

'ENVIRONMENTAL SUSTAINABILITY', AGRICULTURAL  
INTENSIFICATION AND WATER RESOURCE  
DEVELOPMENT IN SUB-SAHARAN AFRICA.

"SOSTENIBILIDAD AMBIENTAL", AGRICULTURA  
INTENSIVA Y DESARROLLO DE LOS RECURSOS  
HÍDRICOS EN ÁFRICA SUBSAHARIANA.

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ABSTRACT.

Progress in achieving the Millennium Development Goals (MDG) in Africa has been undermined by failure to reduce under-nutrition, yet efforts to increase agricultural output are circumscribed by indicators for MDG 7, particularly with regard to maintenance of forested areas and conservation of water resources. This implies that increasing agricultural production must be sought from agricultural intensification. The paper sets out the critical role that development of water resource management will play for agricultural intensification in Africa. It argues that past failure to invest in water for agriculture is now compounded by recent trends that are intensifying competition for land and water for agriculture. The paper concludes these are likely to increase uncertainty about prospects for improved nutrition that underpins the achievement of the MDGs in Africa.

*Keywords:* Millenium Development Goals (MDG); Africa; Intensive Agriculture.

## RESUMEN.

Los progresos alcanzados en el logro de los Objetivos de Desarrollo del Milenio (ODM) en África se ven perjudicados por su incapacidad para reducir la desnutrición, en parte debido a que los esfuerzos por incrementar la producción agrícola se circunscriben al ODM 7, en particular a la conservación de los bosques y de los recursos hídricos. Ello implica que el aumento de la producción agrícola se afronta desde el punto de vista del desarrollo de la agricultura intensiva. Este artículo plantea el papel crítico que el desarrollo de la gestión de los recursos hídricos va a ejercer en la intensificación de la agricultura africana. Se argumenta que los fracasos anteriores en el desarrollo del regadío se ven complicados en la actualidad, cuando se observa un aumento de la competencia por la tierra y el agua para riego. El artículo concluye que estas tendencias aumentan la incertidumbre sobre el futuro de la mejora de la nutrición, necesaria para alcanzar los ODMs en África.

*Palabras clave:* Objetivos de Desarrollo del Milenio (ODM); África; Agricultura intensiva.

*JEL Classification:* N37, O15.



## 1. INTRODUCTION: THE MILLENNIUM DEVELOPMENT GOALS AND ENVIRONMENTAL SUSTAINABILITY.

In the discourse of international development the Millennium Development Goals (MDG) have rapidly attained the status of talisman for humanity's better nature. The eight goals, subdivided into eighteen targets and 48 indicators against which human progress is to be measured, have been the object of a consensus embraced by not only the UN agencies but also the OECD, IMF and World Bank (UNDP, 2010). All but two of the eight goals relate to the state of human health and education, with indicators relating to nutrition and income, school attendance, maternal and child mortality, and disease prevalence. As such, these goals may be related directly to economic growth and political (distributional) aspects of economic accumulation. Of the two exceptions, one (Goal 8) seeks 'global partnership for development', and addresses the international relationships deemed necessary to foster economic growth in poorer countries, notably through encouraging trade and investment and international transfer of new technology, while the other (Goal 7) relates to ensuring environmental sustainability, with which this paper is primarily concerned. The United Nations' (2009) Millennium Development Goals Report claims some progress towards meeting many of the goals, while cautioning that subsequent advances are likely to be restricted by economic recession. Moreover, such progress that has been achieved is disproportionately located in East and South-East Asia, while comparatively little improvement has been registered for sub-Saharan Africa in income, employment or labour productivity. Statistics that indicate more positive trends for African countries, such as those showing improvements in school enrolment and child mortality, are tempered by others showing slow progress in reducing child malnutrition. The latter are projected to worsen following food prices rises since 2007, particularly since, despite falls in international food commodity prices since early 2008, food prices in many developing countries have remained high, (UN, 2009: 11). As a consequence, renewed efforts to raise agricultural productivity are likely, particularly in sub-Saharan Africa, where the proportion of undernourished people, estimated by the UN

(2009: 11) as 29% for 2008, has changed little from the figure (32%) for the years 1990-2.

This paper addresses the challenges of increasing agricultural productivity in sub-Saharan Africa. It argues that the development of water resources is a key factor among these challenges, and that, although this has long been recognised, water development for agriculture has not been effectively integrated into support for the majority of African farmers. Moreover, water use for agriculture will in future be subject to a set of new imperatives and constraints linked to official perceptions of environmental change. These may be traced to two principal environmental concerns: that of restricting the area occupied by agriculture in order to conserve natural resources, and that of mitigation of climate change. The paper argues that in both cases, however, it is policy measures responding to these concerns that are likely to have a greater effect than the environmental hazards themselves.

To some extent, this latter point can be illustrated by the Millennium Development Goals themselves. In particular, the indicators for Goal 7 – to ‘ensure environmental sustainability’ – include several that imply severe restrictions on expansion of land and water use for agriculture. Thus, indicators 7.1 (proportion of land area occupied by forest), 7.5 (proportion of total water resources used), and 7.6 (proportion of terrestrial and marine areas protected) all imply ‘improvement’ through preventing conversion of forest or other ‘wild’ ecosystems to farmland. This goal is often justified by reference to observations that deforestation rates in sub-Saharan Africa, at 4.1 million ha per year, are among the highest in the world (UN, 2009: 43). However, data from the World Database of Protected Areas shows that while the proportion of a country’s territory set aside as ‘protected areas’ averaged about 5% for sub-Saharan African countries in the 1960s, by 2000 this average had more than doubled (Brockington et al., 2008: 30-31). The extent to which this expansion of ‘protection’ actually restricts agriculture is not entirely clear, since official figures do not always indicate the intensity with which protection (ie exclusion of cultivation) is enforced in specific areas. The designation ‘protected areas’ includes all six categories defined by the World Conservation Union (IUCN). These include some (category I ‘nature reserve’ and category II ‘national park’) which are required to ‘contain one or more entire ecosystems not materially altered by current human occupation or exploitation’, while others, (category V ‘protected landscape’ and category VI ‘managed resource protected area’) allow management to “support lifestyles and economic activities which are in harmony with nature and the preservation of the social and cultural fabric of the communities concerned” or to promote “practices for sustainable production purposes” (UNEP-WCMC, 2010). Thus the total ‘protected area’ will include some areas in which (‘traditional’) agriculture is tolerated but others in which it is not.

Despite this uncertainty, the trend towards increasing appropriation of land in the name of biodiversity conservation suggests that agricultural expansion



in many African countries faces increasing competition from other types of land use. As a consequence, increases in agricultural output must be sought from intensification of agricultural activity: that is, increasing output from the same or smaller land area, rather than expansion of the area cultivated. In the following sections the paper first sets out the critical role of development of water resource management for agricultural intensification in Africa, and its comparative neglect in recent decades. It then identifies new dynamics, and notably those linked with strategies of mitigation of, and adaptation to, climate change, that will influence the pattern of water resource development for agriculture in Africa, and discusses their implications for agricultural intensification.

## 2. WATER RESOURCES AND AGRICULTURAL INTENSIFICATION.

### 2.1. WATER MANAGEMENT AND THE CRISIS IN AFRICAN AGRICULTURE.

In discussing limitations to agricultural productivity in Africa, it is important to recognise that policy debate has been heavily influenced by 'crisis narratives', such as: 'over 45 percent of Africa is affected by desertification' (UNEP, 2006). While influential, most continent-wide assertions of this kind are not based on unequivocal data or rigorous analysis (Thomas and Middleton, 1994). Reij et al. (1996: 1-4) observe that estimates of soil erosion in Africa may be based on little more than 'informed guesswork', or unjustified extrapolation of small-scale measurements of soil loss to characterise entire landscapes or regions. Such aggregate estimates are therefore unhelpful as a guide to understanding the nature of constraints to agricultural productivity. This is not to deny that agricultural productivity in sub-Saharan Africa is low by comparison with almost every other geographical region. Mean cereal yields in Africa, at 1.89 tonnes per hectare in 2008, are less than half those in Latin America and barely a third of those typical of developed countries (FAO, 2010). Equally, many people in rural areas in Africa live in extreme poverty or seek a better life by migrating to towns and cities. While this is clear evidence of an economic and social crisis, its connection to the management or degradation of natural resources cannot be understood in terms of simple causal models, such as 'population growth' or lack of private property rights ('tragedy of the commons'), or even 'globalisation' and the disruption or erosion of traditional institutions. Rather, the nature of the 'crisis' needs to be characterised through empirical study of specific contexts. This argument and its implications for environmental management in Africa have been more fully explored by Bernstein and Woodhouse (2006). They observe that the critical role of investment of capital and/or labour in order to raise and sustain productivity in the use of natural resources, means that processes of environmental conservation and degradation will reflect socio-economic differentiation. Those with capacity to invest capital or labour in

more productive farming methods will be best placed to conserve the natural resources (especially land) they use. Conversely, in the absence of social investment (e.g. by the state), the poorest land users will be most likely to over-exploit and degrade their land. Thus, in areas with strong economic differentiation among the population, both degradation (by the poor) and conservation (by the better-off) may be occurring simultaneously in the same area. Such patterns are also likely to be associated with transfer of resources such as land from poorer to wealthier households over time (Murton, 1999).

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 consisting of a great range of grassland types with widely differing densities of trees, reflecting the principle underlying influence of rainfall. Annual rainfall may vary from as little as 400mm in 'Sahelian' climate zones to up to 1200mm in 'savanna woodlands', but in all cases is strongly seasonal, being restricted to 4-5 months per year. In all savanna zones inter-annual variation of rainfall is high and thus the risk of large deviations from average (including years of very low rainfall) is also high. African agriculture includes many different approaches to reducing risks associated with low and unreliable rainfall. Reij et al. (1996) provide case studies of many of these, which they classify as 'indigenous soil and water conservation', 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, such as in the Chagga culture on the slopes of Kilimanjaro, 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 is commonly split so as to occupy a variety of topographical positions so as to spread risk associated with rainfall (floods in lower lying sites in wet years, drought of higher, better-drained sites in drier years).

#### *STATE-LED WATER MANAGEMENT.*

Colonial administrations sought to secure a major increase in cash crops for export through the construction of large-scale irrigation schemes. Two major examples from the 1920s, both designed to produce cotton, were the Gezira scheme on the Nile in Sudan, and the Office du Niger in Mali. Productivity on such schemes proved disappointing, however, and a major stimulus to new irrigation investment came only in the 1970s, when two decades of relatively high rainfall in West Africa were followed by two decades of relatively dry years that began with a severe drought in 1972-3. The impact of these drought years on agricultural output and livelihoods in the Sahel and in Ethiopia cannot be attributed solely to changes in rainfall, but reflected also changes in land use and other economic activity which increased the vulnerability of many rural households to drought since the 1950s, particularly as a consequence of the



expansion of cultivation into more drought-prone areas during the decades of good rainfall (Franke and Chasin, 1980; Agnew, 2002). Nonetheless, the association of drought with food insecurity in the Sahel firmly established within international development discourse an environmental dimension to Africa's crisis of agricultural productivity. Yet, despite a clear identification of drought as a key factor in low productivity, the development of 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.

Any effort to interpret the significance of such comparisons is hampered by the extremely weak data available on the extent of water management in African agriculture. Most figures discriminate 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 use indigenous technology to achieve a measure of water management, for example through 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. This is consistent with the relative neglect of such 'indigenous technology' within agricultural research for much of the 20<sup>th</sup> century. Indeed, in some instances government policy hampered indigenous risk-reduction strategies, and made risks of crop failure higher, for example by prohibiting cultivation of wetlands in many parts of southern Africa (Whitlow, 1983), or by promoting comparatively costly or ineffectual measures, such as contour-ridges with high labour requirements for maintenance (Lutz et al. 1994). Consistent with these earlier policy positions, there is a continuing tendency of development agencies to address questions of improved water availability in African agriculture in terms of a relatively narrow set of 'irrigation' options.

However, reviews undertaken in the 1980s 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 (Moris and Thom 1985), or inappropriate dimensions of reservoirs or pumping stations due to designs based on inadequate river flow records (Hocombe et al., 1986). 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 (Adams, 1988). Yet further problems were encountered over state agencies' attempts to ensure that irrigated areas were used to produce commercial crops, usually rice or cotton, in the face of African cultivators' priorities to produce staples such as sorghum or maize (van der Laan, 1984) or to devote part of the household labour to more remunerative non-agricultural work. As a consequence, government officials charged with enforcing the terms of tenancy on state-run irrigation encountered serious difficulties in obtaining cultivators' compliance in planned crop production programmes or in credit repayments for the supply of water and inputs such as fertilizer. Taken together, this catalogue of design and implementation problems resulted in state-run schemes being operated at a net loss to public budgets and made them prime targets for divestiture under 'structural adjustment' measures to reduce government budgets.

## 2.2. WATER MANAGEMENT IN THE NEO-LIBERAL ERA.

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 (Holcombe 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 suggest that investment in formal irrigation slowed substantially in the 1990s. In part this reflects a halt to public investment in irrigation in Africa for a decade from the mid-1980s, 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).

The moratorium on investment in irrigation since the 1980s was consistent with 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, rising to 12 percent in 2010 as a result of the rise in food prices in 2007-8 (IPS, 2010). However, there appears also a manifestation of the ideological shift within international financial institutions against state involvement in development activity and in favour of market mechanisms of resource allocation. This resulted not only in a halt to state investment in new irrigation, but a withdrawal of state agencies from managing existing irrigation, which was to be 'turned over' to farmers' associations, with the private sector expected to provide services such as input supply, crop marketing and equipment servicing and replacement. The consequences of state disengagement from management of irrigation schemes during the 1990s have been mixed, and in many cases cannot be clearly separated from the outcomes of other processes, such as civil war, for example in Sudan. In some instances, it is hard to escape the conclusion that expectations that commercial entities would take over from state agencies as providers of services to irrigated agriculture were misplaced.

In the Senegal River Valley, for example, 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 be undertaken by 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 marked 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 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 Mauretanian 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.

If the case of the Senegal river valley exemplifies the negative outcomes of precipitate withdrawal of state support for irrigated agriculture, the case of 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 has been used to produce higher value crops, such as fruit and vegetables, adding 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. Such pressures are liable to be intensified where state policy seeks further investment primarily through commercial partners, as will be explored further below.

Thus far I have considered primarily the trajectory of investment in 'formal' irrigation. It is important to observe that one consequence of the emphasis on private sector, rather than the state, for investment in irrigation infrastructure is that this sets up pressures towards exclusive or privatised access to both land and water that may quickly become manifest outside the commercial or formal irrigated sector, even among small-scale land users whose access to land and water is governed by customary authority (Woodhouse et al., 2000).



The interactions of such factors within what have been termed 'vernacular land markets' (Chimhowu and Woodhouse, 2006) will be considered in more detail in the next section.

### 3. NEW CHALLENGES TO DEVELOPING WATER USE IN AGRICULTURE.

The previous section of the paper has identified how contradictory pressures within the MDGs drive a need for greater capital intensity in African agriculture. While many indicators of human wellbeing are predicated on improving levels of nutrition, sustainability indicators suggest that the future use of land and water for agriculture will be subject to constraints that are likely to be overcome only with substantial capital investment. Since the existing level of water resource development is very low in many African countries, it seems inevitable that increased agricultural productivity will require a 'negative' change in the value of sustainability indicator 7.5 (proportion of total water resources used). Thus, achievement of a majority of MDGs may require accepting less positive outcomes for others, particularly with respect to 'sustainability'. In practice, development of irrigation is prone to a number of more localised negative environmental impacts, which can only be overcome by high standards of design, operation and maintenance. These impacts include salt accumulation in soils due to inadequate drainage, and proliferation of water-borne vectors of disease (e.g. malaria, schistosomiasis). While the MDGs thus contain elements that are contradictory, they need to be seen within a context in which rapid change is presenting new sets of challenges to the development of agriculture in Africa. In this section I will now consider the emergence of these, particularly those arising from perceptions of climate change. I will begin by outlining the predicted effects of climate change and then consider the impacts arising from policy measures that draw upon discourses of 'climate change mitigation and adaptation'.

Despite continuing controversy over predictions of climate change, the view of the fourth report of the IPCC (2007) is widely accepted: "Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level." (IPCC, 2007: 30). However, beyond this general statement of average global conditions, and particularly for shorter time periods or for smaller geographical areas, prediction of impacts of climate change is subject to considerable uncertainty (Agnew and Woodhouse, 2011). Thus, for example, long-run trends of rising global temperature are subject to short-term reversals, as in 2008 when a marked decline in temperature was linked to La Niña ocean current circulation in the Pacific Ocean. 'Downscaling' predictions of future rainfall change from global circulation models based on energy flux is beset with particular difficulties and has given rise to contradictory scenarios for sub-Saharan Africa (Hulme, 1996). Determinants of inter-year rainfall variation at a regional scale are only recently becoming identified, as

with 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). Moreover, such studies are hampered in sub-Saharan Africa, where rainfall records are subject to discontinuities and changes in geographical distribution of meteorological stations (Chappell and Agnew, 2004).

Given these levels of uncertainty, the most that can be said about climate change impacts on moisture availability in African agriculture is that it is likely to be subject to more extreme fluctuation, giving rise to greater risks from both floods and drought. 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 the future, if in more intense form. It is likely to make water management an even more central component of support to agricultural productivity. Such perceptions have led some to call for a massive expansion of irrigation in Africa, such as the Commission for Africa's (2005) call for a doubling of irrigation (i.e. an increase of 7 million ha) by 2010. In practice, it seems clear that African governments in the 21<sup>st</sup> century find it difficult to emulate the model of large-scale water infrastructure development established by the US federal government, for example through construction of the Hoover and Grand Coulee Dams in the 1930s, and more recently by the Chinese government with the Three Gorges Dam. Not only will it be difficult for African governments to raise capital for such projects, not least due to the past record of government agencies discussed earlier, but they are likely to be subject to intense international criticism on grounds of environmental impact, as in case of the Ugandan government's 15-year delay in construction of the Bujagali Dam on the Nile and Ethiopia's construction of the Gibe III Dam on the Blue Nile (Rice, 2010). A more common approach is for African governments to seek agricultural development via agreements with foreign commercial agribusiness. A number of developments linked with climate change have made this more likely, principally through the expansion of 'biofuels' or 'agro-fuels'.

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 (Ilmai 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 is important to note that not only is most<sup>1</sup> biofuel production uneconomic, requiring subsidies as observed above, but it does not necessarily produce a net reduction in carbon emissions (Pimental and Patzek 2005). The more important conclusion is that policy decisions favouring biofuel production on grounds of climate change mitigation and energy security have become a factor driving up agricultural commodity prices and are likely, as a consequence, to promote 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 in Brazil, from 20 million ha currently 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).

The combination of subsidised prices for biofuel production and its consequence, a 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). It is the transactions in Africa, which typically involve land acquired as 40-99 year leases agreed between commercial companies and African governments, that have aroused the greatest controversy, and have been denounced by some as a 'land grab'. 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 domestic (i.e. Middle East) markets.

It is beyond the scope of this paper to explore the ramifications of these land deals in detail, and it is in any case premature to assess the impact of agreements that have only recently been announced. A number of observations are worth making, however. Firstly, there is evidence that such investments in agricultural production, particularly those in 'less risky' South East Asian locations, have quickly become packaged into financial instruments for sale

<sup>1</sup> The exception being ethanol produced from sugar cane in Brazil (FAO, 2009).

to a wide range of potential investors, offering scope for a speculative ‘bubble’ fuelled by rising agricultural commodity prices. There may therefore be some instability in the capital base for these investments, as also for similar land deals for afforestation schemes premised on the sale of ‘carbon credits’ derived from carbon dioxide sequestered from the atmosphere by the growing trees. Secondly, although capital investment in agricultural production can potentially bring considerable economic benefits to local rural populations, in terms of employment, technological transfer, and improved services and infrastructure, it is not clear that these are always specified in the terms of agreements on land acquisition. Indeed it has been observed that the agreements, where they have been made public at all, contain very few details as to what benefits are to be generated and for whom (Cotula, et al., 2009). Thirdly, relatively few of the agreements have yet been translated into productive agricultural activity. To do so will mean overcoming considerable obstacles arising from poor communications infrastructure and consequent increased costs that have historically disadvantaged mechanised agriculture in many rural parts of sub-Saharan Africa. Finally, the deals generally are characterised as ‘land deals’ but are in effect deals to acquire water. This is particularly evident in instances of investment by Middle Eastern sovereign funds to produce for their ‘domestic’ markets. More generally, however, since water , rather than land, is the more important constraint to agricultural production in sub-Saharan Africa, it is in guarantees of priority use of water that such investments may pose the most significant questions about their wider impact on African agriculture.

The impact of such deals is illustrated in concerns over recent agreements by the Malian government to seek Libyan investment to rapidly expand the Office du Niger from its existing 67,000ha by a further 100,000ha through construction of a new canal from the Niger river. In principal, the water available in the Niger is sufficient to irrigate a greatly enlarged scheme, but concerns arise from the observation that the Libyan agricultural subsidiary in Mali, Malibya, “is negotiating with the Malian government for priority in water allocation during the off-season, when water levels are low.” (GRAIN, 2009). This is of particular concern because it is the ‘off-season’ crop – typically vegetables – that are the most lucrative output from the irrigation scheme. This raises the possibility that even without displacing existing Malian cultivators from their land on the Office du Niger, the new agreement could have the effect of undermining their profitable use of the irrigation system in favour of foreign-owned agricultural producers.

Taken together, these factors suggest that African agriculture will be subject to increasing pressures driven by international concerns over food and energy supplies, and mediated by financial investment from both international corporate and foreign state interests. Such pressures and the international action taken in response to them are likely to be legitimated by underlying uncertainties associated with the international consensus on climate change. One consequence of these new pressures is to highlight the status



and functioning of legal rights over resources such as land and water. This is significant because in many parts of Sub-Saharan Africa the past two decades have witnessed a wave of reforms of both land and water legislation, much of which remains 'work in progress'. Most importantly, from the perspective of support to agricultural productivity, land and water reforms have generally been pursued independently. I will briefly identify elements of these processes before considering the relationship between them.

Reform of land tenure has been driven by concerns that the forms of customary tenure that typically apply to 90 percent of land in sub-Saharan Africa (World Bank, 2003) are insufficiently 'secure', on the one hand to protect the poor from distress sales, and on the other to provide incentives for investment. These two perspectives mark a dichotomy between the goals of land reform, with the former emphasising strengthened collective rights which may not be transferred (e.g. by sale or rental) outside a defined land-holding 'community', and the latter advocating a move to register land titles as individually owned and transferable through a land market. In practice, a dual form of land tenure continues in many parts of sub-Saharan Africa, either as a consequence of formal legislation (e.g. in Zimbabwe and Mozambique) which identifies a category of community land tenure distinct from private, 'commercial', or 'estate' land titles, or because implementation of plans for the formal registration of individuals' customary rights has so far proved beyond government administrative capacity (e.g. in Uganda). While land reform has tended to focus on questions of property rights, water reform has laid more stress on payment for water use, while property rights have remained vested in a collectivity – typically the state. This pattern has been associated with 'Integrated Water Resource Management' (IWRM) which effectively subordinates individual water use to an authority based on a hydrological unit (usually a river catchment or basin). IWRM is one of the 'Dublin Principles' that have informed water reforms since they were formulated by an international conference in Dublin in 1992 (Young et al., 1994). The other principles refer to the need for water to be treated as an economic good, and hence paid for, and the need for democratic governance that is representative of all water users. Water reforms have thus focused on delineating control of water allocation decisions between central government ministries and decentralised river basin committees of water users.

One consequence of the 'sectoral' separation of reform processes is that water reform tends to deal with water use through formal, discrete infrastructure. While this would evidently include formal irrigation schemes, it is much less clear how 'integrated water management' addresses the water used 'informally' by small-scale farmers, whether through small dams or water harvesting or through 'non-equipped' wetland cultivation. In practice, it seems likely that informal water management is largely excluded from oversight by catchment management committees. This is exemplified in South Africa's Catchment Management Agencies (CMA), created by the National Water Act

of 1998. While a CMA is expected to take on responsibility for allocation of water through the issue of water permits (and the levy of charges) to individual water users, in ex-bantustan areas where land use is dominated by large numbers of small-scale cultivators, water use has in practice been allowed under 'general authorisation', to be administered by local customary, or 'tribal' authorities (Woodhouse, 2008). In such instances, water reforms effectively create a dualism in rights to water that parallels dualistic patterns of land rights noted above.

It is legitimate to question whether the persistence of dualistic land and water rights constitute a problem. After all, this may be regarded as providing an escape for small-scale agricultural producers from bureaucratic land registration or water use permits. There are two reasons to question the adequacy of such arrangements for the future, particularly where water management may become even more critical for viable agriculture. The first reason relates to the growth in foreign investment in agriculture and the likelihood that such investments will require guarantees (formal or informal) of priority access to water. In the absence of formal water allocations, there is a risk that water use by local agricultural producers will become a residual category, to be met once other allocations have been satisfied (Mann and Smaller, 2010). A second reason is provided by evidence that increased land productivity arising from better water access may be associated with increasing competition for land and changing land tenure, including informal land markets, even where land remains governed by 'traditional' customary authority (Peters and Kambewa, 2007). Moreover, unforeseen and informal land markets have often characterized irrigation in Africa whether in large-scale formal schemes (see Robertson, 1987 on the case of Gezira in Sudan; Aw and Diemer, 2004 on the Office du Niger, in Mali) or on small-scale farmer-financed schemes (see Southgate and Hulme, 2000 on Kenya; Woodhouse et al. 2000, on Mali). In such 'vernacular' land markets, land allocation can be expected to follow purchasing power, but is also shaped by non-market power relations, such as those deriving from customary hierarchy, which typically determine who has rights to sell or rent land (whether or not such practices are contested under 'custom'). From this perspective, increasing values of land amenable to water management may become increasingly subject to market transactions (Sale, rent, sharecropping) for the benefit of senior members of customary hierarchies, in much the same way as has become commonplace in peri-urban areas (Abudulai, 1996 Benjaminsen and Sjaastad, 2002).

#### 4. CONCLUSIONS: TECHNICAL MODELS, POLITICAL AGENCY.

At the start of this paper I observed that the conservationist criteria under Goal 7 of the Millennium Development Goals create constraints on the increase in agricultural areas as a means of raising food production. Achievement of progress towards the other MDGs, which hinges critically upon improving



nutrition levels, will increasingly depend therefore on raising agricultural productivity through intensifying investment. The paper has outlined how highly uncertain rainfall has both shaped indigenous African agricultural practice but also constitutes the most severe limitation to increasing productivity on the savannas that make up most of sub-Saharan Africa. This constraint is likely to become more severe as a result of climate change, although in ways that may vary greatly from one place to another.

At the same time, recent policy seems set to raise the intensity of competition for water use in agriculture. This arises at a 'national' level from an intersection of 'willing buyer' and 'willing seller' originating from quite distinct dynamics. The 'buyers' are constituted by international corporate and sovereign wealth funds for whom investment in agricultural production in Africa is driven by escalating concerns over food and energy security and the commercial opportunities presented by rising agricultural commodity prices. The 'sellers' are African governments seeking investment to expand national agricultural output and/or influential individuals seeking personal gain through the sale or lease of state or customary land. In addition, local competition for land that has better moisture availability can also be expected wherever there is good access to agricultural markets (typically in peri-urban areas or along major roads), mediated in many instances by informal markets. I have suggested in this paper that, although many African countries have undertaken reforms of land tenure in the past two decades, these may need to be further reviewed to more explicitly address rapid processes of commoditisation of land dictated by patterns of water availability. It is evident also that, in contrast to the parallel 'sectoral' approach followed to date, policy to support agricultural productivity must have consideration of water management at its centre, and conversely, decisions on water allocation must address explicitly expectations of improved agricultural output and its political and economic effects.

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