IMPROVING CREDIT ALLOCATION TO SUSTAINABLE AGRICULTURE IN SUB-SAHARAN AFRICA: REVIEW OF BIO-BASED ECONOMY BENEFITS

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Abstract: Financing of agriculture by commercial and non-commercial institutions in rural Sub-Saharan African in recent years has being relatively constant despite remarkable increase in the number of institutions operating within this area. This development may be attributed to how these institutions rate the business of agriculture and the risks involved. However the slow pace of financing sustainable agriculture such as bio-based economy in the presence of internationalization i.e. Clean Development Mechanism CDM and voluntary carbon market needs to be analyzed. Diverse literatures are used in exploring the potential of "bio-based economy" with emphasizes not just on carbon sequestration but agricultural value added. The results suggest that if financial and non-financial institution re-evaluate and reassess their stands on sustainable farming, development of sustainable agriculture in rural areas is inevitable. Constraint to agriculture financing due to lack of access to credit may be reduced if innovative and sustainable smallholders are identified.

Keywords: agricultural credit, carbon (CER), sustainable agriculture, collateral.

INTRODUCTION

Agriculture remains a vital economic driver for developing countries and would play a critical role in eradicating poverty especially in low-income countries. This sector generates a substantial level of revenue while increasing real income (Christiaensen and Demery, 2007). The agricultural sector not only employs an estimated 75 per cent of the work-force in low income countries in sub-Saharan Africa which is the highest level recorded for any sector but it is also a major contributor to Gross Domestic Product (GDP) estimated at approximately 30 per cent (World Bank, 2007). The development and growth of agriculture apart from ensuring food security and sustainability is also a milestone in establishing a stable bio-based economy which provides an alternative to conventional energy. Energy security is vital for the development of low-income developing countries. In the sub-Saharan Africa region, households, medium and small scale industries, excluding those in southern Africa, make use of biomass most notably "firewood" or fuel-wood, charcoal and animal waste (dung) on a large scale (81.18 per cent), implying that long term energy supply cannot be sustained and pollution will be on the increase (UN-DESA report, 2004). The regions per capita energy consumption which is estimated at 387.89 Mtoe is also ranked amongst the lowest (UN-DESA report, 2004). This low consumption may serve as an indicator for low economic activity and therefore moderate development. The continent thus appears not to be self-sufficient, which may to a large extent be attributed to natural as well as man-made causes such as lack of proper policy, diseases, war, climate change, credit constraints, lack of technical know-how and urban migration (Jayne et. al., 2005). Global challenges such as food security, dependency on fossil energy and rural development in the presence of climate change are therefore of particular concern. These concerns are justified considering the exponential growth rate of global population which is forecasted to reach between 7.4 and 10.6 billion by 2050, with Africa expecting a 7 per cent population growth (United Nations, 2004). This trend could further exert pressure on food as well as energy leading to spike in prices. Taking the continent's endowment of natural resources into consideration, while acknowledging regional differences, the question then arises if the agricultural potentials that abound are able to support a move towards Sustainability and bio-based economy. A vast array of literature identifies credit constraints as one of the major problems confronting development of agriculture, especially in the adoption of innovation, not only in sub-Saharan Africa but globally (Ahmad, 2005; Feder and Umali, 1993; Fernandez-Cornejo and McBride, 2002). The fact that a number of smallholders use different farming method, some sustainable and environmentally friendly while others contribute more hazards to the environment, means it may not be ideal to generalize farmers. The paper looks at the potential of segmenting rural agriculture into sustainable and non-sustainable entities while approximating the benefits of sustainable farming to asset/income then analysing how this could ease credit constraints. The first section elaborates on why formal credit may not be available to the rural smallholders while taking some of their unique characteristics into consideration. The second section explores the potential of bio-based economy in agriculture with the view of revealing what the future may hold for alternative energy production in sub-Saharan Africa. The third section sheds light on the possibility of using Jatropha plant in a bio-based economy to provide environmental services and increase smallholder's income through soap processing. The fourth section examines how commercial lenders and/or investors can readjust operations and reduce the risk of sustainable agriculture as they go about their operations. The paper concludes with the need for a different approach to rural agriculture credit risk in the light of sustainability such as bio-based economy.

Financial Constraints To Sustainable Agriculture In Africa

Credit constraint is a major problem confronting the development of sustainable agriculture therefore a move towards bio-based economy especially in the adoption of innovation globally (Feder and Umali, 1993; Fernandez-Cornejo and McBride, 2002; Ahmad, 2005). Studies have shown that by providing credit to smallholders, adoption of new technology (e.g. hybrid maize) is being encouraged and the ability of smallholders to bear risk has increased (Diagne et al, 2009). All studies found that a credit constraint had a negative impact on the adoption of agricultural innovation, which ultimately might lead to limited agricultural growth and development and increased poverty. The rural smallholders are therefore limited to sourcing funds from their savings (when and if available) or from family and friends or other sources such as rich people or money lenders in the community who usually charge above market interest rates (Salami et al., 2010). There is little doubt that such a development will not help promote sustainable agricultural. Smallholders in Kenya have expressed their dismay at the credit situation they are facing, insisting that it was the main cause of low agriculture productivity. Low government spending on agriculture of less than 6 per cent of GDP in the last three decades in sub-Saharan Africa has had little impact on agricultural development (Salami et al, 2010). It is estimated that less than 10 per cent of total lending by commercial financial institution in sub-Saharan Africa goes to agriculture with large scale farmers as core benefactors (Mhlanga, 2010). Table 1 provides an overview of the lending pattern of commercial banks to agriculture in a number of selected sub-Saharan African countries. The resulting graph (figure 1) shows that lending in most of the countries have been either constant in some cases on a slight decline. One major reason deterring commercial and non-commercial financial institutions from disbursing credit to smallholders is their lack of collateral (Salami et al, 2010). The essence of collateral and why it is important for the financial institution is illustrated later in this section. Sub-Saharan African agricultural production is characterized by a disproportionately large fraction of agricultural output which is in the hands of smallholder farmers whose average land holding is about one to three hectares. While some sort of agricultural asset (in the form of farmlands) is available in rural areas, a number of smallholders lease or rent farmlands for cultivation (Ogunlela and Mukhtar, 2009). Although non-commercial financial institutions such as micro-finance institutions (MFIs) have helped facilitate credit to the rural smallholder by adopting a different approach which is based on business's cash flow evaluation or income instead of collateral, its impact has however not been widespread (Salami et al., 2010). Co-operatives in rural areas have also helped to spread agricultural credit, as information complied on respective members by the organization is useful not only in the loan assessment process but also repayment due to peer pressure, furthermore financial institutions do not have to engage in high infrastructure costs which come with institutional set-up (Admasu and Paul, 2010). Financial institutions can thus reduce transaction costs by aligning operations to those of the co-operatives.

Table 1: Share of commercial bank lending to the agricultural sector of selected countries in Africa, 1995 - 2008 (percentage of total portfolio)

Country	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008
Botswana	1.04	0.61	0.93	0.67	0.76	1.42	1.42	1.13	1.06	0.68
Gambia	-	-	-	-	-	-	-	-	7.20	5.53
Ghana	-	9.65	9.56	9.38	9.45	7.65	6.71	5.37	4.41	4.28
Kenya	-	6.57	6.01	6.07	6.20	6.00	6.25	5.38	4.08	3.60
Lesotho	-	-	-	-	-	-	-	0.31	1.90	8.17
Malawi	28.62	7.55	8.63	3.23	10.40	12.11	9.90	15.25	16.27	14.60
Mozambique	-	-	17.87	15.97	12.37	10.69	8.66	6.39	9.42	8.05
Nigeria	-	-	-	-	5.16	4.46	2.44	1.96	3.11	1.37
Sierra lone	-	4.84	8.29	1.12	1.75	1.93	1.97	0.88	2,49	2.95
Uganda	22.54	10.71	8.57	11.14	9.69	11.07	10.05	9.13	6.67	5.88
Tanzania	8.10	6.30	9.60	17.1	12.0	13.90	12.40	13.94	11.01	12.35

Source: Mhlanga , 2010

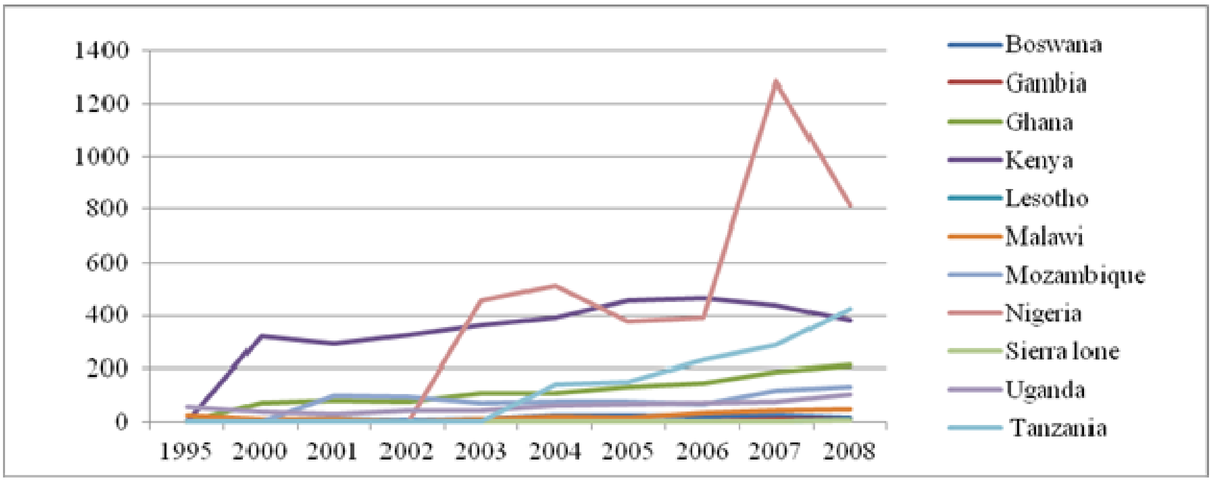

Figure1: Value of commercial Bank lending to the agricultural sector of selected countries in Africa 1995 – 2008 (USD million)

Source: Authors calculation using the data of Mhlanga , 2010

As financial and non-financial institutions in sub-Saharan regions are increasing regional operations, it is important that these institutions also adhere to international and regional financial regulations (Lafourcade et al., 2005). In 2003 available data for micro-finance entity operated by commercial and non-commercial institutions in sub-Saharan Africa shows that of the total 163 institutions only thirty six were unregulated, these unregulated institution were however quite restricted in their operations (Lafourcade et al, 2005). In other to protect stakeholders and/or depositors of these commercial and non-commercial institutions, monitoring and measuring of risk is a vital component of financial investment management. Portfolio quality is an indication of the risk associated with loan delinquency and also determines future revenues, as well as the institutions capability to serve existing clients (Lafourcade et al, 2005). A reason commercial and non-commercial financial institutions may overlook smallholders is due to their lack of collateral which is restricted to just farmland (Katchova and Barry, 2005). As earlier stated, stable income (off- and on-farm) may also be a proxy to collateral. The fact however remains that collateral plays a major role in evaluating credit risk and capital requirement of an agriculture portfolio (Katchova and Barry, 2005). For instance credit risk calculation such as the probability of default (PD) estimates the probability that an individual farmer will not be able to meet his/her obligation, in other word, the likelihood that the farmer´s asset will fall below the farmer´s debt, while capital requirement is based on the Value-at-risk (VaR), which estimate probability distribution of credit losses conditional on portfolio composition. The asset valuation of the rural smallholder at the initial period is perceived to be zero, default therefore already occurs as at the time that the smallholder applied for the loan, this method of modeling credit risk does marginalizes small scale thus smallholders due to the high risk and even higher capital requirements that the commercial banks have to set aside. This method of modeling agriculture risk and lending may however be discriminatory toward sustainable agriculture which may present a different type of collateral eligible for credit apart from the conventional farmland.

POTENTIAL OF A RURAL SUSTAINBLE BIO-BASED ECONOMY

Certain countries on the African continent such as Algeria, Egypt, Libya Nigeria, Angola and South Africa are endorsed with relatively huge reserves of natural resources such as coal, fossil fuel and natural gas, while the rest are energy importers (IEA, 2007). Bio-based economy potential of sub-Saharan Africa looks at the possibility of using products which are biologically educed as an energy source in a sustainable manner. Rural inhabitants and business rely mostly on combustible renewable (firewood) for their energy demand even in so-called oil rich countries (IEA, 2007). In sub-Saharan Africa it is estimated that 1.6 billion people are without electricity while 2.5 billion people are dependent on firewood. The balance between energy production and consumption in Africa remains to be seen, as 79 per cent of total electricity production is traceable to certain countries that constitute a mere 22 per cent of the continent´s total population (IEA, 2007). The negative environmental effect of using firewood such as erosion, desert encroachment, soil fertility- and biodiversity losses, and health hazard are therefore eminent. It is estimated that combustible renewable (firewood) supplies 284 Mtoes which is equivalent to 47 per cent of sub-Saharan Africa´s Total Primary Energy Supply (TPES) (IEA, 2007). Low income countries endowed with relatively limited natural resources pay heavily for the high price volatility of conventional energy (Mol, 2007). It is argued that a spike in the price of crude oil of US$10 would lower the GDP of oil importing sub-Saharan Africa countries by 1.5 per cent, as a large proportion of sub-Saharan Africa countries spend 14 per cent of their revenue on oil importation (Sielhorst et al., 2008). This assumption corresponds to the events in 2005 when the surge in oil price reduced the GDP of oil importing developing countries by almost half from 6.4 to 3.7 per cent which further plunged more people into poverty (Rossi and Lambrou, 2009). Despite bioenergy investments and projects being undertaken to supplement conventional energy in sub-Saharan Africa, reliable scientific data on sub-Saharan African bioenergy stock are not comprehensive (FAO, 2008). The reluctance of investment in sustainable bioenergy may be due to the fact that information on the relationship between yields and other variables such as soil, climate, crop management and crop genetic material, on which to base investment decisions, are poorly documented (FAO, 2008). The unsustainable alternative energy consumption of most rural sub-Saharan in form of firewood and agricultural residue, are becoming scarce and unaffordable for rural inhabitants. It is important for developing countries to seriously consider an alternative to conventional energy and moving towards sustainable bio-based economy if it is deemed viable. The feasibility of bio-based economy was elaborated in a study which found that cultivating 10 per cent of land in sub-Saharan Africa which is not forest, wilderness or cropland with biomass energy crops, would produce 18 EJ an equivalent of 429.92 Mtoes of energy (Amigun et al., 2008). This is almost twice the amount of TPES currently generated by the solid “combustible renewable”. However utilizing rainforest and other areas such the savannah or grassland solely for biofuel production will be more polluting, releasing 17 to 420 more tons of CO_2, compared to the reduction which occurs by replacing fossil fuel with biofuel (Brittaine and Lutaladio 2010). The global consumption of biofuel, which stood at between 0.50 EJ (11 Mtoes) in 2002, is expected to rise drastically to 50 EJ (1,194.22 Mtoes) by 2050 (Sims et al., 2006). There is however, no doubt that a bio-based economy and sustainable agriculture brings benefits and challenges. Examples of some of these benefits include knowledge transfer on bioenergy production, employment, carbon dioxide (CO_2) emission reduction, revenue generation. Perennial bioenergy crops improved soil conditions, increased soil carbon storage and reduced soil erosion. Potential benefits therefore provide important (additional) reasons to invest in bio-based economy across the regions. International organizations however caution that without proper institutional monitoring mechanisms there might be a complete shift to a bio-based economy, thus giving rise to food insecurity, high food prices and agro-biodiversity losses as well as increasing pressure on natural resources (FAO, 2009). The food and agricultural organization (FAO) argues that bio-based economy on a small scale can be viable and in the interest of the public if it is derived from local sources thereby boosting employment and wealth. Constraints to bioenergy and sustainable agriculture production in developing countries are mainly due to lack of access to capital, technology and markets by smallholders, as well as pre-existing socio-economic and gender inequality particularly in terms of access to - and control over - productive assets (FAO, 2009). A United Nations report on the potential and benefits of biofuel depicts how ongoing bioenergy cropping projects, especially via planting and processing in sub-Saharan Africa have improved the rural energy matrix and livelihood (United Nations, 2007). The report also stresses the need for finance and investment in bioenergy and co-existence of sustainable large scale and rural small scale biofuel production, concluding that it is particularly important to enlist local financial and micro-finance institutions that understand of local markets, conditions and clients. Despite high production costs, sustainable bioenergy production in semi-arid and arid regions of sub-Saharan Africa may still be desirable because it is a potential driver for rural economic and social development (Wicke et Al., 2011).

ADVANTAGES OF BIO-BASED ECONOMY

Climate change due to the emission of greenhouse gases (GHGs) such as carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) as a result of human induced consumption, amongst others, is a global threat. Agricultural practices contribute to atmospheric GHGs, for instance fertilizer usage releases N_2O, burning, felling of trees and land conversion all release CO_2 while animal dung contains both gases (Seeberg-Elverfeldt, 2010). Activities such as afforestation and reforestation, the management of forest, soil, livestock, manure and land, sustainable biofuel production, energy efficiencies and biodiversity conservation are methods that help reduce GHGs emissions (Seeberg-Elverfeldt, 2010). Therefore a solution to climate change is sustiable agriculture, since it has the ability to store and capture CO_2. Today carbon uptake and storage is economically viable due to the ability to trade these on the secondary market similar to those being carried out on the stock exchange. Rural smallholders may therefore be able to sustainably mitigation climate change by engaging in afforestation (reforestation) with bioenergy potential. One plant that may be used for this purpose by rural smallholders is the ***Jatropha curcas,*** which, due to its robustness, minimal maintenance requirements and ability to prevail in semi-arid and arid areas makes it unique (Brittaine and Lutaladio, 2010). The fact that this tropical, low-growing-oilseed tree can be inter-cropped or cultivated on marginal land makes it a more formidable candidate in the face of climate change. An estimated 120,000 hectares of jatropha is currently being cultivated in Africa, while Asia and Latin America have 760,000 and 20,000 hectares respectively, bringing the toll of global Jatropha to 900,000 hectares which by 2015 should hit 12.8 million hectares (Brittaine and Lutaladio, 2010). The jatropha tree, especially its seed, has been in use in sub-Saharan Africa for half a century, predominantly in the making of soap and as oil for lighting lamps. The jatropha tree is also dreaded due to its high level of toxicity and invasive nature. One aspect that has received less attention is the carbon sequestration opportunities that jatropha presents, considering that a tree has a life span of between thirty and fifty years, which means equals carbon capture and storage. To illustrate what an environmental service may look like, a rural smallholder with three hectares of land could grow staple crops while simultaneously cultivating a total of one hectare with Jatropha, which depending on plant density, would amount to between 1100 and 2500 trees (Benge, 2006). If the farmer happens to cultivate on marginal land or wasteland, then jatropha cultivation looks even more attractive in a socio-economic sense but one should not expect optimal growth. Of the 1600 trees cultivated on the three hectares of land it is estimated that after seven years each tree comprises about 200 kg of biomass which altogether is approximately 320,000 kg, dry matter content or wood makes up 25 per cent of the total weight which is 80,000 kg or 80 tons (Benge, 2006). This then implies that half of the dry matter content or wood (40 tons) of the farmers total jatropha trees is pure CO_2 (Benge, 2006). The

40 tons of carbon sequestrated by the farmer in the last seven years, in essence is a climate change mitigation measure which should and is under certain climate agreements pre-requisite eligible for compensation in the form of carbon credit. The fact that little is being done to explore the carbon sequestration potential in rural sub-Saharan Africa, which may be due to a range of reasons ranging from information asymmetry, lack of commitment to high initial investment cost means that the use of the jatropha tree is limited. The immediate benefit of jatropha cultivation to the farmer is the extra revenue generated through its seed oil based medicated soap production due to the simple local production techniques. The yield of the jatropha tree in the form of pure oil varies between 400 and 2,200 litres per hectares (Sielhorst et al, 2008). The amount of soap derived from 12kg of Jatropha seed which is equivalent to three litres of Jatropha oil, given an estimated five working hours, is Twenty eight pieces of soap each weighing 170 g (Benge, 2006). The total value of the input for soap production is valued at US$3.04, while the revenue from soap and seed cake residue sales is US$4.20, the farmer thus earned a net profit of US$1.36 or US$0.28 per hour (Benge, 2006). Seed cake residue which is a by-product of soap production serves as an organic fertilizer, apply this type of fertilizer on farmland may also be eligible for carbon credit because it does not contribute to the release of N_2O. The production of biodiesel from Jatropha oil in sub-Saharan Africa is assumed to have its complications, for instance it requires the use of methanol which is may not be produced locally. Jatropha biodiesel production costs range from 26 US$ GJ^{-1} in semi-arid Zambia, Tanzania, Kenya and Burkina Faso to 889 US$ GJ^{-1} in arid South Africa (Wicke et al., 2011). To this end, the handfuls of firms mostly in the southern part of the continent producing the biodiesel have stopped production due to high seed and production prices. Sustainable agriculture as described above may therefore lead to a steady income if used in the conventional sense (soap production) but also represent a new type of asset if taking climate change mitigation mechanism into consideration.

CARBON AS A COLLATERAL

Opportunities and benefits of climate change mitigation such as the Kyoto protocol´s Clean Development Mechanism (CDM) or voluntary carbon trading abound for rural development if properly implemented (Jurgens et al., 2006). There have also been several discussions and studies on how to create a broker between the demand and the supply of carbon certification within the CDMs and voluntary carbon market. It is argued that promoting carbon sink (even on degraded African drylands) either through the Kyoto protocol or other international agreements provides a promising avenue to address the north-south equity issues combined with necessary support for the rural poor (Tschakert, 2004). The conservation or sustainable practice is beneficial to smallholders while the degree of benefit varies depending on the practice and household endowment (Tschakert, 2004). Carbon trading presents a win-win situation for both carbon buyers and sellers especially for sustainable smallholders in developing countries (The World Bank, 2011). The trading partners however have to be linked by an investment vehicle with adequate financial capital willing to dedicate substantial capital to the project (Perez et al., 2007). The investment vehicle aims to establish a contract with a pool of sustainable smallholders which gives them the right to their ecosystem services which is then sold to potential buyers. Payments to farmers may be on a per hectare basis or per ton of carbon sequestrated which may also increase the value of poorly fertile or common agricultural land. The complexity of the carbon market in practice is its integration on a multiple level ranging from farmers technical ability to store carbon in the production system, monitoring of carbon stock to technical financial and allocation capabilities of the investment vehicle (Perez et al 2007). There is therefore a strong need for a suitable institutional arrangement which will facilitate process of aggregation, monitoring and verification. A negative observable trend of the climate change mitigation tools is that international organizations are encouraging a shift towards a demand-driven system based on private service providers which may benefit the powerful stakeholders but discriminate against landless poor, women and minorities (Perez et al., 2007). There is therefore need for a detailed financial assessment (cost and return) of carbon sequestration (on African dryland is) as earlier studies have underestimated costs (Tschakert, 2004). Thus, applied research and practical experience are needed to better understand the uncertainties entailed in carbon sequestration and trading and to device approaches that minimizes risk and cost, creates efficiencies, and promote participation (Perez et al., 2007). The magnitude of the productivity effect of conservation or sustainable investment plays a critical role in determining its profitability and interacts strongly with factors such as financial position, commitment etc. (Antle and Diagana, 2003). Sustainable smallholders entering into a carbon contract, with either commercial or non-commercial institutions acting as local partners or brokers, may be viewed as providing environmental service resulting in carbon credit or agricultural asset. Payment to farmers per unit of environmental benefit or carbon produced was identified to be more efficient than per hectare mode of payment.

Table 2: Household attributes by per capita land access quartile

Country	Dimension		Quartiles of per capita land access			
		Aver.	1	2	3	4
Kenya	Land access (ha)	2.65	0.58	1.26	2.11	6.69
	Per capita income (1996 US$)	336.7	209.9	275.3	312.4	550.3
Ethiopia	Land access (ha)	1.17	0.20	0.67	1.15	2.58
	Per capita income (1996 US$)	71.6	53.1	52.1	88.3	91.0
Rwanda *	Land access (ha)	0.94	0.32	0.63	1.00	1.82
	Per capita income (1991 US$)	78.7	54.5	59.4	79.3	121.7
Mozambique **	Land access (ha)	1.80	0.55	1.17	1.92	3.46
	Per capita income (1996 US$)	43.1	26.2	34.1	42.7	69.2
Zambia	Land access (ha)	2.81	0.79	1.61	2.68	6.16
	Per capita income (2000 US$)	62.9	48.2	53.3	65.9	84.2

Source: Jayne, 2003

Note: All numbers are weighted except for Kenya where weights are not available. Exchange rates:
Kenya 58Ksh-1997 US$; Ethiopia 6.2birr-1996US$; Rwanda 125.1FRW-1991 US$; Mozambique 11,294 Meticais-1996 US$; and Zambia 2811Kw-2000 US$.
* Income figures include gross income derived from crop production on rented land.
** North-Central Mozambique only where income data is available.

Accumulating and storing carbon may also yield higher returns whereby these returns may come with a lag or delay, if this is the case farmers may require a positive financial incentive, such as a loan, to be encouraged to bear the fixed and variable costs of adopting and maintaining conservation practices (Antle and Diagana, 2003). In a country with well-defined financial institutions, farmers could plausibly participate in a domestic or international market for tradable emission credits, carbon market could function as a form of financing of this sustainable investment, by paying in advance all or part of the capitalized value of the carbon expected to be sequestrated (Antle and Diagana, 2003). Detailed case studies are needed to assess the economic feasibility of soil carbon sequestration under conditions representing different regions of the world. Assessing the feasibility and cost of an institutional mechanism is essential in coordinating the creation of carbon sequestration contracts. Commercial and non-commercial institutions may come up with innovative carbon credit program or loan or which could help rural farmers overcome barriers caused by imperfect capital market. Going back to the previous example of the smallholder with the jatropha plantation, it was established that 40tons of CO_2 can be sequestrated in seven years by the 1600 jatropha trees intercropped on three hectares of land (Benge, 2006). Taking into consideration that carbon prices differ depending on market participation, 2007 carbon data show that on average the clean development mechanism (CDM) offered US$11 per ton of carbon dioxide equivalent (CO_2e), for the European Union´s Emission Trading System (ETS) it was US$20.5 per Ton CO_2e while on the voluntary carbon market it was US$12.5 per Ton CO_2e (Green Markets International, 2007). For his carbon capture and storage in the last seven years, the farmer may then be entitled to the respective payments of US$440 (CDM), US$820 (ETS) or US$500 (voluntary carbon market). The life duration of the jatropha tree on average is about 40 years, with an interval of seven years, the total carbon payment payable to the farmer would amount to US$2,514 (CDM), US$4,685 (ETS) or US$2,857 (voluntary carbon market). The fact that no land use, land use change and forestry (LULUCF) change is observed and more so application of organic fertilizer (jatropha seed cake) by the farmer means that payments may be higher due to non-emissive characteristics of this manure. A sub-Saharan financial institution wanting to innovate and internationalize its portfolio may carefully examine the case of the farmer while exploring the cost and revenue it will incur by going into certified emission reduction (CER). The estimated cost of carbon market participation of a micro-scale project (less than 5000 ton CO_2/yr) for potential financial or non-financial investor is US$65,000 (or higher) for the CDM and US$25,000 (or higher) for the voluntary carbon market. The variation in cost is largely due to the periodic project monitoring and periodic verification (cost per verification) as other components such as project design document preparation, registration fee, validation, transaction negotiation and contracting and initial verification are fixed (Green markets international, 2007). The revenue that the investors may generate varies depending on the number of participating sustainable smallholders. If 500 sustainable smallholders sign up for the project under the CDM then potential revenue will amount to nearly US$1.25 million over the life-span of jatropha plantations. The annual carbon sequestration payment for each smallholder is about US$ 62.85, after taking a potential investor´s profit margin of 10 per cent and the initial cost for market participation of US$ 3.25 for each smallholder, the actual receivables or payment is about US$ 53.31. The return on investment (ROI) for the financial institution or investor is positive at an estimated 5.28. An annual payment of US$ 53.31 has immense impact on his/her income revenue and may go a long way in improving agricultural productivity via innovation adoption such as purchase of improved seeds. Table 2 shows that the average per capita income of smallholders with access to land of between one and three hectares in five sub-Saharan African countries is less than US$100 in four of the five countries (Jayne, 2003). Kenyan smallholders command a higher income, the reason been that the economy is comparatively better developed and diversified, which enables these smallholders to engage in off-farm activities via the labor market which helps them earn a better livelihood (Jayne, 2003).

In the case of an annual carbon payment of US$ 53.31 to smallholders in Ethiopia results in an increase in income of 74.1 per cent. For Rwanda, Mozambique and Zambia the percentage increase in smallholder income due to carbon payment will be 67.5, 123 and 84 per cent respectively. However the payments for environmental services should take the form of a carbon loan where the initial investment as well as the periodic cost of monitoring bore by the financial institution would be incorporated into an affordable interest payment scheme. Where initially asset was valued as 0 it now may corresponds to the carbon sequestration asset (CSA) which is equivalent to the number of jatropha trees - ultimately carbon capture and storage potential. The price of carbon may be volatile, depending on its demand and supply, especially in times of economic downturn. However depending on the market the structures of the CDM or voluntary market contract, the amount paid for each ton of carbon sequestrated over the duration of a jatropha tree may be relatively constant. There are other risk factor which needs to be considered such as bush fire, flooding and plant diseases which might require alternative solutions in the likes of agricultural insurance schemes and may further reduce payment fee to sustainable farmers.

CONCLUSION

The problems confronting sub-Saharan agriculture and ultimately a move towards a sustainable agriculture e.g. bio-based economy are complex and far reaching. The continent has not had its fair share of the green revolution which swept across Asia and Latin America in last three decades while improving food and energy security. Anticipated increase in population by 2050 may put Africa at a disadvantage. As the demand for and the prices of exhaustible fossil fuel continue to surge thereby raising concern about sustainability and climate change, sub-Saharan Africa would most probably be highly vulnerable to these dynamics. In order to ensure sustainable food and energy security the current focus is on agriculture development. A consequence of this is the emergence of the food versus fuel debate. A possible solution to correct such an imbalance is the cultivation of perennial non-edible agricultural plants which can be propagated on arable, arid or semi-arid land, possess bio-energy potential and can be intercrop with staples. An example of such a perennial non-edible agricultural plants is the jatropha tree planted on farmlands in and around a number of rural communities in sub-Saharan Africa. This type of sustainable farming practices carried out in rural communities should be identified and segmented by both financial and non-financial institution. The eligibility for carbon credit due to sustainable agriculture as stated in international agreement e.g. Kyoto protocol or voluntary carbon market means that these farmers are potential recipient of long-term income from provision of environmental services by the asset (tress) on their farm land. The active participation of financial and non-financial institutions on the carbon market may provide a base for the asset valuation of these local smallholders. The opportunities that climate mitigation instruments presents may be used to reverse the trend of credit constraints due to lack of Asset or stable income. The regulations and law guiding international climate agreements such as the Kyoto protocol´s CDM and voluntary carbon markets, if properly formulated and amended may be beneficial to rural sustainable smallholders in developing countries may significantly contribute to agricultural productivity thus rural development as well as food and energy security. A number of issues however need further investigation, such as the interrelationship between smallholders, financial and non-financial institutional investors and carbon market and other possible risks involved.

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