ADDING VALUE TO TRADITIONAL GRAINS AND THE POTENTIAL FOR BIO-RESOURCES BASED ECONOMIC GROWTH IN SUB-SAHARAN AFRICA

I.Virgin, M. Nilsson and F. Johnson

Stockholm Environment Institute (SEI), Stockholm, Kräftriket 2B, 106 91 Stockholm, Sweden. ivar.virgin@sei.se

INTRODUCTION

Trade and export have been decisive factors for the economic growth of many countries. However, most countries in Sub-Saharan Africa have not been able to effectively engage and use international trade as an engine for growth. In the era of globalisation and rapidly expanding global trade, Sub-Sahara's share of world trade has fallen dramatically. This is to a large part a result of the combined impacts of economic globalisation and profound structural weaknesses at the national level resulting in an inability to develop attractive products for export that are able to compete on the global market. Key problems include weak innovation structures, lack of entrepreneurial capacity, unfocused S&T investments leading to a thin human resource base and inappropriate routing of scarce risk capital (UNDP, 2001).

The work towards the Millennium Development Goals (MDGs) and the development of national Poverty Reduction Strategies (PRS) are presently dominating the Sub-Saharan development efforts. The focus on MDGs is necessary, critical and logical. However, the question on how Sub-Saharan countries could build a solid foundation for long-term sustainable growth is also very important. This includes the discussion on long-term development goals and visions of a more solid economy and niche on the global trade scene, some 25-50 years ahead. Key questions in this regard are; how Sub-Saharan countries, with all their constraints, best make use of new technologies and new market opportunities? What type of investments in education, science and technology, entrepreneurship, natural resource management systems and associated production systems can assist Sub-Saharan countries to make better use of their agrogenetic resources, to improve livelihoods and to generate increased export incomes? Since resources at all levels are scarce, effective, realistic and focused priorities are needed.

Long-term economic prospects for many developing countries are tightly coupled to their ability to increase their trade (both domestic and export trade) and integrate in the global economy (Sachs, 2005). In this context, some of the key questions for policy makers in many parts of Sub-Saharan Africa are;

- What should the country produce and sell on the world market in the future? What type of productions systems, what infrastructure, what actors, what trade-offs and prioritisations ?
- How should these products be developed? What specific investments are needed and how can this capacity be built? What strategies and what policies need to be put in place? What type R&D systems and entrepreneurship are needed?
- How to ensure sustainable and effective productions systems that take into account social, economic, environmental and social constraints?

The point is that it is already now time for policy makers and stakeholders in Sub-Saharan countries to plan how to proceed to benefit from future potential markets. This would involve long term planning and strong prioritisation of investments in human capacity, Science

&Technology infrastructure, technology dissemination systems, entrepreneurial capacity, and policy development. This in turn, requires strategic, realistic and clear thinking as regards the potential of future agrobased production systems and which trade niches are the most appropriate and suitable for Sub-Saharan countries.

BIORESOURCE BASED ECONOMIC GROWTH IN SUB-SAHARAN AFRICA

A majority of the countries in Sub-Saharan Africa are, to a large extent, basing their economy on export of raw materials and fairly unprocessed agricultural products which are facing an increased global competition (coffee, tea, vanilla, cacao etc). Given the various constraints, it is unlikely that Sub-Saharan Africa would be able to compete on the world grain markets. Neither is it likely that the region will be able to successfully compete with the rapidly expanding countries in Asia in the development of a manufacturing economy (e.g. production of various high-value consumer products and services, electronics, textiles, etc.).

Economies in most Sub-Saharan countries are mainly agrarian, with the agricultural sector contributing to the largest part of the gross domestic product (GDP), supporting the major part of the population. Many of the Sub-Saharan countries are, and will also in the foreseeable future continue to be, agrarian economies, with relatively cheap labour and large farming communities. At the same time, the rapid globalisation, new technology, trade regimes, increasing energy prices and the growing demand for bio-resource based renewable materials will change the conditions for the agricultural sector world wide, not least for countries in Sub-Saharan Africa.

The question is how countries in Sub-Saharan Africa could respond to this situation? Instead of passively adapting to these new conditions, countries in Sub-Saharan Africa could, to a larger extent than today, develop and strategically invest in its agricultural sector. Africa is a huge continent, rich in genetic resources, but still relatively sparsely populated and with a great variety of agro-ecological niches many with a significant agricultural production potential. In casting about for a route that still may be open for significant and sustained economic growth, one's thoughts turn to the refinement and value adding of Africa's biological and genetic resources. If the tools of modern technology can be brought to bear on these resources, one could, in principle, create innovative biofuels and new bioresource based materials increasingly in demand on a global market and in growing domestic and regional markets.

An appealing vision, for many countries in Sub-Sahara would thus be to use bio-resources as a strategic base for a sustainable industrial growth and to develop an effective "Bio-resource Economy". One of the aims of such a vision would be to revitalise rural areas and broaden livelihood opportunities, increasing the base for market driven agro-economic activities, where the countries can produce their own food and agricultural products, but also to a significant extent produce and export valuable products for specific world market niches. An economy where agro-industries, private sector actors and the public sector could co-operate and encourage a diversified small-holder production. Through such a successful collaboration, small-holders and rural poor can be given access to the international markets and processing infrastructure and at the same time benefit from extension services from both the public and the private sector.

The development of efficient Sub-Saharan bioresource economies requires appropriate leadership, strategic investments, environmental management, regional collaboration, continued donor assistance, public and private sector investments and last, but not least, a

long-term vision and strategy. The latter is, in our view, to a large extent absent in the political and planning arenas in many Sub-Saharan countries. Visions and strategies are also rarely discussed by the development community.

CREATING BIORESOURCE INNOVATION SYSTEMS

Most farmers in Sub-Saharan Africa have great difficulties to successfully compete on the world grain markets. To become more profitable and productive, Sub-Saharan farmers need more options for marketable agricultural products. Adding value to indigenous bioresources (e.g. traditional grains) could be one potentially important avenue for improving livelihoods thus allowing subsistence farmers, should they wish, to develop into more commercial farmers.

In Sub Saharan Africa far too little attention is being paid to the prospects of crop value addition. A key building block to enhance Sub-Saharan bio-resource economies is therefore innovation systems geared towards adding value to indigenous bioresources thus contributing towards alleviating poverty and to promoting sustainable development. A prominent feature of such an innovation system would be the integration of actors and disciplines in the product value chain. Key components of such future bio-resource innovation systems would be;

1. Sustainable bioenergy/biofuel/biomass production systems.
2. Using modern technologies to add value to indigenous genetic resources and development of sustainable genetic resource exploitation systems.
3. Innovative agro-industrial applications and high value processing.

SUB-SAHARAN BIOFUEL SYSTEMS BASED ON TRADITIONAL GRAINS

Sustainable bioenergy/biomass production systems is a key building block in the development of a bio-resource economy. At present, biomass/biofuel resources in Sub-Saharan Africa are utilised in an extremely inefficient manner at different levels, due to the lack of infrastructure, poor market access, and institutions that do not, or cannot, promote innovation or strategic investments. To determine the full potential, one must go on to consider the vast opportunities for improving crop management cycles, breeding options, diversifying the genetic resource base, incorporating drought-resistant species, co-cropping strategies, and the introduction of crops that require significantly lower water inputs.

In a future bioresource economy, biofuels and energy will be central. In many African countries, biofuels present opportunities, and this implies biofuels not from cane only but from a variety of crops. African countries have a comparative advantage in bio-energy and biomass in several respects. First, tropical and sub-tropical biomass is much more productive than biomass grown in temperate regions, such as Europe and North America. Second, the labour content of biomass is generally higher than any other form of energy, be it renewable or non-renewable. Third, the vast rural regions in many Sub-Saharan countries offer opportunities for expansion of biomass that automatically create added value at zero opportunity cost by improving degraded or poorly-maintained lands. A recent study found that the bio-energy potential of Sub-Saharan Africa, after having accounted for food production and resource constraints, was the greatest among all major world regions (Smeets et al, 2004.). The high potential results from the large areas of suitable cropland in the region, large areas of pasture land that are not currently used and the low productivity of existing agricultural production system. In addition to the favourable physical conditions for biomass, the low cost of labour is another important factor that contributes to a comparative advantage for production of biomass and bioenergy in the region.

Biofuel/biomass production can be combined with a wide variety of by-products. One such example is sweet sorghum which with its high sugar content is a very promising traditional Sub-Saharan crop for biofuel production and value addition. Sweet sorghum can produce approximately 30 ton/ha per year of biomass on low quality soils with low inputs of fertilizer and limited water requirements in comparison with sugarcane or corn (Bulawayo et.al. 1996). Following the biofuel processing, the post process remains can be used as fodder, while the bagasse residue, which is similar to that of sugarcane, can be the source for heat and /or electricity.

The potential for sweet sorghum production was recently evaluated in Zambia, by University of Zambia, through multilocation trials with a large number of different varieties (Matsika et al., 2006). The results of these trials were very encouraging demonstrating many varieties with high sugar content and high yield (with stem yields above 25 ton/ha). The trials also highlighted the significant variability of yield in relation to the agroecological conditions. A major concern, however, in the cultivation of sweet sorghum is the high impact of pest and diseases pointing to the need for Sub-Saharan based sweet sorghum breeding and development of disease resistant varieties.

Sweet sorghum appears to be a promising feedstock for bioethanol production in many places in Sub-Saharan Africa, but national governments need to provide enabling policy frameworks and other supportive structures (fiscal incentives, regulatory coherence etc). The challenge is also to build an appropriate sweet sorghum breeding and varietal testing infrastructure, and viable disseminating systems. This requires long term capacity building, investments, strategies and focused efforts. Leadership, entrepreneurship and product development partnership between private and public sector needs also to be encouraged.

ADDING VALUE TO BIORESOURCES USING BIOTECHNOLOGY

Biotechnology and targeted genetic resource exploration is the second important key building block in the development of a bio-resource economy.

Sorghum is a very important crop ensuring food security in many parts of Sub-Sahara but has received comparatively less research attention compared to maize. Despite its importance, sorghum grain yield is low and has been declining mainly due to abiotic stress (e.g. frequent drought, low soil fertility) and biotic stress *(*e.g Striga weed, insect pests and diseases).The combined biotic stresses can reduce yields dramatically, up to 60%, while drought and nutrient imbalances may cause total loss of a crop (De Vries and Toenniessen 2001). Agricultural biotechnology, such as DNA marker assisted selection, can make sorghum breeding for resistance to abiotic stresses and biotic stresses more efficient (Eicher et al., 2006). A number of efforts are ongoing, and a recent example is the effort to develop molecular marker assisted breeding schemes for sorghum in East Africa within the BIO-EARN Programme (www.bio-earn.org). Another example were biotechnology is used in the improvement of traditional grains is the recently started “super sorghum project”, supported by Gates Foundation which uses genetic engineering in the biofortification of sorghum. (www.supersorghum.org).

Biotechnology can also assist Sub-Saharan countries to develop new industrial (non food/feed) agricultural products based on traditional grains. Genetic resources have for long been important raw materials in agriculture and in the natural products industry. Today, with the arrival of modern biotechnology a new chapter in the history of gene hunting has started. Using advanced biotechnology tools such as DNA-marker assisted breeding, genetic

engineering and bioinformatics, genetic resources can be highly characterised, improved and "tailor made" to produce certain metabolic compounds. The competitiveness of biological based compounds in relation to increasingly costly mineral based products (e.g. plastics, fossil fuel etc) has improved dramatically. Consequently, the demand for high quality genetic resources is likely to grow rapidly as the techniques to add value to these resources are improved and investments in research and development begins to pay off. This also involves the development of sustainable production systems for food (e.g. new functional food products) and industrial crops and the production of biofuels, fibres, starch products, "green" chemicals (biodegradable plastics, oils, lubricants and detergents), and micro-organisms generating commercially attractive compounds (e.g. cosmetics, fragrances and flavours based on natural products). Improved technologies and the capacity to characterize and modify germplasm, will thus be increasingly important in the development of diversified and expanding bioresource economies, not least for Sub-Saharan Africa.

This development offers both challenges and risks, but also opportunities for Sub-Saharan countries. Despite a number of constraints, many countries in Sub-Saharan Africa can make use of the above opportunities according to their own needs and potential and develop bio-resource economies. However, this requires strategic investments in human capacity, R&D infrastructure including, biosafety regulatory and technology dissemination systems. It will also be critical to develop long-term visions, strategies and policies to provide a basis for prioritising investments in capacity building and innovation systems.

PROSPECTS FOR AGRO-INDUSTRIAL GROWTH IN SUB-SAHARAN AFRICA

A developed and functional agro-processing industry is the third important key building block in the development of a bio-resource innovation system. There are untapped agricultural resources for expanded utilisation of bio-processes and the growth of agro-industries (e.g. millet production for brewing and other value addition). This also includes the transformation of "traditional" agro-industries such as sugar refineries, breweries etc, where new modern technologies could convert agrowaste into valuable products such as feed and enzymes and at the same time minimize environmental impact. Agricultural biomass resources are widely available in much of Africa, often with high photosynthetic productivity, since biomass from tropical and sub-tropical regions is on average five times as productive as biomass from the temperate regions (North America and Europe). At the same time, the higher labour content of bio-products and processes as compared to their chemical product counterparts (substitutes) offers another comparative advantage for developing countries to produce not only for their own use but for export.

The development of agro-industrial platforms that can sustain a bio-resource economy is complex and challenging and requires cross-sectoral action at several levels. There are many questions as to how countries in Sub-Saharan Africa can benefit from their ample biomass resources, such as: How to build sufficient human capacity and infrastructure? What regulations, policy frameworks, and systems of governance are needed for the various industries and regions? What are the options for scaling-up production in different regions and where are the most likely export markets? How can bio-based products and services expand into global markets from the current regional and/or niche markets? How can expansion of agro-industrial activities be done in an environmentally and socially sustainable fashion? How to integrate local production systems, including small scale farming and various types of agroforestry, into functional and productive agro-industrial systems?

THE CHALLENGES

The problems and challenges to realise an efficient bioresource economy are for many countries in Sub-Sahara formidable. These include:

- Governance and management deficiencies in Sub-Saharan institutions.
- Lack of vision, leadership and strategic planning and concrete priority setting.
- Lack of funding, venture capital and policy frameworks (e.g. incentives, market conditions).
- Weak markets and limited awareness of the potential of market niches and commercial viability.
- Weak R&D structures in both the public and the (domestic) commercial sector and lack of understanding of key aspects regarding technology development and diffusion.
- Weak links between the research institutions and the market, as well as between public and private sector actors.

There are also physical, environmental constrains which need to be seriously addressed in the development of bioresource innovation systems. These include;

- Semiarid conditions, scarcity of water and the lack of efficient water resource management systems limiting agricultural production. Nutrient poor soils is another key problem. The development of agroproduction systems therefore needs to be based on a sustainable use of water resources and nutrients.
- Many Sub-Saharan countries are on an unsustainable development track, suffering from problems such as habitat destruction, soil erosion, poor environmental management systems unregulated use of chemicals, and loss of social and cultural capital. It is therefore imperative that the development of Sub-Saharan bio-resource economies facilitates a development reversing present unsustainable trends.

CONCLUSION

Sub-Saharan countries can strategically use bio-resources and bio-processes for expanding agro-industrial economic growth and to stimulate the evolution of bio-resource economies. A key building block of bio-resource economies is an innovation system focusing on adding value to indigenous bioresources and contributing towards alleviating poverty and promoting sustainable development.

Innovation platforms bringing different innovation actors and perspectives together, enabling cross-disciplinary, cross-sectoral analysis and linking market actors, could be a very effective learning and demonstration tool for the region. Such innovation platforms could be regional, enabling the pooling of key expertise across the region.

REFERENCES

Bulawayo, B., Bvochora, J.M, Muzundo, M.I. and Zvauya, R. (1996) World J. Microbiol. Biotechnol. 12: 357-360.

De Vries, J. and G. Toenniessen (2001), Eds. De Vries, J. and Toenniessen, G. CABI, publishing, 199pp.

Eicher, C.K., Maredia, K. and Sithole-Niang, I. (2006) Food Policy 31: 504 -527

Sachs, J. (2005), The End of Poverty, New York, The Penguin Press, 397 pp

Smeets E., Faaij A, Lewandowski I. (2004), Report NWS-E-2004-109, ISBN 90-393-3909-0, http://www.chem.uu.nl/nws/www/publica/e2004-109.pdf

Matsika, E. & Yamba, F. (2006) Renewable Energy for Development, Vol 19, No.3:6-8.

UNDP. (2001). Human Development Report 2001, New York, Oxford University Press.