TANZANIA COMMISSION FOR SCIENCE AND TECHNOLOGY

PROJECT BRIEF - PROMOTING THE USE OF MINJINGU PHOSPHATE ROCK IN ORGANIC VEGETABLE PRODUCTION

Can Minjingu Phosphate Rock (MPR) alleviate phosphorus deficiencies and sustain vegetable production in the Southern Highlands of Tanzania?

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SUMMARY

Organic produce have become increasingly popular in recent years due to increasing market demand for natural products, concern about side effects of chemicals in fruits and vegetables as well as increased environmental protection. However, studies investigating whole-farm phosphorus (P) budgets (all of the P that comes into and goes out of the farm) have found nutrient P deficits in many organic farms. In order to replace the P removed in harvested crops additions of non-processed mineral sources such as Phosphate rock (PR) is recommended in organic farming systems. Tanzania has two principal deposits of phosphate rock (PR); one located at Minjingu area along lake Manyara with a proven 10 million tons deposit of rock phosphates and the other at Panda hill in Mbeya. However, inadequate knowledge and poor plant responses especially during the first year of application have resulted into low adoption of this locally available fertilizer material despite its potential in increasing soil P. Also, limited studies to demonstrate effectiveness of PR in increasing crop productivity also contribute to low adoption.

This policy brief looks at the use of phosphate rock (PR) in organic vegetable farming in the Southern highlands of Tanzania where soils are inherently low in P. It highlights the results of a study "Increasing Phosphorus Availability in Organic Farming Systems" conducted in 2009/2012. The results revealed that there is great potential in using PR in organic vegetable farming. Combining PR with organic fertilizer materials increases soil available P due to enhanced PR dissolution thus making it available to short seasoned crops like vegetables. The results also suggest that including cabbage in the cropping sequence increases effectiveness of PR for subsequent crops. The use of PR in vegetable farming, supplies both calcium (Ca) and P nutrients which are essential for growth and yield. Promotional activities should be conducted to increase the number of farmers accessing the product and adopting the use of MPR in vegetable production especially in the southern highlands and other areas where soils have low pH, Ca and P. This is especially seen as important in light of the Government of the United Republic of Tanzania (URT) push for "Kilimo Kwanza" and agriculture's predominance in the economy. At a time when the government is embarking on Kilimo Kwanza as Tanzania's green revolution to transform its agriculture into a modern and commercial sector, it is interesting to see if Tanzania could use such findings to increase agricultural production in a safe manner.

INTRODUCTION

Agriculture plays an important role in poverty reduction, particularly in poorer countries such as Tanzania where the majority of people depends on agriculture for their livelihood. As such, the government instituted "Kilimo Kwanza". One of the ten main pillars in Kilimo Kwanza is industrialization where enhancement and improved production and quality of fertilizer from the current Phosphates and NPK production at Minjingu to 300,000 tons are identified as a critical activity. In addition to the above, among the eight Millennium Development Goals (MDGs) which Tanzania as a country ratified include, eradicating extreme poverty and hunger and ensuring environmental sustainability. Based on its principles that include health, ecology, fairness and care, organic farming contributes to achieving MDGs through providing a long term solution to poverty and food insecurity and promoting environmental sustainability.

By definition organic agriculture is a production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Organic agriculture combines tradition, innovation and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved (IFOAM, 2008). Awareness on organic farming is growing worldwide due to increasing global market demand, concern about side effects of chemicals and environmental protection. For example, in Finland 100 new companies have entered the organic sector in 2012 while 365 farms have submitted a request for an organic certificate (Ule Uutiset, 2012). Figure 1.1 below illustrates the growth of organic agricultural land between 2000 and 2010. In Tanzania, by the end of the year 2002, there were only 4,000 registered organic farmers (Crawley, 2002). However, in 2010 the land area under organic cultivation in Tanzania was 72,665 ha while the number of producers had increased to 85,366 (Willer et al. 2012), showing the growth in this sector and its potential

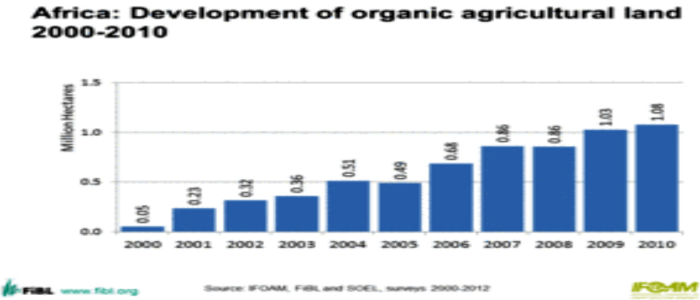
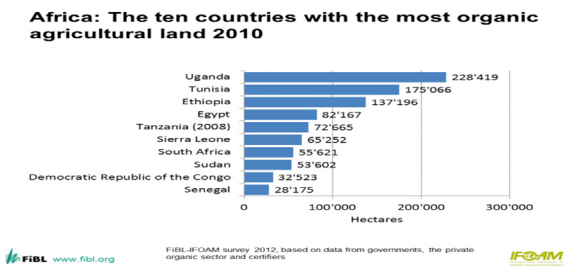


Figure 1.1: The growth of organic agricultural land between 2000 and 2010



Looking at comparative data, Tanzania is in the top 10 countries with the most organic agricultural land in 2010 signalling the further potential for this area if properly managed.

Figure 1.2: top 10 countries with the most organic agricultural land in Africa

However, despite this potential, one of factors limiting production of organic crops is low supply and availability of soil phosphorus. The problem is more serious in Sub-Saharan Africa because of the low content of soluble P on bedrock in many regions. In addition, continuous leaching of nutrients to deeper soil layers due to high rainfall is a common predicament in areas such as the southern highlands of Tanzania. Leached soils become increasingly acidic and therefore unsuitable for sustained crop production because nutrients such as P become fixed whereas nitrogen is lost to deeper layers. Adequate soil available P enables plants to store and transfer energy, promotes root, flower and fruit development, and allows early maturity.

The southern highlands of Tanzania has potential for growing vegetables such as cabbage, tomato, amaranth, carrots and many others which are grown either conventionally or organically for home consumption and commercial purposes. Such kinds of vegetables demand high levels of N and P nutrients. The sole use of organic materials does not supply adequate amounts of P for optimum plant growth. While water soluble P fertilizers (e.g. TSP, DAP) are not accepted, in order to avoid depletion of nutrients and sustain organic vegetable production in these areas, the use of phosphate rock is recommended (IFOAM, (2009). However, Minjingu Phosphate Rock (MPR) that is locally available in Tanzania has not been widely tested in vegetable crops. Three different MPR products (Minjingu Hyperphosphate, Minjingu Mazao and Minjingu Dust) are already available in agro-input shops in the southern highlands but they are not commonly used in vegetable growing. Limited studies on the use of MPR in vegetable crops and lack of awareness of technologies to improve PR dissolution have led to low adoption of the product. This gap in research and understanding has led to limited use of this product which has substantive potential for vegetable farming in Tanzania. The study undertaken in 2012 sought to fill this gap by using scientifically rigorous methodology to test validity of adopting the use of phosphate rock.

APPROACHES AND RESULTS

A study was conducted from 2009 to 2012 to investigate the effect of cropping sequence and frequency of MPR application on soil phosphorus (P) availability and vegetable crops yield. The study involved a researcher managed on farm field experiment conducted in Mbeya region and screen house pot experiments at Agricultural Research Institutes (ARI) Mikocheni and Uyole using a split plot design with three replications. Crop sequence constituted the main plots while the P sources were the sub plots. The cropping sequence included (i) Cabbage - tomato - maize (ii) Maize - tomato -cabbage (iii) Cabbage - cabbage - maize, and (iv) Maize - tomato - maize. The P sources included (i) control (no fertilizer material added), (ii) direct application of MPR, (iii) compost + MPR, (iv) crotalaria green manure + MPR and (v) NPK (standard). The field experiment was repeated three times on the same plots. In the fourth season, bean crop was planted in all plots without fertilizer application to capture the residual nutrients. The frequence of MPR application was studied in pot experiment. Application intervals constituted the main plots while the sources of PR were the sub plots. The PR application intervals included (i) Once in the 1st crop cycle (ii) During 1st and 3rd crop (iii) During each crop cycle. The same P sources applied in the field experiment were used. Results from the study reveal that:

FINDING 1:

Amendment of compost with MPR increases soil pH (Fig.1), available P, organic carbon, vegetable yield (Fig. 2, 3, and 4) and P uptake. Compared with NPK treatment, MPR application increased cabbage yield especially during the first season when soil Ca level was low due to its ability to supply Ca. After three crop cycles, compost + MPR treatment increased soil available P by 218%.

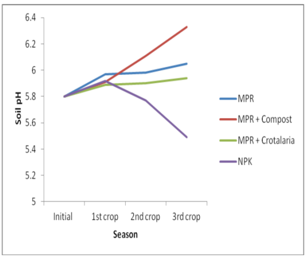


Fig: 1 Changes in soil pH following application of MPR for three seasons

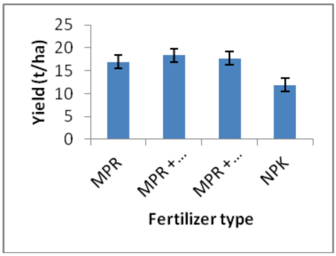


Fig: 2 Cabbage yield (t/ha) as affected by MPR.

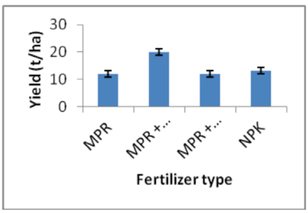


Fig: 3 Tomato yield (t/ha) as affected by MPR

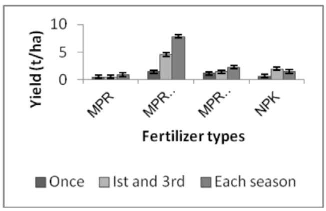


Fig: 4 Effect of MPR applied at different intervals on amaranth yield

FINDING 2:
Plants in the cabbage family can influence the effectiveness of PR for subsequent crops. In the plots where cabbage was omitted from the crop rotation final P had increased only by 85% as opposed to 207% where cabbage was included.

FINDING 3:
After three seasons there was higher residual P in plots where MPR was applied as compared with NPK. Bean crop planted to capture the residual P produced higher pod yield in MPR than NPK-treated plots.

WHAT SHOULD BE DONE? POLICY IMPLICATIONS
Contribution of organic agriculture to food security, integrated soil fertility management (ISFM) and environmental sustainability cannot be overemphasized. The governments continued push for Kilimo Kwanza as Tanzania's Green Revolution to transform its agriculture into a modern and commercial sector highlights industrialization for agricultural transformation as well as the use of science and technology. It is pertinent to therefore use research findings to inform decision making in the agricultural sector. Findings from this study illustrate that the declining soil P could increase if the depletion rate is not brought under control. In order to alleviate the situation more efforts and promotional activities are needed to increase the uptake and utilization of MPR. Based on the above analysis it is recommended that:

Action point 1:
- Up scaling programme including farmers training should be conducted in the southern highlands and other areas with low soil pH, phosphorus and calcium to increase the number of farmers adopting the use of MPR in vegetable production. Participatory methods including farmer field school (FFS) should be used to demonstrate on application methods, appropriate cropping sequences and other best agronomical practices for effective use of MPR. In order to ensure sustainability, important stakeholders including farmers, extension staff, leaders, primary schools and media should be involved in the program.

Action point 2
- Local government authorities in areas suitable for application of MPR should support, sensitize and build capacity of stakeholders so as to promote wider use of this fertilizer material

Action point 3
- The government should subsidize the costs for MPR so as to increase the number of farmers accessing the product in Tanzania.

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