SOLUTION SUMMARY

We will eliminate the use of synthetic pesticide in tomato production by producing organic pesticides made from *Tithonia diversifolia* (Mexican sunflower). We will also make organic fertilizer made from *Tithonia diversifolia* and leverage on tomato wastes for biogas production for cooking. This system will not give any room for the use of inorganic inputs thereby giving a secured solution to land degradation and environmental restoration.

CONTEXT

Tanzania has a population of more than 56 million of people and its economy is highly dependent on agriculture, which accounts for 26% of the gross domestic product (GDP) and about two-thirds of the total exports. Tomato (*Solanum lycopersicum*) is the single most dominant vegetable crop which contributes the highest percentage (63%) of all annually harvested fruits and vegetables in Tanzania (Ministry of Agriculture Food Security and Cooperatives, 2012). A survey done by Match-Maker-Associates-Limited shows that, tomato production in Tanzania is basically in the temperate areas including Southern and Northern highlands (MMA,2008). Furthermore, among regions cultivating tomatoes, Morogoro has the largest area of about 2,442 ha (9.2% of its land), followed by Kagera (2386 ha,9%), Tanga (2,326 ha, 8.7%), Mwanza (2,235 ha, 8.4%) and Iringa (2,223 ha, 8.4%). The biggest markets for tomato are urban areas including Dar es Salaam, Mbeya, Moshi and Arusha.

Tomato contributes the highest percent to the fruit and vegetables consumed in Tanzania. Its high consumption is attributed to the presence of bioactive compounds and vitamins known to prevent noncommunicable diseases. However, synthetic pesticides used to control pests and diseases cause direct accumulation of pesticide residues in food. Consumption of pesticide contaminated tomato increases the risk of pesticide exposure. Actually levels of pesticide residues in tomatoes consumed in Tanzania exceed the recommended maximum residual limits. As such in order to assure pesticide safety of food, there is a need to identify and control farmers' practices which are highly associated with pesticide contamination in tomatoes.

Health effects of synthetic pesticides

All synthetic pesticides can be harmful, although the levels of toxicity vary from pesticide to pesticide. Most comon toxicity is a long-term low-level exposure or chronic toxicity which is linked with pesticide residues in food as well as contact with pesticide residues in the air, water, soil, sediment, and food. Higher consumers of synthetic pesticide contaminated tomatoes have the greatest exposure to these pesticides. Effects of pesticides ranges from mild skin irritation to birth defects, tumours, genetic changes, blood and nerve disorders, endocrine disruption, and even coma or death (Hong-Sheng Wang et al., 2011;Tebourbi et al., 2011). It also affects reproductive, endocrine and immune systems. Chronic exposure causes infertility, neurobehavioral disorder, diseases such as cancer and mutagenic effects (Al-Waili et al., 2012). Furthermore, Intensive application of pesticides affects, in addition to human health, the environment due to residues that remain in different environmental matrices as well as water and air (Mekonen et al., 2014).

In Tanzania, pesticide residues were detected in the samples of irrigation water for which frequency of detection was increased for samples collected downstream in the fields as well as in fresh tomatoes (Kihampa et al., 2010b).

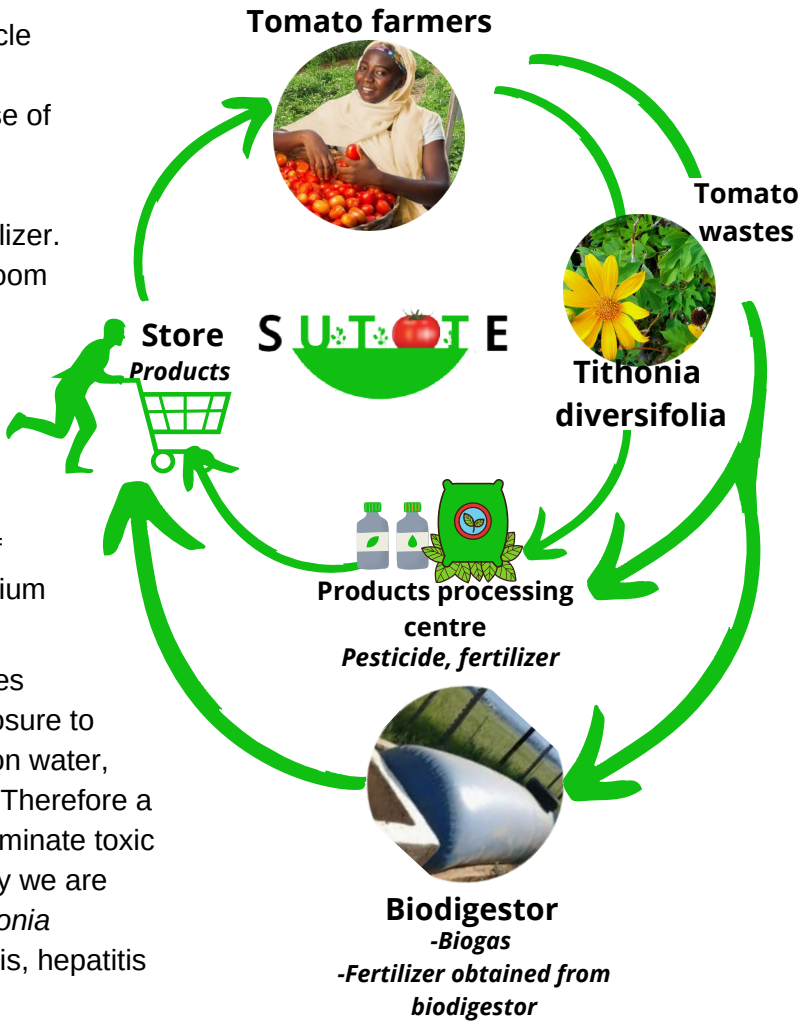
Related problem

As a total, biomass makes up close to 90% of the total primary energy consumption in Tanzania. Unfortunately, this leads to the deforestation of 100,000 ha per year, of which only about a quarter is reforested. As a matter of facts, 63.5% of the households in Tanzania Mainland use firewood as the main source of energy for cooking, followed by charcoal 26.2%, liquified petroleum gas 5.1% and electricity 3.0% (Rural Energy Agency, 2020).

SOLUTION OVERVIEW

Solution details

We will implement a closed circle production system of tomatoes which will employ maximum use of organic pesticides made from *Tithonia diversifolia* and use of wastes for making organic fertilizer. This system will not give any room for the use of inorganic inputs thereby giving a secured solution to land degradation and environmental restoration.



We are leveraging on the pesticidal capacity of Mexican sunflower for the production of organic pesticide. Furthermore, the green leaf biomass of tithonia is rich in Nitrogen, phosphorus and potasium which is a good substitute for chemical fertilizers.

We are geared to elimate the problem of pesticides poisoning for farm workers due to excessive exposure to synthetic pesticides. Pesticide residues in irrigation water, food put workers' and consumer´s health at risk. Therefore a shift to our organic pesticide is the best way to eliminate toxic pesticide exposure for everyone. To ensure safety we are leveraging the polyphenols and flavonoids of *tithonia diversifolia which* are used as medicine for diabetis, hepatitis etc (Giacom *et al,*2015)

Our solution demonstrate that organic agriculture contribute substantially to a more sustainable system of food production as it will enable farmers to contribute substantially to feeding the current and future human population on the current agricultural land base, while maintaining soil fertility.

NEXT MILESTONE

We will be buying tomato wastes from farmers for production of biogas and organic fertilizer in the biodigesters. 20% of the wastes bought will be put in the biodigesters and 80% will be mixed with tithonia branches for making fertilizer

ANOTHER BIG THING

We will set up a green house for production of tomatoes using our products to save as a demonstration farm. This project will be self sufficient because the tomatoes produced will be sold to sustain the operation at the farm.

CUSTOMER/USER VALIDATION

We will have more stakeholder's support. For example, The Tanzanian´s Organic Agriculture Movement (TOAM) which is striving to develop a sustainable organic sector through promotion of ecological agriculture inputs and establishments of reliable markets for organic inputs. As SUTOTE, we will leverage on this opportunity to make TOAM a trusted partner which will help us maintain required standard of our organic products.

Furthermore, there is high revolution in the preferences of farmers and consumers in Tanzania in which both farmers and consumers are looking for organic solutions to their farm needs. Firstly, smallholders farmers are being driven to farm organically by the soaring prices of inorganic pesticides and fertilizers. Furthermore, more farmers are adopting organic practices because it attracts many customers who prefer to buy food that is healthy and environmentally friendly. Furthermore, The rapidly growing organic sector in Tanzania is being propelled by attempts to engage smallholders, with estimated certified land area range from 37,000ha to over 64,000ha. A 2001 survey recorded an organic area of 55,867ha, comprising 0.14% of the agricultural area and approximately 27,000 farms.(Lleblein, 2008).

Incentive

Health and environmental effects of synthetic pesticides and other non-natural substances used to increase agricultural production have stimulated consumer and marketer interest in organic foods. Previous studies indicated that consumers are more likely to pay a premium for the superior quality and taste of organic foods, as well as their certified "safeness" (Emerald Insight, 2015).According to Faostat, tomato consumption per capita reached 382,658 kilograms in 2013 in Tanzania. Fruthermore,according to Roselyne Alphonce (2012), in Tanzania 33.33% of consumers are willing to pay a premium for organic tomatoes. Wang 2018, argues that Fast-spreading information through social and other media on food scandals and multiple warnings about conventional foods have influenced consumers to consider organic foods.

As part of our social responsibility, we will be teaching farmers on how to use our solution. Therefore,it will be easy for farmers to double their farm produce without compromising ability of the future generation to double their yields because *Tithonia diversifolia* is widely spread plant in Tanzania which means that it is readily available solution to sustainability which farmers can use for making pesticides and fertilizer at no cost. As a matter of fact, *Tithonia diversifolia* is a common weed of roadsides, wastelands, field edges, riverbanks in tropical regions (Williams,2018).

Creative effective flows

We have designed our system in a very self-sufficient way whereby we will plant the Tithonia diversifolia in our farm which will guarantee us a readily available flow of resources for making the pesticides and fertilizers. Furthermore we will have a good partnership with our farmers who will also be sources of tomato waste which we will be using for organic fertilizer (mixed with mexican sunflower). As a backup, we have planned to plant the *Tithonia diversifolia* along the Ruaha river in Iringa region which will also guarantee us a nonstop availability of inputs to our solution.

Innovation

Pesticides made from *Tithonia diversifolia* is a product that provide a holistic farm management system which aims to optimize the health and productivity of interdependent aspects of circular economy such as soil life, plants, animals, and people. Rather than relying on expensive and nonrenewable external inputs, our solution promotes the use of locally available ornament plants to contribute to sustainability in agriculture. In addition to that, residuals of tomatoes will be used to make organic fertilizers and, in biodigester obtaining organic fertilizer after producing biogas which will contribute to reduction in reliance on synthetic fertilizers and, firewood and charcoal respectively. There are more than 30,000 smallholders farmers in our target area who are willing to produce tomatoes in a most affordable and safest way.

IMPACT ASSESSMENT

SUTOTE is inspired by the availability of *Tithonia diversifolia* in Tanzania and its nutritional and pesticidal ability. According to research conducted, crude extracts of T. Diversifolia was toxic to the leaf cutting ants and insects that transfer diseases (Quintana, 2013). Furthermore, *Tithonia diversifolia* plant (Mexican sunflower) is a rich source of nitrogen, phosphorus and potassium which is ideal for land restoration (Jama, 2000). Green leaf biomass of tithonia is high in nutrients, averaging about 3.5% N, 0.37% P and 4.1% K on a dry matter basis. Tithonia biomass decomposes rapidly after application to soil, and incorporated biomass is effective source of N, P and K for crops. For example, in some cases, on a sample of maize farm, yields were higher with incorporation of tithonia biomass than with inorganic fertilizer at equivalent rates of N, P and K. As SUTOTE we thought of leveraging on the power of *Tithonia diversifolia* to kill insects to come up with pestcides for tomatoes thereby eliminating agents for diseases in Tomato plants.

Impact

The use of *tithonia diversifolia* will reduce reliance on synthetic pesticides and fertilizers which will reduce the effects of these synthetic products on people´s health. Our solution will also reduce the contamination of land and water bodies. If replicated, our solution will provide a sustainable solution for low-income farmers who will be able to produce tomatoes using low-cost inputs.

We are targetting 1750 farmers in the first year of operation in Iringa region. According to the Ministry of industry, trade and marketing, Iringa region has more than 30,000 tomato farmers most of whom are small with an average of 0.25 acres per farmer who produce 70% of total tomatoes in Tanzania so 1750 farmers is a very achievable target.

PROTOTYPING

1. Tithonia as a pesticide in tomatoes

Organic pesticide assures the safety of the farmers,consumers and environmental conservation as well, therefore to test the viability of the organic pesticide made from *Tithonia diversifolia*, we conducted a test in 2019 in a small tomato farm with 16 tomato plants. Two handfuls of tithonia leaves were chopped and mixed with 5 liters of water and later the solution was left for 24 hours so that all the extacts could be absorbed. The solution was applied in tomato plants twice a week. The pesticide was applied to the leaves of tomato plants at a dosis of 7ml per plant three weeks after germination and **from the same third week of germination**, pesticide was applied twice in a week. The results suggested that the organic pesticides produced with 90% of concentration of the liquid solution, and diluted to 15% by water, can kill (after direct contact) insects such as stink bugs, cutworms, tomato hornworms, cabbage loopers, whiteflies, tomato fruitworms, flea beetles, red spider mite, slugs, and Colorado potato beetles which are agents for diseases that affect tomato plants.

Pictorial presentation of pestcide formation process from Tithonia diversifolia

2. The use of tithonia diversifolia to make organic fertilizer

A *Tithonia diversifolia* produces a lot of branches in a period of two months and that worked to our advantage. In our test conducted, we used tithonia diversifolia to produce compost which is rich in N,P and K. We combined it with kitchen wastes where the large content was tomato waste at the ratio of 4:6. Datas were recorded at 7 days interval in a period of two months from the time of transplantation. We observed the diameter of the stem collar above the soil surface was 3 cm, increase in the number of leaves and the height of the plant. The harvested tomato fruits were high in biomass by 50% than unfertilized tomato plants.

Pictorial presentation of organic fertilizer formation process from Tithonia diversifolia

ACKNOWLEDGEMENT ON PROTOTYPE SUCCESS

We did our prototype with leadership of Professor José Cristino Melgar Melgar, Professor of Phytopathology at EARTH University.

BARRIER ACKNOWLEDGEMENT

The expected challenge is on the farmers to adapt to the use of this new and sustainable solution, to combat it, we aim to cooperate with The Tanzanian´s Organic Agriculture Movement (TOAM) and Tanzania Horticultural Association(TAHA) to use the best approach posible to make sure that farmers use our solution for best results. These two organizations are already connected to many farmers and promotes organic farming methods throughout the country. **Another barrier is finance and for that we are looking forward to the grant from the Wege Prize competition,on other alternatives reaching out to the Ministry of Agriculture in Tanzania and Tanzania Agricultural Development Bank (TADB) for the support through its programs of helping the young people venturing into agriculture understandingthe demand of Organic food in the world market whereby in the high note the ministry encourages more farmers to practice organic farming.**

DETAILED MATERIAL ANALYSIS

1.Raw materials

a.Mexican sunflower (*Tithonia diversifolia*)

It is a common weed of roadsides, wastelands, field edges, riverbanks, disturbed sites, forest edges, borders of orchards, groves, and disturbed secondary forests available in different parts of Tanzania, which is a raw material for making organic pesticide and fertilizer. The *Tithonia diversifolia* will be obtained from our farm and also harvested from roadsides and riversides by workers.

b.Tomato wastes

Tomato wastes are rich in macronutrients, including Nitrogen, Phosphorus and Potasium. These wastes will be mixed with Tithonia diversifolia to boost the nutritional contents.

According to the test carried out, in which 500 kgs of organic fertilizer and inorganic fertilizer were used for application at the same time in two diferent maize blocks. The organic fertilizer produced higher nutritional values plants. This is inline with Adediran et al (2007) who found out that effectiveness of organic fertilizers is higher than that of inorganic fertilizer. The optimum rates of the organic fertilizers for sustainable maize was between 5 and 10t per hectare higher that the yield for inorganic fertilizer.

2. Processing

The organic pesticides will be produced with 90% of concentration of the liquid solution. For application into a farm, farmers will be requiring a concentration of 15% that means they will be required to dilute with water.

3.Packaging

Recyclable plastic gallons for organic pesticide from Silaafrica company in Tanzania and biodegradable paper bags for organic fertilizer from eco friendly bags company in Tanzania. We will set up collection site for recyling of these bags and gallons. Incentives will be put in place to encourage farmers to recyle.

DETAILED ECONOMIC ANALYSIS

S U T O T E BUSINESS MODEL CANVAS

Key partners

- Export promotion of organic products from Africa (EPOPA)
- Tanzanian´s Organic Agriculture movement (TOAM)
- Tanzania Horticultural Association (TAHA)
- Tomato farmers
- Tropical Pesticides Research Institute (TPRI)

Key activities

- Making organic pesticides and fertilizers
- Teaching farmers best use of our products

Key resources

- Tithonia diversifolia
- Tomato wastes
- Machinery
- Human resource

Value proposition

- Affordable farm inputs
- User friendly farm materials
- Healthy benefits to consumers
- Timely delivery
- Free trainings to farmers

Customer relationship

- Field presentations on use of our products.
- Fields follow ups and farm visists.

Channels

- Social media advertisements
- Point of sells will be retailers, wholesalers, direct delivery and online platforms

Customer segments

- Tomato farmers.
- Organic crops farmers.
- Non organic crops farmers.
- Agro dealers within Tanzania and neighboring countries.

Cost structure

- Land and building
- Labour and tax
- Transportation
- Electricity
- Grinding machine
- Packaging
- Storage materials
- Marketing and branding
- Other expenses

Revenue model

- Sales of organic pesticides.
- Sales of organic fertilizers.

SWOT ANALYSIS

INTERNAL FACTORS

STRENGTHS

- Secured and reliable availability of raw materials for our products.
- A very diverse team that is fully knowledgeable to the wicked problem.
- Affordable and high quality products that suits the needs of farmers *(pesticide and fertilizer).*

WEAKNESS

- Limited financial to start the project (Of which we aim to start a little as we will be expanding in the near future)

EXTERNAL FACTORS

OPPORTUNITIES

- Organic foods are in very high demand at the national level and the world at large.
- The ministry of agriculture in Tanzania is calling for and support innovations in organic food production through Tanzania Agricultural Development Bank.
- Experts feedback and seed funding from Wege prize

THREATS

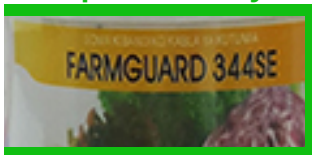
- Farmers adapting to our solution as being the first time being introduced.
- Competition from other organic products producers.
- Competition from inorganic producers who are already in the market now.

	PRE-STARTUP	1st year	2nd year	3rd year	TOTAL
1. Startup	$ 14,230.00	$ 360.00	$ 6,360.00	$ 5,610.00	$ 26,560.00
2. Cash Receipts					
(a) Cash Sales for pesticides		$ 7,000.00	$ 9,800.00	$ 4,165.00	$ 20,965.00
(c) Cash sales for fertilizer		$ 11,000.00	$ 19,250.00	$ 24,750.00	$ 55,000.00
3. Total Cash Receipts	$ -	$ 18,000.00	$ 29,050.00	$ 28,915.00	$ 75,965.00
4. Total Cash Available	$ 14,230.00	$ 17,640.00	$ 22,690.00	$ 23,305.00	$ 77,865.00
Cash paid out		Covered in pre-startup			
(a) Land and building	$ 3,400.00		$ -	$ -	$ 3,400.00
(b) Labour	$ 1,550.00		$ 1,550.00	$ 1,550.00	$ 4,650.00
(c) Transportation	$ 850.00		$ 1,600.00	$ 850.00	$ 3,300.00
(d) Grinding machine	$ 2,500.00		$ -	$ -	$ 2,500.00
(e) Utilities (electricity,water)	$ 880.00		$ 800.00	$ 800.00	$ 2,480.00
(f) Packaging	$ 750.00		$ 1,300.00	$ 1,300.00	$ 3,350.00
(g) Stores materials	$ 650.00		$ -	$ -	$ 650.00
(h) Marketing and branding	$ 750.00		$ 750.00	$ 750.00	$ 2,250.00
(i) Legal and Tax	$ 200.00	$ 360.00	$ 360.00	$ 360.00	$ 1,280.00
(j) Raw materials	$ 1,000.00				$ 1,000.00
(k) Sealing machine	$ 1,700.00		$ -		$ 1,700.00
6. Total Cash Paid Out	$ 14,230.00	$ 360.00	$ 6,360.00	$ 5,610.00	$ 26,560.00
7. Cash Position	$ -	$ 3,050.00	$ 16,330.00	$ 17,695.00	$ 37,075.00

SUMMARY OF REVENUE PROJECTION		
Parameter	**Organic pesticide**	**Organic fertilizer**
Total units sold monthly	125	146
Product price	$ 4.00	$ 11.00
Monthly revenue	$ 583.33	$ 1,375.00
Annual revenue	**$ 7,000.00**	**$ 16,500.00**

We will be able to break even in the first 7.5 months (if all things remain constant). We need to sell 1,093 galons of organic pestcide and 937 of 50kgs bags of organic fertilizer to reach the break-even point.

Competitor analysis



Inorganic insecticide for the control of Aphids, bollworms and other sucking pests on fruits and vegetable.

Is an organic fertilizer made from green and brown organic wastes made in Tanzania.

It is inorganic fertilizer for tomatoes made in Uganda

Inorganic insecticide for the control of Aphids, bollworms and other sucking pests on fruits and vegetable.

Our competitive advantage

- **We will be the only entity producing organic pesticides with combined power of controlling sucking pests and other disease-causing insects in tomatoes.**
- **Our organic pesticides is environmental friendly and does not pose any risk of pesticides poisoning thereby upholds the safety of users and consumers. For example, our pestcide doesnt kill good bugs like bees and Monarch Butterflies which are useful for pollination.**
- **Our products will be afforbable and readily available any time farmers need them.**

Price analysis

Pesticides		Unit	Fertilizers		Unit
Cypermethrin	$ 6.91	Litre	Hakika organic	$ 20.69	50kg
Farm guard	$ 2.50	100ml	Green pulse inorganic	$ 23.71	50kg
SUTOTE organic	$ 4.00	Galon	SUTOTE organic	$ 11.00	50kg

OUR MENTOR

Professor Jose Cristino Melgar Melgar ,Professor of Phytopathology at EARTH University in Costa Rica

SUTOTE TEAM

Chief Executive Officer

TENNYSON NKHOMA

***U*-Agriculture Science and Natural Resources Management**

Costa Rica

Production manager

WINFRED NZIKU

***U*-Agriculture Science and Natural Resources Management**

Costa Rica

Sales and financial manager

MIRIAM NYONI

***U*-Business Management and Entrepreneurship**

Malawi

Africa

Health and safety manager

SAMWELI MPANGALA

***U*-Medicine**

Tanzania

Africa

Technical and research manager

FAUSTER MUTTANI

***U*-Water Resources and Irrigation Engineering**

Tanzania

Africa

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