Potential of Technology of Effective Microorganisms (EM) in Zanzibar

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Abstract

Effective microorganisms (EM) innovative technology is growing and dispersing approach that has been proved efficient in enhancing crop yields as well as purifying polluted environment. Several scientific researches have already been conducted to assess its validity along with its impacts and all of them have revealed encouraging results confirming that the technology has numerous benefits in both agriculture and environment that have never been realized before through any other existing technology.

Zanzibar depends mainly on agriculture to strengthening its economy with estimated 80% of its population involved in agriculture. However, it has been facing several limitations and troubles in agriculture practices. Some biofertilisers have been tested especially in rice cultivation such as azolla- *Anabaena* and *Azospirillum lipoferum* in rice and Rhizobium in cowpeas and have shown encouraging results and thus signifying the use of beneficial microorganisms.

This paper discusses the status of agriculture in Zanzibar and assessing the current biofertilisers systems that are under research. It forecasts the position of EM Technology to promote agricultural activities. It therefore ascertains the suitability and feasibility of the technology to be disseminated and implemented in the country to alleviate poverty that has largely been contributed by poor agriculture practices. The paper also unveils the existing environmental problems such as coastal water pollution that can be eliminated using EM Technology. The paper provides substantial information proving the viability of the EM technology to be used in Zanzibar tropical Islands to enhance agriculture and improve environmental profile of the islands.

Zanzibar: background information

Zanzibar consists of two relatively large islands- Unguja and Pemba, plus a number of small islands that form a total area of 2,332 square kilometres. It is estimated that the current population is about 800,000 persons.

The climate of Zanzibar is dominated by a bimodal pattern of rainfall, which is influenced by the monsoon winds. The long rainy season (known as Masika) commences at the end of March until mid-May, while the short rains (known as Vuli) fall in November and December. Unguja Island receives about 1600 mm of rains while Pemba Island receives about 1900 mm, and more than half of the rains in both islands fall during the long rainy season. There is a period of intermittent showers between June and September, which are the coolest months of the year. The western sides of both islands receive more rains than the eastern sides, which are

mainly coral and less fertile. The mean maximum temperatures for Unguja and Pemba Islands are, 30.3^{0}C and 29.3^{0}C, while the mean minimum temperatures are 23.5^{0}C and 21.1^{0}C, respectively. The relative humidity of both islands range between 60 and 70%.
This warm and humid weather is favourable for the growth of almost all tropical crops, and the multiplication and survival of a number of beneficial and harmful microorganisms.

The situation of agriculture in Zanzibar

More than 50% of the total land area is used for crop production at a subsistence level. The major crops that are grown are:

- Cereals: rice, maize, sorghum and millet
- Legumes: cowpeas, mungbeans, pigeon peas, bambara nuts
- Root crops: sweet potatoes, yams, cassava
- Fruits: papaya, banana, citrus, mangoes, and many other tropical fruits
- Spices: cardamom, cinnamon, blackpepper

In Zanzibar, agriculture forms the backbone of the economy of the country. It is the occupation of about 80% of the population, of whom a majority are poor and live as subsistence farmers. In an effort to minimize the use of chemical fertilisers because of their expensive nature and its impact to the environment, efforts have been made to look at alternative ways of using nitrogen-fixing organisms in order to optimise yields per unit area of the farm.

The current situation of fertiliser use is minimal. Most of the fertiliser is used in rice farming, at much less than the recommended rates. The chemical fertilisers that are used are N, P and K, while farmyard manure or compost is organic fertilisers that are predominantly used in vegetable production. There are numerous drawbacks due to use of chemical fertilizers including soil fertility reduction, pollution of water bodies etc. Hence there is a great potential for farmers to be encouraged to use these other sources of fertilisers in order to maximise their yields and safeguard the environment.

Biofertilisers that have been tested, especially in rice cultivation are azolla- *Anabaena* and *Azospirillum lipoferum* in rice, and Rhizobium in cowpeas.

Azolla

Azolla is an aquatic fern that lives in association with the nitrogen-fixing corynebacterium *Anabena azollae*. It is therefore used as a nitrogenous fertiliser in the rice fields. The use of azolla in rice fields has increased rice yields in the Asian countries at less cost when compared with the chemical N fertilisers. Azolla has also been found to fix up to 80 kg N/ha under Zanzibar conditions. The nitrogen that is available in azolla is available to rice plants after its decomposition.

Azolla is not a native fern in Zanzibar, but *A. nilotica* has been found to exist around Lake Victoria and Lake Malawi in Tanzania mainland. Three species were introduced in Zanzibar in 1985: *A. caroliniana, A. pinnata pinnata, A. pinnata imbricata* and *A. microphylla*. Of these *A. pinnata pinnata* has been found to be the best adapted species in the islands.

Apart from its nitrogen-fixing ability, azolla has several other uses. When intercropped with rice, its coverage on standing water within a short time restricts weed growth, hence greatly reducing the weeding operation. Azolla powder or fresh, is also used as feed for poultry such as

ducks, and as green fodder for livestock, and can be used as an organic manure in vegetables. It has also been found to suppress the larval growth of mosquitoes.

Although azolla has several advantages, but there are drawbacks to its use and care has to be taken regarding its utilisation. If too much azolla is left to multiply in the rice fields without being incorporated, it tends to choke the young seedlings that have been recently transplanted and therefore reduce the tillering ability of rice. Similarly it can choke the sewage systems, and therefore it has to be constantly removed from the drainage canals.

Azospirillum lipoferum in rice

With the help of the International Atomic Energy Agency (IAEA), trials on the use of biofertiliser in rice and cowpeas have started. The research is looking into the effect of using bacterial *Azospiyrillum lipoferum* – N4 that fixes nitrogen, which is later utilised by the rice crop.

Initial results have been promising (table 1). The use of biofertiliser has increased the plant height, number of tillers and yields by up to 19% in one variety BKN when compared with control. Although its yields are much lower when compared with the use of chemical fertilisers, it must be noted that the farmers in Zanzibar are very poor and use minimum amounts of chemical fertilisers. Hence, this can be used together with small amounts of chemical fertilisers to increase the yields of the crop per unit area.

Further research will be carried out on the economic analysis by using biofertiliser plus different rates of industrial fertiliser, so as to come up with recommendations that farmers can use on their crop.

Table 1. Influence of biofertiliser on plant height, tiller number and grain yields of rice varieties, 1999.

Treatment	Variety					
	BKN			RP		
	Inoculated	Chemical fertiliser[1]	Control	Inoculated	Chemical fertiliser	Control
Plant height (cm)	90	105	82	93	110	90
Number of tillers produced	181	274	157	160	219	148
Grain yields (kg/ha)	1924	3447	1619	1684	2861	1624
% Yield increase	19	113		4	76	

Source: Khatib, K. J. 2000. Kizimbani Agricultural Research Institute, Zanzibar.

[1] Nitrogen fertiliser was applied at the rate of 100 kg N/ha. Phosphate fertiliser was applied in all treatments at the rate of 60 kg P_2O_5/ha.

Biofertiliser in cowpeas and beans

Another trial that is in progress is on the use of nitrogen-fixing rhizobeum in cowpeas and beans. Trials are in progress to evaluate and compare the local strains with the introduced ones, and to look at the rate of their nitrogen-fixing ability.

Environmental Situation

Zanzibar has four towns including its capital town known as Zanzibar Town, which includes historical stone town. The towns are overcrowded and lack adequate water supply with

poor sanitation facilities. There is no centralized sewerage system at any place over all the Zanzibar. In the case of Zanzibar town only small part (Stone town) is served with sewer system. Domestic wastewater is discharged into septic tanks (appr. 1700 in total), after which overflow combines with part of the storm water and gets finally disposed into the sea. At present over 1,300 tones/day of sewage are discharged into the marine environment without effective treatment and thus impair coastal environment. A build-up of algae already visible at the beaches surrounding old stone town that increases the bio-oxygen demand and pathogen micro-organisms in the water and hence alters the balance of marine resources in the area and makes the water unfit for recreation or socio-economic uses.

Table 2. Average concentration of seawater samples collected along the coast of Zanzibar town.

Sampling Site	Water Temp. °C	DO mg/l	Fecal coli/ml	Total coli/ml	BOD mg/l	COD mg/l
Maruhubi	33	7.6	6	68	2	1530
Port	29	7.2	1500	4350	2	1066
Bwawani	33	4.5	7066	10270	132	899
Shangani	30	7.3	1515	5585	13	1234

Source: Van Bruggen 1990. Preliminary Study on Environmental Pollution on Zanzibar.

Future strategies to promote the use of EM

EM is considered useful to improve both agriculture and environment. The use of EM in agriculture has several beneficial impacts and have proved efficient in purifying polluted aquatic and land environment and remains as best choice to combat water pollution. It enhances crop yields in organic systems and develops soil to improve its ability to sustain crops. The technology is particularly potential and significant due to its several economic benefits and its friendly nature to the environment.

Despite the fact that there is a great potential on the use of beneficial microorganisms in both agriculture and environment, very little has been carried out although with the little research, success has been obtained. Most of the farmers can benefit from this type of research, because a majority are resource-poor farmers who use minimum amounts of chemical fertilisers.

EM technology appears the best technology that needs to be introduced and applied in agriculture and environmental system. This technology seems excellent over current innovative approaches, as it has been proved efficient without any significant drawbacks unlike to Azola and other biofertilizers. The following reasons make the EM technology vital in Zanzibar situation.

- Effective microrganisms (EM) are naturally occurring organisms that are available ubiquitously.
- EM can be easily prepared and easily applied.
- It does not need larger area for its application
- Less expensive
- Can treat both sewage and solid waste completely to harmless valuable substances.
- EM can be applied in integrated system of agriculture, aquaculture, environment etc.
- It is sustainable

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