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ECHO Development Notes



BIOLIQUID FERTILIZER UPDATE

Bioliq liquid fertilizer is popular within ECHO's network and smallholder farmers around the world. This article shares results of nutrient analysis for two different formulations.



CONSIDERATIONS FOR CROP SELECTION

ECHO often receives questions about crop selection. This article will focus on the initial selection of a crop for cultivation using moringa, sweet potatoes, and tomato as examples.



TITHONIA AND NEEM FERMENTED LIQUID FOR TERMITE CONTROL

Network member Tim Tanner has experimented with using tithonia and neem to control termites before planting trees.



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Bioliq Fertilizer Update

by Tim Motis and Stacy Swartz

Bioliq fertilizer (BLF; also known as organic liquid fertilizer; Figure 1) is popular within ECHO's network and smallholder farmers around the world. ECHO West Africa introduces and instructs on how to prepare this amendment in *ECHO West Africa Note 1* (Sié Kansié, 2017; <http://edn.link/y3mrg2>). This fertilizer is easier to make than other on-farm amendments such as compost and is easily adaptable. ECHO encourages using locally available manure and plant options. Recognizing a need for information on the nutrient composition of BLF, we (ECHO staff in Florida) created two formulations of BLF and sampled them over time for nutrient analysis. This article summarizes our findings, which shed light on when to apply BLF and nutrient amounts with and without manure.



Figure 1. Bioliq Fertilizer ingredient ratios (A) and the process of mixing (B).
Source: Weslee Green (A) and Tim Motis (B)

Two options for generating on-farm bioliq fertilizer

In March, 2022 we made two different batches of BLF. The first was based on the formula outlined by Sié Kansié (2017) using pigeon manure and the new growth (leaves and stems) of Mexican sunflower (*Tithonia diversifolia*). The second, simplified formula contained tithonia and water only. Table 1 outlines formula ingredients and proportions. Table 1 outlines formula ingredients and proportions.

Results from nutrient analyses

Comparing nutrient content of manure and tithonia raw ingredients

Minerals analyzed, with their abbreviations, are listed in table 2. The local pigeon manure contained 4.0% total N (40 g N/kg manure), 2.7% total P (27 g P/kg manure), and 2.3% total K (23 g K/kg manure) based on dry weight. Our results are comparable to those reported by Chastain *et al.* (2001) for meat chicken manure (35.5-36 g N/kg manure, 34.5-36 g P/kg manure, and 23 g K/kg manure). Pigeon manure is nitrogen-rich

Table 1. Formula ingredients used in making bioliq fertilizers with rough guidelines refined to include more precise information in terms of weights of ingredients.

Formula	Ingredient	Rough guideline	Measured weight (kg or L)
Manure-based	Pigeon manure	1/3 of volume	25.4 kg
	Plants (<i>Tithonia diversifolia</i>)*	1/3 of volume	6.3 kg
	Wood ash	1 shovelful	0.8 kg
	Living soil	1 shovelful	2.7 kg
	Water	Remainder of volume	205 L
Tithonia only	Plants (<i>Tithonia diversifolia</i>)*	Full container (unpacked)	0.345 kg
	Water	Remainder of volume	18 kg

* *Tithonia* plant material used for both formulas were primarily leaf tissue and some new shoot growth (Figure 2).



Figure 2. Tithonia plant material used in both formulations. Source: Quinn Beitzel

and has a Carbon:Nitrogen (C:N) ratio of 8.24 on average (Villa-Serrano *et al.*, 2010). This low ratio is common among poultry manures because excrement contains both urine and solids. Cattle manure, in comparison, has a C:N ratio of about 20:1¹ (Macias-Corral *et al.*, 2019).

The young *Tithonia diversifolia* leaves used in both formulations contained 4.4% N, 0.7% P, and 2.5% K. Tithonia's high N content (Motis, 2017) is the primary reason for its use in making natural fertilizers such as compost and BLF. While the N and K content between the two main ingredients (pigeon manure and tithonia) are comparable, pigeon manure has greater P content. Livestock manures are common sources of P, a plant macronutrient needed for root development, photosynthesis, and cell division.

We thoroughly mixed each formula with the ingredients detailed in table 1 until uniform in appearance. The manure-based BLF was covered with a breathable cloth, allowing for aerobic decomposition. The manure-based BLF was mixed daily as outlined by Sié Kansié (2017). The tithonia-only formulation was covered with a plastic lid and was not mixed daily. Each week (including the week of initial mixing: week 0), we thoroughly mixed each formulation and obtained a sample. The tithonia-only liquid fertilizer was sampled for the first five weeks while the manure-based BLF was sampled for eleven weeks. At each sampling, a bottle of BLF was sent to a laboratory for mineral analysis.

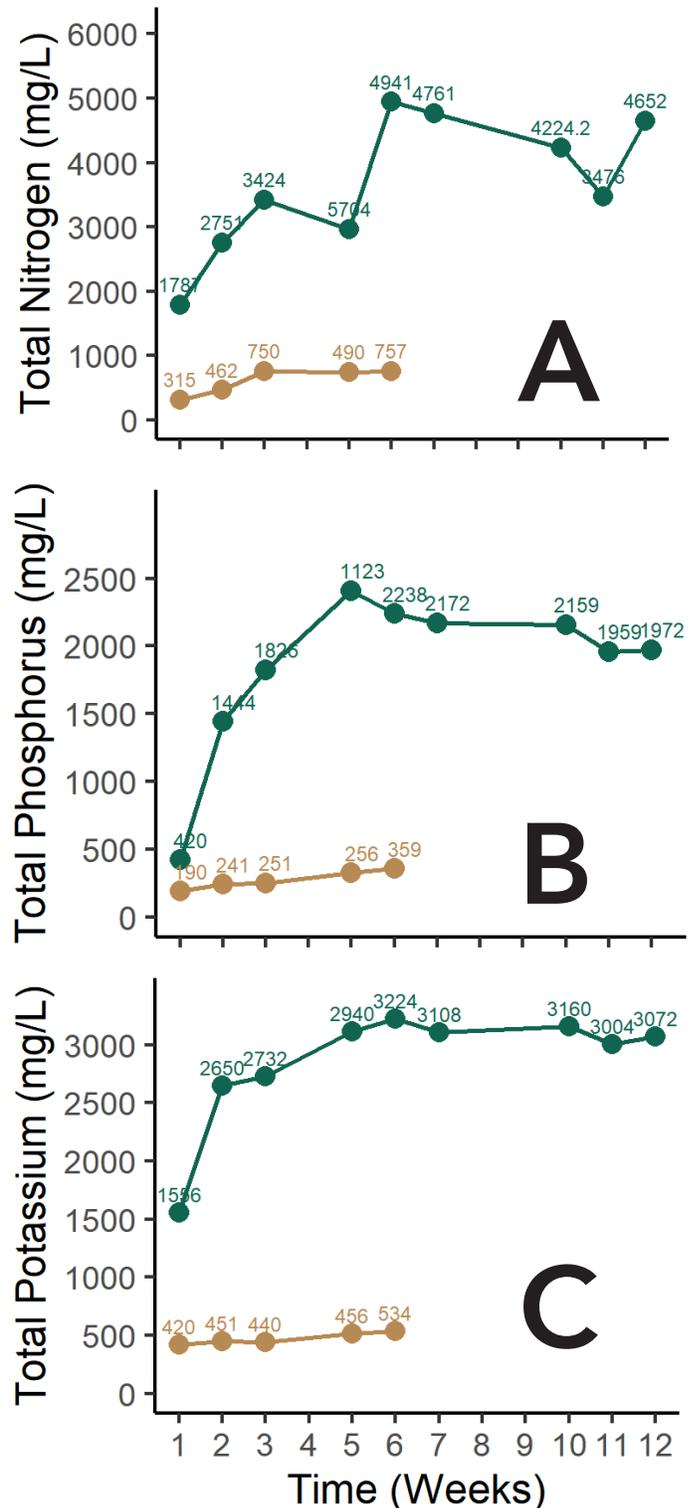


Figure 3. Total N (A), P (B), and K (C) content of the manure-based (green) and tithonia-only (brown) BLF formulations over time. Source: Stacy Swartz

¹ A low C:N ratio is ideal when utilizing manures in thermophilic composting (composting with the aid of heat-loving bacteria) but these manures cannot be used directly on most plants because the high nitrogen content can be toxic to plants. Poultry excrement is often captured using carbon-based litter such as sawdust or peanut shells to increase the C:N ratio. Livestock diet can impact C:N ratios of manures.

Table 2. Macronutrient, micronutrient, and sodium content of both BLF formulations over time.

Week	Type	Macronutrients*						Micronutrients*						Na
		Total N	Total P	Total K	S	Ca	Mg	B	Zn	Mn	Fe	Cu	Al	Na
0	Manure-based BLF	1787	420	1556	110	456	102	1.3	1.3	1.7	4.9	0.1	3.7	121
1	Manure-based BLF	2751	1444	2650	202	1658	281	1.8	5.4	8.4	20.1	0.8	11.3	179
2	Manure-based BLF	3424	1826	2732	234	2132	292	1.9	8.7	11.2	16.0	1.6	6.7	182
3	Manure-based BLF	5704	1123	2940	211	1329	282	2.0	4.3	6.3	17.4	0.9	9.6	190
5	Manure-based BLF	4941	2238	3224	551	5744	784	6.0	23.2	34.9	13.7	4.8	39.4	426
6	Manure-based BLF	4761	2172	3108	509	5702	774	5.8	23.6	33.3	25.0	4.9	41.4	405
9	Manure-based BLF	4224	2159	3160	522	5541	821	6.4	23.8	31.8	84.0	5.0	48.8	427
10	Manure-based BLF	3476	1959	3004	464	5080	803	5.8	23.0	27.6	76.0	4.6	43.1	404
11	Manure-based BLF	4652	1972	3072	452	5258	823	6.3	22.5	25.1	80.9	4.7	24.8	410
0	Tithonia-only	315	190	420	17	176	124	0.8	0.0	0.0	0.0	0.0	0.1	38
1	Tithonia- only	462	241	451	22	213	137	0.8	0.0	0.0	0.0	0.0	0.4	40
2	Tithonia- only	750	251	440	23	209	133	0.6	0.4	0.0	0.6	0.1	0.1	38
3	Tithonia- only	490	256	456	21	230	143	0.6	0.2	0.2	0.5	0.1	0.8	39
5	Tithonia- only	742	326	518	70	589	322	1.5	1.8	0.4	2.0	0.3	5.2	86
6	Tithonia- only	757	359	534	79	662	337	1.6	2.3	0.7	2.6	0.3	1.8	87

*Minerals analyzed were nitrogen (N), phosphorus (P), potassium (K), sulfur (S), calcium (Ca), magnesium (Mg), boron (B), zinc (Zn), manganese (Mn), iron (Fe), copper (Cu), aluminum (Al), and sodium (Na).

Comparing formulations over time

Figure 3 and table 2 present macronutrient values in mg/L (the equivalent of parts per million, ppm). Nitrogen content of both mixtures increased for the first two weeks after mixing and was optimal at week three for the manure-based BLF (Figure 3A). Phosphorus content increased each week for the tithonia-only formulation but peaked for the manure-based BLF at week five (Figure 3B). Potassium content followed a similar trend as P, increasing slightly in the tithonia-only fertilizer over time and increasing rapidly in the manure-based BLF until week five (Figure 3C). Average pH for the manure-based BLF was 6.76. Micronutrient and sodium content values are detailed in table 2.

② A 1:15 dilution for example means that you would mix one part BLF with 14 parts water. "Part" could be any unit of measure (e.g. mL, gallon, used water bottle).

③ Liquid fertilizers are often applied to the leaves as a foliar spray. This is sometimes done with compost teas as well; however, there is a risk of contamination with human pathogens such as *Escherichia coli* and *Salmonella*. This is especially a concern with leafy greens. The risk can be reduced by applying BLF as a soil drench, and applying it well before the crop is to be harvested and consumed.

In summary, we saw that:

- Nitrogen levels peaked at two (tithonia) to three (manure-based) weeks after making the fertilizer.
- Most of the other nutrients reached their highest levels at week five.
- These trends indicate that the optimum time to apply BLF is earlier (2 to 3 weeks, depending on the formulation) for nitrogen than other nutrients. Factors such as temperature, thoroughness of mixing, and sample handling may have impacted nutrient content values over sampling weeks.

Application recommendations

Sié Kansié (2017) recommends a dilution of 1:15 to 1:20^② applied near the base of plants^③ once or twice a week. Avoid applying too strong of a solution which could be toxic to sensitive plants. To avoid salt

buildup or salt-toxicity, use a hand-held TDS meter to confirm overall salt levels in the solution before application. Hoagland's solution used in hydroponic plant production is a potential benchmark to base dilutions rates on. Hoagland's solution has around 300 ppm N, so a 5000 ppm BLF formulation could be diluted 15 times to reach close to 300 ppm N. If you are using more plant material than manure, BLF N levels are unlikely to reach higher than 1000 ppm in which case a 1:3 BLF:water ratio is recommended. Even with manure included in the ingredients, nutrients in BLF are not highly concentrated, especially after dilution (e.g., a final concentration of 300 ppm N is only 0.03% N). ECHO uses BLF in combination with other nutrient sources such as compost or NPK fertilizer. Due to microbes and plant hormones that BLF contains, BLF can help plants use fertilizers more efficiently (Eudoxie and Martin, 2019).

Another factor to consider when diluting is the stage of the crop. Young seedlings are more sensitive to leaf burn caused by high salts than more established plants and therefore require more dilution (to lower the amount of BLF in relation to water) early on. Plants entering reproductive stages (flowering and fruiting) require less macronutrients than they did during vegetative stages (leaves and stem growth). After flowering, you could decrease or halt application of the fertilizer entirely.

Network member Tim Tanner (founder of [Kilimo Timilifu](#)) has also experimented with using tithonia-only fermented liquid in East Africa for the control of termites! Read more about his methods and experiences in the "Echoes from our Network" segment of this issue of *EDN*.

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Considerations for crop selection

by Stacy Swartz and Tim Motis

Introduction

ECHO often receives questions about crop selection as network members start new agricultural initiatives or enter a new area. Each agroecosystem is complex and should be evaluated for production, environmental, and socioeconomic tradeoffs as you consider the selection of a crop for cultivation, whether exotic or native. This article will focus on the initial selection of a crop for cultivation using moringa (*Moringa oleifera*), sweet potatoes (*Ipomoea batatas*), and tomato (*Solanum lycopersicum*) as examples.

Factors to consider

Crop use (Table 3)

A crop must have a local use that **meets felt needs** in the community. Conduct a needs assessment before planning what crop to cultivate. Flanagan (2015) outlines options for participatory community mapping tools such as resource mapping and transect walks. Some crops may have more than one use, which may be desirable if there are several needs. People may find alternative uses for a crop than what was initially intended which should be viewed favorably and encouraged. For example, some farmers may wish to use green manure cover crops for forage instead of for soil improvement. If a crop or practice fills needs and increases sustainability and/or productivity of the agroecosystem, it should be celebrated. Remember that sustainability is a scale, not an absolute.



Figure 4. Several sweet potato varieties prepared for cooking. *Source:* Emily Iverson

Table 3. Example crop uses and cautions.

Crop	Uses	Cautions
Moringa	Moringa leaves can be used nutritionally to boost human or animal health (Witt, 2014). Immature pods can be eaten as a cooked vegetable. Moringa seeds are consumed in some areas of the world and can be shelled, crushed, and used as a coagulant to reduce water turbidity.	Crushing moringa seeds does not remove all bacteria, viruses, or fungi (Bancesi <i>et al.</i> , 2020); purification of water with moringa seed can be combined with the SODIS (Solar Disinfection of Water) method. The nutritional value of moringa leaf powder decreases if leaves are dried in direct sunlight (Satawase <i>et al.</i> , 2013).
Sweet Potato	Sweet potato can be used nutritionally in human or animal health. Both the tubers and leaves are consumed. Improved varieties with orange flesh contain higher concentrations of beta-carotene. Leaves can be fed to livestock.	Some varieties have more palatable leaves or tubers (Figure 4) than other varieties.
Tomato	In subtropical and tropical settings, Roma-type tomatoes are often utilized in cooked meals. Cherry or grape tomatoes have applications for home or community gardening for fresh consumption.	Varieties differ in use and taste. You could conduct a screening trial of different varieties before selecting one for larger-scale cultivation.

Cultivation parameters (Table 4)

Whether or not a crop will succeed depends on the cultivation requirements of the crop. This includes parameters such as rainfall, temperature, elevation, soil type and pH, management, and seasonality. Select a crop that is **well-adapted** to your region's growing conditions.

Table 4. Example crop cultivation considerations and cautions.

Crop	Cultivation	Cautions
Moringa	Moringa is drought-tolerant and can handle heavy coppicing (repeated heavy pruning). It requires very little nutrients to grow but fertilization in sandy soils increases leaf production (Motis and Reader, 2019).	Moringa does not grow well in regions that have cold seasons. Moringa does not thrive in low-lying areas where water pools.
Sweet Potato	Sweet potatoes can be harvested as early as three months and as late as eight months, but ideal texture and size is typically achieved in five to six months. Sweet potatoes thrive in hot, sunny conditions, with ample water. Vines crawl across the ground, but do not climb.	In areas where sweet potato weevils exist, crop rotation must be possible to control the pest. Soil type can impact tuber production.
Tomato	Tomatoes grow best in dry, warm seasons with irrigation supplements. Tomato plants are large and take up growing space. Some varieties, such as those with a 'VFN' (Verticillium, Fusarium, and Nematodes) in the name, are resistant to diseases. Cherry and grape varieties tend to be more resilient (due to heat tolerance) in tropical and subtropical settings.	Most varieties are highly susceptible to many different insect pests and diseases (Figure 5). Tomatoes require intensive management.

FAO's [ECOCROP Database of Crop Constraints and Characteristics](#) is a valuable resource in learning about the conditions a crop can grow in. Select **high yielding** crops and varieties with **resiliency** traits such as drought tolerance or natural pest resistance. A selected crop must also fit the local farming system and be **compatible with other land uses**. Consider crop growth habits during selection.

Accessibility and availability (Table 5)

Select a crop that is available and accessible over time. This is especially a concern for crops multiplied using seeds. An ideal seed-propagated crop is one that will maintain desirable traits over successive seasons of planting, harvesting, and seed saving. This is more attainable with open-pollinated than hybrid varieties, as explained in an *ECHO Technical Note* [No. 63 (<http://edn.link/tn63#opv>)] by Motis (2010). If you are considering a hybrid variety, make sure seeds are available for farmers to purchase at a reasonable price. Before sharing seeds with farmers, check the germination percentage of a sample quantity. A germination test serves as an indicator of seed quality; several methods are explained in the above-mentioned *ECHO Technical Note* [No. 63 (<http://>]



Figure 5. Caterpillar damage on tomato fruit. Source: Tim Motis

Table 5. Example availability or access considerations and cautions.

Crop	Availability or access	Cautions
Moringa	Moringa can be propagated by seed or woody cuttings. It grows year-round in most subtropical and tropical climates.	<i>Moringa oleifera</i> does have several varieties that can cross with one another. Appropriate leaf drying conditions can be difficult in humid climates.
Sweet Potato	Sweet potato can be propagated by cuttings or slips (sprouts from the tuber). In the tropics sweet potatoes can be grown year-round though farmers will want to rotate production to break pest cycles.	Availability of improved varieties such as those promoted by International Institute of Tropical Agriculture (IITA) may be limited.
Tomato	Tomato seeds can be easily saved from year to year if the variety is open-pollinated. Tomato seeds are typically easy to find from agrodealers.	Initial acquisition of improved varieties may be difficult. Hybrid varieties require repurchasing every season. Tomatoes require extensive inputs to cultivate including fertilizer, trellising material, and a greenhouse in some situations. Farmers may not have access to these items.

④ Here we refer to species/varieties of non-native plants that reproduce on their own in an area, without human assistance. As pointed out by Olson (2017), naturalized plants are not necessarily weedy.

edn.link/tn63#germ]). If quality seed or other propagation material is too expensive or too difficult to transport, the impact of the crop may be limited due to inaccessibility. For crops that require infrastructure such as a greenhouse or fence or other inputs to grow, limited access to these materials may impact farmer adoption. Select crops that are **easy to establish** with **minimal inputs required**.

Impact on environment (Table 6)

Look at native or naturalized^④ options for cultivation before considering an exotic crop. Native and naturalized plants are already adapted to local climate and pests and are known in the community. Sometimes a plant is unknown to young people, but older generations remember its usefulness and typical growth pattern. If the genetic material has been lost, try travelling to a market further away to look for the crop. Select crops that **do not have potential for weediness**.

Some crops require intensive management. If the crop requires fertility inputs, plan ways to minimize negative impacts from nutrient leaching on the surrounding ecosystems, especially bodies of water. If the crop requires tillage, plan for other ways to build soil health.

Table 6. Example environmental considerations and cautions.

Crop	Environmental impact	Cautions
Moringa	Moringa is cultivated in many countries outside its native range in India (Olson, 2017), as would be expected for a crop with many uses and widely known to alleviate malnutrition. Moringa is not an agricultural weed according to assessments in Hawaii (Daehler and Denslow, n.d.) and Florida (UF/IFAS, 2022). ECHO staff ^⑤ and others (Olson, 2017; Mashamaite <i>et al.</i> , 2021; and Vélez-Gavilán, 2017) report that moringa has not been observed to displace native ecology/plant life.	The University of Florida describes moringa as a high invasion risk for Florida, noting its presence as a non-native in many countries (UF/IFAS, 2022). Vélez-Gavilán (2017) states that moringa is listed as invasive in some places, but concludes that information on the alleged invasiveness of moringa is conflicting and that moringa should be thought of as a widely cultivated species with low invasive potential.
Sweet Potato	There are most likely sweet potato varieties already growing in your region. Sweet potatoes do not typically require intensive management.	Sweet potato cultivation does require soil disturbance for harvest at a minimum.
Tomato	Cultivated, intentional tomato production does not have weedy potential. Pull any “volunteer” tomatoes that sprout after the season.	Tomato cultivation typically requires fertilization. To prevent nutrient runoff, utilize efficient nutrient management practices. ^⑥

⑤ ECHO Regional Impact Center staff shared the following insights regarding the environmental impact of moringa:

Promesse Kansie (West Africa [Burkina Faso])- “. . . I wanted to get the opinion of other researchers in the sub-region. . . About moringa, all the actors around the plant agree that it is a plant that grows quickly. And that more and more producers integrate it into some farms and in the family yard. But moringa is not an invasive plant since there are localities in the West Africa sub-region where moringa is not known, and left freely in the fields, moringa sometimes disappears because the animals eat the leaves, branches and even the trunk.”

Erwin Kinsey (East Africa [Tanzania])- “In the wider perspective, there is little defence for its being an invasive and I have yet to see where it is replacing local vegetation.”

Patrick Trail (Southeast Asia [Thailand])- “From what I have seen, moringa is always localized to the one or two trees that were intentionally planted.”

⑥ The four main aspects of efficient nutrient management are using the right source and right rate, placing nutrients at the right place, and applying fertilizers when the plant needs them.

Impact on local economy (Table 7)

A successful marketed commodity must **meet demands** in the local economy. It is a good idea to conduct a market analysis before planning what crop to cultivate. When there is an ample supply of a commodity in the market, the price of the item decreases. Farmers experience this most strongly during the peak of production season. When there is a shortage of a commodity in the market, the price of the item increases. Farmers can take advantage of this if they have an early-maturing crop or have found a way to extend their growing season. Select crops that produce **quality products** or can be processed post-harvest to create a valuable commodity.



Figure 6. Fresh moringa leaves for sale among other fresh greens at a market in Cambodia.

Source: Lay Bun John

Table 7. Example economic impact considerations and cautions.

Crop	Economic impact	Cautions
Moringa	The versatility in moringa's uses makes it more likely to fit at least one niche in the local economy, either as a fresh leafy vegetable (Figure 6), dried leaf powder, edible green vegetable, or dried seeds. Leaves can be dried (in the shade) and made into powder and therefore have a longer shelf life (up to six months).	There may not be a place in the local economy for moringa. Conduct a market analysis before investing time, energy, and labor into establishment.
Sweet Potato	In many tropical countries sweet potato ranks close to cassava and even maize in terms of its importance as a cultivated crop (Echodu <i>et al.</i> , 2019). Small-scale farmers value sweet potato for its high productivity with few inputs and under a range of growing constraints including drought. Sweet potato tubers are harvested both for household consumption and as a source of cash. Sugri <i>et al.</i> (2017) discuss postharvest methods to reduce losses and lengthen storage life, thereby improving economic return. Curing and storing sweet potatoes may allow farmers to sell them for a higher price in the off-season.	In some regions other tubers such as cassava may be preferred over sweet potato at markets. Pests such as the sweet potato weevil (<i>Cylas formicarius</i>) can limit the yield potential of sweet potato if steps such as crop rotation are not taken.
Tomato	Tomatoes are marketable year-round in most places due to their culinary importance. To be marketable, tomatoes need to be free of blemishes or bruises. Tomatoes bruise easily when ripe. Recommendations for harvesting tomatoes are summarized in EDN 154 .	Tomato prices fluctuate drastically based on seasonal supply. For this reason, ECHO's West Africa Impact Center has conducted training on processing tomatoes into tomato paste (Figure 7).

Impact on society (Table 8)

Some countries have legal restrictions that prohibit or discourage the cultivation of certain crops. Review local limitations before cultivating a crop to verify that it is **free of legal restrictions**. Consider how a crop might impact labor dynamics. For example, a crop may need additional weeding or processing which may overburden one gender or age group over another if roles are already divided. A crop must fit local **culinary preferences** to be accepted.

Closing Thoughts

Overall, ECHO encourages the cultivation of crops that are **low-risk**. All the considerations mentioned in this article help guide crop selection that has minimal risk to local production, environmental, and socioeconomic outcomes while attempting to fill a felt need in the community. Additionally, selecting crops utilizing these parameters



Figure 7. Participant of a training displays course certificate and tomato paste.

Source: ECHO West Africa

Table 8. Example societal impact considerations and cautions.

Crop	Societal impact	Cautions
Moringa	Moringa may have traditional uses in local contexts. Shucking, drying, and pounding moringa leaves to make powder can be tedious work.	Moringa, though nutritious, is bitter. If bitter foods are not common in local culinary preferences, be sensitive to this.
Sweet Potato	If seeking improved varieties, contact local extension services to see what plant resources may be available. If you are planning on importing varieties from outside the country, make sure to contact the country agriculture department first.	Sweet potatoes may not be the desired tuber or starch in the local community. Some cultures are used to one color of sweet potato and may not be open to varieties of a different color.
Tomato	Tomatoes are a very intensive crop to grow, requiring fertilization, irrigation, pest management, removal of suckers, trellising, and weeding. Think about labor divisions and how that might impact the workload of farming families.	If tomatoes are not typically eaten fresh, do not push the consumption of fresh tomatoes.

encourages acceptance of the crop. For wide acceptance of a crop to be achieved, many of these considerations must be met. If you are thinking of introducing a new crop to your region, ECHO staff and network members share additional ideas and cautions in *ECHO Technical Notes Introducing New Seeds* and *Introducing a New Fruit Crop*.

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Tithonia is known for its high nitrogen content, palatability as a livestock forage, and rapid growth throughout the tropics and subtropics. Network member Tim Tanner has also experimented with using it, as well as neem, to control termites (Figure 8) before planting trees.

Methods

At first, I was not covering the tithonia-only fermented liquid. I would stuff as much tithonia biomass as I could in a bucket by stomping on it, pounding on it, whatever it took to really stuff it [full]. I would add water just enough to make sure the top layer was covered in water. I left the bucket open. It would decompose totally with just a few stringy stems left within five days normally.

It stunk and I was doing [this] just next to our homeschool classroom. So, I started covering the buckets with a lid. But [by] about day four or five the lid would burst off if it was on too tight.

Application

I was primarily using it as a termite prevention around my saplings. I had to make sure to leave a good 6-inch [15-cm] diameter from the stem/stock as my solution was strong, but again, I was going for termite protection, not necessarily fertilizer.

I would get anywhere from four to six weeks of good termite protection. If it rained, that seemed to weaken and dilute the protection somewhat.

Echoes from our Network Tithonia and neem fermented liquid for termite control

by Tim Tanner, founder of *Kilimo Timilifu*



Figure 8. Inside of termite colony (A) and termite activity (B). Source: Noah Elhardt (A) and Jason Weigner (B).

But it did really help me establish saplings and other plants. I presume it was also helping with nitrogen and phosphorus additions [to the soil].

Cautions and adaptations

Since I was normally going for termite protection, I did not dilute [the fermented liquid]. But I found if I poured it too close to the sapling it would burn the sapling. Thus, my thought would be [if you] use it as a fertilizer you would have to dilute it in order to put it directly on a plant. Play with the ratio and try [it in a small area of your field/garden].

At Kilimo Timilifu we have no tithonia. But we have played around some with neem (*Azadirachta indica*) leaf [fermented liquid or] "tea" made the same way (though it takes a bit longer to decompose) and have had some undocumented success. We have had quite a problem with establishing saplings due to termites. So, we dig the hole and line the hole with ash. Then transplant the sapling into the hole. Then, we pour the neem tea around the sapling. The neem tea makes a shaft of protection and meets up with the ash at the bottom of the hole which is preventing termites from coming up from underneath.



From ECHO's Seed Bank 'Asia Cayenne': A Mild-Tasting Chili Pepper

by Tim Motis



Figure 9. 'Asia Cayenne' plant with green and red peppers.
Source: Holly Sobetski.

Capsicum annuum includes many varieties of chili and sweet peppers, with wide diversity in fruit size, shape, color, and flavor. Cayenne peppers are typically long and thin in shape. As a chili type, most cayenne varieties are pungent. Pungency is what gives hot peppers their spicy flavor. Cayenne peppers can be hotter than jalapeños. Not all cayenne varieties, however, are pungent. ECHO's global seed bank offers 'Asia Cayenne', which produces an abundance of long, narrow, bright-red peppers (Figure 9) without the pungency of other chili peppers.

Peppers are grown in many parts of the tropics and sub-tropics, with top-producing countries including India, Sri-Lanka, Ghana, Nigeria, and Mexico (Olatunji and Afolayan, 2018). Ideal growing temperatures are between 18 and 30°C (Grubben and El Tahir, 2004). Night temperatures above 32°C can adversely affect flowers, reducing fruit yield. At ECHO, in southwest Florida, *Capsicum annuum* varieties grow best when planted in the fall (at the end of the hot, rainy season), allowing plants to flower and fruit during the cooler and drier winter months (Sobetski, 2022).

Sow pepper seeds in a nursery bed or trays protected from rain and direct sun. Transplant pepper seedlings 4 to 6 weeks after seeding, when seedlings have 8 to 10 leaves (Grubben and El Tahir, 2004). Here are some tips to maximize survival of seedlings:

- To protect nursery seedlings from rain and direct sun, shelter beds or trays with materials like straw or palm branches.
- A week before transplanting, reduce watering and shade to acclimate seedlings to dryer soil and more sun. This practice, called **hardening**, prepares seedlings for growing conditions in the garden or field.
- Minimize wilting of newly transplanted seedlings by transplanting late in the day when the sun is less intense, keeping some of the

original soil with the roots when transplanting, and watering right after transplanting.

Grubben and El Tahir (2004) suggest a plant spacing of 20-40 cm (in-row) X 50-80 cm (between-rows). Their online Plant Resources of Tropical Africa (PROTA) content includes details on other aspects of growing the crop like weeding, watering, fertility inputs, and pest management.

'Asia Cayenne' peppers turn from green to red as they mature. Once the peppers have reached full size, you can harvest and eat them at both the green and red stages. Harvest by hand or with a small knife. Pick the fruit regularly to prolong production. 'Asia Cayenne' peppers can be eaten fresh and are excellent in salads. You can also cook them and incorporate them into other foods. They are a good source of vitamins (e.g., A and C) and minerals (e.g., calcium and potassium).

'Asia Cayenne' is an open-pollinated variety; stability of traits over successive generations of seed saving⁷ is higher with open-pollinated than hybrid varieties. There is some variation in this variety, so if you notice any plants that have fruit with pungency or that are uncharacteristic with traits you don't like, remove those plants as early as possible before collecting seeds (Sobetski, 2022).

Active development workers who are members on ECHOcommunity.org may request a trial packet of this or other seed. (See [the website](#) for how to register as a member and how to order seeds.)

References

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VITA resources revived

ECHO recently rereleased 137 documents in 6 languages that were originally published by Volunteers in Technical Assistance (VITA) between 1959 and 2005. VITA valued shared knowledge as being key to lasting community development. Through the years, VITA published a wide range of practical guides and how-to's, from a few pages to complete manuals of 200 pages and more, featuring clear instructions and easy-to-follow plans and illustrations. These useful guides cover topics such as:

⁷ Save seeds from fully mature fruit, those that have reached full size and have undergone the change in color from green to red. See the online section of *The Seed Garden* (Colley *et al.*, 2015) for more information on saving pepper seeds, paying special attention to discussion on isolating a variety/species of pepper to prevent cross-pollination that could erode genetic purity and increase variation in traits.

Books, Websites, and Other Resources

- agriculture and animal husbandry,
- building and construction,
- business,
- industry and crafts,
- communication and transportation,
- energy,
- food processing,
- health and nutrition,
- stoves,
- ovens and kilns,
- water supply,
- natural resources, and
- conservation.

As businesses or organizations change over time, sometimes organizations serving in the international development space have merged with other groups or changed objectives, resulting in the loss of access to books and research that still have value today. At ECHO, we revive access to resources that might have value within the ECHO community. Research revealed that VITA had been merged with other organizations over time and that many of the historical resources were no longer readily accessible online. ECHO reached out to the organization and received a positive response to the idea of ECHO hosting a repository of historical VITA documents for the benefit of community development globally. In this case, an impressive collection of 137 VITA documents in 6 languages (English, French, German, Italian, Portuguese, and Spanish) have been republished. This list includes titles like:

- [Understanding Evaporative Cooling](http://edn.link/5dc3a09) [http://edn.link/5dc3a09],
- [Candle Making](http://edn.link/9r3fyh) [http://edn.link/9r3fyh],
- [Understanding Pedal Power](http://edn.link/481adb8) [http://edn.link/481adb8],
- [Solar Water Heaters](http://edn.link/06ea411) [http://edn.link/06ea411],
- [Raising Chickens and Ducks](http://edn.link/27e9f20) [http://edn.link/27e9f20], and
- [Understanding Agroforestry Techniques](http://edn.link/jdt49k) [http://edn.link/jdt49k].

All the available texts have been loaded into ECHOcommunity and can be found at <http://edn.link/vitapub> and through the ECHOcommunity Mobile app.



The Fertilizer and Seed Recommendations Map for West Africa

This [interactive tool](http://edn.link/ej9pmd) [http://edn.link/ej9pmd] delivers “agro-input packages” based on parameters that users can select to describe their production system. Users can input West African towns, countries, or

select regional climate (arid, semi-arid, sub-humid or humid). The tool also contains filters for crop and fertilizer type including bioliquid fertilizer (BLF), though currently no crops are displayed for use of BLF. For a more advanced search, the user can click “More” and then filter for potential yield, days to maturity, pest/disease resistance, and rainfall. Agro-input packages include crop details, fertilizer recommendations, best management practices, and color-coded maps showing where the crop grows (Figure 10). Each package is downloadable.

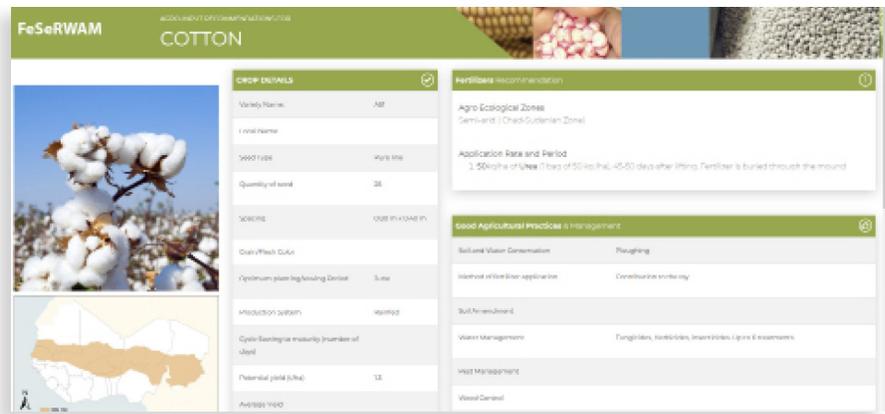


Figure 10. Example of an “agro-input” package about cotton.
Source: <https://app.feserwam.org>

Crops included in the tool are:

- Grains: maize, rice, sorghum, millet, wheat
- Vegetables: tomato, eggplant, onion, pepper, okra
- Legumes: cowpea, soybean, peanut (groundnut)
- Fruits: cocoa, pineapple
- Tubers: cassava, yam, sweet potato
- Other: cotton, sesame, coffee

Some variety listings don’t have as much information or diverse fertilization options lists as others. Most agro-input packages highlight hybrid seed, which is not desirable for farmers who save seed from season to season, but general recommendations and best management practices may be a good starting point to guide local practices. The tool is limited currently to the crops listed above. This tool represents the combined efforts of the [International Fertilizer Development Center](#) and [West and Central African Council for Agricultural Research and Development](#) through USAID funding.



ECHO 29th Annual International Agriculture Conference - in Person

ECHO Global Demonstration Farm | Florida, USA
November 15-17, 2022

Reflecting, Restoring, Renewing Hope is the theme for this year’s ECHO International Conference! We want to take the time to share lessons learned, work together to troubleshoot ongoing needs, and inspire each other to try new ideas.

Upcoming Events

ECHO East Africa

7th ECHO East Africa Biennial Symposium on Sustainable Agriculture and Appropriate Technologies

Arusha, Tanzania

February 21-23, 2023