Mulch-L mailing list correspondence

A project of the Management of Organic Inputs in Soils of the Tropics (MOIST)
in association with the Cornell International Institute for Food, Agriculture and Development (CIIFAD)
and the Tropical Soil Cover and Organic Resource Exchange (TropSCORE)

Discussions about the possibility of building soil fertility without chemical fertililizers (inorganic NPK) (11/19/02 - 11/24/02)

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postings: 25
countries: Australia, Germany, Honduras, Laos, UK, USA
organizations/institutions/companies: Center for Development Research (ZEF-Uni Bonn), Christian Reformed World Relief Committee (CRWRC), Cornell International Institute for Food, Agriculture and Development (CIIFAD), Cornell University, COSECHA, GTZ, Michigan State University, Minifarms, Oakley Ks, Rodale Institute, Royal Agricultural College, (plus several growers and government employees)

From: "william cook"
To: mulch-l@cornell.edu (MULCH-L)
Subject: Soil fertility without a sack of NPK?
Date: Tue, 19 Nov 2002

I have found several experts who tell me that there is NO WAY to build soil fertility without a sack of NPK.
What do you say?
Thanks in advance,

WmCook
Honolulu

Date: Wed, 20 Nov 2002
From: "Steiner Kurt 1060"
To: MULCH-L@cornell.edu
Subject: Soil fertility without a sack of NPK?

This is correct. For recycling there must be something to recycle. If there is no P in the system, it needs to be added from outside. Fertilizer helps to stimulate biomass production, required for soil protection and organic recycling. Sometimes relatively small amounts of N and P (e.g. 20-40 kg/ha) are suffient to double biomass production.

Dr. Kurt G. Steiner
Senior Technical Advisor - Sustainable Land Management GTZ Dpt. 106/45
P.O.Box 5180, 65726 Eschborn/Germany
web: www.fao.org/act-network

Date: Wed, 20 Nov 2002

From: John Conway
To: "Steiner Kurt 1060 " , <MULCH-L@cornell.edu>
Subject: Soil fertility without a sack of NPK?
Date: Wed, 20 Nov 2002

I doubt the organic farmers would agree with you - whatever is wrong with a good dose of animal manure???

[Dr. John S Conway
Principal Lecturer in Soil Science
Royal Agricultural College, Cirencester, Glos. GL7 6JS]

Subject: Soil fertility without a sack of NPK?
Date: Thu, 21 Nov 2002
From: "Steiner Kurt 1060"
To: "John Conway", <'MULCH-L@cornell.edu>

In cases where soils are deficient in P your forage and fodder is also P- deficient, especially as the animals absorbe the little P abvailable in the fodder. Our farm yard manure in Rwanda was defiecient in P and could not fill the P-gap,. The same is valid for compost and green manures.

Dr. Kurt G. Steiner
Senior Technical Advisor - Sustainable Land Management
GTZ Dpt. 106/45
P.O.Box 5180, 65726 Eschborn/Germany

From: "william cook"
To: kurt.steiner, mulch-l@cornell.edu
Subject: P
Date: Thu, 21 Nov 2002

Dr. Steiner,

On the P depleted soils....how about farmers saving all bones (then burning them) and fireplace ash to apply....is that practical in Rwanda?

WmCook

From: "Tom Post"
To: <MULCH-L@cornell.edu>
Subject: Re: Organic Approaches to soil fertility and Chemical Ferilizer
Reply-To: MULCH-L@cornell.edu
Date: Nov 21, 2002

Kurt: the results of my research in P-deficient soils in northern Belize are the same as yours in Rwanda.

At this point my approach would be to use chemical P, and sometimes micronutrient fertilizers in low-risk, cost-effective amounts----to give the legume enough nutrients so that they can run their metabolic and N-fixing pathways. I don't think we should take take an either-or approach, that pits organic vs chemical fertilizer approaches.

Yours,
Tom Post
Christian Reformed World Relief Committee

From: "Konrad Vielhauer"
To: <MULCH-L@cornell.edu>
Subject: Soil fertility without a sack of NPK?
Date: Wed, 20 Nov 2002
Organization: ZEF - Uni Bonn

I completely agree with Dr. Steiner. In our project we try to short-cycle nutrients as narrow as we can by applying a chop-and-mulch technology instead of traditional slash-and-burn and by enriching the fallow vegetation with fast-growing legume trees. However, there is no such thing as pure organic farming. As long as nutrients are transported from rural areas to big cities from where they do not return, the nutrient cycle has been opened on one side, the output side, so it has to be opened on the other side, the input side as well by applying mineral fertilizer. If soil build up is to be done parallel to agricultural production, indeed there is no way arround some amount of mineral fertilizer. However, it works best and lower quantities are needed if combined with good technologies of management of organic matter, such as the two mentioned above.

Dr. Konrad Vielhauer
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Date: Wed, 20 Nov 2002
To: MULCH-L@cornell.edu
From: David Weight
Subject: Soil fertility without NPK?

There is a wide range of opinion on this issue. The historical research that I have seen suggests the same. For example, in the US, fertilizer was critical in building up depleted levels of soil organic matter in the Great Plain states- to current levels (in combination with conservation practices). In South America, no-till systems with an emphasis on use of residues mostly use fertilizers at the start- then phase out over time, esp. in the case of P.

Would appreciate references to research data that shows evidence to contrary- for depleted soils. In Africa (where I work), fertilizers are either too expensive (imported) or unavailable. If there are alternative approaches (without fertilizer) that work in depleted tropical systems, they would be most welcome, if there is sufficient historical evidence. The impression I have is that organic systems work in Western environments where soil fertility has already been built up over time via fertilizers.

I look forward to your comments.
David Weight

From: "FLO"
To: <MULCH-L@cornell.edu>
Subject: Soil fertility without NPK?
Date: Wed, 20 Nov 2002

I use old hay! I spread it all over the chicken yard and hen house and goat house.
I scoop it out once a month and put it where I want it! Hogs (feeder pigs) can be put in small portable pens with electric fence and moved weekly. Then you feed them a bedding of a few inches of hay and toss the grain out to them on top of it. The scrounge for the grain, and bury half of it, and then they fertilize it. Then you move them, and let them do it elsewhere. Hay gives back to the soil what it needs. The animals-
ducks, chickens, goats, sheep, and hogs fertilze. Some animals give back better than others! I've heard, and beleive that over three years, you can build your soli back naturally, if we give back the pulp of the fruit of it's harvest! What do you think?
I happen to love sharing the work with the animals, and they cut the expense in half, or more. And then the hogs feed you!

Flo, in Louisiana!
PS How's Hawaii?

From: "Diop, Amadou"
To: <MULCH-L@cornell.edu> (MULCH-L)
Subject: Soil fertility without NPK?

Hello everyone:

I think this is a very pretentious statement. Many reports have indicated just the opposite. Please refer to the book edited by Norman Uphoff: Sustainable Agriculture: New Paradigms And Old Practices?
(Environment, Development and Sustainability, 2000 Kluwer Academic Publishers, Netherlands). In this publication you will find several papers discussing successful cases where soil regeneration was achieved without chemical fertilizers. Good rotation, use of cover crops and good quality compost
should do it, in my opinion.

Thanks,

Amadou Makhtar Diop, PhD
Technical Director
The Rodale Institute
611 Siegfriedale Road
Kutztown, PA 19530
Phone: 610-683-1453

Subject: Soil fertility without NPK?
Date: Thu, 21 Nov 2002
From: "Steiner Kurt 1060"
To: <MULCH-L@cornell.edu><amadou.diop>

Amadou,
The question is, how to produce "good" compost in case your plants are deficient in P and other nutrients and consequently your plant material, too. I have worked several years in Rwanda on P depleted soils (< 5ppm). Green manures, recycling of crop residues, manure, etc. could not fill the P-gap. In addition, legumes fix hardly any N when soils are P deficient, as P is reuqired for N-synthesis.

Dr. Kurt G. Steiner
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From: "Diop, Amadou"
Subject: Soil fertility without NPK?
Date: Thu, 21 Nov 2002 13:16:46 -0500
To: <MULCH-L@cornell.edu>

Kurt:
I agree- the challenge is how to produce good compost and in sufficient quantities. I agree with you with a situation when P is deficient. In Senegal we have been successful in producing a high quality compost using millet straws, grasses, wood ash, animal manure and rock phosphate. Significant millet yield increases were observed with in a rotation with groundnut.

Thanks,

Amadou Diop
Rodale Institute

Subject: Soil fertility without NPK?
Date: Wed, 20 Nov 2002
From: "Lotter, Don"
To: MULCH-L

Attached is a paper I wrote that shows that, hands down, organic methods build better soils than methods using NPK *[Note for www archives: this paper is not attached due to copyright - contact Don Lotter for the paper]*. It's all from scientific research. I gave a talk on it to the Penn State University Dept. of Crops and Soils, where it would have gone an inch without good solid evidence. I had three professors come up at the end, wanting to do collaborative research.

Cheers and keep up the good work.

Don Lotter, Ph.D.
The Rodale Institute
611 Siegfriedale Rd.
Kutztown, PA 19530
(610)683-1400

Subject: Soil fertility without NPK?
Date: Thu, 21 Nov 2002
From: "Steiner Kurt 1060"
To: <MULCH-L@cornell.edu>, <don.lotter>

Don,
Y ou cannot compare the situation in industrialised countries with that of developing countries especially African countries. In Germany, Europe, you can do organic farming as the soils have been filled up with P, K Ca etc. and have reserves for 20 years at least. In such a case you have sufficient nutrients for recycling. In African countries (and probably other developing countries),

where soils have been mined for decades, there is hardly anything left for reycling. Your biomass production is minimal in quantity and quality.
Thus recipies for industrialised countries do not necessarily fit developing countries.

Dr. Kurt G. Steiner
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From: "Stan"
To: <MULCH-L@cornell.edu>
Subject: Soil fertility without NPK?
Date: Wed, 20 Nov 2002

Try a summerfallow rotation, (i.e.. allow land to lay idle one season) to regenerate. We do this all the time in the Midwest where we grow wheat.

Stan Stephens
Oakley Ks

From: "Konrad Vielhauer"
To: <MULCH-L@cornell.edu>
Subject: Soil fertility without NPK?
Date: Thu, 21 Nov 2002
Organization: ZEF - Uni Bonn

Dear Dr. Cook,
You realy kicked off a hot topic, as we can see by the innumerous reactions. Let me just make one further comment to the opinion of John Conway below, which is even more vigorously being defended by Don Lotter in another email.

I am not defending mineral fertilizers, but instead of saying "organic farming" I would rather say "farming as organic as possible", because when you think in global nutrient cycles, that is the only possible way.
When you read Don Lotters paper and other comments, please be sure to try and track down, where the nutrients in the organic inputs (manure and plant material) come from. In case they always and exclusively come from the production site itself, it is o.k. but unlikely to work for a long period. If they come from somwhere else, we are dealing with an organic matter and thus nutrient transfer system. Then you have to track the nutrients to the very end, backwards through the animal stomach and so on and you will end up on a site that is either being exploited or minerally fertilized. I repeat, what I said before. In the overall global nutrient budget there is a disbalance of the system, which we all, that live in cities and do not return our wastes to the rural areas (not to speak of cross continent nutrient transfers), contribute to considerably and which has to be compensated for by one way or the other. For nitrogen, biological fixation has great potential, but for P and K and micronutrients the only means we have so far is mineral fertilizer. Of course I would support any idea such as applying unprocessed rock phosphates combined with mycorrhizally facilitated uptake and all other biological means of getting arround mineral fertilization but for the time being it would be risky to think that the world population could be fead without this input. And if some farmers are applying pure organic farming, which may be very nice to some consumers, who are willing to pay high prices to the farmers, you can be sure that there is a trade-off for that somewhere else. So, there is nothing wrong with a good dose of animal manure

but be sure to know where the nutrients in it come from and make your nutrient balance.

Greetings,
Konrad Vielhauer

From: John Conway
To: "'MULCH-L@cornell.edu"'
Subject: Soil fertility without NPK?
Date: Thu, 21 Nov 2002

I agree with Konrad's reply in general. The original question, however, was slightly different using the phrase "NO WAY". I teach an organic soil management course which currently has a very intensely committed German woman the group. Her view, and that of her fellow students is to build up soil fertility gradually using organic means. I wouldn't go so far as to say that organic farming is the only way, but I would seriously worry about only using mineral fertilisers, and so I am inagreement with Konrad's views.

Dr. John S Conway
Principal Lecturer in Soil Science
Royal Agricultural College, Cirencester, Glos. GL7 6JS
Phone +44 (0) 1285 652531 ext 2234

Subject: Soil fertility without NPK?
Date: Thu, 21 Nov 2002
From: "Bunn, Joel"
To: <MULCH-L@cornell.edu>

While I would have to say that I think the jury is still out on this, I do feel that there are some situations where fertility could be achieved through some biointensive methods, and other situations where supplemental NPK must be added. I doubt the situation is black and white, and looking at the comments coming in, it appears that both sides of the fence feel strongly about their positions. Rather than rely on one method or the other, in our IPM program we often utilize a mixed, or balanced approach, and have found that utilizing some standard fertilizer early in the rebuilding helps jumpstart the process, particularly where soils are dead from overuse of pesticides, etc. and then we shift to a more organic/biological approach to maintain the fertility long-term. It seems to work well, and is a bit faster than a completely organic approach. I realize fast isn't always better, but there are times when it is a requirement.

Joel Bunn
Supervisor of IPM/Arboriculture

Subject: Soil fertility without NPK?
Date: Thu, 21 Nov 2002
From: "Lotter, Don"
To: <MULCH-L@cornell.edu>

My reply to Mr. Cook's posting (about his having talked to several "experts" who say that "there is NO WAY (sic) to build soil fertility without a sack of NPK") was meant for Mr. Cook only. I didn't mean for it to post to MULCH-L. However, I will stand behind my statements.

I've spent, like I said, 25 years in this area of research (soil ecology and fertility of organically

managed crop systems) at UC Davis, Cornell, UC Berkeley, UC Santa Cruz, and now Rodale (as well as the tropics). I've seen too many scientists and ag extension people make dismissive statements about organic agriculture that they can't back up - they are simply stating old myths that they haven't bothered to research. Add to this the fact that I spent most of this graduate school time surviving on the crumbs thrown to those of us in the area of sustainable and organic agriculture. I was often unfunded. Yet we have consistently shown yield parity or near parity in organic systems when compared to conventional, both domestically and worldwide, with clearly demonstrated lower environmental costs. My review paper details this.

I am in the process of getting published a paper on the drought years of the Rodale Farming Systems Trial, in which the organic systems (one manure-based, the other legume-only) outyielded the conventional corn and soy in all six drought years, by up to 40%. The average over the 21 years of the FST is basically yield parity between the 3 systems, with a small underyield of the LEG soybean. Just today I received an email from a Philippino researcher doing comparative research on organic and conventional rice. The dry season organic rice consistently outyields conventional - and both seasons show organic with better net returns because of lower input costs and near yield parity. Other comparative research from the University of Philippines Los Banos shows a similar result over four seasons and two sites. I will be reporting on both of these (Rodale and Philippines) in my weekly column in New Farm Online (www.newfarm.org). We can discuss these issues more if anyone likes.

Don Lotter, Ph.D.
The Rodale Institute
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(610)683-1400

Subject: Building Soil
From: Stephan Reeve

Hello Mulch Listers,

Perhaps it would be useful to consider what is meant by "building soil". In general I imagine we are referring to increasing the productive capacity of the soil rather than only increasing production for the current crop. Typically soluble fertilizers are aimed at increasing short-term production and may increase or decrease the productive capacity of the soil.

Building soil might include balancing mineral content, increasing organic matter, balancing soil pH, stimulating a healthy soil microbial population, etc. This often includes bringing nutrients into the system. Sources can include synthetic fertilizers, composts, plant materials, manures, mined minerals, biological nitrogen fixation, etc. There are also many management strategies that build the productive capacity of the soil that do not involve the importation of nutrients. Consider how the soils were "built" in the first place. Certainly not with sacks of fertilizer.

Farmers of today too often are attempting to cultivate lands degraded by past management. I don't think we serve them by telling them "there is NO WAY to build soil fertility without a sack of NPK". There are many ways to manage soil nutrients, one of which is to import nutrients into the system, one source of which are sacks of synthesized fertilizers.

A farmer will choose among management strategies based on a complicated mix of social, economic, cultural, biological, and intellectual factors. Let's help them expand their range of choices so they can choose what serves them best.

Toward a useful dialogue,
Stephan Reeve
HC1 Box 168
Hana Maui, HI 96713

From: Minifarms
Subject: poor soils/Bunch

Dear Mulchers,
If you want to understand how poor soils [low in most things] can have high yields, you need to read and/or download a document by Roland Bunch.
It can be found at: **http://ppathw3.cals.cornell.edu/mba_project/moist/Roland.pdf** .
Excellent.

Ken Hargesheimer
Minifarms

From: "Reid, Aileen"
Subject: Soil fertility without NPK?

I haven't had time to follow all the dialogue but one thread coming through makes a lot of sense according to what we are experiencing here in Perth,Western Australia. We have been working with compost, trying to build soil out of our gutless sands. That is one project. The other project I have been involved in is trying to grow organically in sand (y) soil. Neither is working.

The organic approach runs into MAJOR N problems. We can't get enough organic N - even with green manures under the constraints of the NASAA accreditation. And even the biodynamic people we have surveyed that have been doing it for years, still don't have appreciable levels of organic matter in their soil . And they are putting on in the order of 150t/ha/year of compost - way above what NASAA allows.

On the compost side of things we are running into problems with irrigation due to the non-wetting characteristics of the compost. Water is running through/slipping through the profile more than before. Our P goes up high quickly - don't tell me using compost - or organic production in sands prevents leaching of P!

We are coming to the conclusion - and in fact our most trials are incorporating clay to try and get a bit more structure into the soil.

Aileen Reid
[Perth, Western Austrailia]

From: Norman Uphoff
Subject: Soliciting comments: P Sustainability

I am interested in the lively debate on the MULCH-L list-serve that you told me about, over the extent to which one needs to "replace" P taken out of mulch/organic systems, or whether biological processes can "replenish" the supply, in whole or in large part. As you know, I am not an agronomist, but I have been looking into this question in order to understand how and why we

continue to get some remarkable rice yields with the System of Rice Intensification (SRI) developed in Madagascar. I will assume that most MULCHers know about SRI already, or can easily learn about the System from our home page that is part of your/CIIFAD's outreach operation < **http://ciifad.cornell.edu/sri/** >

This issue of P limitation, and the effects of taking off large harvests where available P is low, was raised dramatically when we found that farmers around Ranomafana National Park, by using SRI methods, could raise their irrigated rice yields from 2 t/ha to 8 t/ha on average (some got as high as 12-16 t/ha) on soils that NC State PhD agronomy thesis research had concluded were some of the poorest NC State ever evaluated: pH 3.8-4.5; low to very low CEC in all horizons; Fe toxicity; Al toxicity. The most critical deficiency pointed out was an average (available) P of only 3-4 ppm, less than half the usually assumed threshold for getting an acceptable yield. The low yields usually obtained around Ranomafana were attributed to P deficiency, among other things.

The 1994 thesis by Bruce Johnson said that there were "no inherently fertile soils within tens of kilometers of the park" due to the nature of the parent rock from which the soils had been created. With HYVs and fertilizer, NC State staff helped farmers get average yield up from 2 t/ha to 3 t/ha, with a maximum of 5 t/ha. How could our NGO partner help farmers get 8 t/ha average and up to 16 t/ha without fertilizer or new vareities?

With such dismal soil chemistry, how could yields be quadrupled, not just one year but for five years in a row, with no sign of yield decline on fields where SRI was used, despite the high yields taken off? A few yields even increased 6-8 times, without adding chemical fertilizer to build up the soil fertility. Something strange was going on, though it was surely something explainable.

My proposition now, after several years of observation, talking with farmers, and reading in the literature, is that the soil, plant, water and nutrient management practices have been building up the soil in terms of abundance and diversity of microbial life, and they in turn have been improving the soil chemically and physically. Farmers say that their soil gets "better" year to year with SRI cultivation, without adding fertilizer, despite taking off high yields. Farmers who put compost on their fields usually put it on their inter-season vegetable crop (potatoes, beans or peas) rather than on the rice crop, and get better yields from both that way than by putting it onto the rice directly.

The main changes in soil and water management with SRI are keeping the soil moist during the vegetative growth period but never continuously saturated, so that it does not become anaerobic for more than a few days at a time. This is done through alternate periods (up to 5 days) of flooding and then draining and keeping the field dry; or applying small amounts of water daily in the afternoon or evening and draining off any standing excess in the morning, with the field being drained for 3-5 days at a time several times during the growth period.

There is evidence that mixing aerobic and anaerobic horizons increases biological nitrogen fixation (BNF), which could explain where the N comes from for these high yields. Surely having both aerobic and anaerobic phases or horizons means that there is more opportunity for BNF. This could explain that part of the high yield with SRI. But where does the P come from?

We think that there is also increased P solubilization promoted by the plant, soil, water and nutrient management practices.There is an article that appeared in NATURE in May 2001, by British environmental scientists (who don't like to have P in the soil runoff) which I can forward to those who are interested (contact lhf2@cornell.edu as attachments are discouraged on mulch-L). This shows that when soil is wetted and dried alternately, the soluble P in soil water increases tremendously (the range report from studies in the UK were 185-1,900%, admittedly from a low base but huge relative increases).

The mechanism is for aerobic bacteria to acquire P from the "unavailable" pool in the soil, for their own purposes. When soil is saturated, these aerobes lyse (burst) under the osmotic pressure and release their P (and other nutrients) into the soil solution. When the soil dries again, the aerobes go back to work "mining" P from parts of the soil that the plant cannot normally access. Thus a process of wetting and drying soil can accomplish "microbiological weathering" that complements or competes with "thermogeochemical weathering," which is the process usually referred to to explain soil buildup. I think, though we don't have evidence on this, that MB weathering can be much faster, and more abundant, than TGC weathering.

I have read estimates that about 90% of the P in soil is "unavailable," meaning not accessible to the plant, for a variety of reasons, pH levels, physical location, sequestering in soil structure, etc. The process of continually renewing the "available" pool has gone on for eons, only disrupted by our agricultural practices in recent decades of centuries. The point is that there are huge reserves of P, and the question is, can this be accessed efficiently, sufficiently?

I remind myself when thinking about this question that plants have grown on the earth's surface for more than 300 million years. Surely there has been a lot of natural recycling, but it seems likely that even with 99.9% recycling, there has had to be massive transfer of unavailable P into available P to sustain obviously robust plant-based ecosystems. This is done surely not just by TGC processes.

Are we in danger of running out of P? This is certainly a possibility, but I think it is exaggerated because we do not pay enough attention to, or do enough to support, soil microbiological capabilities and processes. We note, with respect to SRI, that under flooded (anaerobic) conditions the rice plants will be deprived of the nutrient-accessing services of mycorrhizal fungi, which support the nutrient uptake of about 90% of plants. They can expand the volume of soil accessed by a root system, extended by mycorrhizal "infection," by 10-100 times.

Mycorrhizal fungi are especially important for accessing and uptaking P. So plant/soil/water/nutrient management practices that support mycorrhizal associations could be compensating for superficially reduced supplies of P. The mycorrhizal hyphae can get into soil pores smaller than roots can access. This is "mining" the soil, in a way, but there are no opportunity costs since this P could hardly be taken up otherwise.

I would also call our attention to what we all learned in Biology 101, about the plant stem being a two-way street (remember the xylem and the phloem? I always wondered why there would be any vascular tissue carrying nutrients down from the canopy into the roots). Plants send about 30-60% of their photosynthate into the roots, where some is exuded into the rhizosphere (to "feed" the bacteria, fungi, protozoa, etc.) while other material is lost through rhizodeposition (with the same effect). How much time has anyone in the MULCH network spent thinking about exudates in the past year? I think we should be paying a lot more attention to them.

Evolutionarily speaking, it is pretty clear that if plants did not get back more benefit from their exudation and root cell losses than their biological cost of creating this material (sugars, amino acids, vitamins, hormones, etc.), they could not have evolved as they have over hundreds of millions of years. In fact, we should never look at a plant as a separate species; its survival depends on its intimate association with millions and millions of microorganisms, just as ours does as mammals. [This is a view obviously influenced by the work of Lynn Margulis; anyone who hasn't read her book MICROCOSMOS has a treat in store. Her more recent books are even better, but broader.]

So I think there is reason for questioning a lot of the "closed system, chemically-focused" thinking that has gone into the conceptualization and measurement of soil/plant/nutrient relationships reported in current agronomic science. This is a bold statement that I can make more safely from

the standpoint of someone outside the discipline than I could if a certified agronomist. There are lots of things that I have been reading (e.g., the new Marcel Dekker book on THE RHIZOSPHERE, a collection of state-of-the-art reviews on exudation, mycorrhizae, rhizobia, etc., edited by Pinton et al.) which support this more "open system, biologically-driven" view, which would conclude that P availability need not be a constraint, even without inorganic P amendments, in well-managed, biomass-enriched agricultural systems. We have been managing with a small fraction of the total amount of P that there is in the soil. More attention should be given, I think, to how this available pool gets restored and expanded. These thoughts should surely trigger off a storm of reaction and make your life more complicated.

Norman Uphoff
Cornell International Institute for Food, Agriculture and Development (CIIFAD)

From: Rolando Bunch
Subject: Soil fertility without NPK?

Dear William,

Frankly, I would disagree strenuously with the general conclusion. Of course, in a sand, you're going to have a problem. But I have seen farmers build up soils to very high levels of productivity in thousands of cases, without using chemical fertilizers.

OK, first of all, in the simple logical sense, you can't argue something is impossible just because you haven't seen it yourself. That's how we got to the idea that you can't build up and maintain high levels of organic matter in tropical soils (now disproven) and grasses can't access N from legumes (it's now been shown that this very thing DOES happen, through micorrhyzae) and a whole raft of other mistakes having to do with soil dynamics. The problem with this reasoning is that we may have tried the WRONG way to do it, or even many wrong ways. (Such as growing clean-ploughed rowcrops for 40 years in India. Sure, if you try to do it THAT way, it's impossible!)

So how do farmers build up their soils? Well, of course, the first problem with this question is, what do we mean by "build up"? If our definition of to "build up" is based on the nutrient quantity theory, then by definition, we will need NPK. But NPK can, of course, be obtained in purchased chicken manure, purchased urban wastes, from a composting latrine, from incoming irrigation water, incoming water-borne soil, etc. Or even birds and bats. (And the quantities in the last case are more than a lot of people would ever dream.) So much for the argument that inorganic NPK is needed. Not even theoretically, using the nutrient quantity theory, is it necessary, unless you want to do it on a huge scale. I frankly don't see how anyone can say what I have just said is impossible--chicken manure (which thousands of farmers use here in Honduras every year) has all three nutrients, and in decent enough quantities to get very good yields. So the proposition that inorganic NPK is necessary to build soils is false. Period. In the theoretical sense.

But the above argument really only has value for theoreticians who don't care much about the real world. If we are going to be practical, we need to go a lot further than this. We need to ask: "Can poorer farmers increase substantially their productivity on initially very poor soils without spending any more than their increased yields would pay for, and can they do it with resources that would be available for the vast majority of poor farmers around the world? Now we're asking a question that has widespread developing nation applicability. And, incidentally, this is precisely the question World Neighbors/Central America, COSECHA, and CIDICCO have been working on for the last 20 years (all of which I have been
involved with).

My answer? YES. Resoundingly. In most cases. You don't believe me? Come visit us. I'll have my

personnel take you to see any number of farmers you want, as long as the number's less than 5,000.

How? Well, I can't go into it all that deeply here. (We do have papers on a lot of these subjects that are available). For instance, I could get into issues like the nutrient access vs nutrient quantity theories, but I won't. Let's just say that we use all sorts of tropical legumes, some trees, some viny or bushy or crawly. These are capable of fixing commonly from 75 to 150 kg N/ha/crop. They make the soil softer, more able to hold water, and increase the CEC (none of which chemical fertilizers can do). They decrease erosion, cover the soil much of the year, and eventually allow farmers to switch to zero tillage, which also improves soil fertility in at least half a dozen additional ways (none of which chemical fertilizer can do). They also buffer pH (while most chemical fertilizer used acidifies the soil, making most tropical soils worse.) And they defend plants significantly against a whole array of insects and diseases, from white grubs and striga to termites and the corn borer worm (which is, of course, endemic here in Honduras, but no longer a worry for our farmers). Chemical fertilizer's impact on these problems is arguable, but nowhere near as good as that of organic matter.

But I said the interventions had to be economic. Well, the way we use green manure/cover crops is not the traditional way (plant monocropped, cut at flowering and bury). This system is neither economically attractive nor best for the soil, in most cases. We use gm/cc's in such a way that the soil they are in has no opportunity cost (known to the farmers involved), that they are not generally buried, nor are they cut before maturity. We also use multi-purpose legumes: ones that can be eaten, preferably, or ones that can serve as fodder, major controllers of noxious weeds, or as income producers. As a result, productivity of basic grains has gone from, say, 0.5 t/ha/year to 4.5 t/ha/year. Yes, with no chemical fertilizer use.

But now I can hear the eternal cry of, "What about the phosphorus?" Well, it isn't necessary for about the first 15 years, at least. (In northern Honduras farmers have been getting good yields for 40+ years with no phosphorus applications and there is STILL no response to phosphorus applications. Why? Now this time, you got me. I can't explain that one, either.)

But allow me to admit that phosphorus IS necessary sooner or later, and that farmers shouldn't just mine it down to nothing. Fine. What do we do? We use some animal manure. Or we recommend superphosphate (farmers don't always use it, ergo the 5,000 farmers out there I can show you.) (Although I am NOT an organic farming advocate, I do believe strongly that many scientists have failed to understand its potential without ever becoming well-informed about it.)

So, what about phosphorus? A die-hard organic person would have two possibilities. Phosphorus-accumulating plants would be one, but then we're back to robbing Peter to pay Paul--something not everyone can do. Or mining our own soils. So then we have rock phosphate. But it doesn't work very well--the response of crops is way too small. Once again, we're back with the "If I haven't seen it, it doesn't work" phenomenon. In fact, if rock phosphate is applied to the MULCH instead of the soil, the response is dramatic--MUCH more than if chemical fertilizer is applied directly to acid soils.

In fact, after years of working with both, I feel the evidence says that if you were restricted to one or the other, organics will improve soil a lot faster and MUCH cheaper than will inorganics.

So at this point I rest my case. And invite comments.

Sincerely, Roland Bunch
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