DEVELOPING AN INNOVATION-LED BIOECONOMY STRATEGY FOR EASTERN AFRICA (BISEA)

FORESIGHT AND SCENARIO BUILDING STUDY REPORT

Submitted by:

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ACRONYMS

ACET: African Centre for Economic Transformation

AfDB: African Development Bank

BAU: Business-As-Usual

CAADP: Comprehensive Africa Agriculture Development Programme

CDM: Clean Development Mechanism

CER: Certified Emission Reduction

CO_2: Carbon Dioxide

DFI: Development Finance Institutions

FAO: Food and Agriculture Organization of the United Nations

FLL: Futures Literacy Lab

GAFSP: Global Agriculture and Food Security Program

GBS: Global Bioeconomy Summit

GDP: Gross Domestic Product

GEF: Global Environmental Fund

GHG: Green House Gases

ICT: Information and Communication Technologies

Ifs: International Futures

IMF: International Monetary Fund

IPCC: International Panel in Climate Change

MB: Moderate Bioeconomy

NEPAD: New Partnership for Africa's Development

SB-S: Strong Bioeconomy-Sustainable

SB-U: Strong Bioeconomy-Unsustainable (SB-U)

SDGs: Sustainable Development Goals

UNESCO: United Nations Educational, Scientific and Cultural Organization

UNFCC: United Nations Framework Convention on Climate Change

EXECUTIVE SUMMARY

Exploitation of biological natural resources is a basic economic activity of humankind, providing food, shelter and energy. However, over the years, new bases of economic activity have been developed based on non-biological natural economic bases e.g. minerals and fossil fuels that have eclipsed agriculture and forestry and fisheries especially in the developed world. However, this has been at huge cost as many non-renewable resources have been depleted and exploitation has also seen significant environmental degradation. Currently the biggest threat to humanity is climate change due to release of greenhouse gases mainly from burning fossil fuels to power economies. There is now a rethink of how economies should be organized with a desire to shift from non-renewable resources driven economies. An economy based on the use of renewable natural resources and especially carbon is seen as a way forward, this has seen a growing interest developing biological resource based economic sector even as countries industrialize. Developing a strong bio-economy is thus gaining traction globally and the promotion of bio-economies has been placed on the political agenda of more than fifty countries. The Bio-economy can be sub-divided to four subsectors: traditional food and animal feed sector; biofuels sector; bio-based products sector; and bio-diversity services.

As much as interest in bio-economy has been spurred by desire to mitigate impact of current economy based on largely non-renewable and largely carbon based natural resources, Bioeconomy has potential to develop whole new sectors of economy that are not about substitution of current product and services, but about innovation of new production and services. Indeed, with innovation totally new sectors of economy can emerge from Bioeconomy. More so, it cuts across many sector and seeks integration across applications such as agriculture, health and industry. It is therefore important to have a deep understanding of the drivers and associated trends behind the shift to Bioeconomy to appreciate potential impacts and also potential policy levers in shaping the development of the sector.

Drivers and Trends of Bioeconomy

Two competing trends that will profoundly impact on the regional Bioeconomy are unfolding. On the one hand, populations in the region are rising rapidly, incomes are rising and urbanization is underway pointing to huge changes in aggregate demand and demand of biological resources to meet food, infrastructure and other needs. This is happening when already the region is food insecure and the land degraded and forests under threat from deforestation[1]. Challenges that are further compounded by the on-going threat of climate change. At the same time, there are trends indicating growing consensus globally for a shift towards more sustainable consumption and greening the economies. Sustainability and the need to mitigate climate change impact are now key issues being tackled by global governance institutions with important agreements e.g. SDGs, Convention on Biodiversity, Climate Change (COP21) reached. While technologies needed to support the transition to greener economies are still in the early stages of development, a growing mass of consumers concerned with sustainability and demanding sustainable products is creating a market and hastening the transition. With the growing power of global governance institutions and also as local governance institutions grow there is a real chance for making the needed transition.

Bioeconomy Futures

While prospect for shift towards Bioeconomy is real, what is not clear are the futures that these trends are likely to yield. More crucially is what levers are available to shape the potential futures. To get insights, a foresight exercise with key stakeholders was done. The exercise pointed to a number of Bioeconomy futures. The key determinant of the futures as innovation and investment on the one hand and conducive environment for bio-economy on the other. The potential futures can be categorized as:

[1] All countries in the region have lost forest cover between 17% (Tanzania) to 56% (Uganda) between 1990 and 2015. While Rwanda increased cover by 50% (kiprop, 2018)

i. Strong Bioeconomy: Where conducive policy for a bio-economy combines with a sustainable innovations and investments. The majority of the futures generated fell in this scenario reflecting that the group and many of them reflected the preferred futures. This can be expected as these were stakeholders who are invested in developing a strong Bioeconomy for the region.

ii. Conflict Riven Bioeconomy: This scenario combines weak bio-economy conducive policies (but strong policies to support free markets) with unsustainable investment generated the second most set of futures. Bio-resources based conflicts was the main feature of the projected futures. Most of these fall under probable futures indicating that the stakeholders are wary of the current trajectory.

iii. Conflicted Bioeconomy: This is where conducive policies are combined with unsustainable investments. Therefore, a Bioeconomy sector emerges but industries emerging are not necessarily sustainable e.g. monoculture indigenous forest. These scenario underscores the challenge of building sustainable business models. Policies are much easier to put in place. Getting the right business models is much harder especially given the fact that the landscape is characterized by small firms which are also largely informal.

iv. Out-competed Bioeconomy: This scenario where free markets policies and sustainable investment produce a world where products can outcompete bio-based products. Though not many scenarios were generated here, the overriding theme was the emergence of the 4th industrial revolution and its potential to generate new products and indeed re-organize how society.

There was a strong expressed preference of need to move towards strong bio-economy with the region becoming a centre of excellence (CoE) in bio-economy with a vibrant bio-economy industrial sector producing and exporting a wide range of bio-based products and even exporting knowledge. Potential pathways for bio-based economies identified included:

- Agriculture including GMO products e.g. gene edited maize, insect farming
- Chemicals substitutes: Bio-pesticides, Bio-enzymes
- Pharmaceuticals: Medicines derived from herbal remedies
- Tourism including eco-tourism and medical (herbal) tourism
- Construction products including timber

Towards a Strong Bioeconomy Strategy

From the foresight exercise, it is clear that stakeholders understand the potential dangers that current trends pose with many seeing potential conflicts emerging as biological resources become scarce. However, there is huge optimism for a better future through proper exploitation of the biological resources. Many stakeholders see potential of an industrial transformation through production an array of bio-based products. However, the key enablers must be in place. Markets need to be created, business need to be developed, skills need to be build and necessary financing infrastructure be put in place. These are not in place and right mix of policies and proper sequencing will be key in getting the desired bio-economy future.

Beyond the key enablers, there is the need to broaden perspective on what bio-economy is and also pay attention to political economy issues and also the issue of inclusiveness. Some key points include:

- Food vs Feed debate can blinker thinking: Is Bioeconomy "about achieving food security or about wealth creation from sustainable comparative advantage? Maybe if feedstock for industry provides better returns for some countries they can specialize and import food from other countries. Comparative advantage should be a key consideration when making choices. Regional specialization in bio-economy should be explored

- Bioeconomy is at heart a knowledge based economy: Though bio-products are the final outputs the key value addition from traditional products is the knowledge added to them. Thus, knowledge is the key commodity and we should seek to commercialize this too
- Political economy is key: Development of a strong bio-economy will involve coordination of a number if sectors especially agriculture, energy, health and trade and industry and also finance and development of long term policies. Supportive policies must be made across these sectors. A strong case for bio-economy through compelling narrative is key to ensure policies survive political regime changes.
- Inclusiveness: The issue of inclusion was seen as crucial and the need for women playing a leading role was emphasized given the already important role they play in agriculture yet capture little of the benefit that come when agriculture is upgraded. A good regulatory framework also need to pay particular attention inclusiveness

Impact of Bioeconomy

A strong Bioeconomy means many things including higher productivity, increased land use, upgraded value chains, emergence of manufacturing sectors etc. How these changes interact can mean very different outcomes. Simulating the impact of a strong bio-economy reveals a number of insights:

- Bioeconomy means increasing agricultural production to meet food and industrial feedstock demand. This can the through productivity or expansion of land or a combination of both. Simulations indicate that a strong Bioeconomy can mean significant rise in food imports if forest are to be protected. Even in a very aggressive scenario with rise in yields, crop area and relaxation of forest protection imports can still persist underscores how difficult it is to become self-sufficient in food. There is need to emphasis specialization in agriculture and trade rather than food self-sufficiency as the key message in moving towards a strong Bioeconomy.
- In a strong Bioeconomy, agriculture contribution to GDP falls underscoring that the Bioeconomy strategies are stimulating the part of the value chain beyond agricultural production. This is also reflected in the higher value added from manufacturing. Interestingly this happens when a less aggressive and more sustainable Bioeconomy strategy is pursued
- There is a significant reduction in poverty under all scenarios, however, even in this best case, poverty still hovers at around 12% of the population underscoring that a strong Bioeconomy is not enough to eradicate poverty. The GINI coefficient also remains high. The fact is that as value chains are upgraded those with more resources and who make the needed investments capture a disproportionate share of value created. This underscores the need for deliberate inclusive policies to ensure growth is translated to improved livelihoods for all.
- The impact on environment can be devastating for even under a moderate Bioeconomy scenario forests are devastated. Even under a strong Bioeconomy scenario which also seeks to increase forest cover manages to do so. The scenario has higher GHG emissions than the base case. This underscores the need for care in pursuing the strong Bioeconomy strategy

Conclusion

There is a need to increase the productivity of the agricultural sector, increased the innovation capacity, increase investment in the sector to foster a strong Bioeconomy. However, this must be done in conjunction with policies to protect the environment and encourage sustainable practices. Indeed, a strong Bioeconomy does not necessarily mean development objectives are fully met are met, economies can grow, environment protected but still, poverty remains high as ensuing benefit might be captured by a few. A Bioeconomy strategy should thus, be part of package of strategy to ensure

sustainable and inclusive growth. So energy polices, social protection policies, gender policies should be coordinate with Bioeconomy policies.

I. INTRODUCTION

Exploitation of biological natural resources is a basic economic activity of humankind, providing food, shelter and energy. Perhaps the first biggest step ever made by human was the harnessing of agriculture some 10,000 years ago. While new bases of economic activity have developed based on non-biological natural economic bases e.g. minerals and fossil fuels, agriculture and forestry and fisheries constitute important economic activities. For many developing countries these form the mainstay of livelihoods, for the more industrialized countries land and water based biological resources provides many of the basic materials that power their industries.

Over the years, development in technologies has seen the role of biological resource based economic sector play a declining role in economies. The first industrial revolution which saw the harnessing of fossil fuels (coal) and steam engine[2] to develop new economies that are now based on exploitation of minerals and fossil fuels and this has seen tremendous improvement in livelihoods for many countries, especially the industrialized countries. However, this has come at a cost. Mineral resources are not renewable and thus current consumption jeopardizes future consumption, the economies as structured have created significant pollution and especially released tremendous amount of Greenhouse Gases (GHGs) that are causing climate change and threatening livelihoods of many. Significant biodiversity is also being lost as natural resources that are feedstock to many industries get overexploited and also higher living standards have created huge demands that cannot be sustainably met by current economic system[3]. This has seen efforts to reduce the environmental footprint of current economic activities on the one hand through more sustainable production and consumption patterns to outright call for rethinking the whole economic structure to make it sustainable and yet able to support high living standards.

An economy based on the use of renewable natural resources and especially carbon is seen as a way forward, this has seen a growing interest developing biological resource based economic sector even as countries industrialize. Developing a strong bio-economy is thus gaining traction globally.

> Bioeconomy has been defined as the production, utilization and conservation of biological resources, including related knowledge, science, technology, and innovation, to provide information, products, processes and services across all economic sectors aiming toward a sustainable economy (GBS, 2018, p.2)[4].

Bio-economy can be sub-divided to four subsectors; (i) traditional food and animal feed sector; (ii) biofuels sector; (iii) bio-based products sector and (iv) biodiversity dependent sectors:

- Food and Feed: Food and feed are significant sectors and indeed with agro-processing and agribusiness activities they are some of the biggest economic sector in both developed and developing countries. For African countries with highly under developed value chains the key concern is increasing productivity and upgrading value chains to produce a diverse range of food products. Indeed, agro-processing is seen as a key pathway to transformation of African economies (ACET 2018).
- Bioenergy sector: For many in developing countries biomass is the key source of energy. However, this has a potentially huge cost in environmental degradation (through

[2] Though coal and steam engine were key, the 1st industrial revolution was driven by a number of innovations that when combined created a whole new economy. These were innovations in transport (the railway, business model (the factory) and communication (the telegraph). This allowed good to be produced cheaply (steam engine + factory production system) and distributed wide(railways) and people to know about them (newspapers and telegraph)

[3] This concern was first brought to global debate by the well-known Limits to Growth study by the Club of Rome (Meadows, 1972) which forecasted a global crisis by around 2000 for several metals (for instance copper reserves were to be exhausted in 2008).

[4] Some authors make a further differentiation between “Bioeconomy” and “bio-based economy”. Whilst “Bioeconomy” also includes the food and feed sector, the “bio-based economy” only comprises the sectors of bio-based materials and products (incl. pharma) as well as bioenergy / biofuels

deforestation) and health (smoke pollution). More modern fuels (bio-fuels) have been developed through chemical processes. Biofuels have a long history and technologies well developed. They are already a key energy sector in some economies like Brazil (with sugar-cane based ethanol).

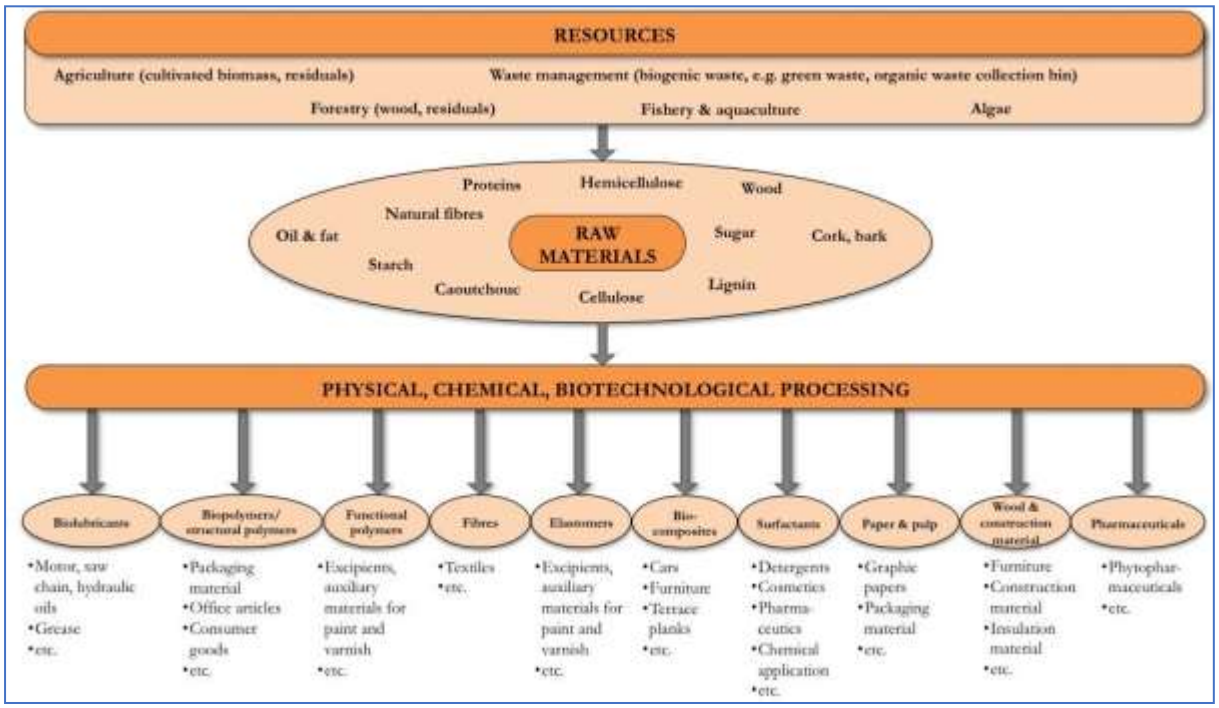

Figure 1: Potential range of bio-product

Source: BIOPRO Baden-Württemberg GmbH

- Bio-based products: Also products made from biological based resources beyond food and fuel have a long history i.e. furniture, building material, paper. However, potential for increasing functionality of old products (e.g. stronger building materials) and developing new materials e.g. bio-plastics is huge. (see figure 1)
- Biodiversity related sectors: As bio-economy is also about sustainability and conservation, a bio-economy based approach also means improvement in biodiversity and thus eco-system services that are key to economy. A major beneficiary of improved biodiversity is tourism sector, a sector that is already important[5] has great potential for transformation (ACET 2014).

Three key points need highlighting in the renewed focus on Bioeconomy:

- <u>It is about innovation</u>: Innovation is central feature of this economy. Bioeconomy is much more about shift to knowledge economy rather than a "back to the future" story of biological resources exploitation. It is about revisit of the old sectors and applying knowledge to improve old products and processes and also create new products.
- <u>More than about substitution of products</u>: Also as much as interest in bio-economy has been spurred by desire to mitigate impact of current economy based on largely non-renewable and largely carbon based natural resources, Bioeconomy has potential to develop whole new sectors of economy that are not about substitution of current product and services, but on innovation of new production and services. Indeed, with innovation totally new sectors of economy can emerge from Bioeconomy

[5] In Uganda, nature based tourism is estimated as having accounted for about 9 percent of GDP in 2012/13 (NPA 2017).

- It is more than a sector: It cuts across many sector and seeks integration across applications such as agriculture, health and industry. Its cross-cutting nature offers a unique opportunity to comprehensively address interconnected societal challenges such as food security, fossil-resource dependence, natural resource scarcity and climate change, while achieving sustainable economic development[6].

The shift towards Bioeconomy is becoming global. The promotion of a Bioeconomy has been placed on the political agenda of more than fifty countries, including the creation of dedicated visions, strategies and action plans (FAO 2019). Some country strategies have emphasized linkages between Bioeconomy and health (e.g. biopharmaceuticals; healthy nutrition), whereas other country strategies have focused on sustainable biomass production and utilization (GBS 2018).

All the same, FAO (2017) points that achieving sustainable Bioeconomy development faces many challenges especially how to address the interrelated concerns of ensuring food security, addressing climate change, managing natural resources in a sustainable way and managing competition between different uses of biomass feedstocks and crucially guaranteeing that Bioeconomy development benefits everybody. Bioeconomy activities are also not necessarily sustainable and thus the development of an economy that is based on biological resources faces several trade-offs. (FAO 2019). It is, therefore, key to have a deep understanding of the drivers and associated trends behind the shift to Bioeconomy to appreciate potential impacts and also potential policy levers in shaping the development of the sector. This paper seeks to explore this through a review of literature and also through a futures exercise involving key stakeholders in the region. Section II looks at the trends and driver of shift towards Bioeconomy, section III explores potential Bioeconomy futures, section IV simulates Bioeconomy futures to assess potential economic impact of various scenarios, section v concludes.

II. TRENDS AND DRIVERS OF SHIFT TOWARDS BIOECONOMY

As pointed above, concern for sustainability of current economic model has given impetus for search of new economic models. However, trends seen are usually the result of deeper drivers. Thus concerns could be about ability to sustain current consumption in face or rising population or the impact of consumption on environment. Even without concern for sustainability rising population is creating pressure for jobs thus forcing policy makers to think of new economic bases that can provide jobs. A trend may be due to more than one driver. To get an understanding, we will explore the key megatrends their impacts and see how they inform the trends observed.

II.I MEGATREND I: HIGH AND SUSTAINED ECONOMIC GROWTH

Africa's economies have been growing faster than other parts of the world. The growth is being driven by both demand for commodities and ongoing economic transformation and inflow in investments due to good returns:

- Six of the world's 12 fastest-growing countries are in Africa (Ethiopia, Democratic Republic of the Congo, Côte d'Ivoire, Mozambique, Tanzania, and Rwanda). Further, between 2018 and 2023, Africa's growth prospects will be among the highest in the world, according to the IMF (Odusola, 2018).
- A report by the UN Conference on Trade and Development states that between 2006 and 2011, Africa had the highest rate of return on inflows of Foreign Direct Investment: 11.4%. This is compared to 9.1% in Asia, 8.9% in Latin America and the Caribbean (Odusola, 2018).

[6] http://www.fao.org/energy/bioeconomy/en/

Sustained growth will have a profound effect in aggregate demand as incomes rise. Most profound impact will be the rise of the middle class as a result (see below).

II.II MEGATREND II: DEMOGRAPHICS

Demand for goods and services is a function of population as whole, the urban populations and incomes distribution among the population. These key trends of relevance to Bioeconomy are:

- Population growth: The world's population is expected to grow to almost 10 billion by 2050. Rising population in will mean higher demand on agriculture. By 2050 it is estimated to lead to a 70% increase in food demand. Note that Africa is the region where its population is set to show most growth and is expected to reach more than 2.2 billion by 2050 with countries located in Central and Eastern Africa will show the greatest rates of growth[7]. The huge population growth has raised concerns. FAO (2017) warns that based on current trends, if these countries were to rely exclusively on domestic production for their food supply, they could be confronted with a neo-Malthusian future, unless agricultural productivity dramatically improves.
- Rising Urban population: Africa's urban population is the fastest growing globally. In less than 20 years, every second person in Africa is likely to live in a town or a city, and by 2030 Africa will host six of the world's 41 megacities[8]. Urbanization impacts food consumption patterns. Higher urban income tends to increase demand for processed foods, as well as animal-source food, fruits and vegetables, as part of a broad dietary transition. Higher urban wages also tend to increase the opportunity costs of preparing food and favour food products that have a large amount of labour embedded in them, such as fast food, store-bought convenience foods and foods prepared and marketed by street vendors. With these changes, the nutrient content of diets is changing. Typically, diets are becoming higher in salt, fat and sugar and are, in general, more energy-dense (FAO 2017).
- Rising Middle Class*:* The combination of a rising income and a growing population has also seen a fast-growing middle class. The African Development Bank notes that by 2010, the middle class rose to 35 percent of Africa's population, up from 27 per cent in 1980[9]. Modelling the growth of middle class, Tschirley et al (2015) project that by 2040, the middle class in East and Southern Africa will rise to nearly three-quarters of the population. Middle class rise has significant implications on consumption. The rise will hasten dietary transition towards higher consumption of meat, fruits and vegetables adding pressure on natural resources (FAO 2017). Increased demand for value-added food products from the processing sector (Reardon *et al*., 2013) The higher incomes also lead to greater demand for durable goods and housing putting pressure on biodiversity through increased demand for timber (for building and furniture) and

[7] with annual growth rates of more than 2.5 percent to 2050 projected for Angola, Burundi, Chad, the Democratic Republic of the Congo, Gambia, Malawi, Mali, Senegal, Somalia, the United Republic of Tanzania, Uganda and Zambia. The combined population of these countries will nearly double by 2050 (FAO 2017)

[8] Cairo, Lagos, Kinshasa, Johannesburg, Luanda and Dar es Salaam will have more than 10 million inhabitants each

[9] They use a broad definition of $2–20 a day in purchasing power parity (PPP) terms and divide the class into three sub-classes: (1) 60 per cent in the 'vulnerable middle', at $2–4/day, just out of poverty and with the potential to slip back; (2) the rest of the middle class is divided into the 'lower middle' class, with $4–10 a day; and (3) an 'upper middle' class, with per capita consumption of $10–20 a day

also demand for minerals and other materials who production has impact on biodiversity e.g. mining.

- Rising Youth Bulge*:* Rapid population growth has also seen a huge growth youth population. However, of Africa's nearly 420 million youth, ages 15–35, a third are unemployed, another third are in vulnerable employment, and only one in six is in wage employment (AfDB 2016). Creating jobs for these young people is now a top policy agenda.

II.II.I IMPACTS

The changes in demographics are having profound impact on agriculture with significant implication on land and new trends are being observed that have relevance to Bioeconomy capacity.

II.II.I.I RISING INTEREST IN INVESTMENT IN AGRICULTURE

Population rise is creating demand for food and especially well processed foods leading to significant flows of investment in agricultural value chains. This is attracting investment and changing the agricultural landscape.

While Africa is characterized by small holder farmers, this landscape is rapidly changing driven by two developments:

- Rise of domestic investor farmer: Jayne et al (2016) find that urban based middle class are buying up land and, in some countries, the middle class already control a significant amount of farmland with almost a quarter of farmland owned by urban households in Kenya, Zambia, Ghana and Tanzania. Between 2002 and 2010 the share rose from 12% to 33%. This development is seeing rapid expansion of medium scale farms (5–100 hectares). The proportions of medium scale farms are 31.8% in Ghana, 19.0% in Kenya, 39.0% in Tanzania, and 52.9% in Zambia
- International demand**:** The international demand for arable land globally is being fueled by two drivers. International investors are also seeing an opportunity through high profit in farming and also through speculation for future price rises (Collier and Dercon, 2014)[10]. On the one hand some countries are wary of depending on global food markets that are volatile for food security and are thus keen to secure future food security by acquiring land with intention for producing food for their needs[11]. This has thus seen scramble for arable land globally and in Africa.

[10] Other important drivers include: (i) the push for biofuels e.g. the EU 2020 mandates); (ii) the commodification of resources, including carbon and biodiversity, in response to the environmental and climate crises; (iii) FDIs fueled by the development of infrastructure corridors and economic zones as sites for investment and extraction e.g. SAGCOT corridor in Tanzania; (iv) the creation of new financial instruments to channel investment, enhancing speculative behavior; and (v) global development narratives that emphasise the role of private, foreign investment.

[11] The 2008 food price spike and ensuing crisis was the key trigger. Deininger, et al (2011) points that compared to an average annual expansion of global agricultural land of less than 4 million hectares before 2008, approximately 56 million hectares worth of large-scale farmland deals were announced even before the end of 2009 with more than 70 percent of such demand has been in Africa Though Deiniger et al (2011) point that at the time only 21% of announced deals had started. Plans were scaled back due to a variety of reasons including unrealistic objectives, price changes, and inadequate infrastructure, technology, and institutions.

II.II.I.II LAND DEGRADATION

The increasing demand for food and pasture has put pressure of land. This has seen increased and unsustainable intensification of farming. Jayne *et al.* (2016) points that as long as global and local food prices remain favourable, and with continued development of agricultural value chains and rapid population growth in the region, both domestic and international investors may continue to put upward pressure on the demand for, and price of, farmland in many parts of Africa. This is going to happen in the context of rapidly growing rural population. Already evidence land is becoming an increasingly constraining factor of production for a sizeable and growing proportion of Kenya's rural population leading to intensification and also lower incomes[12]. Lower incomes may impede smallholder ability to invest in inputs leading to soil mining and subsequent soil degradation

Already many soils are now degraded and in dire need of rehabilitation. Figure 3 shows the level of degradation in Africa.

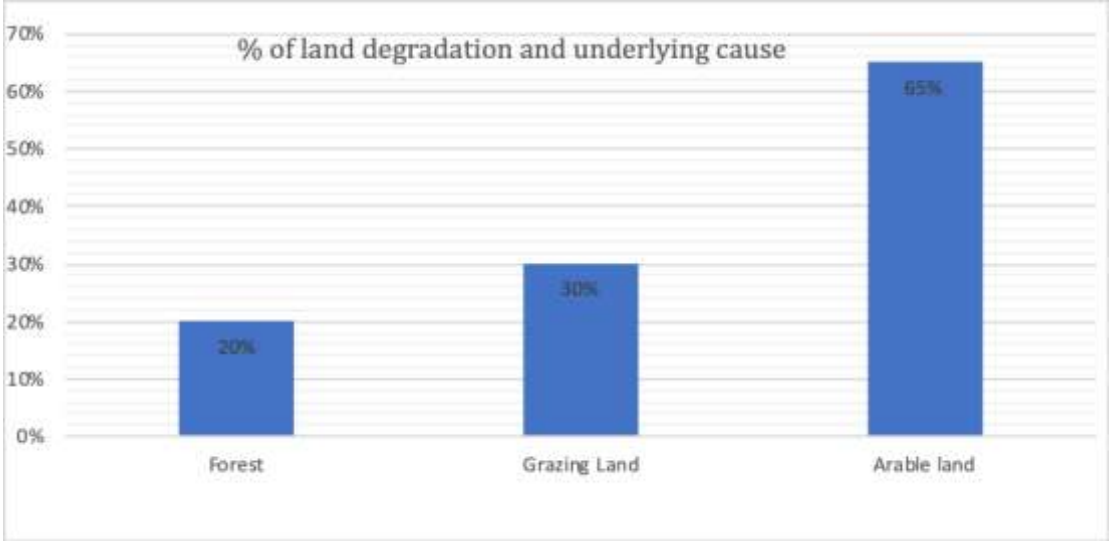

Figure 2: Land degradation
Source: Heady and Jayne (2014)

According to Alexandratos and Bruinsma (2012) there is an emergence of growing scarcities of natural resources for agriculture as we approach 2050. The overexploitation of natural resource (land, air, water, mineral, oceans, forests) and their attendant unsustainable use, will lead to degradation of the environment thus creating a destructive feedback loop between resource degradation and escalating exploitation. In terms of impact, there will be far reaching effect on millions of farmers, foresters, pastoralists and fisher folk.

URGENCY TO CREATE JOBS

The huge and rising youth population has put significant pressure to create jobs. Agriculture, the key employer, cannot provide decent jobs to these people. There is a realization that jobs will come from transforming economies (ACET 2014).

[12] An increase in population density by 100 persons/km2 reduces household's mean income directly by 4% and indirectly by 3% through the influence of population density on factor prices and landholdings

II.III MEGATREND III: GROWING INTERNATIONAL ACTIONS ON CLIMATE CHANGE AND BIODIVERSITY LOSS

Though sustainability movement has a long history, there is now a much greater focus on the issue due to two key developments: (ii) ongoing climate change; (ii) biodiversity threats (massive species extinction).

II.III.I CLIMATE CHANGE

There is now consensus that GHG emissions caused by human activities are resulting in climate change and with deleterious consequences. African ecosystems are already being affected by climate change, and future impacts are expected to be substantial Africa's food production systems are among the world's most vulnerable because of extensive reliance on rainfed crop production[13], high intra- and inter-seasonal climate variability, recurrent droughts and floods that affect both crops and livestock, and persistent poverty that limits the capacity to adapt (Boko *et al.*, 2007). It is projected that climate change will interact with non-climate drivers and stressors to exacerbate vulnerability of agricultural systems, particularly in semi-arid areas (IPCC 2018).

Concern for climate change has seen efforts to reduce GHGs emission coupled with efforts to mitigate the impacts as well as adapt. The Paris Accord (CoP 21) is the latest iteration of the global framework. The Paris Agreement's central aim is to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2 degrees Celsius. Additionally, the Agreement aims to strengthen the ability of countries to deal with the impacts of climate change. To reach these ambitious goals, appropriate financial flows, a new technology framework and an enhanced capacity building framework will be put in place, thus supporting action by developing countries and the most vulnerable countries, in line with their own national objectives (UNFCC, online). The need to respond to climate change is seeing behavioral changes and spurring innovation that are fundamentally changing the economies

Shift to bio-based products is of a high importance when it comes to addressing climate change. The two key pathways are: (i) bio-based products and (ii) biofuels. The big advantage of the Bioeconomy is that it can contribute through:

- Reduction: Most bio-based products show a lower GHG footprint compared to fossil products. GHG savings for bio-based products show huge savings with saving going as high as 130% improvement (Carey, 2017)
- Sequestration: Bio-based products sequester CO_2 during lifetime
- Climate change adaptation: Higher diversity in applications increases security, stability and resilience of farmers. Production of bio-based products can create non-farm employment and drive rural transformation

II.III.II BIODIVERSITY LOSS

The degradation of the Earth's land surface through human activities is pushing the planet towards what is now being described as the sixth mass species extinction (Ceballos, 2015). UN Environment (2019) pointed out that this costs more than 10 per cent of the annual global gross product in loss of biodiversity. Unfortunately, ecosystem services are negatively impacting the well-being of at least 3.2 billion people. The main direct drivers of land degradation and associated biodiversity loss are expansion of crop and grazing lands into native vegetation, unsustainable agricultural and forestry

[13] Increasing temperatures and changes in precipitation are highly likely to reduce productivity of cereal crops and high value perennial crops adversely affecting food security (Schlenker and Lobell, 2010; Sultan et al., 2013)By 2080 across Africa, as climate change progresses, cereal output potential could fall by 16%–27% on average and by up to 60% in some countries.

practices, climate change, and in specific areas, urban expansion, infrastructure development and the extractive industry

Combating land degradation and restoring degraded land is now seen an urgent priority to protect the biodiversity and ecosystem services vital to all life on Earth. Some actions being taken to mitigate this includes:

- Convention on Biodiversity: The Convention on Biodiversity is perhaps the most well-known global attempt to stem biodiversity loss[14]. The Aicihi Targets (2010) on biodiversity committed the treaty's 196 signatories: to a 20-point program to protect biodiversity. Among other target it seeks that by 2020, the rate of loss of all natural habitats, including forests, is at least halved and areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity[15] xxx
- The recently announced UN Decade of Ecosystem Restoration 2021-2030, led by UN Environment and the Food and Agriculture Organization of the United Nations, will drive more coherent action restoration on farmland, forests, rivers, lakes and seas globally,"

II.III.III IMPACT

The call for action to curb climate change and biodiversity loss and the international commitments made therefore has had two important impacts relevant to Bioeconomy. First it has galvanized political will to act and indeed countries have developed strategies in line with their commitments, secondly this has seen release of significant resource that can be leveraged for investment in developing the Bioeconomy sector (both in conservation of biodiversity and also in production of products). Some examples include:

- The Global Environmental Fund (GEF): GEF funds are available to developing countries and countries with economies in transition to meet the objectives of the international environmental conventions and agreements. GEF support country priorities that are ultimately aimed at tackling the drivers of environmental degradation in an integrated fashion. For this reason, the focal areas (Biodiversity, Climate Change Mitigation, Land Degradation, International Waters and Chemicals and Waste). GEF support is provided to government agencies, civil society organizations, private sector companies, research institutions[16].
- The Green Climate Fund (GCF): GCF was set up by the 194 countries who are parties to the United Nations Framework Convention on Climate Change (UNFCCC) in 2010, as part of the Convention's financial mechanism GCF helps developing countries limit or reduce their greenhouse gas (GHG) emissions and adapt to climate change. It seeks to promote a paradigm shift to low-emission and climate-resilient development. GCF seeks to use public investment to stimulate private finance thus unlocking the power of climate-friendly investment.

[14] Several international conventions focus on biodiversity issues: the Convention on Biological Diversity (year of entry into force: 1993), the Convention on Conservation of Migratory Species, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (1975), the International Treaty on Plant Genetic Resources for Food and Agriculture (2004), the Ramsar Convention on Wetlands (1971), the World Heritage Convention (1972) and the International Plant Protection Convention (1952), the International Whaling Commission (1946). https://www.cbd.int/brc/

[15] See the rest of the targets here https://www.cbd.int/sp/targets/?

[16] The status of grant funding is as follows: Kenya $114.7 M, Ethiopia $120.79M, S. Sudan $26.73M, Uganda 119.64M, Rwanda $72.98M, Burundi, $40.19M, Tanzania, $129.51 M (see https://www.thegef.org/country. Also see http://www.thegef.org/about/funding)

Therefore, GCF seeks to catalyze funds, multiplying the effect of its initial financing by opening markets to new investments.

- The Clean Development Mechanism (CDM): Defined in Article 12 of the Protocol, allows a country with an emission-reduction or emission-limitation commitment under the Kyoto Protocol to implement an emission-reduction project in developing countries. Such projects can earn saleable certified emission reduction (CER) credits, each equivalent to one ton of CO2, which can be counted towards meeting Kyoto targets.[17]
- Catalysing and Attracting FDI to address emerging markets: For example EU2020 mandate on fuel has created huge market for ethanol and thus attracting investment in development of biofuels sector. For example Addax bioenergy was able to secure funds from several European Development Finance Institutions (DFIs) including Swedish Swedfund and Dutch FMO to invest in production of ethanol from sugarcane in Sierra Leone for export to EU as part of efforts to meet the EU 2020 mandate[18].

II.IV MEGATREND IV: CHANGING SOCIETY VALUES ENERGIZING SUSTAINABILITY MOVEMENT

Society values are changing. Consumers are increasingly demanding ever more sustainably produced products and requiring that global supply chains provide these guarantees. The concern for sustainability has been given further energized by rising concerns of climate change and biodiversity loss. This has been given further impetus by the moral power of religious bodies that are calling for concern for sustainability and basing this on theological reasoning, for example the Church of England, National Investment Bodies (NIBs), Climate Change Policy (2015), seeks appropriate action on climate change from the companies in which they invest, and have implemented an investment exclusion relating to the most carbon intensive fossil fuels[19].

III.IV. Increasingly Accommodating Political Economy

The economics of Bioeconomy is partly driven by technological development and also by policy support. Policies currently allow many producers to socialize cost of production especially pollution cost. So bioplastics have potential to displace fossil fuel based plastics, however, the market environment remains challenging with low crude oil prices which makes conventional plastics competitive as cost of plastic pollution is not factor is not factored in price of plastics. Chinthapalli et

[17] Operational since the beginning of 2006, the mechanism has already registered more than 1,650 projects and is anticipated to produce CERs amounting to more than 2.9 billion tonnes of CO2 equivalent in the first commitment period of the Kyoto Protocol, 2008–2012 https://unfccc.int/process-and-meetings/the-kyoto-protocol/mechanisms-under-the-kyoto-protocol/the-clean-development-mechanism. CDM projects are present in only four sub-Saharan countries: South Africa, Nigeria, Kenya and Uganda (https://www.ke.undp.org/content/kenya/en/home/operations/projects/environment_and_energy/regional_CDM.html)

[18] Though this project has not lived to its expectations, it is still a demonstration of how climate change mandates are fueling investment. For more on Addax bioenergy project see https://swedwatch.org/en/regions/africa-south-of-the-sahara/sierra-leone-bioenergy-project-poses-new-challenges-communities/

[19]This policy has been extended under a new investment policy for the extractive sector that aims to address are responsibility, corporate governance, and five broad areas under which there are 'ethical risks': human rights; social concerns; health and safety; corruption and taxation; environment and ecology. The policy call for disinvestment from and exclusion of companies that are unresponsive to this concerns

https://gallery.mailchimp.com/50eac70851c7245ce1ce00c45/files/3de6701c-8404-4429-88f0-a01776e6ba8f/Extractive_Industries_Policy_1_.pdf

al (2019) argues that if the sustainability benefits of bio-based polymers were taken into consideration the economics favour bioplastics. There are trends showing shift to this directions. Many countries are phasing out single use plastics especially used for shopping. In East Africa Kenya, Rwanda and Tanzania have already done this. Canada plans to ban single use plastics by 2021[20] and other big economies are following suit[21.] Beyond bans, economics can also be improved by incentives. For example, Chinthapalli et al (2019) argues that if bio-based polymers were to be accepted as a solution and promoted in a similar way as biofuels, annual growth rates of 10 to 20% could be expected.

Beyond piecemeal policies to tackle issues of sustainability, there is now a growing agreement that the current model of growth cannot be supported by materials available in the longer run (SFC 2013). This is especially urgent as many countries are rapidly growing putting pressure on resources. This is seeing a push towards a less resource intensive growth paths or the green economy[22.]

The combination of public pressure, the need to respond to real threats posed by climate change and realization by policy makers of opportunities of pursuing a less resource intensive economies is seeing greater support a sustainable development agenda. The promulgation of sustainable development goals (SDGs) is the culmination of this shift

III.IV. II Fast Growing Market for sustainably produced goods and services

The shift in consumer sentiment has created market for goods that can meet sustainability criteria and these consumers are willing to pay a premium. A survey found 66% of global consumers and 73% of global millennials are willing to pay extra for sustainable offering[23] and indeed committing to sustainability is paying off, the survey also found that sales of consumer goods from brands with a demonstrated commitment to sustainability have grown 4 times faster (Nielsen, 2015).

This has also seen the re-arrangement of global supply chains as firms seek to source sustainably. Thus, actors at different positions of the supply chain are starting to request information about the extent to which sustainability is assured. This is creating demand for standard setting platforms, whereby compliance can be verified by the business itself or by third parties. WEF (2015) points that between 2011 and 2013, the number of commodity companies reporting proactively on sustainability strategy and criteria has increased by almost 58%. This is further spurring the market for sustainable goods by helping develop brands and trust systems.

III.IV. III Emergence of Green financing/investments

The shift in society sentiment has seen the emergence of sustainability/green investment funds. People now care where their money is invested. Investment funds focused on business that meet sustainability criteria have increased significantly and sustainability is becoming an essential

[20] https://www.cnn.com/2019/06/10/americas/canada-single-use-plastics-intl-hnk/index.html

[21] California became the first state in the USA to ban on single-use plastic bags through a referendum in the November 2016 election and other states are following suit New York bans take effect in May 2020. Cities that have banned plastic bags include New York, Chicago, Seatlle, Los Angeles, Boston, San Franciso. Reducing bag use can mitigate harmful impacts to oceans, rivers, lakes, forests and the wildlife that inhabit them. It can also relieve pressure on landfills and waste management http://www.ncsl.org/research/environment-and-natural-resources/plastic-bag-legislation.aspx

[22] Green growth provides for the incorporation of the environment and natural resources into the national accounts to ensure that prices and economic growth metrics reflect the corresponding effect of production processes on the environment.

[23] Survey found that it is generally harder to influence consumers in developed markets to pay more. Consumers in Latin America, Asia, Middle East, and Africa are 23%-29% more willing to pay a premium for sustainable offerings.

investment criterion. These types of investments accounted for $3.74 trillion in total assets under management at the end of 2011 (Macpherson and Ulrich 2017). Many market players have started using sustainable, responsible and impact-based strategies for investing in assets. For example, PFZW, the Dutch giant healthcare pension fund, has announced that it intends to quadruple its sustainable investments to a value of $16 billion before 2020 (WEF 2015). Over the past decade, green bonds[24] have emerged.

Macpherson and Ulrich (2017) point that Green finance will likely be supported across the investment value chain and bolstered by the Paris Agreement in 2016. Further the SDGs, which have become a framework for environmental and social investment themes (will gain momentum, especially among millennial, value, and impact investors.

II.V MEGATREND V: TECHNOLOGICAL AND BUSINESS MODEL INNOVATIONS

The desire for sustainable development and emerging political will and investments are good for emergence of a Bioeconomy sector and has created a window of opportunity. However, the true emergence will come from dislodging entrenched sectors e.g. plastics. Innovation in products and business model will play a key part in tilting the balance towards a bio-economy driven sector.

As pointed, a rapid progress in the life sciences as well as in key enabling and converging technologies are central engines of Bioeconomy development (EU 2012). There is much research happening now and showing good promise. A case in point is Finland and its attempt to develop a bio-based economy. Through research and innovation it is building a strong Bioeconomy sector. Some of the innovations coming out include:

- Making textile from wood to replace cotton based textiles
- Making bio-plastics from wood products
- Renewable diesel and petrol from wood residues
- Developing timber products than can be used for a much wider applications including multi-storey buildings.

Strengthening the role of businesses as a driver of Bioeconomy is key. In many countries, small and medium-sized enterprises are key drivers of biobased innovation (MEAE, 2017). More crucially, Bioeconomy will benefit from a vibrant start-up environment which fosters innovation and the introduction of new bio-based products.

Box 2: Accelerating Youth Innovation

Greenpreneurs is a twelve-week global green entrepreneurship accelerator and competition open to youth between the ages of 17 and 35. Youth may submit their idea for a solution that positively impacts the future of sustainable energy; water and sanitation; sustainable landscapes (forestry and agriculture); or green city development.

These priority themes reflect the urgent issues impeding growth in developing countries in the context of green growth, climate change, and Sustainable Development Goals (SDGs). Its intentional

[24] According to the Climate Bonds Initiative, the total amount of green-labeled bond issuances amounted to USD 42.2 billion at the end of 2015. It then doubled to USD 86.1 billion at the end of 2016, supported by large-scale issuances from China

broadness is expected to ensure maximum inclusion of creative and innovative ideas from around the world.

https://gggi.org/global-program/greenpreneurs/

Development in Information and Communication Technologies (ICTs) are also helping. The acceleration of biotechnology is largely aided by new tools emerging from ICT technologies e.g. gene editing tools, 3D printing. Technologies like satellite mapping, as well as better inventories of the status of threatened species and forests and thus make it possible hold governments accountability the Aichi 2010 targets to reduce the rate of biodiversity loss (Esterman, 2018).

II.VI MEGATREND VI: THE QUEST FOR ECONOMIC TRANSFORMATION

Though African economies have shown rapid growth since the turn of the millennium, this growth has yet to translate to transformation and create jobs. Economies remain undiversified largely relying on commodities production and exports, the result is that few jobs have been created and unemployment and especially youth unemployment is now one of the biggest challenges facing Africa. Transforming economies so that they can create jobs is now a key development agenda and transformation strategies have been proposed (see ACET 2014)). A transformation pathways proposed is upgrading of agriculture. This is indeed a quick win for many economies as agriculture is the base of many of the economies contributing between 30-70% of the GDP. At the same time the sector is highly underdeveloped and thus unable to respond to emerging urban markets. Significant opportunities therefore existing in upgrading agricultural value chains and thus adding value to agriculture and more crucially creating jobs along the upgraded value chains.

This has seen refocusing of energies and resources to agriculture. The Comprehensive Africa Agriculture Development Programme (CAADP)[25] is the testimony to this. CAADP prescribes a rapid six percent agricultural growth rate, a minimum ten percent of government expenditure on agriculture, and agricultural driven growth (AU-NEPAD 2014). Using CAADP as the key input, country development strategies have put agriculture at the centre as can be seen in many vision documents of African countries. CAADP has also helped engender positive paradigm shifts as it has significantly raised the political profile of agriculture in the continent and promoted greater participation of multiple state and non-state actors in agricultural policy dialogues and strategy development. Increasingly, donors are following CAADP's lead on issues the process has identified and are working through the program rather than setting up parallel initiatives. For instance, in order to be eligible for support from the Global Agriculture and Food Security Program (GAFSP), a country must sign a CAADP compact (Kimenyi *et al.* 2012).

II.VI.I POTENTIAL IMPACT

While agriculture driven transformation make the best case for thinking about transformation in Africa, this is a narrow approach. A much broader thinking that looks at bio-economy as the transformation pathway is needed. The economic transformation potential of a Bioeconomy is huge.

[25] At the Second Ordinary Session of the Assembly of the African Union held in July 2003 in Maputo, Mozambique, the heads of state and government launched the Comprehensive Africa Agriculture Development Programme (CAADP). This agriculture-led integrated framework of development priorities in Africa is aimed at reducing poverty and increasing food security in the continent (AU-NEPAD 2003). Principles underpinning CAADP include, African ownership and leadership, accountability and transparency, inclusiveness, and evidence-based planning and decision making, among others.

It promises to introduce new chemicals, building-blocks and polymers with new functionalities; to develop new process technologies such as industrial biotechnology and launch new sectors in energy, chemicals, health/pharmaceuticals, building materials. It can bring new business opportunities, investment and employment to rural areas (Cares 2017). The value unlocked is huge, for example, the processing of sugarcane to produce bioplastics creates almost 10-times value added benefits. More crucially bio-economy can complement agro processing as it can be based on waste from agro processing (Chaisu, 2016, see box 2 on Thailand). With the added benefits of boosting tourism and other sector that depend on ecosystems services.

The renewed focus on agricultural driven transformation means that more resources available for research and business development. The ground is fertile to expand the agenda to this much broader thinking of a bio-economy driven transformation.

Box 2: Thailand; From Agriculture Powerhouse to Bioeconomy Powerhouse

Thailand is one of the most successful agricultural countries in the world. It is the biggest exporter of cassava (60% market share), the second biggest exporter of sugar and rice. The export value of the agricultural raw material is approximately USD 20 billion. Thailand is transforming itself into an advanced, knowledge-based economy and is moving its manufacturing products up the value chain. It is seeking to leverage in already developed agro processing base to transition to be a leader in Bioeconomy. It has established the Biodiversity-Based Economy Development Office (BEDO) to support and promote the bio-based economy. A primary focus of Thailand Bioeconomy strategy is to become Asia's "Bio Hub". Some of the accomplishments include

Thailand has the first PBS* plant in the world with capacity of 20,000 tons/year. In 2018, the second largest PLA plant will start operations in Thailand.

Thailand is the world's major lactic acid producer with capacity of 330,000 tons/year.

Thailand is also at the forefront of innovation. A potential new raw materials for bioplastic being explored is utilizing waste product as feedstock e.g. waste from the rice milling processes[26] PTT MCC Biochem, has developed bio-based polybutylenesuccinate (BioPBS), a breakthrough compostable plastic material derived from corn, cassava, and sugarcane. PTT, has also made significant investments in research by backing Thailand's first-ever medical-focused bioplastics lab at Chiang Mai University last year

Bio energy is also an active area of investments[27].

Beyond a strong agricultural base, the success of Thailand is mainly due to:

- Leveraging existing industrial infrastructure of plastic manufacturing. Thailand has more than 3,000 local plastics converters

[26] Approximately 34 % of 1,000 kilogram of rice including rice bran and rice hull. Ministry of Industry and Plastic Institute of Thailand has studied biodegradable plastic produced from rice waste called "Rice Resin Project".

[27] Singapore and Irish-backed *Asia Biogas* now converts palm oil by-products into renewable biogas for power generation. Japanese fiber expert Toray is building a new plant that is expected to produce bio-ethanol using half as much energy as current standard.

- Strong research systems that includes various government research institutes and research Centre in universities
- An industrial policy with strong support for research and also investment incentives.[28]
- Market development incentives. The government is subsidizing bioethanol-blended gasoline as part of a policy to promote the use of plant-derived fuels and reduce oil imports.

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II.VII MEGATREND VII: THE INCREASING DISPERSAL/DECENTRALIZATION OF POWER/GOVERNANCE

There is a growing realization that many of the challenges facing humanity can be effectively handled through national governance structures. So over the years two trends have emerged, the rise of global governance structures on one hand and strengthening of grassroots governance. This is especially true in case of issues concerned with environment where local people bear the brunt of impacts and thus have clamoured for greater say in the governance and also where resources have an impacts cross boundaries e.g. rivers and GHG emissions. Power of national government is increasingly being dissipated and dispersed downwards to local level and upwards to international bodies.

II.VII.I IMPACT

The governance structure can make it easier to implement bio-economy strategies as local governments can take greater initiatives. Indeed the Green Climate Finance facility can provide finance to local governments. Given the diversity in natural resource endowments potential for bio-economy can differ greatly across a country and thus power to do something at local level can be more effective than national level **strategies**

II.VIII MEGATREND VIII: THE EMERGENCE OF A GLOBAL BIO-ECONOMY SECTOR

While climate change has been the major driver of shift towards a Bioeconomy, the larger transformation potential seems to be driving the shift now. This is now one of the fastest growing sectors, for example consumption of bioplastics has increased more than 600% in the past decades and is expected to have a market share of 40% in 2030 as petro-chemical based plastics are phased out (BOI nd). The power to drive transformation has been appreciated and many developed countries are creating bio-economy strategies. Globally, more than forty countries have integrated Bioeconomy in their policy strategies. Among others, the G7 and the BRICS countries have launched comprehensive initiatives fostering the advancement of a Bioeconomy (GBS 2015).

II.VIII.I IMPACT

[28] For example the Manufacture of eco-friendly chemicals or polymers get 8years corporate tax break and exemption from import duties

This has implications for the region. As these countries invest further in Bioeconomy, innovations are going to be speeded up creating new knowledge that can diffuse and accelerate the sector. In a globalized world, it can also mean that countries that develop strong Bioeconomy sector can quickly insert themselves in global bio-economy value chains that are emerging. For instance, Thailand is now one of the biggest producers of bio-plastics.

However, it might not be rosy for farmers in developing regions that depend on agriculture exports. As technologies to exploits biomass waste get developed, old sources of raw materials maybe discarded. For example,

- In the EU region is the shift to locally sourced rubber from dandelion instead of tropical rubber trees (Cares 2017).
- Finland has made significant progress in producing textiles from wood thus creating competition for cotton. This has implication for countries like Tanzania which export cotton

Thus, in areas like agriculture where Africa has been unable to compete and imports dominate the lucrative urban markets, global developments in bio-economy can also see these new sector being taken over. The key competitive advantage in building a competitive bio-economy is not land or agro-ecological endowment but innovation capacity.

II.IX SYNTHESIS POTENTIAL IMPACTS

The rise of a strong Bioeconomy sector will critically depend on having conducive policy that support sustainable investment and sustainable consumption. Beyond conducive policies market development will be key in attracting needed investments which will in turn rely on research and innovation to develop products that can satisfy demand.

The megatrends described above which are largely outside the control of any one government in Eastern Africa, are setting in motion a number of trends that are interacting in various ways. When taken together the drivers and the trends resulting that are either pointing to emergence of a strong or a weak Bioeconomy sector. This is summarized in figure 3.

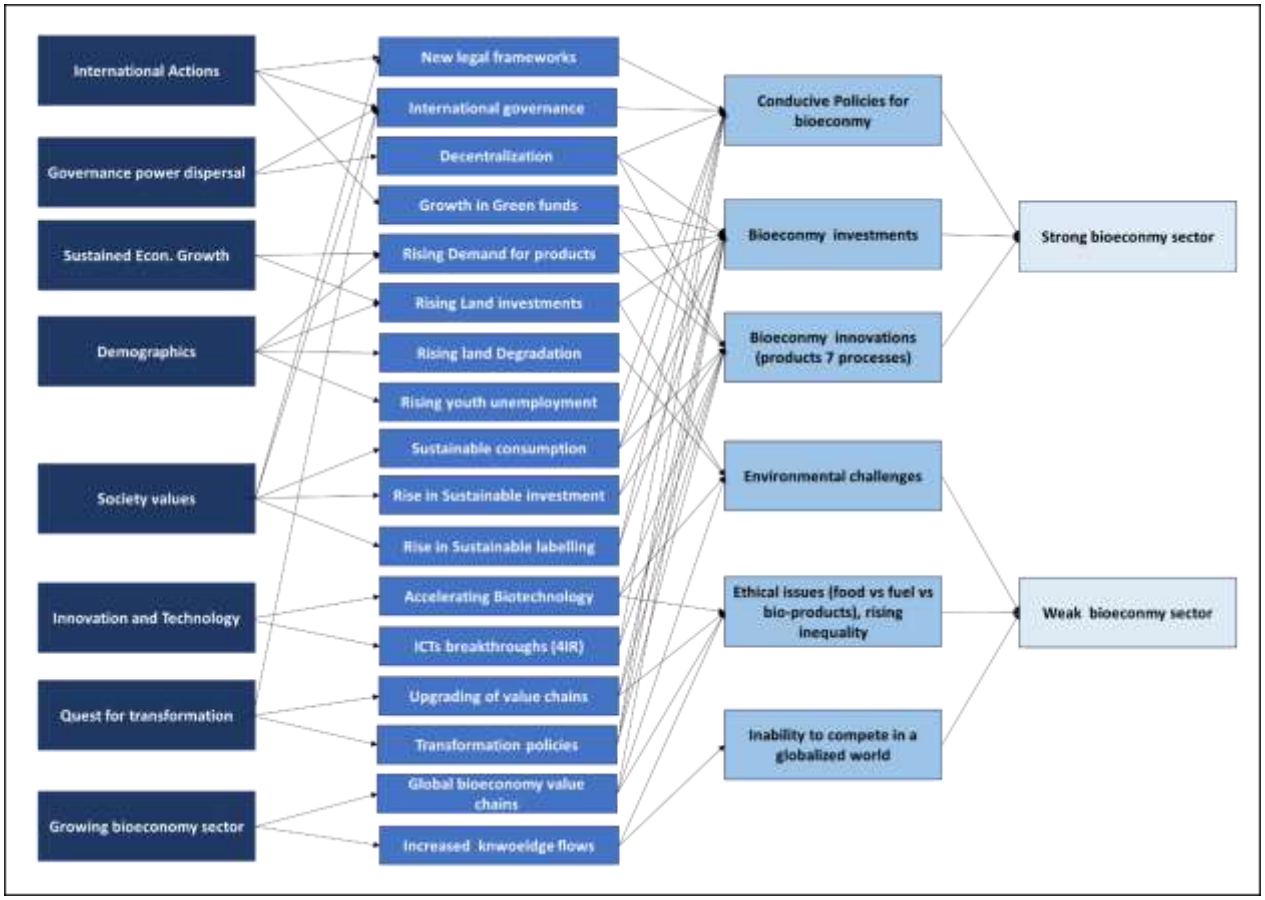

Figure 3: Bioeconomy, Bioeconomy - Drivers, Trends and Impact
Source: Authors' construct

The trend towards a conducive environment for emergence of strong Bioeconomy sector is supported by:

- Emerging policy frameworks: The rise of international legal frameworks, international governance bodies, strengthened local governments, and new desire for transformative policies is creating a conducive environment for developing supporting policies for emergence of a strong Bioeconomy.
- Investments Funds: Green finance funds, rise of sustainability investment are creating funds that investors can draw upon. The emergence of market for sustainable goods and institutions for certifications (that are key to development of the markets) in inspiring businesses (both start-ups and also existing) to enter into the markets. Not that certification systems can be the basis for setting up legal standards for sustainable goods further boosting the markets
- Innovation: Innovation of Bioeconomy products and process is also being supported by advance in research biotechnology and ICTs and in particular the emerging technologies that are heralding the 4th Industrial Revolution (4IR). Market demand is also driving innovations as business and start-ups see new opportunity.

At the same time the emerging trends are also raising challenges that do not portend well for a strong Bioeconomy sector. These include:

- Environmental degradation: The potential for increased environmental challenges (for example a successful forest based textile sector can mean increased deforestation)
- Ethical issues: competition for land between food and other uses and also issues of inequality as value chains are upgraded and new value captured by those most able.
- Losing out in globalized value chains: In the globalized economy the winners in the emerging Bioeconomy sectors are those best able to innovate in products and business model.

II.X LOOKING AHEAD

The Bioeconomy cross-cutting nature offers a unique opportunity to comprehensively address inter-connected societal challenges such as food security, natural resource scarcity, fossil resource dependence and climate change, while achieving sustainable production particularly in agriculture (and forestry), food processing, bioenergy, healthcare, biotechnology and green chemistry. Bioeconomy can create decent job and drive rural transformation. However, establishing a Bioeconomy sector will require among other things:

- Provide knowledge-base for sustainable intensification of primary production;
- Improve understanding of biomass/biowaste availability and demand
- Promote the setting up of networks for integrated and diversified biorefineries
- Establish a PPP for bio-based industries;
- Support expansion of new markets;
- Facilitate green procurement for bio-based products;
- Develop science-based approaches to inform consumers about product properties

Policy will be key in enabling the shift and there are now international framework upon which Bioeconomy strategies can be built. The climate change agenda, the SDGs Agenda and other related global agreements stress the interdependence of the challenges they are to address. However, FAO (2017) points that achieving policy coherence will be challenging. Also integrating different actions to achieve linked objectives will pose new technical demands on policy-makers, at all levels, as well as new demands on institutional arrangements and coordination at various levels of governance, underscoring the policy challenge (FAO 2017).

Beyond policy, Bioeconomy approach also touches on ethical and social issues. Agricultural land is limited. Government will need to decide how much land is to be set aside for the production of food and feed, fuels and bio based materials. The competition between food and fuel calls for a fundamental assessment of the respective fields of action in ethical terms.

The shift to Bioeconomy has been described as a very large wheel that natural scientists, engineers, economists, ethicists, politicians and others are starting to turn. A wheel that, understandably, is only slowly gaining momentum. After all, it is a question of creating a whole new raw material basis for industry and the economy. It is about developing a new system in which science, industry and value creation interact in different ways than they did before. More than ever before industry and science will have to act as a system, and previously non-existent connections will be established between different value creation chains (Bächtle, 2013).

III. BIOECONOMY FUTURES FORECASTING

The driver of Bioeconomy discussed point to several futures depending on how the drivers evolved and interact. For example, if the momentum to mitigate greenhouse gases, shift towards a green

economy, and the efforts to achieve the SDGs gathers pace, adequate research funds are created to enable needed innovations and this send signals to private sector to invest, then a strong bio-economy might emerge. However, if rising aggregate demand due to population and emergence of significant middle class see investments made to meet this demand without due consideration to sustainability, a very unsustainable Bioeconomy might emerge. In between pockets of strong Bioeconomy might emerge as significant constituents of consumers concerned about sustainability emerge and create significant niche markets able to sustain continued innovation. How the key drivers and trends will evolve will be key in determining how bio-economies will look like. Policies and actions by other stakeholders will be key in shaping this evolution. Thus, a better understanding of potential futures is key as this can point to policy levers and tools available to stakeholders.

To get a better understanding of potential futures of bio-economy in the region stakeholders from the region were called for a foresight exercise using UNESCO's Futures Literacy Lab (FLL) approach (see appendix). The work sought to:

- Generate a range of probable and preferred futures and also what it would take to achieve the preferred futures.
- Have participants to examine the drivers of bio-economies, their importance in shaping the future and the level of uncertainty regarding the how the driver will evolve
- Generate the enabling conditions needed to arrive at preferred futures

III.I BIOECONOMY FUTURES

The potential bio economies futures were generated by asking participate to take themselves to 2040 and generate potential headlines of newspapers in that period that can capture what they see as the future of Bioeconomy. This essentially captured what the participants felt were the Bioeconomy futures under Business as Usual (BAU) Scenario i.e. probable futures if the trends seen continue. The preferred futures were also explored and this generated potential outcomes of a strong bio economies (see appendix for a description of the FLL methodology). The exercise generated many potential futures. Participants also generated actors and systems that could generate the potential futures.

Examining the futures proposed pointed to the key determinant of the futures as innovation and investment on the one hand and conducive environment for Bioeconomy on the other. The potential futures were then organized along these two axes to generate potential Bioeconomy futures as shown in figure 1. The futures can be categorized as:

Strong Bioeconomy: Where conducive policy for a bio-economy combines with a sustainable innovations and investments. The majority of the futures generated fell in this scenario reflecting that the group and many of them reflected the preferred futures. This can be expected as these were stakeholders who are invested in developing a strong Bioeconomy for the region.

Conflict Riven Bioeconomy: This scenario combines weak bio-economy conducive policies (but strong policies to support free markets) with unsustainable investment generated the second most set of futures. These produce bad outcomes with bio-resources based conflicts as the main feature of the projected futures. Most of these fell under probable futures indicating that the stakeholders are wary of the current trajectory.

Conflicted Bio-economy: This is where conducive policies are combined with unsustainable investments. Therefore, a bio-economy sector emerges but industries emerging are not necessarily sustainable e.g. monoculture indigenous forest. These scenario underscores the challenge of building

sustainable business models. Policies are much easier to put in place getting the right business models is much harder especially given the fact that the landscape is characterized by small firms which are also largely informal.

Out-competed Bio-economy: This scenario where free markets polices and sustainable investment produce a world where products can outcompete biobased products. Though not many scenarios were generate here, the overriding theme was the emergence of the 4th industrial revolution and its potential to generate new products and indeed re-organize how society.

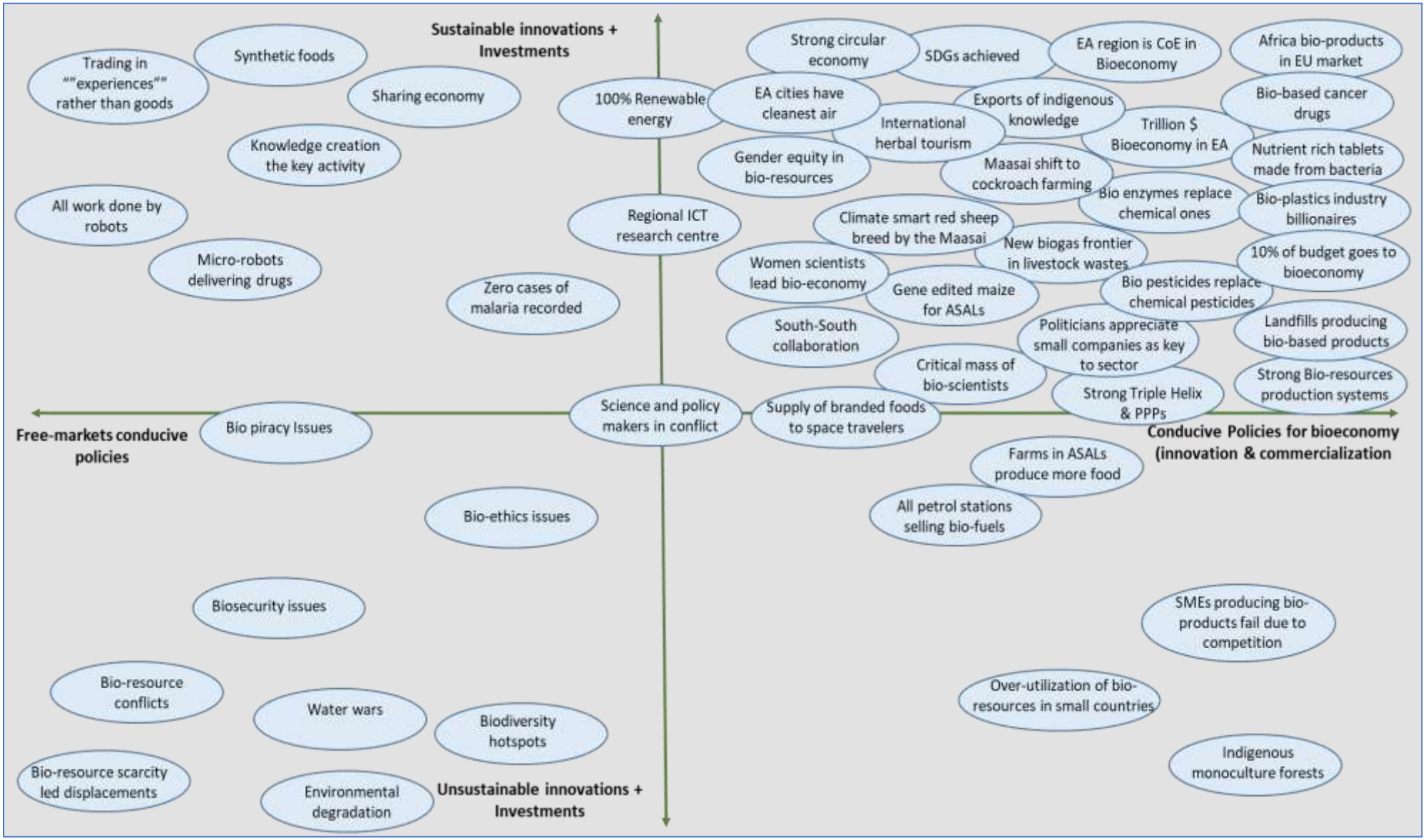

Figure 4: Probable and Preferred Bioeconomy Futures (FLL Lab Outputs)

III.II ENABLING A STRONG BIO-ECONOMY – WHAT WILL IT TAKE?

As pointed there is was a strong expressed for preference of strong bio-economy with the region becoming a centre of excellence (CoE) in bio-economy with a vibrant bio-economy industrial sector producing and exporting a wide range of bio-based products and even exporting knowledge.

The discussion also explored potential pathways beyond the traditional agriculture and agro processing pathways that seems to be that default pathways given the huge role that agriculture plays in the region economies. The outcomes featured very few scenario that were traditional agriculture focused indicating the wider lens of participants. Potential pathways for bio-based economies identified included:

- Agriculture including GMO products e.g. gene edited maize, insect farming
- Chemicals substitutes: Bio-pesticides, Bio-enzymes
- Pharmaceuticals: Medicines derived from herbal remedies
- Tourism including eco-tourism and medical (herbal) tourism
- Construction products including timber

Box 2: Ginette's Ecosystem life.

One of the preferred Bioeconomy scenarios captured many of the elements participants considered to constitute a strong Bioeconomy future. This was a description of the self-sustaining Bioeconomy village/town. The key highlight of this town included:

- A factory that uses biogas from the animal produce. The factory produces repellents, cosmetics.
- Planted trees for soil conservation, climate change, mitigation, medicinal
- Rearing of cows for food security and biogas production.
- Because of the stability, there is more revenue generation and reaches the international level and draws the attention of the international trade partners.
- Modernized industry, gain more knowledge from the international exposure to improve life at the local level including Ginette getting empowerment.
- Improved housing (good green apartments), good packaging of milk,
- Improved infrastructure
- International university for bio-economy knowledge growth.
- A regional campus built

A strong bio-based economy necessarily means that bio-based business are sustainable and profitable. The participants also interrogated the key enablers needed to make this a reality. The enablers are identified were group under four categories: Market Demand; Business Development; Infrastructure; Human Capital; Financing. The key futures under these enablers were discussed and the following emerged

III.II.I MARKET DEMAND

Market demand is a key pre-requisite. A market must exist for there to be a bio-based industry this requires the following:

- There is need for a high preference for bio-based products. The calls for promotion of local bio-based products and also ensuring the availability of the products

- Consumers must have trust in the product. This will require a common understanding of the bio-economy including the standardization of bio-based products and a quality assurance framework to give consumers the needed confidence i.e. a commercialization and functional regulatory system
- Favorable procurement policies by governments e.g. green procurement, etc.

III.II.II BUSINESS DEVELOPMENT

Fulfilling a market hinges on business development. While conducive policies are key to attract needed investment, much more is needed. The following are also key action needed:

- Feasibility studies to understand the needs
- Intellectual property frameworks that allows EA countries to leverage their indigenous knowledge and at the same time being able to tap to knowledge from modern science
- A strong bio-economy ecosystem with all actors (government, researchers, private sector, civil society) fulfilling their required roles so that this leads to the development of products that are viable and marketable,
- Entrepreneurship capacity well developed and Effective incubation services and infrastructure us available
- Production capacity for bio-products is well developed and necessary support systems including supply chains for raw materials
- A strong triple helix network that bring universities, government and private sector together in collaborative arrangement. This will help building trust and shared vision
- Ethical issues surrounding Bioeconomy are resolved and communicated
- Political goodwill and also implementation and enforcement of relevant policies

III.II.III FINANCING

A financing ecosystems that can fund all stages of development of products and viable business is key. This requires:

- Public funds especially for research and development and also start-ups. This can be supported by ring-fenced funding for bio-economy
- Venture capital (especially for scaling viable start-ups),
- Incentives and subsidies (to jump start investment in production)
- Standard financing for on-going business.
- Building public-private partnerships to mobilize resources and share risk

III.II.III HUMAN CAPITAL

Developing requisite skills to generate bio-based products and services is key. The basic foundation is education and especially in bio-sciences. However, beyond the sciences, entrepreneurship skills and also hands-on production skills are also crucial. Having needed skills will require:

- Building know-how of bio-based products is supported by key stakeholders especially Universities and also training in schools on production of bio-based products especially the hands-on skills.
- Bio-based curricula is developed at all levels of education and should include other technologies like robotics. This will require significant reform of the education curricula and

putting in place the infrastructures for teaching Bio-economy including Bioscience and bioinformatics labs.

- Entrepreneurship capacity is developed.
- Students have enthusiasm bio-economy and embrace the career in Bio-economy. For this to happen, bio-based business need to be seen as profitable enough to justify early learning curricula.

III.III TOWARDS A STRONG BIOECONOMY STRATEGY

Beyond the key enablers discussed above a number of issues were also raised that are pertinent to having the desired bio-economy future. This is basically the need to broaden perspective on what bio-economy is and also pay attention to political economy issues and also the issue of inclusiveness.

1) **The need for broadening perspective:** The discussion also pointed to the need to broaden mindsets and perspective so that opportunities are not missed. The fact that agriculture and food security issues dominate the debate in region means that the wider bio-economy might be missed if critical questions are asked. It was pointed that if one carries a hammer then one will only see nails, so there is need to put the agriculture "hammer" down. Some reflection that could help in developing this broader perspective include:
   - Food vs Feed debate can blinker thinking: Is Bioeconomy "about achieving food security or about wealth creation from sustainable comparative advantage? Maybe if feedstock for industry provides better returns for some countries they can specialize and import food from other countries. Comparative advantage should be a key consideration when making choices. Regional specialization in bio-economy should be explored
   - Who are the stakeholders: Currently agriculture and bio-technology sector stakeholders dominate thus limiting perspectives on opportunities. The table need to be expanded and non-traditional stakeholders brought in including herbalists, architects, engineers, business consultants etc.
   - Bioeconomy is at heart a knowledge based economy: Though bio-products are the final outputs the key value addition from traditional products is the knowledge added to them. Thus, knowledge is the key commodity and we should seek to commercialize this too
   - Bioeconomy is not a new concept: Traditional African economies were bio-based. Nature provided building materials, medicines and fuel. The Baganda made clothes from tree barks. Tree resigns were used to manufacture many products including treatment of leather. Smelting of metals to make implements and weapons depended on inputs from nature. Thus, the proposed transition to Bioeconomy is really a "Back to The Future" story thus, traditional knowledge is key.
2) **Political economy matters:** Development of a strong bio-economy will involve coordination of a number if sectors especially agriculture, energy, health and trade and industry and also finance. Supportive policies must be made across these sectors. Development of a Bio-based economy is long term endeavour that will take years to realize. A long term planning horizon is needed and policies stability is key. Policy coherence and consistency (long term commitment) is key. This can be challenges given that democracies mean regime changes and with this new vested interests coming into play. A strong case for bio-economy through compelling narrative is key to ensure policies survive regime changes.
3) **Inclusiveness:** The issue of inclusion was seen as crucial and indeed in the scenario the need for women playing a leading role was emphasis given the already important role they play in

agriculture yet capture little of the benefit that come when agriculture is upgraded. A good regulatory framework also need to pay particular attention inclusiveness

Also in crafting a strategy, there is need for caution and the following advice was given:

- Strategy must have a priority since not all activities can be done at once. Develop ideas around a viable idea to ensure it matures.
- Policy issues may limit some viable ideas.
- The community may not perceive the whole idea which may lead to sabotage. We should know our bio-economy prospects considering the different societal changes.
- The community may be slow to adopt new ideas and technology
- Political instability is also a factor especially for foreign investors
- The market may have an alternative (a market survey may not give the full picture)
- Some innovations may not be accepted by the market)

IV. BUILDING A STRONG BIOECONOMY- SIMULATING BIOECONOMY SCENARIOS

Using the International Futures (IFs) Modelling Platform (see appendix) Bioeconomy scenarios were developed to capture impact of various policy levers. The previous section detailed key enablers of a strong Bioeconomy. The IFs platform is a general platform and thus cannot capture the specific enablers for a Bioeconomy. However, it provides a fairly extensive number of levers that can help simulate Bioeconomy scenarios. A strong Bioeconomy can be impacted through a number of pathways using the IFs platform. This are summarized below:

Supply chain

- Increase agricultural production. This can be through productivity i.e. yields or expansion of land under agriculture
- Increasing agricultural investment
- Reducing waste

Innovation

- Increasing investment in education
- Increasing/expanding tertiary education and in particular STEM
- Increasing R&D expenditure

Industrial development/policy

- Increasing investment by businesses through conducive environment e.g. incentives, subsidies, PPP opportunities
- Increasing FDI inflows
- Building agro-industry through Increasing industrial demand for agricultural raw materials through appropriate incentives
- Increasing protection of local industries
- Exports promotion

International political economy/Governance

- Increase development support inflows
- Lobby for favorable terms e.g. terms of trade, carbon credits

- Economic freedom
- Increase government effectiveness
- Reduce government corruption

VI.I SCENARIO DESCRIPTIONS

Using the levers provided by the IFs platform a number of scenarios were developed to capture potential ways the Bioeconomy sector evolves. The scenarios developed are summarized in Table 1 and discussed below:

Table 1: Bioeconomy scenarios parameters

	Moderate Bioeconomy	**Strong Bioeconomy - Unsustainable**	**Strong Bioeconomy – Sustainable**
Supply chain			
Increase agricultural production- Accelerate yields increase	20%	50%	50%
Increase agricultural production. Accelerate land expansion by	20%	50%	50%
Increasing agricultural investment- Accelerate investment	20%	50%	50%
Reducing waste – accelerate reduction rate	50%	50%	50%
Innovation			
Increasing expenditure in education		20%	20%
Improve quality of primary education		10%	10%
Increasing/expanding tertiary education and in particular STEM	10%	10%	10%
Increasing R&D expenditure	20%	50%	50%
Industrial development/policy			
Increasing investment by businesses through conducive environment e.g. incentives, subsidies, PPP opportunities	20%	50%	50%
Increasing FDI inflows		20%	20%
Building agro-industry through Increasing industrial demand for agricultural raw materials through appropriate incentives	20%	50%	50%
Increasing protection of local industries			50%
Exports promotion (export shift)			2%
International political economy/Governance			
Increase development support inflows		20%	20%
Terms of trade,		10%	20%

	Moderate Bioeconomy	**Strong Bioeconomy - Unsustainable**	**Strong Bioeconomy – Sustainable**
Economic freedom		20%	20%
Government effectiveness		50%	50%
Government corruption		20%	20%
Environment			
Cropland increase	20%	20%	
Forest protection	-20%	-20%	+20%

i. Base Case or Business-As-Usual (BAU) Scenario: The BAU is the scenario that projects the trends forward. It is already in-built in the IFs model. The other scenarios are built around this by accelerating of decelerating parameters as need be as shown in table 1.

ii. Moderate Bioeconomy (MB) scenario: This scenario assumes moderate acceleration of key parameters as shown in table 1. This is can be done within the political framework assuming Bioeconomy does not hold a central position. It is indeed more of an enhanced agricultural productivity improvement policy with industrialization incentives.

iii. Strong Bioeconomy-Unsustainable (SB-U): SB-U assumes potential of Bioeconomy seen and it is taken up enthusiastically with a coordinated agricultural and industrial polices undertaken. Also resources of R&D are increased and also funding for education with particular attention to tertiary education and STEM. Foreign investors are also targeted and land made available through expansion of cropland and relaxation of forest protection.

iv. Strong Bioeconomy -Sustainable (SB-S): This is an improvement of SB-U where care is taken to protect forest land so that agricultural production does not happen at the expense of deforestation. The protection of forest is rapidly accelerated.

VI.II SIMULATION RESULTS

Using the IFs platforms simulation were run for each of the scenarios with time horizon of 2040. While the IFs platforms has hundreds of variable for a researcher to explore we will look a few variables to assess the impact of the policy simulations. Four impact are assed to get an insight on the potential impact. The results are discussed below:

- First, we are keen on agricultural production has been impacted and how resulting output patterns in terms of food use and industrial use. The objective is really to see greater use agricultural product by industry without impact in usage as food, i.e. we want to explore food vs feed competition, a major concern in region especially given the food security challenges the region experiences.
- A second impact of interest is the economy in particular of the impact on GDP and incomes (i.e. GDP per capita) as a key objective of a Bioeconomy strategy is to stimulate growth and economic transformation. To get insight on transformation impact we look at how the value added by agriculture and by the manufacturing sectors are impacted.
- The third impact of interest is the developmental impact. To assess this we look at the impact on poverty and inequality to see how value created is captured. We also assess the

environmental impact by looking at how the area under forest is impacted and trajectory of CO2 emissions.

VI.II.I Agriculture Production and Use

As pointed a strong Bioeconomy depends on having an adequate supply of raw materials. The Moderate Bioeconomy (MB) and the Strong Bioeconomy-Unsustainable (SB-U) scenarios rapidly increase agricultural production (by 65% and 124% respectively) over the base case scenario (BAU scenario). However, agriculture production under Strong Bioeconomy-Sustainable (SB-S) rises then around 2025 starts to drop to almost the values at the start. The outcome for under the 4 scenarios are given in are given in figure 5.

The agriculture use for food does not change much from the BAU scenario over the three scenarios. However, the use by industry rises significantly above the base case (BAU). For both strong Bioeconomy scenarios the rise is 54% while for the moderate scenario a rise of 24% is seen. This is a sign of an emerged Bioeconomy industrial sector. However, the sector, in the case of SB-S scenario, the increase demand is met by significant rise in imports. Note that while MB and SB-U reduce agricultural imports, the agricultural imports are not totally eliminated. The fact the SB-U is a very aggressive scenario with rise in yields, crop area and relaxation of forest protection underscores how difficult it is to become self-sufficient in food underscoring the need to emphasis specialization and trade rather than food self-sufficiency.

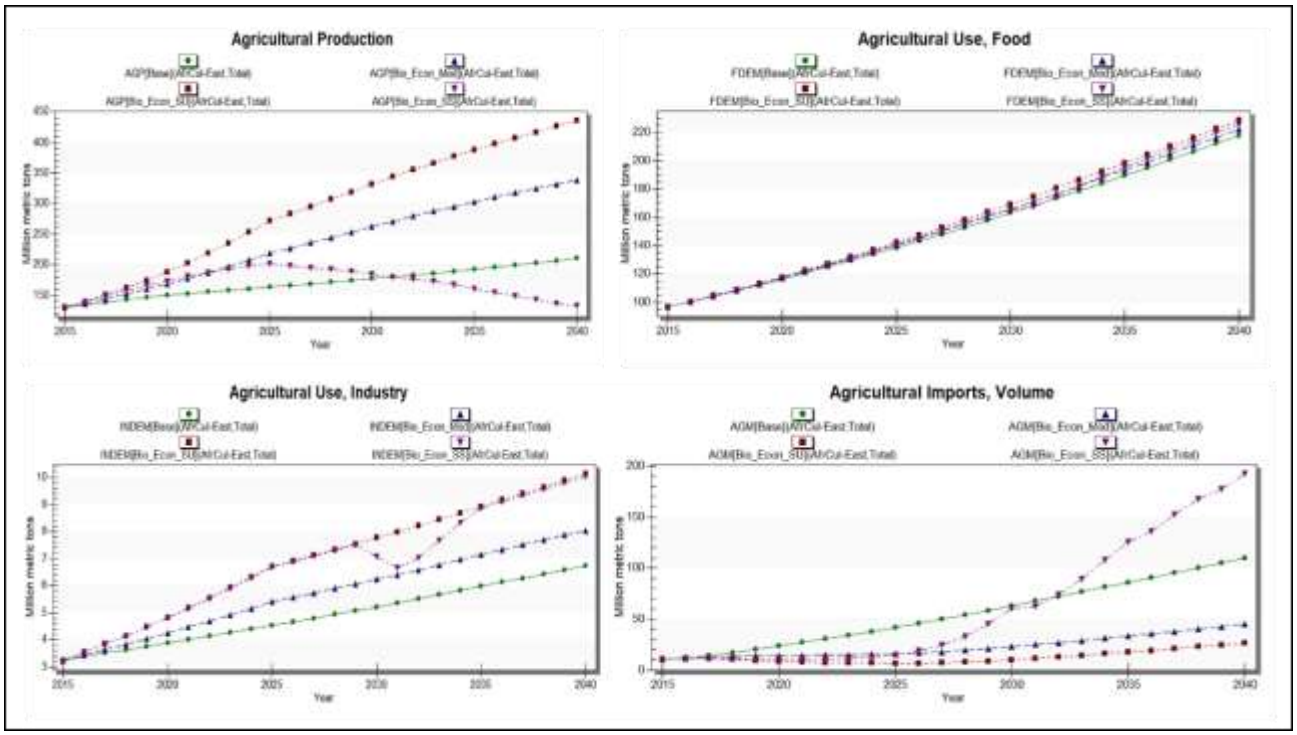

Figure 5: Impact on Agricultural Production and Use

VI.III.II Economic Impact

The economic impact is shown in fig 6. As expected the GDP rises from the base case with SB-U having the biggest impact at almost double the base case. Similarly, the GDP per capita also rise under the three scenarios.

Of interest is that fact the agriculture contribution falls underscoring that the Bioeconomy strategies are stimulating the part of the value chain beyond agricultural production. This is also reflected in the higher value added from manufacturing. The strategy that is most successful is the SB-S where agriculture contribution falls from about 36% to almost 2% of GDP and contribution of manufacturing rise from about 10% to about 24%. Note that the MB and SB-U do not do better than BAU case in terms of stimulating the manufacturing sector.

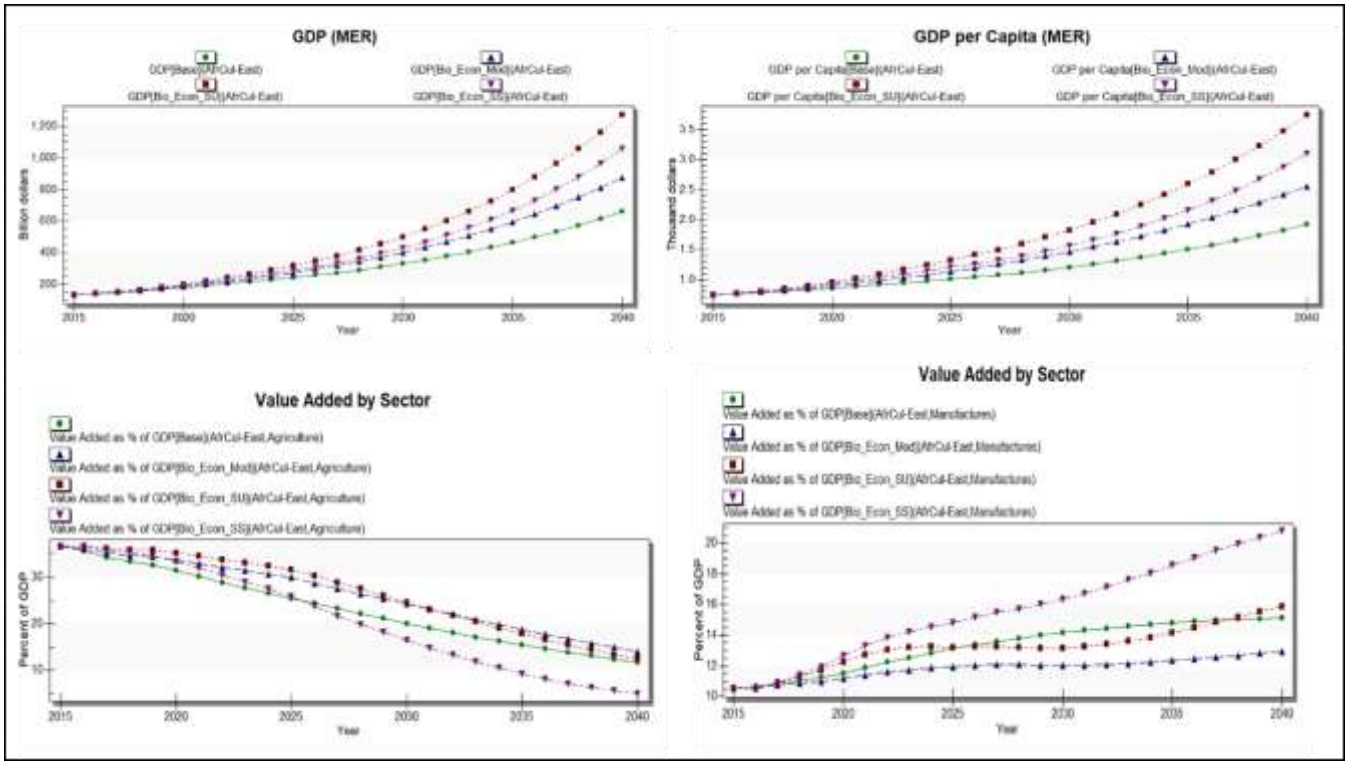

Figure 6: Impact in Economic performance

VI.III.III Impact on Development and Environmental Impact

The impact of the scenarios from a development perspective as shown in fig 7. As can be observed, there is a significant reduction in poverty under all scenarios with SB-U scenario showing the most impact. However, even in this best case, poverty still hovers at around 12% of the population underscoring that a strong Bioeconomy is not enough to eradicate poverty. Indeed, as seen gini coefficient does not fall except for the SB-U (and even then it is still high). The fact is that as value chains are upgraded those with more resources and who make the needed investments capture a disproportionate share of value created. This underscores the need for deliberate inclusive policies to ensure growth translated to improved livelihoods for all.

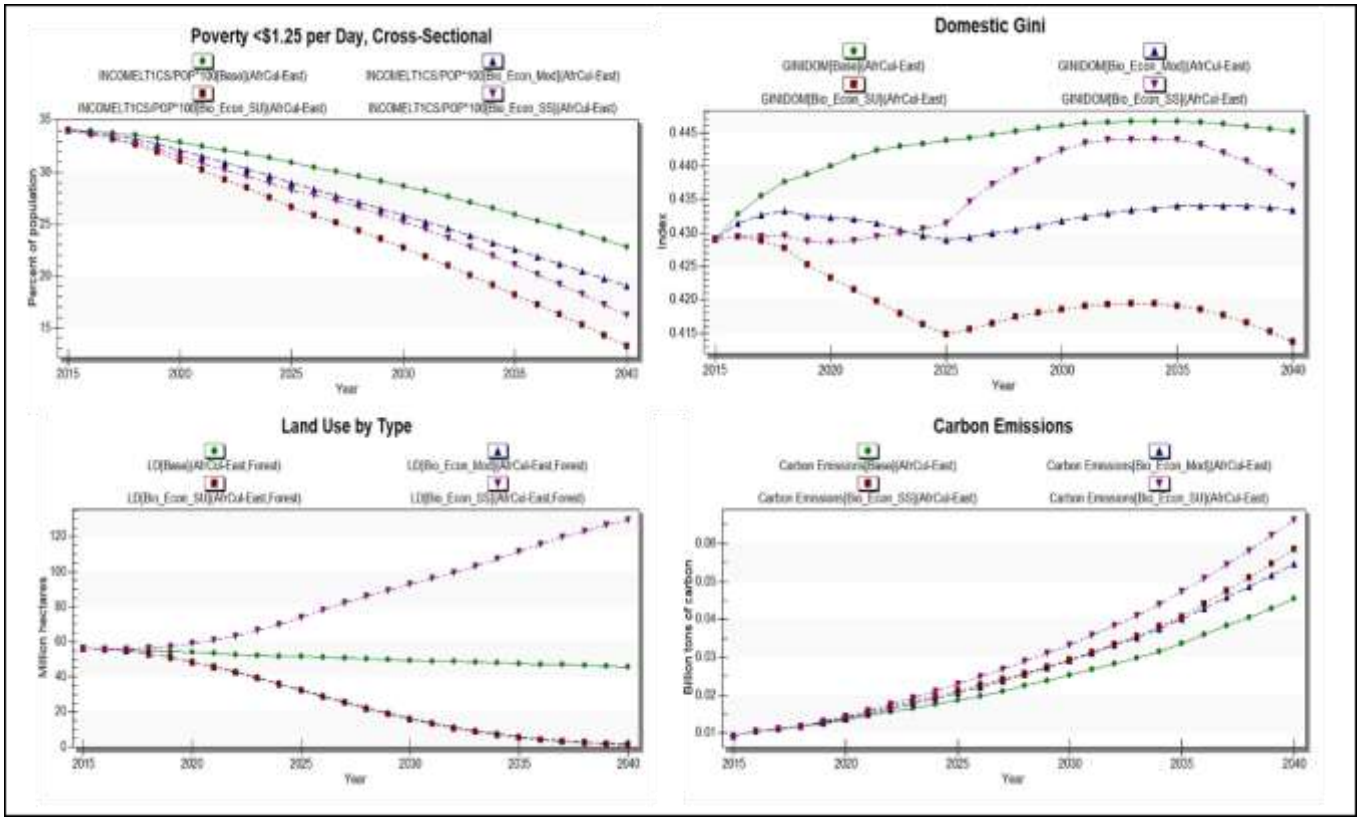

Figure 7: Development and environmental impact

As much as the SB-U shows good impact on poverty the impact on environment is devastating. The forest is almost finished. Surprisingly, the moderate Bioeconomy scenario also sees forests devastated. The Strong Bioeconomy scenario which also seeks to increase forest cover (SB-S) manages to do so. However, even with this feat, the scenario has higher emission than the base case. This underscores the need for care in pursuing the strong Bioeconomy strategy.

C) DISCUSSION

The analysis points to the potential of a Bioeconomy driven economic strategy to drive transformation. However, the simulation point to the fact that if now well thought out it can also be costly in terms of environment and indeed such a strategy can lead to a disaster in the long run. It is also clear that having a strong Bioeconomy does not necessarily mean a being self-sufficient in agricultural production. Indeed if saving the forests or increasing forest cover means agricultural imports rise this should be fine. Also a strong Bioeconomy does not necessarily mean development objectives are fully met. A Bioeconomy strategy should be part of package of strategy to ensure sustainable and inclusive growth.

Note that this analysis is fairly limited. It is hard to simulate the full picture of a Bioeconomy and it is unlikely a general purpose model like IFs can do this. Doing a proper forecast may require a specially built model which might be very costly and insights generated unlikely to justify the investment in such a model. The insight from this model gives us a good starting point to understand the levers available to transition towards a good Bioeconomy futures.

V. CONCLUSION

The foregoing discussion point to a big trends underway that are going to have a major impact in the natural resource base. Populations in the region are rising rapidly, incomes are rising and urbanization

is underway pointing to huge changes in aggregate demand and demand of biological resources to meet food, infrastructure and other needs. This is happening when already the region is food insecure and land degraded and forests under threat. Challenges further compounded by the on-going threat of climate change.

At the same time, there are trends indicating growing consensus globally for a shift towards more sustainable consumption and greening the economies. Sustainability and the need to mitigate climate change impact are now key issues being tackled by global governance institutions with important agreements e.g. SDGs, Convention on Biodiversity, climate change (COP21) reached. While technologies needed to support the transition to greener economies are still in the early stages of development, a growing mass of consumers concerned with sustainability and demanding sustainable products is creating a market and hastening the transition. With the growing power of global governance institutions and also as local governance institutions grow there is a real chance for making the needed transition.

From the foresight exercise, it is clear that stakeholders understand the potential dangers that current trends pose with many seeing potential conflicts emerging as biological resources become scarce. However, there is huge optimism of a better future through proper exploitation of the biological resources. Many stakeholders see potential of an industrial transformation through production an array of bio-based products. However, the key enablers must be in place. Markets need to be created, business need to be developed, skills need to be build and necessary financing infrastructure be put in place. These are not in place and right mix of policies and proper sequencing will be key in getting the desired bio-economy future.

There is a need to increase the productivity of the agricultural sector, increased the innovation capacity, increase investment in the sector to foster a strong Bioeconomy. However, this must be done in conjunction with policies to protect the environment and encourage sustainable practices. Indeed, a strong Bioeconomy does not necessarily mean development objectives are fully met are met, economies can grow, environment protected but still, poverty remains high as ensuing benefit might be captured by a few. A Bioeconomy strategy should thus, be part of package of strategy to ensure sustainable and inclusive growth. So energy polices, social protection policies, gender policies should be coordinate with Bioeconomy policies.

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APPENDIX 1: BIOECONOMY FUTURES FUTURES LITERACY LAB (FLL) WORKSHOP-BRIEFING NOTE

INTRODUCTION

The emergence of a strong Bioeconomy that can drive economic transformation depends on anticipating the future and developing needed strategies and policies to address the opportunities presented. The anticipation depends very much on the trends we see and assumptions (implicit and explicit) we make about them and thus the impact. The futures we see are as good as the assumptions we make. There is, therefore, a need for revealing the assumptions and questioning them. Hopefully we can then revise them with better grounded assumptions and thus identify better policy levers to shape the futures we want.

The objective of this workshop is to enable participants to start reassessing their original assumptions and ask new questions about their current situation and thus craft better futures. Offering a 'best guess' or defining a single 'preferred future' is not the purpose of this workshop

The workshops seeks to generate knowledge through 'action research' methods. Participants are invited, step by step, to make explicit their assumptions about the future (their 'anticipatory assumptions') and to become aware that there are different ways of using the future to understand how alternative assumptions about the future help to define different aspects of the present. The workshop process enables researchers to record the participant's anticipatory assumptions and how different ideas about the future alter perceptions of the present.

WORKSHOP PROCESS

The workshop has three sessions that are describe below.

SESSION 1: OVERVIEW - GETTING PEOPLE TO 'THINK FUTURES'

The session seeks to put the participants into a frame of mind which is happy to explore past/ present/ future; what they think/ predict will happen, and what they would like (their values) to happen. Gives participants a chance to say how they think it is and will be. They'll be drawing on their professional knowledge and experience. Specifically it will seek to get perspectives from different group members (many have different backgrounds and perspectives) on:

- What are the main attributes of a strong Bioeconomy in next 10-15 years?
- In what ways is it different from that of today?
- What's likely to happen to the Bioeconomy sector during this time given the way things are going in health sector/ wider economy?
- Relative roles of public/ private/ voluntary/ informal sectors
- What would they <u>like</u> to see happen – their <u>positive</u> hopes
- What are their assumptions and values (e.g. equity/ efficiency/ safety, etc.)? If they give broad values like that, then ask more specifically how they would define each of them (e.g. 'equity' based on access (age/ immigrants/ poverty) and what are the barriers to achieving that equity).

At the end of this first group session the rapporteurs should be able to present a rough list of <u>anticipatory assumptions</u> regarding expectations and values for each group.

SESSION 1: PLENARY

The groups report on their discussions. The facilitator will then need to:

- List themes and highlight any that are common/ different across groups.
- Draw out key values and definitions.

- Clarify your/ their understanding.
- What is within the control of the organization(s) represented at the workshop and what is outside their control?

SESSION 2: POTENTIAL FUTURES

Session 2 will seek to help participants think beyond simple extrapolation, become aware of alternative systems and to be able to describe a snapshot of a Bioeconomy in a very different future. One major step in doing this is to take them, a long way forward into the future, beyond existing easy to imagine time frames say 2050 defined a 'Learning Intensive Society' (LIS)[29]. A society that is no longer about mass-production and mass-consumption. It is this greater capacity to make decisions that works in functional harmony with the shift to unique creation. Thinking about an economy that is not dominated in organizational terms by the division of supply and demand allows our imaginations to escape from descriptions of the future that are limited to different ways of organizing supply and demand. Thus we can begin to describe an economy that is not necessarily dominated by firms, jobs, management. The 3D printer is a way of illustrating the idea of desktop factories where people create their unique products. Examples of things produced using 3-D printing techniques – now even available at the domestic level to custom-produce toys. Point is – what might this mean for the toy factories in China and the shipping trade that exports goods from factories to consumers… In a unique creation economy where people produce locally there would be entirely new patterns of trade. The global sharing of ideas would become even more central but locally grown and local resources, largely from recycling and recovery, could be the source of raw material inputs

This is in order to equip them with the ability to 'let go' of simple (Session 1-type) visions of the future based on simple extrapolation. Learning Intensive Society (LIS) is meant to give them some words to describe the future in a different way – it is to help them to begin to construct new anticipatory assumptions that entertain changes in the conditions of change. The LIS is not presented as being probable or likely, nor desirable or preferable.

SESSION 3: REFRAMING

The session seeks to connect session 2 discussion and description of 2050 to our current situation. The participants will then begin to identify the way in which their anticipatory assumptions – the image of the future that they use – can change what they see and do in the present.

The trick is trying to spot what may be emergent trends right now – even before they've happened! What is it that participants are doing today in their systems that might be a new emergent trend and how might they go about spotting it? One way to help kick start this discussion, is to get them to discuss Bioeconomy systems without agriculture (say assume all nutrients could be chemically synthesized and 3D printed at home. If the future is radically different in organizational and even outcome terms, does it change how they think about some of the things that are happening today? If they see some changes in the present in a different, more emergent, more systemic way, does that provoke or inspire ideas about changes in what they do now or assumptions they make about the future?

[29] They will be asked to wake up in this different world – the Learning Intensive Society – without worrying about how you got there, is it likely or desirable.