Meeting organic export banana nitrogen demand from local sources: Options and estimates for Peru and Dominican Republic

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What is potential nitrogen generated by local sources?

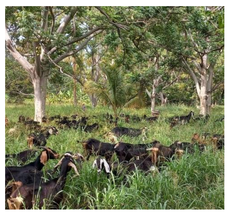
Tropical banana production for distant consumers faces diverse sustainability challenges. Organic banana production addresses environmental and human health impacts, an important contribution compared to conventional banana. However, both conventional and organic banana also face questions about carbon and water footprint, food miles and nutrient miles and recycling. The banana carbon footprint, 0.79 kg CO2 eq/kg, is the highest of the field-grown fruits, on average 0.50 kg CO2 eq/kg (Clune et al. 2016). Nutrients such as potassium are almost always imported. Organic fertilizer for nitrogen can also be imported from Europe or Brazil, although local compost and animal manure are also used. We asked whether nitrogen nutrient miles could be reduced through more systematic local and on-farm practices to replace nitrogen taken off-farm?

Study objective: examine through a desk study the potential to source nitrogen locally to replenish harvested fruit-N for the organic export sectors in Peru and the Dominican Republic.
Five options were quantified:
- Manure collected from extensive livestock raising which is the current main source of local N.
- On-farm manure production from livestock fed on hedges of cut and carry leguminous shrubs, grasses, reject bananas
- Leguminous leaf and small branch mulch based on hedges of leguminous shrubs
- Leguminous cover crops in established plantations
- Rotations of banana with nitrogen fixing fodder crops

Do current sources – extensive grazing - cover banana N?







Peru – Manure from goats grazed in *Prosopis*-dominated arid lands is collected from corrals. Backyard goat units are also found in irrigated zones. A 45 kg goat produces 226 kg manure dry weight with 6 kg N. A recovery rate of 33% indicates up to 400,000 goats to generate 800 tons N for banana. Current sheep and goat population on the North Coast is estimated at 300 – 400,000 head.





Dominican Republic Manure from cattle accumulates in corrals and is collected for compost production. A 450 kg cow produces 1014 kg manure dry matter with 35 kg N. A recovery rate of 50% indicates up to 8,500 cows to produce 1470 tons N for banana. The current cattle population in the central valley of Linea Noroeste is approximately 22,000, although in the foothills are another 80,000 head.

How much fruit-N is taken off fields from organic banana export?

Peru – Approximately 9000 hectares of organic banana are in production. Total bunch biomass harvested was estimated as: 1600 mats/ha * 25 kg average bunch weight * 1.1 bunches/year = 44,000 kg/year. Approximate nitrogen for sector = 44,000 kg/ha* 9000 ha * 0.00207 kg N/kg bunch = **820 tons N**.

Dominican Republic – Approximately 15000 hectares of organic banana are in production. Total bunch biomass harvested was estimated as: 2400 mats/ha * 18 kg average bunch weight * 1.1 bunches/year = 47,500 kg/year. Approximate nitrogen for sector = 47,500 kg* 15,000 * 0.00207 kg N/kg bunch = **1470 tons N**.

How much N from hedges on field borders?

Leguminous hedges as mulch – Shrubs such as *Leucaena* and *Calliandra* yield up to 12 kg of fresh biomass rich in N per lineal meter from leaf and small branch pruning. Planted on field borders and canals, 400 meters of hedges yields approximately 60 kg N as mulch, more than half the nitrogen export/ha/year.

Leguminous shrubs, cut fodder and reject bananas – Banana plots can produce protein and energy rich fodder for manure-producing ruminants for N. Income from milk and meat generate additional income.

Cattle – 400 meters perimeter planting of one hectares dedicated to leguminous shrubs and king grass along with 15 kg of reject bananas/day feeds 2/3 of a milk cow and yields 6 liters of milk/day and 17 kg N/year in manure. Urine collection could add 10 kg year.

Goats – 400 meters of fodder shrubs and grass along with 15 kg reject bananas feed 6 zero-grazed adults weighing 37kg. The resulting manure has 28 kg N. Another 10 kg are available in the urine.

How much N from herbaceous legumes within fields or in rotation?

Perennial herbaceous legumes as ground cover in established banana fields is another possible source of N. Testing of shade-tolerant species like *Pueraria phaseoloides, Clitoria ternatea, Calopogonium mucunoides, Centrosema pascuorum* and *Neonotonia wightii* indicates a potential to generate biomass and nitrogen using radiation filtering through the banana canopy. Calculations based on radiation filtering through the canopy indicate that 1-4 ton dry matter/ha/year with an N content of 22 – 90 kg is attainable with little modification of mat density. The amount from N fixation could be increased with more direct radiation to ground level.

A second approach to the use of perennial herbaceous legumes is in rotation. Studies of N credits from perennial forage legumes, principally alfalfa, indicate 25 to 70 kg after a single legume year, while multiple years of perennial legumes is worth 40 to 120 kg/ha the firs crop cycle and some N available the second year. The resulting N-rich biomass harvested might be used as mulch for banana or as animal fodder and N contribution through manure.

Research and action: reducing nutrient miles in organic banana

The organic export banana sectors in Peru and Dominican Republic have options to explore for increasing local N sources. Herbaceous legumes as ground cover in established fields appear most viable on the short term along with local manure sources.


Wasted manure resources
Water pollution

Assessment current situation	Feasibility studies - alternatives
- Current local livestock production, fodder sources and manure/urine management - Current use, logistics and cost of off-farm local manure - Sampling of biomass and N content and fixation in established legume ground cover in banana	- Estimation of water / land demands for on-farm legumes - Options for lower cost and more efficient off-farm manure use - Labor costs versus N purchase for alternatives - Germplasm and seed supply strategies - Climate change implications for alternative N generation and use

References: Clune, S., Crossin, E. and Verghese, K. 2016. Systematic review of greenhouse gas emissions for different fresh food categories, *Journal of Cleaner Production* 140, 766–83.
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