Report of the Wang'waray (Tanzania) Farmers Field Day on the preparation and use of compost from indigenous leguminous plants and phosphate rocks

Mawazo Shitindi, Kokoasse Kpomblekou, Mateete Bekunda, Festo Ngulu, Johnson Semoka, Ramble Ankumah, and Conrad Bonsi

Produced by Tuskegee University and Sokoine University of Agriculture

Published by International Institute of Tropical Agriculture (IITA)

August 2015

www.africa-rising.net

The Africa Research In Sustainable Intensification for the Next Generation (Africa RISING) program comprises three research-for-development projects supported by the United States Agency for International Development as part of the U.S. government's Feed the Future initiative.

Through action research and development partnerships, Africa RISING will create opportunities for smallholder farm households to move out of hunger and poverty through sustainably intensified farming systems that improve food, nutrition, and income security, particularly for women and children, and conserve or enhance the natural resource base.

The three regional projects are led by the International Institute of Tropical Agriculture (in West Africa and East and Southern Africa) and the International Livestock Research Institute (in the Ethiopian Highlands). The International Food Policy Research Institute leads the program's monitoring, evaluation and impact assessment. http://africa-rising.net/

This document was made possible with support from the American people delivered through the United States Agency for International Development (USAID) as part of the US Government's Feed the Future Initiative. The contents are the responsibility of the producing organization and do not necessarily reflect the opinion of USAID or the U.S. Government.

Contents

Executive Summary 1
Cover crop biomass production and composting 2
Visit to maize field experimental plots 3
Questions and discussions 4
Conclusions 7
Appendix 1: List of Participants 8
Appendix 2: Event media coverage 10

Executive Summary

The field day was organized as an activity of a collaborative research project being implemented at Wang'waray Farmers Training Center in Babati District since 2013 by Tuskegee University (TU), Africa RISING, and Sokoine University of Agriculture (SUA).

Implemented in two phases, the project aims to find out the best ways in which cover crop biomass and Tanzanian phosphate rocks can be used as alternative to industrial nitrogen (N) and phosphate (P) fertilizers to improve soil fertility under smallholder maize production in the northern zone of Tanzania.

During the first phase (December 2013-December 2014), compost was produced using funds from the Norman Borlaug LEAP Fellowship program and Africa RISING project. During the second phase (January -- July 2015), supported by The Innovative Agricultural Research Initiative (iAGRI) and Africa RISING, maize was grown at Wang'Waray Farmers Training Center using the compost produced and stored during the first phase. Four months following maize planting, a field day was conducted on May 14, 2015 to demonstrate how leguminous cover crops (*Crotalaria juncea, Dolichos lablab*, and *Mucuna pruriens*) and Tanzanian phosphate rocks (Minjingu and Panda Hill) can be composted and used to improve soil fertility in order to increase maize yield in smallholder maize production zone in northern Tanzania.

The field day attracted eighty participants, 37.5% of them were women (appendix 1). The participants were drawn from seven villages in the area (Sabilo, Seloto, Hallu, Arri, Gidas, Endasago and Wang'waray) accompanied by their extension officers. The participants were eager to learn the new technology proposed. The participating farmers were selected from villages either involved in maize production, with serious soil fertility constraints, or involved in soil conservation and sustainable agriculture project with Africa RASING project. Other participants included three invited guests from Babati District Council, three representatives from IITA, Ramble Ankumah (Tuskegee University), and two media reporters from Mwananchi communications LTD and Star television (Appendix 1).

Themed, ***preparation and use of compost from indigenous leguminous plants and phosphate rocks***, the activities at the field day included three technical interactive sessions intended to highlight and respond to concerns raised by smallholder farmers from rural areas where access to commercial inorganic fertilizers is out of reach to farmers due to their prohibitive costs.

Cover crop biomass production and composting

The participants learned about cover crop biomass production and procedures for composting the biomass with phosphate rock to produce phosphate rock enriched composts. Handout leaflets and posters (Figure 1) were distributed to attendees who were taken to the experimental site where they received explanation on how the three cover crops were planted in six strips, harvested, and composted during phase one of the project (Figure 2). Key concepts covered during this session included the preliminary survey conducted to select the site, soil sampling and analysis done to establish soil fertility status, land preparation and planting of the cover crops at recommended spacing of 50 cm x 30 cm for Mucuna and Lablab, or in drills of 50 cm between rows for crotalaria. Harvesting of cover crops at the right (flowering) stage and storage before composting was also discussed. Preparation of compost pits (2.5 m x 2 m x 1 m) and composting of the biomass in alternating layers with phosphate rock, inoculation with cow manure, addition of water to keep compost pile moisture at around 60%, turning of the mixture at 30 day intervals until maturity and storage of mature compost before field application were also explained.

Figure 1: Project summary displayed on posters before the field visit Photo credit: Shitindi Mawazo/SUA

Figure 2: Interactive session on cover crop biomass production and composting process. Photo credit: Shitindi Mawazo/SUA

Visit to maize field experimental plots

The session intended to show farmers and stakeholders how the phosphate rock enriched composts used as alternative for N and P fertilizers performed under field conditions. The participants were accompanied for an interactive tour of the experimental plots containing different treatment combinations of cover crop alone or cover crop biomass composted with phosphate rock with or without urea using maize as a test crop (Figures 3a and 3b). A medium term maize variety (SC 627) preferred over others by farmers in the area was planted as test crop. The treatment combinations were explained to the participants who were allowed to take a walk around the plots, discern observable differences, and annotate questions and comments on treatment effects and performance of the crop for further discussions (Figure4).

Figure 3a: Participants listening to Mr. Shitindi's presentation

Figure 3b: Mr. Shitindi explaining different treatment combinations to participants.

Figure 4: Participants in small groups visiting the experimental plots. Photo: Shitindi Mawazo/SUA

Questions and discussions

A total of 13 questions and comments (Table 1) were recorded from the participating farmers and addressed by the organizers (Figure 5). To end the session, the organizers were interested in finding out whether the farmers were able to differentiate the treatment effects on the crop performance in the field, potentials of the technology demonstrated, its potentials for adoption, farmers' perception relative to the new technology, and what they learned during the sessions.

Figure 5: A session was held to address farmers' concerns and observations. Photo: Shitindi Mawazo/SUA

Table 1: Questions and comments posed by participants attending the field day

S/No.	Name of farmer	Village	Question	Answer
1	Daniel Marko	Endasago	What's the cause of plant performance differences between plots (i.e. some plants were short while others were tall)?	The differences might be due to several factors including the following: (i) Differences in nutrient supply from different treatments applied (i.e. Different type of composts, different type of phosphate rocks and combinations of phosphate rocks and Urea). (ii) Natural variations in soil properties such as moisture retention and organic matter content of individual plots, the position of individual plots within the block; and drought effects resulting into uneven germination. However, the most correct reason will only be justified by laboratory and statistical analyses hence communicated through our final report because this research has not reached its end yet
2	Ayoubu	Gidasi	What was the application rate of the different composts?	The application rates were based on the recommended nitrogen rate of 112 kg N/ha for the Northern zone and nitrogen content of each compost.
3	Leandri Daniel	Ari	(a) During composting, what's the amount of phosphate fertilizer mixed with the green manure?	(a) Amounts used were 36 kg of air dry Mucuna biomass + 2 kg Minjingu phosphate (18:1 ratio) 36 kg air dry Mucuna biomass + 2.5 kg Panda Hill phosphate (14.4 :1 ratio) 31 kg of air dry Lablab biomass + 2 kg Minjingu phosphate (15.5 :1 ratio) 31 kg of air dry Lablab biomass + 2.5 kg Panda Hill phosphate (12.4 :1 ratio) 30 kg of air dry Crotalaria biomass + 2 kg Minjingu phosphate (15:1 ratio)

			(b) What are the possible reasons for the differences observed between plants treated with composts of different cover crops?	30 kg air dry Crotalaria biomass + 2.5 kg Panda phosphate (12:1 ratio) (b) The cover crops differ in their physical and chemical properties hence their effect on soil properties and nutrient release for plant growth and production may also be different.
4.	John Matei	Seloto	Why mix the phosphate fertilizers with cover crop biomass when preparing the compost?	The aim of our research is to come up with composts which can supply adequate amounts of nitrogen (N) and phosphorus (P) for maize production hence serve as an alternative for industrial N & P fertilizers under smallholder maize production. Thus, leguminous cover crop biomass was used as source of N while phosphate rocks were used as source of P. Since the decomposition of biomass is facilitated by soil microorganisms which release enzymes and organic acids during the process; we expected that those enzymes and organic acids will act on the phosphate rocks in the compost mixture and improve its dissolution to release P in plant available form to be utilized by maize plants within the same season.
5	Paulo Joachim	Sabilo	Why use industrial fertilizers in making compost while we know they are expensive. Don't we have alternative options?	Industrial fertilizer was not used to make the composts. We used ground /powdery phosphate rocks which are locally available at Minjingu and Panda Hill areas of Manyara and Mbeya regions respectively; and all the two products are reasonably cheaper than industrial phosphate fertilizers. Inorganic fertilizer (Urea was only used in the field as a control to compare the ability of composts to supply N for maize production)
6	Jacob Shauri	Endasago	I have used salty soil from Gidewari to hasten decomposition of plant material and make the process quicker than the duration required for your composts to mature. Have you tested it	I have never used the salt thus, I can't tell anything about its effect on the decomposition process. Since we are doing research to find out cheap and affordable technologies for smallholders, I will try my best to communicate with local researchers and extension officers to find out what they know about its suitability for compost production. However, the same salt might have some negative effects such as increasing the pH beyond the recommended levels for microbial activities in the compost/soil as well as for your crop. It can also neutralize the organic acids required for dissolution of phosphate rock in the compost mixture.
7	Petro Nicomedi	Endasago	(a) Why did you use industrial fertilizers which are expensive in you research plots?	(a) As said before, Urea was used as a control treatment based on which we can evaluate the ability of the compost to supply equivalent amount of N for maize production. This will allow us to come up with conclusions that any of the composts used in our research

			(b) One of our colleagues used Urea to basal dress/sow his maize but most of his seeds did not even germinate what is your recommendation on that?	can be used as an alternative for urea under smallholder maize production. (b) Urea is usually used for top dressing but small amounts can be used with phosphate fertilizers with no N (such as phosphate rocks) at planting. Please consult your local extension officer for advice on how much and when to apply based on properties of soil in your field because when misused urea and other fertilizers will negatively affect your plant growth.
8.	Christina Elias	Endasago	Can we apply the compost to each hill instead of broadcasting?	Broadcasting and incorporation of the compost into the soil is less labor demanding and allows the material to be well distributed in the soil for maximum contact with the soil. This in turn improves nutrient release from composts which usually release nutrients at a slow rate than industrial fertilizers; but can also minimize losses by leaching and erosion effects. Application of composts per hill may be much more labor intensive and can cause localized nutrient concentrations around the rhizosphere.
9.	Petro Kalist	Seloto	How much compost is applied per planting hill?	The compost was uniformly broadcasted and incorporated in individual plots of 16 m^2 based on N composition at the 112 kg N/ha rate due to the reasons said before while addressing the question asked by Mr. Ayoubu from Gidasi Village. This was equivalent to 3.5 – 5 ton/ha (1400 – 200 kg/acre).
10.	Scolastica Michael	Hallu	(a) Maize plants in the first plot of block II had yellowing symptoms. What is the cause for that? (b) Does it imply that the fertilizers applied in the first phase of research 2013/14 did not have any residual effect on maize growing in the field this season (2015)?	(a) The yellowing can be attributed to different factors, especially nutrient deficiencies in the soil. Based on treatments applied in our research plots, N deficiency could be the most likely cause for what you observed but this will only be confirmed by the ongoing laboratory analysis of maize leaf and soil samples collected from each plot. (b) No fertilizer was applied on the plots during the first phase of this research (2013/14). Only three different cover crops were planted in strips and harvested at flowering/early podding stage. Air dry biomass was then composted with phosphate rock as explained before; then, each type of compost was applied back to the plots along the same strip used to produce each cover crop biomass except for control plots. Such a deficiency symptom on a control plot thus, might imply that N fixed by the three leguminous cover crops was not enough to meet the requirements of maize this season or was utilized by weeds growing in the field before maize was planted.

11.	Abel Michael	Seloto	Compost production seems to be too labor demanding, what can I do to produce enough composts to supply my 12 acres of land?	It can be difficult to do that but you are not advised to put all your land under cover crop biomass production for composting. You can divide the land into four or more portions and rotate cover crops with cash and food crops in such a way that when either of the plots is planted with a cover crop other plots are used for food or/and cash crop production.
12.	Josephat Julian	Hallu	The aim of the research is to reduce the work load and other cost of production. Why don't you work on reducing the time required for compost maturity instead of 120 day used in your technology?	Decomposition of any plant material is usually facilitated by microorganisms which use the material as source of food and carbon. However, we can cut down the time required for decomposition by harvesting the biomass at the right growth stage (not too old), inoculating the compost with mature composts or decomposed animal manure and creating favorable conditions for microbial activities in the compost pit or pile by regular turning of material to improve aeration. Cover crop biomass harvested at very tender stage will usually decompose faster but may have low nutrient content than those harvested at early flowering stage and this will have effect on nutrient composition and supply of your compost.
13.	Joseph Naamo	Hallu	**Comment:** It seems like there is non-significant difference between plots treated with compost and those treated with industrial fertilizer. There is a need to publicize this new technology to the wider farming community	

Conclusions

Based on the number and nature of the questions and comments posed by the participating farmers during the discussion session, it was observed that most of them were able to see and understand the effects of the different treatments on maize performance in the field. Most of them were interested in knowing how the compost was produced from the cover crop biomass in combination with the phosphate rocks, especially on the biomass: phosphate rock ratio used in the composted materials and the criteria used to decide the ratio. The farmers were also interested in the final results from the research so as they can apply the technology at their farms. The main concerns of the farmers included: labor requirement of the technology, time required (120-150 days) for compost maturity and the application method (broadcasting and incorporation) which was claimed by the farmers to be uneconomical in terms of compost and time spent per unit area of land thus, most of them preferred application on planting holes which is also a possibility.

Appendix 1: List of Participants

NAME OF PARTICIPANT	GENDER	VILLAGE /INSTITUTION	OCCUPATION
Ezekiel N. Mngumi	M	Sabilo Village	Extension officer
Pascal Ngadi	M	Sabilo Village	Farmer
Lindeli Paul	F	Sabilo Village	Farmer
Shadikia Bombo	M	Sabilo Village	Farmer
Maria Geay	F	Sabilo Village	Farmer
Paul Joakim	M	Sabilo Village	Farmer
Samwel Petro	M	Sabilo Village	Farmer
Israel Petro	M	Sabilo Village	Farmer
Maria Ayoub	F	Sabilo Village	Farmer
Elizabeth Mhindi	F	Sabilo Village	Farmer
Jackson J. Mbwambo	M	Seloto Village	Extension officer
Rozalia Harweli	F	Seloto Village	Farmer
Agness Claud	F	Seloto Village	Farmer
Petro Kalist	M	Seloto Village	Farmer
Francice Michael	M	Seloto Village	Farmer
Abel Michael	M	Seloto Village	Farmer
Adolf Petrol	M	Seloto Village	Farmer
Telesphonia Kastuli	F	Seloto Village	Farmer
Patrice Sist	M	Seloto Village	Farmer
John Nakei	M	Seloto Village	Farmer
Rahabu B. Keremba	F	Hallu village	Extension officer
Victor B. Matay	M	Hallu village	Farmer
Josephat Julian	M	Hallu village	Farmer
Bura Shamba	M	Hallu village	Farmer
Lazaro Derong	M	Hallu village	Farmer
Joseph Naamo	M	Hallu village	Farmer
Marck Theodory	M	Hallu village	Farmer
Scolastica Michael	F	Hallu village	Farmer
Anna A. Lyimo	F	Hallu village	Farmer
Mosses Qaraya	M	Hallu village	Farmer
Elisha Mabelele	M	Arri village	Extension officer
Leandri Daniel	M	Arri village	Farmer
Faustin Dawite	M	Arri village	Farmer
Nicodemo Tiuway	M	Arri village	Farmer
Juma Mohamed	M	Arri village	Farmer
Mwanahamis Isango	F	Arri village	Farmer
Maria Fransis	F	Arri village	Farmer
Hawa Athuman	F	Arri village	Farmer
Agness Samson	F	Arri village	Farmer
Sebastian Paul	M	Arri village	Farmer
Betha Kalist	F	Gidas village	Extension officer
Ayoub Jeremia	M	Gidas village	Farmer
Omari Farayo	M	Gidas village	Farmer
Rashid Farayo	M	Gidas village	Farmer

Marco Sagware	M	Gidas village	Farmer
Rehema Ramadhan	F	Gidas village	Farmer
Yuda Gwichame	M	Gidas village	Farmer
Jacob Shauri	M	Gidas village	Farmer
Yona Pantaleo	M	Gidas village	Farmer
Charless Manase	M	Endasago	Extension officer
Nicdemas Mnyawa	M	Endasago	Farmer
Petro Nicomed	M	Endasago	Farmer
Pendael Elias	F	Endasago	Farmer
Simon Gwandu	M	Endasago	Farmer
Christina Elias	F	Endasago	Farmer
Selina Gichoro	F	Endasago	Farmer
Jacob Nawe	M	Endasago	Farmer
Daniel Marco	M	Endasago	Farmer
Leopord Aurelian	M	Endasago	Farmer
Hidaya Idd	F	Wang'waray village/FTC	Farmer
Edidth Benjamin	F	Wang'waray village/FTC	Farmer
Rehema Augustino	F	Wang'waray village/FTC	Farmer
Mariam Hamis	F	Wang'waray village/FTC	Farmer
Asha Hussein	F	Wang'waray village/FTC	Farmer
Ashura Hassan	F	Wang'waray village/FTC	Farmer
Omary Didian	M	Wang'waray village/FTC	Farmer
Joseph Charless	M	Wang'waray village/FTC	Farmer
E. Urio	F	Wang'waray primary school	Teacher
H. Shedrack	F	Wang'waray primary school	Teacher
E. Mbise	M	Wang'waray FTC	FTC officer in charge
S. Kilonzo	F	Wang'waray FTC	Extension officer
Julius G. Lyatuu	M	Babati District Council	Extension officer
Zuifa Mussa	F	Mwananchi Communications LTD	Media reporter
Zacharia Mtigandi	M	Star Television	Media reporter
Jetrida Kyekaka	F	Babati District Council	DAlCO
Hassan Lugendo	M	Babati District Council	Ag. District Executive Director
F.S. Ngulu	M	IITA -Tanzania	Research officer
Matete Bekunda	M	IITA -Tanzania	Principal Research Officer
Mawazo J. Shitindi	M	Tuskegee University	PhD candidate
Ramble Ankumah	M	Tuskegee University	Professor

Appendix 2: Event media coverage

The Guardian, Monday May 18, 2015

New compost manure scales up soil fertility

By Lusekelo Philemon, Arusha

A researcher-cum-student from a US-based Tuskegee University has come up with compost manure that proved to be an effective tool towards scaling-up soil fertility as well as increasing crop productivity for Tanzania's small -holder farmers.

In his study, Mawazo Shitindi, a PhD student at Tuskegee University said the newly developed compost manure, is being mixed with the Minjingu phosphate fertilizer.

"This is an ideal solution towards addressing the declining of soil fertility, rising energy, nitrogen fertilizer and skyrocketing prices of artificial fertilizers," Shitindi said here over the weekend.

The researcher said the environmentally friendly manure cuts cost of production, while increasing productivity per acre.

Compost manure is a mixture of organic matter, as from leaves and manure, which has decayed or has been digested by organisms, used to improve soil structure and provide nutrients.

Shitindi said his research was aimed at improving soil fertility by using compost manure, hence; reducing cost of production for small-scale farmers.

"This manure reduces the amount of artificial fertilizers, which is expensive for Tanzania's smallholder farmers. This also boosts environmental conservation efforts as well as reduces soil erosion."

The technology also involves the use of remains of leguminous plants, which contain root nodules that use soil bacteria to fix nitrogen, a process that converts atmospheric nitrogen into useful compounds like ammonia.

He said that by mixing the compost manure and Minjingu Phosphate provide a very good result and provide a solution to the farmers' outcry as before the technology farmers used to complain that Minjingu Phosphate fertilizer takes long time to provide a positive results.

"But, with this mixture, Minjingu phosphate takes a short time to dissolve in the soil."

One of the agricultural officers in Babati District, Manyara Region, Jetrida Kyekaka expressed his hope on the new research finding, saying it will scale-up crop production in the area which is highly affected by the negative impacts of climate change.

"I am very optimistic that these research findings will boost maize production in this area and address poverty in this area. Many people here are unable to buy artificial fertilizers because of its skyrocketing prices."