdf Accessed 16 June 2010
Mali	US	Jatropha	10	Cotula et al. (2009)
Mali	Local + S Africa	sugarcane	14	http://farmlandgrab.org/post/view/14258
Mali	Local + Libya	rice	100	www2.gtz.de/wbf/.../gtz2010-0060en-foreign-direct-investment-dc.pdf, http://farmlandgrab.org/post/view/14150
Mali	China	sugar	13	http://farmlandgrab.org/post/view/14152
Mali	France	rice & vegetables	2,6	www2.gtz.de/wbf/.../gtz2010-0060en-foreign-direct-investment-dc.pdf

Mali	Ivory Coast (3 separate investors)	jatropha	5 x 3	www2.gtz.de/wbf/.../gtz2010-0060en-foreign-direct-investment-dc.pdf
Mali	UK	jatropha	20	www2.gtz.de/wbf/.../gtz2010-0060en-foreign-direct-investment-dc.pdf
Mali	UK?	rice	100 [projected]	http://business.timesonline.co.uk/tol/business/industry_sectors/industrials/article6956373.ece
Mali	Burkina Faso	rice & vegetables	2,5	www2.gtz.de/wbf/.../gtz2010-0060en-foreign-direct-investment-dc.pdf
Mali	Saudi Arabia	rice & vegetables	5	www2.gtz.de/wbf/.../gtz2010-0060en-foreign-direct-investment-dc.pdf
Mali	Saudi Arabia	rice and vegetables	700	http://forasinvest.com/en/pages/projects/investments-maps.php.
Mali	West African countries	rice & vegetables	1	www2.gtz.de/wbf/.../gtz2010-0060en-foreign-direct-investment-dc.pdf
Mali	UEMOA	rice & vegetables	11,2	http://www.fondation-farm.org/spip.php?article714&lang=fr www2.gtz.de/wbf/.../gtz2010-0060en-foreign-direct-investment-dc.pdf Cotula *et al.* (2009)
Mozambique	Norway+US	bananas	3	http://www.norfund.no/index.php?option=com_content&view=category&layout=blog&id=94&Itemid=262&lang=en + media reports: (http://macua.blogs.com/moambique_para_todos/2010/04/matanuska-absorve-t%C3%A9cnicos-agr%C3%A1rios.html; http://www.clubofmozambique.com/solutions1/sectionnews.php?id=14440&tipo=one; http://www.clubofmozambique.com/solutions1/sectionnews.php?id=14440&tipo=one)
Mozambique	Sweden	Sorghum, sugarcane, jatropha	120	http://test1.icrisat.org/gt-ci/whatsnew.htm
Mozambique	Local +Portugal	Jatropha	19	http://www.consuladogeral-angola.hk/sub/Press/Press_2010_0810_7.html
Mozambique	Brazil	Sugarcane	53	http://www.miga.org/projects/index_sv.cfm?pid=688
Mozambique	S Africa	Jatropha	2	http://utviklingsfondet.no/filestore/Rapport.pdf
Sierra Leone	Netherlands	Rice Sorghum sesame	0.75	http://www.miga.org/news/index_sv.cfm?aid=2406 http://www.evd.nl/zoeken/showbouwsteen.asp?bstnum=277660&location=&highlight=Genesis%20Farms

Sierra Leone	Switzerland	Sugarcane	30	Addax Bioenergy, Q&A: Addax Bioenergy sugarcane ethanol project in Makeni, Sierra Leone. [Online] Available: http://www.google.co.uk/search?q=Addax+Sierra+Leone&ie=utf-8&oe=utf-8&aq=t&rls=org.mozilla:en-US:official&client=firefox-a[Accessed: 1 July 2010 State Secretariat (2009). 'U.S.$200 Million Bioenergy Project for the Country - 4,000 Jobs Assured'. [Online] Available: http://allafrica.com/stories/200901220728.html [Accessed 1 July 2010]
Senegal	Norway	Jatropha	10	http://farmlandgrab.org/post/view/14253
Sudan	Local +Egypt	Sorghum, groundnut maize, sunflower	200	http://www.zawya.com/story.cfm/sidZAWYA20100329101950/Beltone%20and%20Kenana%20establish%20a%20new%20agriculture%20fund
Sudan	Local +Korea	wheat	84	IFAD (2009) *www.ifad.org/events/gc/32/roundtables/2.pdf*; Daniel with Mittal (2010).
Sudan	China	Wheat, maize	10	Daniel with Mittal, 2010 (based on Sudan Tribune story)
Tanzania	Mauritius	Sugar	45	www.agribenchmark.org/.../download_free_document.php?...Sugarproject...
Tanzania	EU	Sorghum / ethanol	45	http://www.camsglobal.com/whereweare/africa
Tanzania	UK	Jatropha	8	http://news.mongabay.com/bioenergy/2006/11/tanzania-begins-biofuel-production.html

Table 1: Crop type and area in selected foreign direct investment in agriculture in Africa.

Infrastructure investment: improving access, or increasing competition?

The preceding section suggested that foreign direct investment (FDI) is set to increase water demand by agricultural projects. It may be argued that this is indeed necessary to increase agricultural output, as many African governments hope. It needs to be asked to what extent will these projects provide production that is additional to that which is already taking place, and possibly providing infrastructure (dams, canals, drains) which will enhance water management possibilities for existing producers. Conversely, to what extent will water demand by FDI projects simply displace existing water use, resulting in increased agricultural risk and impoverishment? As with other aspects of FDI land deals, press reports provide a source for concern. An account of the agreement by Libya to finance the expansion of irrigation infrastructure to allow irrigation of a further 100,000 ha in Mali's Office du Niger scheme claimed that the project would involve a Libyan-owned local company (Malibya), a Chinese construction company, and the recruitment of Bangladeshi labour to grow rice on the new irrigated areas. More relevant to the focus of this paper, the same report claimed "the project is going to push some local farmers off the land and compete directly with others for water from the Niger river, the most important source of irrigation for the Sahel-Sahara. Already, Malibya is negotiating with the Malian government for priority in water allocation during the off-season, when water levels are low." (GRAIN, 2009). This latter point has also been reported by Cotula (2011: 36). As we noted earlier, the expansion of dry-season irrigation of high-value fruit and vegetables has greatly increased the profitability of farming the land of the Office du Niger, which is used principally for rice production during the wetter part of the year when the river is in flood. Priority in dry-season water allocation for the FDI project would thus clearly threaten the most valuable output of existing producers on the scheme and undermine the viability of their production. Provision of more water for dry-season irrigation would necessitate construction of a dam and reservoir – a very considerable investment with further social and environmental repercussions, as exemplified by the impact of the Manantali dam on the flood regime in the Senegal river valley, also discussed earlier.

The speed with which FDI investments have proliferated means that few detailed studies have explored the impacts of these projects on existing water use, and many have commented on the lack of adequate Environmental Impact Assessments before decisions have been made on investment projects. In this regard, recent studies of water demand and supply in the lower Limpopo river basin usefully illustrate the types of water dynamics that will need to be investigated if the impact of large FDI projects is to be understood. An analysis undertaken by Vilanculos and Macuacua (2010) compared registered and non-registered water use in the Limpopo valley in Mozambique. Under the Water Law of 1991 all water use must be registered and licensed except 'common use' (*usos comuns*) that includes use by rural households for their domestic needs, watering livestock and irrigation of an area of up to one hectare per household as long as this does not involve mechanical devices or siphons. Under the same law 'common use', although not requiring registration, has priority over registered use by individuals or firms for commercial activity. Vilanculos and Macuacua estimate that existing registered and unregistered use of Limpopo water to be comparable, at 95.2 Mm^3yr^{-1} and 88.3 Mm^3yr^{-1}, respectively. This was based on an assessment that about 4000 ha of small-scale (unregistered) irrigation is being undertaken in the river floodplain. Using government projections of formal irrigation development, they estimated that while non-registered use may double in future, registered use will increase by a factor of 13 as planned irrigated area reaches about 70,000ha. They observe that even this greatly increased water use would constitute only half the average annual flow of 3670 Mm^3yr^{-1} (taken as the combined flow of Limpopo and its tributary, the Elefantes).

At this aggregate level, it would appear that there is no conflict between a rapid expansion of commercial irrigation (most likely funded by FDI) and existing small-scale water users. However, as observed earlier, the seasonal variation in flow (average 14.4 Mm^3yr^{-1} in September and 1125.6 Mm^3yr^{-1} in February) and the year-to-year variability mean that total yearly discharge is a poor guide to water availability, particularly since irrigation usage will be most intense when flows are lowest. A more detailed analysis undertaken by van der Zaag et al (2010) takes account of water stored in the reservoir of the Massingir dam, on the Elefantes river, but also uses annual records to estimate the probability or assurance with which a given amount of water will be available. They conclude that, even on the most optimistic assumptions of storage by the Massingir dam (currently being rehabilitated following a major failure in 2008 of its water outlet structures), the maximum area that could be irrigated with 80% assurance (i.e. suffering inadequate water supply in only one year in five) would be 58,000 ha. This is less than the area for which irrigation investment is being sought. The analysis argues that a more likely scenario (with reduced storage capacity at Massingir) would see only 52,000ha irrigated at this level of assurance. More critically, a 30,000 ha sugarcane-ethanol project which had been allocated land close to the dam would have the effect of pre-empting water use downstream, where assurance of supply would fall to between 59 and 65 percent (inadequate water expected in approximately two years in every five). The concession for this biofuel project was subsequently revoked by the government because the investors had failed to comply with the terms of the concession, but the expectation is still that new investors will be found to establish large-scale irrigation, in all likelihood in locations close to the dam where they will have priority of access to water.

The Limpopo case suggests that although small-scale water use is protected under Mozambique's water law, its non-registered status makes it invisible to government planners and thus vulnerable to competition from registered commercial users who will invariably be equipped with more effective means of abstracting water from rivers or aquifers. In many respects this parallels the situation of non-registered customary land rights and highlights the importance of registration of existing use as a means of making such rights visible to the legal framework which (in the case of water at least) claims to protect them.

Conclusion

In this paper we have argued that the water dimension of agricultural land acquisition in Africa has yet to be widely acknowledged, yet in all but the most humid of tropical agroclimatic zones, water is a key constraint and agricultural water management is a pre-requisite for commercial production. While a requirement for irrigation is clear in some investment projects, such as those in the Sahel (some of which involve the construction of irrigation infrastructure) – even if the contractual terms of access to it are not – for a large number of projects in semi-arid or sub-humid zones the nature of water constraints have been largely ignored or obscured in both contractual disclosure and press reporting. We have argued that seasonality, annual variation, and within-season interruptions characteristic of rainfall in Africa's savannas mean that water management is fundamental to successful agriculture and evident in many indigenous farming systems that deploy techniques ranging from water conservation and harvesting to stream diversion and irrigation. However, the nature of water constraints is intermittent and highly specific to key moments in crop development, thus not predictable on the basis of indicators of annual total rainfall or runoff that are used in agroclimatic zoning exercises.

In reviewing the types of crops proposed by FDI projects we have concluded that many will necessarily involve development of water use, and associated infrastructure for storage and distribution of water. There are evidently potential benefits to other water users, including small-scale agricultural producers, if such infrastructure can provide new sources of water at times when green and/or blue water may be scarce. Yet there is also a high risk that new large-scale agricultural projects will have a negative impact on existing small-scale water users. This risk is heightened because the critical nature of water resources is highly specific to time and place, and thus measures such as annual rainfall or average river flow give no guide to likely impacts. In the absence of more sophisticated understanding of how different types of water resources (e.g. riverbanks, swamplands, river flows) are used at different times of the year by different types of users, there is a risk that large-scale commercial agriculture will cause unforeseen but disproportionate damage to existing small-scale production systems. This is likely even where existing small-scale water use has legal protection, because it may lack visibility, in part due to its small physical extent and (often) intermittent duration. A final aspect of the water dimension of large-scale land acquisitions is that impacts are likely to be far more extensive than might be anticipated from the area of land occupied. Unlike land which has a distinct spatial boundary, water use depends on flows through the landscape. Consequently, restriction or interruption of flows of water in an area occupied in one part of the landscape will have potentially widespread downstream impacts.

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