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Synthetic Fertilizer: Friend or Foe?

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“The health of our soils provides the foundation for the productivity of our farming systems, the food and nutrition security of our societies, and the improvement of livelihoods and alleviation of poverty in our world. Soils of sub-Saharan Africa (SSA) are unhealthy, largely due to years of crop nutrient-mining and limited organic or inorganic resupply.”
([Stewart et al., 2020](#))

Crop production without adequate fertility results in cereal yields of less than 500 kg per hectare, which leave households food insecure ([Hove, et al., 2008](#)). Low-yielding plants also produce limited crop biomass to serve as soil cover and to fuel the soil biological activity which leads to soil health.

Without addressing soil fertility needs, smallholder farmers cannot benefit fully from Conservation Agriculture systems. CA techniques like soil cover and reduced soil disturbance can enhance soil moisture status, for example, but without adequate nutrients, even a well-watered plant will not develop or produce in abundance. For this reason, many CA proponents argue that enhanced soil fertility management should always be combined with CA principles.

To overturn this situation farmers can either use organic amendments, synthetic fertilizers or both.



CA practices without adequate soil nutrition leads to poorly developed plants which can't take full advantage of the benefits provided by CA.

ORGANIC AMENDMENTS

Organic amendments can be produced relatively cheaply from animal manures, crop residues, and household wastes. In addition to providing essential plant nutrients, these materials can improve the physical, chemical and biological properties of soils. They release nutrients relatively slowly through the biological and chemical breakdown of complex organic compounds, and thus are less prone to leaching than more soluble synthetic compounds.

On the down-side, organic materials generally have a relatively low nutrient composition and are too bulky to transport easily. Organic amendments like compost and livestock manure require significant labor to prepare and apply properly, and the quantities available to small-scale farmers are often limiting.

Green manure cover crops overcome many of these limitations by producing high-quality organic amendments right in the field where they are used, thus eliminating the need for transportation. However, their productivity depends on environmental conditions, and in dry years they may not perform adequately. Furthermore, they don't always fit easily into desired crop rotations.

INORGANIC FERTILIZER

Synthetic fertilizer use in SSA, has been clouded with myths and controversy. While some claim "We can't practice CA without fertilizer," others assert that "Fertilizers will poison our soils!" The truth, as with most such controversies, lies somewhere in between these extremes.

The properties of synthetic fertilizers are determined predominantly by their mineral content. Essential plant macronutrients such as nitrogen, phosphorus, and potassium are contained in various chemical compounds. Secondary and micronutrients may also be included solely or in combination. The properties of these individual chemicals affect both how fertilizers benefit plants, and their potential to harm plants and the environment.

Direct injury to crops results most often from the salt content of the fertilizer. Nitrogen fertilizers, including urea and CAN, and potassium chloride (KCl) have the highest salt indices of the commonly used materials and care should be taken to avoid placing them in contact with seed or plant foliage. Fertilizers containing mostly phosphorus (e.g. DAP) have a much lower salt index and a much lower risk of plant or seed injury (see table).

Salt Index and Acidification Potential of Common Fertilizers		
Fertilizer	Salt Index ¹	Acidification Potential ²
Ammonium nitrate, 34% N	104	0-3.6
Ammonium sulfate; 21% N, 24% S	68	3.6-7.2
CAN, 27% N	83	0-3.6
Urea, 46% N	74	0-3.6
DAP 18% N, 46% P ₂ O ₅	29	3.6-5.4
MAP 11% N, 52% P ₂ O ₅	27	3-6-7.2
Potassium chloride, 62% K ₂ O	120	n/a
Potassium sulfate, 50% K ₂ O, 18% S	43	n/a

¹ Relative to sodium nitrate. [From J.J. Mortvedt](#)

² Kg of calcium carbonate needed to neutralize the acidity of 1 kg of actual nitrogen. Range = with and without NO₃ leaching. [From M. McLaughlin](#)

A second negative impact of synthetic fertilizers is their potential to acidify soils. Acidification potential depends not only on the chemical content of the fertilizer, but also the starting soil pH and leaching potential. In general,

however, ammonium and sulfur containing fertilizers have the highest acidification potential (see table). Given the relatively low fertilizer rates used by smallholder farmers in SSA, acidification from fertilizers is much less of a risk than in industrialized countries where fertilizer is used at high rates. Nonetheless, if fertilizers are concentrated in planting basins over multiple years, pH changes should be monitored and addressed as needed.

The greatest detriment from synthetic fertilizers occurs when farmers rely on them to maintain crop yields without combining them with organic amendments like those described above and other good management practices like mulching, residue retention and soil conservation. Without these practices, long-term soil health *will* deteriorate and increasing rates of fertilizer will be needed to maintain yields.

When the availability of organic inputs is limited, however, synthetic fertilizer use has the potential to *enhance* the soil-health improvements brought about by the above good agronomic practices. By producing larger plants, fertilizers can make available *more* organic biomass which can be used to increase soil organic matter and soil cover, two key strategies in improving soil health.

RECOMMENDATION FOR SMALLHOLDER FARMERS

Integrated Soil fertility Management (ISFM) – As noted above, both organic and inorganic nutrient sources can contribute to crop productivity and soil health. Used together, in fact, they are more effective than when used separately:

- Soil organic matter increases fertilizer nutrient retention
- Enhanced soil moisture caused by soil organic matter allows plants to take up fertilizer nutrients more effectively
- Nitrogen fertilizer “primes” nutrient release from high-carbon organic sources
- Fertilizer helps produce larger plants with more biomass & organic matter, potentially increasing soil organic matter levels

Micro-dosing – Smallholder farmers in dry areas cite the high risk of crop failure as a major reason for not investing in fertilizers. The precise application of small quantities of inorganic fertilizers, known as *micro-dosing*, is one strategy that can allow such farmers to reduce risk and maximize their return on investment from applying synthetic fertilizers. When promoting micro-dosing, remember to:

1. Use the correct material at the right time. Fertilizer should be applied when the crop can immediately use it.

- Apply manure and/or a compound (NPK) fertilizer to planting stations at planting time
- Top dress with a nitrogen fertilizer at the 5–6 leaf stage for cereal crops
- If rains are good and if you have enough fertilizer, apply once more at stem elongation for cereal crops

2. Apply the right amount of fertilizer.

- One soda or beer bottle cap per 3 plants at planting (or 350 ml manure)
- One soda or beer bottle cap per 2–4 plants at top dressing, depending on the type of fertilizer (see: [Micro Doses, Mega Benefits](#))



Micro-dose rates assume a *full*, 6 g bottle cap (left) not a partial bottle cap (right).

3. Apply at the correct place.

- Avoid broadcasting fertilizers
- Place at least 5 cm from the plant
- Cover with soil unless rain is expected soon after application

Lessons from Covid-19 Livelihoods Projects

Mike Salomons, Agriculture and Livelihoods Technical Advisor

In July 2020, 17 CFGP Partners launched nine-month initiatives to help farmers cope with the disruptions of market, input supply, and agriculture extension caused by the Covid-19 pandemic. Global Affairs Canada provided funding to support smallholder farmers in Ethiopia, Kenya, Uganda, Zimbabwe, and DR Congo. Since the effects of the Covid-19 pandemic are likely continue for the foreseeable future, we would like to share some initial learnings from this program.

AGRICULTURE EXTENSION: FARMERS APPRECIATED THAT ONGOING TRAINING AND SUPPORT FOR THEIR FARMING ACTIVITIES WAS NOT CUT OFF.

This was made possible through both in-person and distance extension methods:

In-person extension: The Covid-19 pandemic made it more difficult for farmers to connect with government trainers and NGO extension workers. Partner staff who don't live within the communities they serve often faced difficulties accessing the farmer groups. However, in most cases community-based trainers and Lead Farmers continued their work while following Covid-19 safety guidelines.



Lead Farmers with Anglican Development Services in western Kenya continued training with appropriate safety measures.

Distance extension: The use of radio turned out to have more beneficial impacts than expected, exceeding targets set by local partners. One local Partner stated that before Covid-19 many farmers had no or little interest in listening to the radio. However, due to radio programming provided by the Partner, which included agricultural extension information as well as health information on the Covid-19 pandemic, there was a renewed interest from project participants, including many families who listened to programming together. Another local Partner incorporated a wide variety of messaging in their radio programming, including agricultural extension, health information, and conversations around gender. They discussed challenges facing people due to Covid-19 such as the increased number of people returning to rural areas and the associated changes in household dynamics. SMS messaging was used effectively by some Partners, and helped more people in the family get agricultural extension information (as opposed to in-person trainings which are generally attended by only one member of the family). Brochures distributed by partners were also helpful in broadening the audience.

SAVINGS GROUPS: STABILIZING SAVINGS AND LOANS GROUPS AND ENSURING ACCESS TO FINANCIAL CREDIT WAS PARTICULARLY APPRECIATED BY PROJECT PARTICIPANTS.

Local partners did not provide any financial resources to these groups, but encouraged different ways of meeting, and provided personal protective equipment for those who were able to continue to meet in person. Finding ways to facilitate groups was critical, and while some groups fell apart due to the stresses of the pandemic, many more were able to continue.

SEED: THE PROVISION OF AGRICULTURAL SEED WAS VERY BENEFICIAL.

Because many of the market systems which provide seed fell apart at the beginning of the Covid-19 pandemic, farmers had fewer than normal options for accessing seed.

MARKETING: SUPPORT TO MARKETING EFFORTS HAD MIXED SUCCESS.

Some participants who were already involved in marketing aggregation groups were able to continue to sell. However, market systems overall were negatively impacted by the pandemic, making collective marketing more challenging than normal. This was exacerbated by the actions of individual farmers, many of whom had good harvests but chose not to sell their surplus because of concerns over what



Hermetic grain storage bags gave farmers like Josephine Mwikali Mutinda of Makeni Kenya, the ability to store crops until prices peaked. Photo: Mwangi Kirubi/Canadian Foodgrains Bank.

might happen in the future. Many local Partners provided hermetic grain storage (PICS) bags, which allowed farmers to store grain more effectively. This gave them the flexibility to sell or consume their harvest at later dates.

Partner Profile: Africa Inland Church of Tanzania - Mara Ukerewe

Neil Rowe Miller, Agriculture and Livelihoods Technical Advisor for Eastern Africa

The Africa Inland Church of Tanzania, Mara Ukerewe Diocese (AICT MUD) covers eight Districts and 30,150 sq km, including 8,532 sq. km of Lake Victoria, with a total population of 2.2 million people. Most of the Diocese is situated between 1000-1200 m above sea level with a mean annual rainfall of 800-1000 mm falling mainly in September through the end of the year. Farmers in the area practice rain-fed cultivation of rice, cotton, maize, sorghum and cassava; and pastoralism is also common.



Champion farmers, Hamisi Simba and Shabani Mwajma in maize field intercropped with jackbean.

The Diocese has a vast experience in agriculture, education, health, advocacy and gender programming with over 60 staff. For the past 10 years, AICT MUD has implemented economic strengthening programs, contributing to improvement of livelihoods and reduction of poverty. These programs emanate from the belief that every person has an inherent God-given potential, regardless of his/her background, which can be realized if they are empowered and provided with the right environment. As individuals, poor people may be voiceless and vulnerable, but when they come together in collective groups, they support one another in building strong and resilient communities.

AICT MUD has been providing agriculture and livelihoods training to communities in the Mara region in partnership with World Renew since 2009. Activities have included organizing farmers into Village Savings and Loan (VSLA) groups, providing training on entrepreneurship and livelihood diversification, introducing new crops and value-adding techniques, as well as promoting improved farming practices.

The Diocese began CA programming in 2012, and in 2015 they joined other CFGB Partners in the Scaling Up Conservation Agriculture (SUCA) in East Africa Program. Over five years they trained 3,826 farmers (2,095 women and 1,731 men) with 2,403 adopting CA-plus methods. In addition to these direct project participants, AICT MUD influenced government programs, other area NGOs, and universities to begin promoting CA-plus. Additionally, staff worked through primary and secondary schools to showcase CA to several hundred youth and their families.

One of the most striking successes of this project was the wide-spread adoption of green manure-cover crops, especially jackbean (*Canavalia ensiformis*). Although jackbean is not edible for humans or livestock, it grows well in the acid, sandy soils surrounding Lake Victoria, and farmers readily testify that it improves yields of subsequent crops. Reducing tillage, on the other hand, was more challenging, as farmers continued to prefer using oxen or tractors to plough their fields.

Government extension officers were seconded to the project by the District agricultural authority. The project also incorporated Champion Farmers, who were identified 3-6 months after starting work in a community so that their selection could be based on advice from village leaders, government extension workers, communities, and program staff.

VSLAs played a significant role in the scale up of CA as their weekly meetings provided a platform to share CA information, experiences, and resources such as cover crop seeds. Through training and discussions about aggregated marketing, MUD was able to help farmers sell 35 MT of maize at a higher price. Farmers were also able to negotiate fair prices for PICS grain storage bags which were purchased by 2,515 farmers in 2020.

In May, 2021 AICT MUD launched a follow-on project promoting CA-plus to 2100 farmers from new communities and 900 farmers from communities reached under SUCA. Farmers will also receive training in marketing, kitchen gardening, and chicken vaccination. An emphasis will be placed on mechanized CA as a way to reduce the practice of ploughing. VSLA training and gender promotion will be provided through a grant from a different funding partner.



Ploughed fields remain vulnerable to erosion, even when planted with cover crops.

Discussions from the Network:

Sebastian Scott: Strip cropping of 3 rows maize (with climbing bean), 1 row pigeonpea and 3 rows soya (see picture). Organic, natural farming. No chemical fertilizer, no booster, no herbicide, no insecticide, low cost, regenerative agriculture. Bring.the.soil.back.to.life!

Edmore Hungwe: How about pest and disease incidences under such? If none, what could be the contributing factors? crop combinations, planting dates, or type of cereal-legume intercropping?



Sebastian Scott: We find providing habitat for diverse species creates perfect conditions for ecological balance and we never take any action for pests in dry land crops, hardly ever for vegetable crops.

Sebastian Scott: We planted all same day.

James Kanyari: Job well done congratulations...a good intercrop.

The CA Technical Officers manage a Facebook Discussion Group from which the above conversations were copied. If you'd like to join the discussion, sign up at www.facebook.com/groups/CAinAfrica.