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Tapping the Potential of Agriculture Transformation in Tanzania Under the BBT-YIA Program: the Case of Organic Waste Management

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Abstract:
This study assess the available potential that can be tapped from organic waste generated under the BBT-YIA program. The study motivated by the ongoing Agriculture transformation in the Tanzania which aimed at increasing: the area under block farming; area under irrigation; and agriculture sector growth from currently, 41,000 acres to one million acres, 10% to 50% and 4% to 10% by 2030 respectively.
However, every step of agricultural production, transportation, and processing generates wastes. Ineffective management of such waste cause social, economic and environmental concern. Despite that, there is potential of turning such waste into valuable resources. The study analyses the available potential that can be tapped from organic waste mostly crop residues generated in the block farms.
The methodology involved purposeful selection of the Ministry of Agriculture, Ministry of Livestock and Fisheries, Ministry of Energy and Local Government authorities. Interviews, direct observations and documentary reviews were part of data collection techniques and the collected data were analysed using descriptive analysis.
The findings show that the BBT-YIA program has a potential of producing 200,000 tons of animal feed annually; 14,129 tons of compost per month; creating about 56,490 jobs through organic waste recycling; generating 1.44 MW of electricity per day; and reducing Greenhouse gas by diverting 734,375 tons of crop residue disposal sites.
The study recommends; establishment of biomass plants; organic waste recycling program; and compost production initiatives.

Keywords: Organic Waste Management, Crop residue, BBT-YIA, Building a Better Tomorrow-Youth Initiative in Agribusiness, Greenhouse gas, Composting, Animal feed, waste-to-energy, Agriculture , and Tanzania.

INTRODUCTION

The role of the agricultural sector in human development and economic development cannot be overemphasized. Agricultural sector development is crucial in the growth of the national economy and development of industrial sector and is equally important for the provision of adequate food and guarantees nutrition security to the population.

Tanzania is currently implementing Agricultural Sector Development Programme Phase II (ASDPII). The main goal of Agricultural Sector Development Program Phase II (ASDP II) is to transform the agricultural sector towards higher productivity, commercialization level and increase smallholder farmer income for improved livelihood and guarantee food and nutrition security. To achieve that objective the country engaged in various initiatives. A ***Building a Better Tomorrow: Youth and Women Initiatives for Agribusiness*** (BBT-YIA) program is among introduced initiatives implemented through the Ministry of Agriculture. The program aimed at promoting the engagement of Tanzanian youth and women in agribusiness for a sustainable improved livelihood. BBT-YIA is regarded as a tool for contributing the attainment of the Agenda 10/30 that envisaged to increase the youth employment by over 1.5 million and obtain the growth rate of the agricultural sector by ten (10) percent from currently 4 percent by 2030.

Tanzania has taken a number of initiatives in order to realize such ambitious targets including increasing crop sector budgetary allocation from USD122.5 million to USD 4041.7 million in the span of 3 years from 2021/2022 to 2023/2024. Also, the Government aimed by 2030 to have the area under block farming systems increased to a total of one million acres from currently 41,000 acres; the area under irrigation from currently 10% to 50%; and agriculture sector grow from currently 4% to 10%.

However, it is worth noting that every step of agricultural production, transportation, processing and consumption depending on the type of agricultural produce or product generates quantities of agricultural solid wastes. Ineffective management of such accumulated waste may cause social, economic and environmental concern. This may include climate change impacts through Greenhouse Gas emission and food insecurity from soil pollution .

Despite the negative impact associated with waste generation, some countries have managed to turn waste into potential source of livelihoods and valuable resources. Therefore, this study aimed at analysing the available potential that can be tapped from management of organic waste mostly crop residues in the block farms under the BBT-YIA program.

OBJECTIVE

To assess the available potential that can be tapped from management of organic waste in the block farms under the BBT-YIA program.

LITERATURE REVIEW

Crop residues are cellulosic material with high fixed carbon content, which could be a potential source of feedstock for energy generation, through its production of biomass, which can be used as biofuel and is a renewable resource. (Prasad, et. al., (2020a).A number of techniques are available to produce different biofuels such as bioethanol (Prasad et al., 2020b, Akbarian-Saravi et al., 2020), biomethane (Prasad, et. al., 2020a), bio hydrogen etc. using crop residue as raw material (Prasad, et. al., 2020a).However, the energy content of residue varies among crop species. For example, the energy content is 3015 kcal/kg for rice straw and 3738 kcal/kg for hay (Stout, 1990). The approximate fuel value per Mg of crop residue is 16×10^6 BTU (Lal, 2005), or 2 barrels of diesel, 18.6×10^9 J or 3×10^6 kcal.

According to Mehta, and Badegaonkar, (2023), about 1.2-1.4 kg of biomass is required for producing 1 kWh of electricity (using 100 % producer gas engine). Crop residues can be utilized as fuel for running a biomass gasifier for multiple applications including electricity, agro-processing, and running decentralized cold storage at the village level (ibid). This can also potentially offer farmers an alternative choice to move to horticulture crops for which most farmers presently are unwilling due to inadequate cold storage

capacity at the local level (Mehta, and Badegaonkar, 2023). According to Mehta, and Badegaonkar, (2023), a 250 kW capacity biomass gasifier plant can consume around 2,000 tonnes of paddy straw annually and support 50 tonnage refrigeration (TR) cold storage facility besides generating electricity (Datta et al., 2020).

However, in 2017-2018, a total of 136.99 Million hectors had generated a total of 682.59 Metric tons of biomass from crop residues India. This was from Rice (225.48Mt,), Wheat (145.45Mt), Maize (27.88Mt), Sugarcane (119.17Mt), cotton (66.58Mt), Pigeon pea (9.16Mt), Sayabean (27.78Mt), Rapeseed (17.08Mt), Gram(26.51Mt),Groundnut (12.90Mt) and Castor (4.60Mt) (TIFAC and IARI, 2018).

Further, Bhaghat, et.al., (1979) has indicated that a farm of average size has the potential for generating far more electricity from crop residues than is used on the farm. For example, the annual consumption of electricity on a farm in United State of America is roughly 12,000 kWh[6] (including electricity consumed at the farm residence). However, the electrical energy potentially available from residues on an average farm ranges from 27,000 to 124,000 kWh/yr (Bhaghat, et.al., 1979).

Table 3
Comparison of Current Electricity Use on Non-Irrigated Farms with Electrical Energy Potentially Available from Residues

Crop residue	Current Annual electrical demand at a farm* (10^3 kWh)	Electrical energy available annually from residues** (10^3 kWh)	Ratio of potential residue-generated electricity to current consumption
Corn	12	48	4.0
Soybeans	12	27	2.3
Wheat	12	124	10.3

*From Reference 6.
**Assumes 25% yield fraction, 20% efficiency of conversion to electricity, and average cultivated acreages of 150 for corn, 90 for soybeans, and 300 for wheat.

Source: Bhaghat, et.al., (1979)

Animal Feed Production

According to Maqsood, et.al., (2022), an acre of rice and wheat can produce on average, 1.44 tonnes and 1.32 tonnes of crop residues respectively. In another study, Vyas et al. (2014) reported that a well-managed chickpea field can provide crop residues up to 8–10 tons per hector. Also, in another development, Wortmann et.al,(2012), indicated that a crop yield of 5tons/ acre of a corn can potentially produce one ton of Crop residue. Further to that, Schafer, (2007) pointed out that one ton of corn crop residue can supply enough forage to sustain a 1,000-lb cow or animal equivalent for 1.5 to 2 months.

Compost Production

Composting was recommended as a practical and economical way of recycling livestock manure and crop residue at the farm and regional levels (Bernal et al., 2009; Onwosi et al., 2017; Sáez et al., 2017).According to (Kumar, and Jnanesha, 2019), composting is a fascinating segment for converting generated on-farm waste materials into a productive resource. According to Sheriff, (2021) the amount of waste generated in Egypt has a potential of producing 5 million tons/year of compost. In Lagos, Nigeria, the authorities aim to implement a programme of decentralized composting and anaerobic digestion systems (The Conversation, 2021). Through Public-private investment the city has managed to enable

construction of waste-to-compost facility at the cost of over $20 million – aiming to convert some 850 metric tonnes/day of organic waste to 250 bags of organic fertilizer.

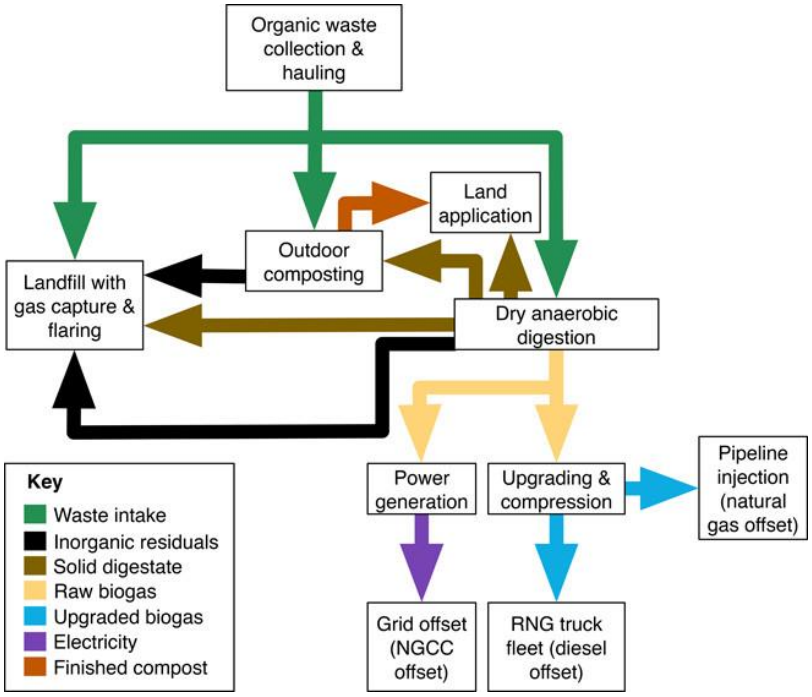
Employment creation

Composting has proven to be one of the important livelihood source in African countries. In Cairo, Egypt organic waste recycling is commonly practiced by Zabbaleen or locally known as Garbage People, whereby they are involved in diverting organic waste from dumpsites for animal feeding (Alsobky, et.al., 2023). According to Omar, (2018), Zabbaleen have also involved in the production of fertilizers in the process of organic waste composting through small industrial project loans. The loan has managed Zabbaleen to recycle 80% of the collected municipal solid waste.

In another study, Kessler, (2004), has proven composting to be a lucrative business. In his study Kessler (2004) from the case drawn in Edem et.al., (2011) revealed that, the gardeners in Lomé, Togo and farmers in town surrounding Lomé need fertilizers for their field but find the cost of artificial fertilizers or natural fertilizers such as kitchen manure to be too high. In turn this claimed by Kessler, (2004) to present a potential market for compost in Lomé, especially for gardeners and farmers. According to Kessler (2004), four composters working 6 hours per day and 6 days a week and sort 52 tons of waste can produce 11 tons of compost per month. The 11 tons of compost would give a monthly revenue for the sale of compost of 588 Euros. According to this study, four full time composters could produce annual profit of 4,656 euros.

Green House Gas Mitigation

According to Sarah.al., (2020), there a various option in the management of organic waste as indicated in Figure 1. This include Landfilling, Composting, Dry and anaerobic digestion.



Source: Sarah.al., (2020),

Landfilling is the most greenhouse gas (GHG)-intensive option, emitting nearly 400 kg CO2e per tonne of organic waste (Sarah.al.,2020). Composting raw organics resulted in the lowest GHG emissions, at −41 kg CO_{2e} per tonne of waste, while upgrading biogas to Renewable Natural Gas (RNG) after dry Anaerobic

Digestion (AD) resulted in −36 to −2 kg CO2e per tonne (ibid). Composting organic materials like crop residue, food scraps, yard waste, soiled paper and manure releases some carbon dioxide into the atmosphere, but has a less adverse impact on the environment compared to methane, which has 23 times more the global warming potential than carbon dioxide (King County Solid waste Division, 2024).
Greenhouse gas emissions are reduced when organic materials are recycled into compost or other soil amendments and applied to the soil in our gardens, landscapes or farms. The biological carbon from the organic materials that are used to make compost or other soil amendments can remain sequestered, or stored, in soils for long periods of time, effectively storing carbon that could otherwise be released into the atmosphere as CO2 (King County Solid waste Division, 2024).

METHODOLOGY

The study methodology involved a purposeful selection of institutions that involved in the management of Block farms under the Building a Better Tomorrow- Youth Initiative in Agribusiness (BBT-YIA) project; institution involved in regulating of fertilizer production and importation; and institution involved in the organic waste management value chain.
On that basis the Ministry of Agriculture was selected bearing in mind that the ministry is the custodian institution in the designing and implementation of the BBT-YIA program; and the Tanzania Fertilizer Regulatory Authority (TFRA) was selected based on its role in regulating fertilizer production and importation.
Further, interviews, were conducted to staff from Ministry of Agriculture in the Directorate of Crop Development, Mechanization and Value addition and Policy and Planning especially BBT-YIA Coordinating unit.
The study also involved a documentary reviews as part of data collection tools and the collected data analysed using descriptive analysis.

FINDINGS AND DISCUSSION

Animal feed (Forage) production potential

According to National Sample Census of Agriculture 2019/20, in URT (2022), The country needs at least 141.4 million tons of forage annually, while the current production is only 16.8 million tons (Ng'hily, 2022). Consequently the country planned to spend **Tshs.879,393,000,000** for Pasture Feed and Water for Livestock in 5 years (2022/23-2026/27) (URT, 2022).
However, Crop residues are a valuable source of animal feed and utilizing the residues by grazing is very effective in returning plant nutrients to the soil. According to Bhandari, (2018) Terrestrial animals especially ruminants are characterized by their ability to convert low quality roughage into high value products e.g. meat, milk, natural fibres, leather and manure.
The established block farms under BBT-YIA program have potential of producing crop residues that can supplement forage deficit. For example, if we are to assume corn will be planted to the 50 percent (500,000 acres) of the proposed 1 million block farms under BBT program a total of **100,000 tons** of Crop residues will be generated annually. However, with the use of irrigation system which may lead to the two seasons of production annually, a total of **200,000** tons of crop residues will be generated. This can potentially supply enough forage to sustain 40,000 of 1000-lb cows or animal equivalent for 1.5 to 2 months.
Again, according to Hickman and Schoenberger, (1989), an acre of Soya bean with an assumption of crop yield of 0.95 tons/acre can potentially produce 0.7875 tons of residue per acre. For the case of Sunflower

with crop yield of 0.95 tons per acre can potentially produce 1.35 tons of crop residue. If we are to assume both sunflower and soya bean will take 25% each from a total 1 million acre of block farm under BBT program, a total of 196,875 tons of Soya bean's residue and 337,500 tons of sunflower residues will be generated annually. That will make a total of about 734,375 tons annually from the 1 million block farm under BBT program by 2030. Conservatively, the amount is enough to feed 146,875 of 1000-lb cows or animal equivalent for 1.5 to 2 months.

Compost production potential

Also, in interview, with the Acting Director of Mechanization and Value Addition Directorate in the Ministry of Agriculture, it was clearly stipulated a demand for farm yard manure mostly from composting for soil conditioning in block farms. For example, he highlighted that the Chinangali block farm which is only 1552 acres requires 1.2 tons of Compost or Farm Yard Manure (FYM) annually . Further, he indicated that the block farm needs a total of 1860 tons of fertilizer whereby, 620 tons, is DAP, 620 tons, CAN and 660 is UREA.

However, in an interview with Tanzania Fertilizer Regulatory Authority and Crop Development Directorate officers in the Ministry of Agriculture, it has been found that the annual fertilizer demand for the year 2023/2024 in the country is 848,884 tons, whereby only 38,369 tons (4.5%) are locally produced. The inadequate production in the country provide opportunity for local production. Therefore, considering more than 734,375 tons of crop residues will be produced through BBT-YIA block farms by 2030 while more than 50% (nearly, 1,750,000 tons annually as indicated in national Environmental master plan) of the municipal waste generated in the country is organic there is a potential opportunity for compost production.

Additionally, by taking a conservative view of the the example of a study conducted by Kessler, (2004), which indicated that 52 tons of waste can produce 11 tons of compost per month, this implies nearly 14,129 tons of compost can produced per month from 734,375 tons of crop residues and 33,654 tons from 1,750,000 tons of organic waste from municipal waste generated in the country annually. However, these projection anchored on the assumption that there has never been much differences in the quality of organic waste and applied compost technologies between Tanzania and Togo.

Employment creation potential

As indicated in literature review, composting of 52 tons of organic waste in Lome, Togo have created 4 jobs. Based on that, the generated 734,375 tons of crop residues under the BBT-YIA program can potentially create about 56,490 jobs through compost production. Therefore, The 10% soft loan given by Government through local Government authorities can be used to establish compost plants whereby youth, women and people with disability can potentially tap the potential of generated waste under the BBT-YIA program.

Crop Residual and Energy Production potential

The established Block farms under BBT-YIA program accompanied with various facilities that require energy. This include residential houses and irrigation infrastructure.–However, based on the estimated provided in the study of Mehta, and Badegaonkar, (2023),whereby it has been indicated that about 1.2-1.4 kg of biomass is required for producing 1 kWh of electricity (using 100 % producer gas engine), then, a total of 734,375 tons of crop residue may produce 1.44 MW per day. The generated electricity can be

used in running agro-processing, and cold storage facilities in the block farms. However, in specific block farms the generated electricity can sustain the farms needs. For example, in Chimangali, a total of 1552 acres may produce 2,095.2 tons of sunflower of crop residues which could potentially generate 4.6 Mw of electricity annually.

Green House Gas Mitigation Potential

The United Republic of Tanzania puts forward four priority sectors for climate change mitigation in its National Determined Contribution document due to their significant potential in greenhouse gas emissions reduction. Waste management is among the identified priority sector in addressing climate change mitigation in the country.

The country plan to reduce greenhouse gas emissions economy-wide between 30 - 35% relative to the Business-As-Usual (BAU) scenario by 2030, whereby about 138 - 153 Million tons of Carbon dioxide equivalent (MtCO2e)-gross emissions is expected to be reduced, depending on the baseline efficiency improvements, consistent with its sustainable development agenda

The developed and proposed one million acres of block farms under BBT-YIA program expected to generate 734,375 tons of crop residues. Recycling and composting of the generated 734,375 tons will help in diverting such amount of organic waste from dumpsites and landfills. In turn, this will reduce generation of Methane gas which has 23 times more the global warming potential than carbon dioxide. Additionally, by composting crop residues and municipal organic waste, there are substantial reductions in energy and greenhouse gas emissions related with production of fertilizers and pesticides, not counting soil carbon sequestration (storing) benefits.

CONCLUSION

Organic waste especially crop residue present a social, economic and environmental potential that need to be tapped in the implementation of *the Building a Better Tomorrow –Youth Initiative in Agribusiness* (BBT-YIA) program. The envisaged potential include production of Animal feed (Forage), Fertilizer, and Energy. Further, climate change mitigation and jobs creation through effective organic waste management are among potentials that must tapped.

RECOMMENDATION

Ministry of Energy to spearheaded Establishment of biomass plants for energy production

The Ministry responsible for energy may take the BBT-YIA block farms as a model of promoting energy diversification. The Ministry may develop a project on utilization of crop residues generated in the block farms and the municipal organic waste in the project area as a strategy of promoting energy mix to enhance energy resilience in the country.

Ministry responsible for Environment to establish organic waste recycling program

The Vice-President Office-Division of Environment in collaboration with President's Office-Regional Administration and Local Government should play a leading role in promoting and establishing organic waste recycling programs in the block farms. This may include compost making, animal feed production and black soldier fly/maggots production. The program can be used to show case the national initiatives in reducing the greenhouse gas emission as part of the implementation of country's commitment in the implementation of the National Determined Contribution (2021).

Ministry of Agriculture to spearheaded compost production initiatives

The ministry of Agriculture through its institutions especially TFC and TFRA in collaboration with local government authorities to establish composting facilities in the block farms. In turn the community around the block farms to be engaged in compost making as part of community wealth creation program. The Ministry of Agriculture may also establish off-taking arrangement of the produced compost with the established BBT Cooperatives.

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