Soil Fertility: Options for smallholder farmers

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Helpful information for nutrient management (1)

- Soil chemical properties through 1) soil testing (preferred!), 2) soil surveys, or 3) local knowledge:
  - Soil pH (and lime requirement if possible)
    - Soil pH is helpful to infer availability of other nutrients
  - Available nutrients
    - In many situations P and K will be most critical
- Soil color (brown/black, orange/yellow, gray)
  - Usually an indication of organic matter content and phosphorus fixation capacity. Drainage also
- Soil texture and mineralogy
  - Helpful to infer other important soil properties
  - Related to soil color

- Caution 1: Translating this information into useful nutrient management decisions requires considerable knowledge of soil science

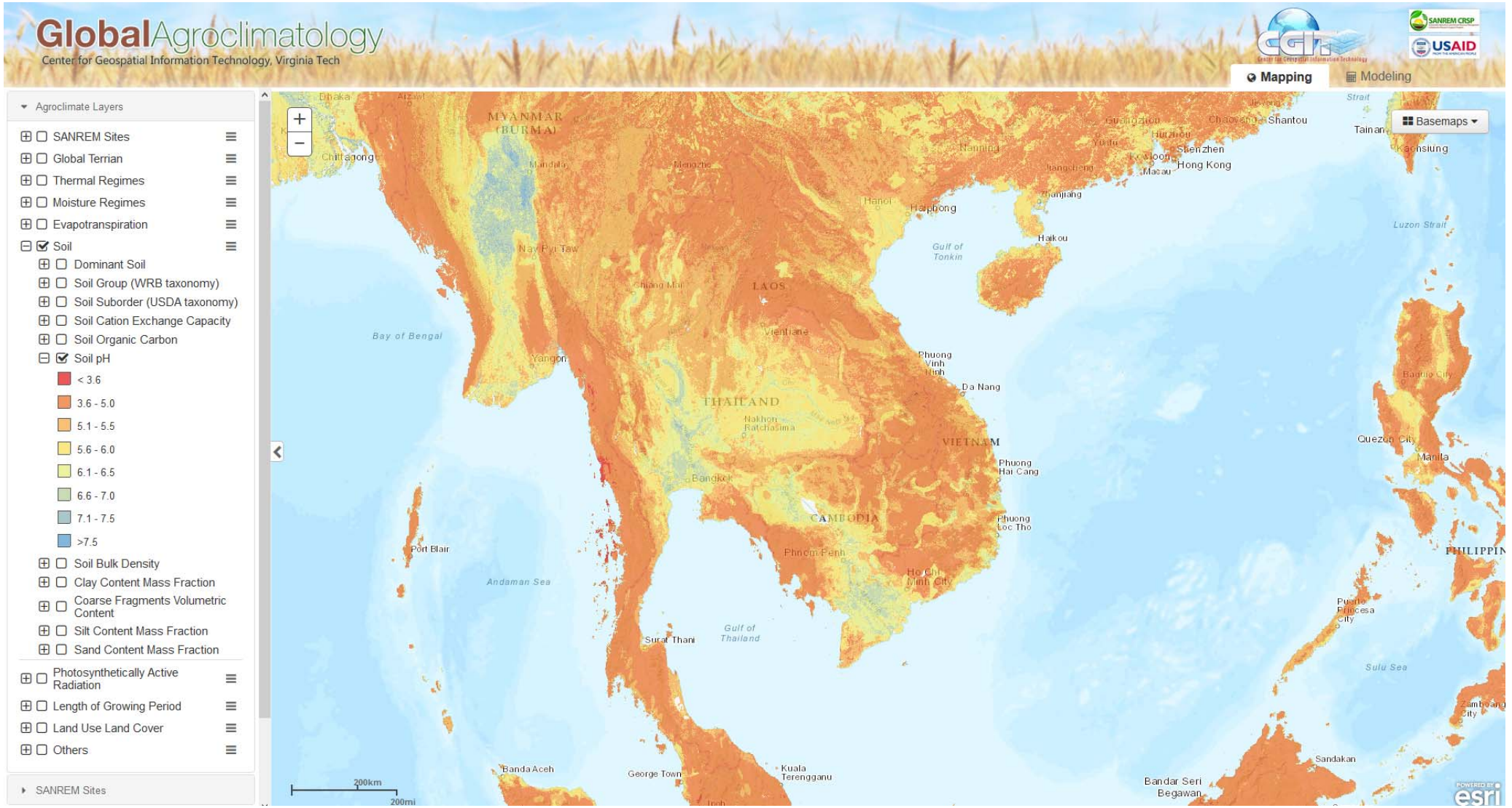
- Caution 2: There is no substitute for information gained from soil sampling, analysis, and recommendation

Soil Resources of Thailand

Thai soils are classified into 9 orders on the basis of USDA Soil Taxonomy:

Ultisols	42.13 %
Entisols, (slope complexes, water bodies and others)	33.75 %
Inceptisols	9.40 %
Alfisols	9.16 %
Mollisols	1.17 %
Vertisols	0.81 %
Histosols	0.14 %
Spodosols	0.12 %
Oxisols	0.03 %

Status and Priorities of Soil Management in Thailand - Pitayakon Limtong



http://arcgis-research.gis.vt.edu/cgit/global/

Helpful information for nutrient management (2)

- Look for signs of nutrient deficiencies on plants
  - Deficiencies (other than N) that show up once will likely appear again unless action is taken
- Realistic yield goal for grain production
  - Critical for nitrogen management
- Online resources can be great
  - IRRI's "Rice Knowledge Bank"

How to manage soil fertility

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Applying nutrients to the crop is essential in managing soil fertility so the plants grow and develop normally. A number of crop problems can be related to inefficient management of nutrients and nutrient imbalances in the field.

Site-Specific Nutrient Management | Crop Manager

Site-specific nutrient management (SSNM) enables farmers to dynamically adjust fertilizer use, by supplying optimum amounts of nutrients at critical time points in the crop's growth to produce high yields.

In SSNM, farmers tailor their nutrient management strategy to the specific conditions of their field.

The following are steps in SSNM:

STEP 1 Establish an attainable yield target

STEP 2 Effectively use existing nutrients

STEP 3 Apply fertilizer to fill in other nutritional needs of the crop

Read: for researchers and scientists - SSNM explained | SSNM in detail

Fact sheets: for farmer-managed research - Addition plots | Nitrogen split applications | Nutrient omission plots

Did this page help you?

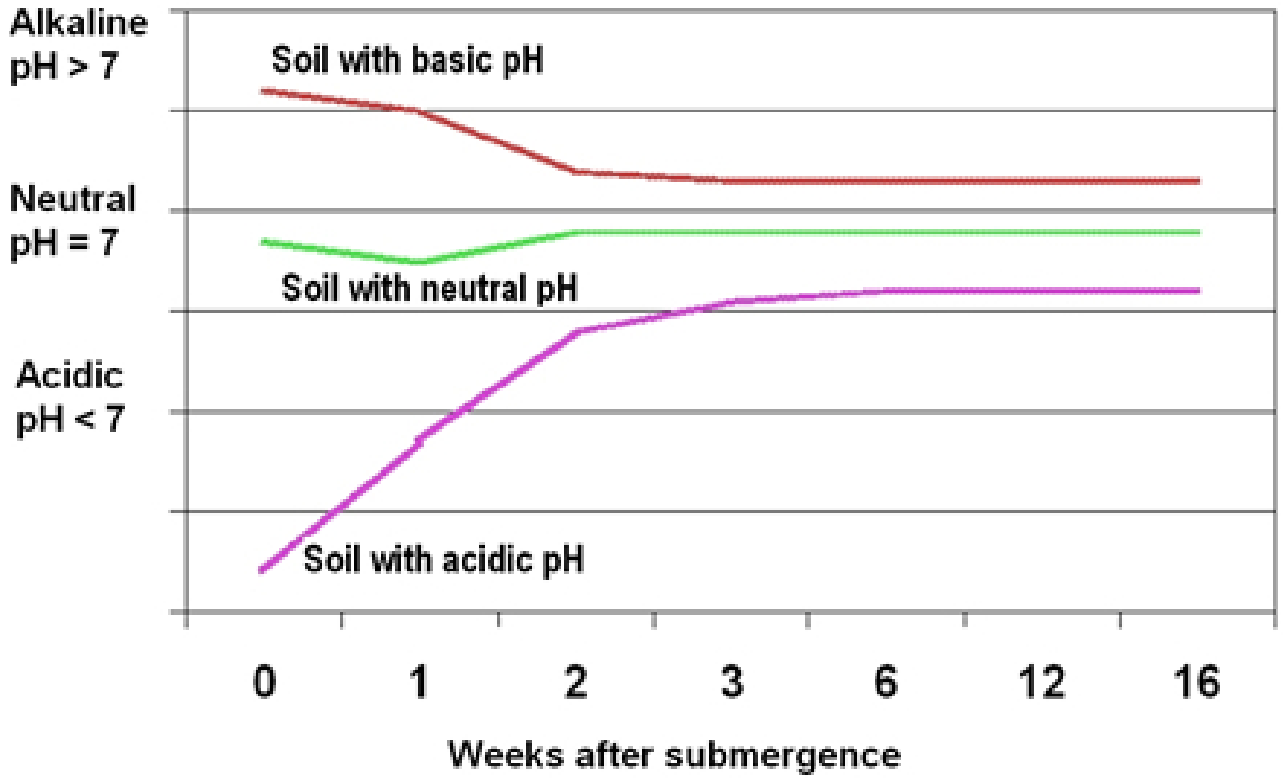
Liming options for smallholder farmers

- Normally, a soil needs lime if the pH is below 5.5.
- Raising soil pH increases availability of some nutrients and reduces toxicity.
- The amount of lime needed depends on pH and soil texture/mineralogy. Amounts needed are in tons/ha.
- The best liming materials are agricultural lime -$CaCO_3$ and dolomitic lime -$CaMg(CO_3)_2$
- Other possibilities:
  - Wood ashes—superior liming material and fertilizer
  - Manures—many manures have liming action
  - Gypsum doesn't increase soil pH but adds calcium, which can have lime-like benefits
  - Adding organic matter to soils can alleviate symptoms of soil acidity

Warning: Most N fertilizers increase soil acidity

Warning: Raising soil pH above 6.5 by liming is bad as well

Typical effect of submergence on soil pH for acid, neutral, and alkaline soil



IRRI Rice Knowledge Bank

Fertilizer options

- Chemical fertilizers have known nutrient content for precisely adding the needed amount of nutrients in available form
- Other options:
  - Legume cover crops/green manures (supply N):
    - Sunn hemp, cowpea, mungbean, Sesbania, etc. etc.
    - The amount of N a cover crop will contribute depends on 1) maturity achieved and 2) amount of biomass retained on soil
  - Agroforestry—leguminous trees
  - Composts—not nutrient-rich but great soil conditioners!
  - Manures—of course
  - Any other organic source is good—there is no such thing as too much soil organic matter!

Why use organic materials and manures

Manures and other organic sources are used to improve soil fertility and soil organic matter content and to provide micronutrients and other growth factors not normally supplied by inorganic fertilizers. Application of these materials may also enhance microbial growth and nutrient turnover in soil.

Addition of rice straw in the field and manure.

Organic material	% N	% P_2O_5	% K_2O
Crop residue (rice straw)	0.5-0.8	0.15-0.26	1.2-1.7
FYM (cattle manure)	0.8-1.2	0.44-0.88	0.4-0.8
Compost	0.5-2.0	0.44-0.88	0.4-1.5
Sewage sludge	1.6	1.76	0.2
Pig manure	0.7-1.0	0.44-0.66	0.6-0.9
Sheep & goat manure	2.0-3.0	0.88	2.1
Poultry manure	1.5-3.0	1.15-2.25	1.0-1.4
Oil cakes	2.5-8.0	0.66-2.86	1.2-2.3
Green manures			
Sesbania	1.7-2.8	0.1-0.2	1.4-1.9
Azolla	2.0-5.3	0.16-1.59	0.4-6.0

Examples for the nutrient content of various organic materials.

How much do I apply?

Urea (46% N)	Poultry Manure (2% N)	Cattle Manure (1% N)	Compost (0.5% N)
217 kg	5,000 kg (or 5 t)	10,000 kg (or 10 t)	20,000 kg (20 t)

Nutrient source	N (%)	P_2O_5 (%)	K_2O (%)	Price (US$/kg)	Amount required (kg)	Price (US$) for 100 kg N, 50kg P_2O_5, & 50 kg K_2O per ha
Cattle manure	0.8	0.3	1.0	0.03	12,500	375
Urea	46	–	–	0.14	217	77
SP36	–	36	–	0.21	139	
KCl	–	–	60	0.21	83	

Organic manures are sometimes more expensive than inorganic fertilizers

Table 4. Nitrogen calculator to estimate legume benefits

Soil type	N required (kg ha^{-1}) to produce 3 t ha^{-1} maize	N benefit (kg ha^{-1}) from previous grain legume crop – about 1.2 t ha^{-1} yield and at least 2 t ha^{-1} residues	N benefit (kg ha^{-1}) from previous green manure – about 2.5 t ha^{-1} residues incorporated
Light textured sandy (<1% organic matter)	45 (2 bags)	11 (½ bag)	23 (1 bag)
Medium textured sandy loam (1-3% organic matter)	34 (1½ bags)	23 (1 bag)	45 (2 bags)
Heavy textured sandy clay loam (>3% organic matter)	23 (1 bag)	34 (1½ bags)	55 (2½ bags)

ICRISAT/MAI. 2000. Cost-effective soil fertility management options for smallholder farmers in Malawi.

The P and K problems

- Tropical and subtropical soils are often depleted of P and K because of natural soil weathering and crop removal of P and K
- Phosphorus depletion is a CRITICAL problem in much of the tropics/subtropics
- P and K cannot be “regenerated” in soils—must be added in fertilizers or organic material
- P and K stocks in fields decline with time unless imported in form of organics or fertilizers

Happy to continue the conversation!

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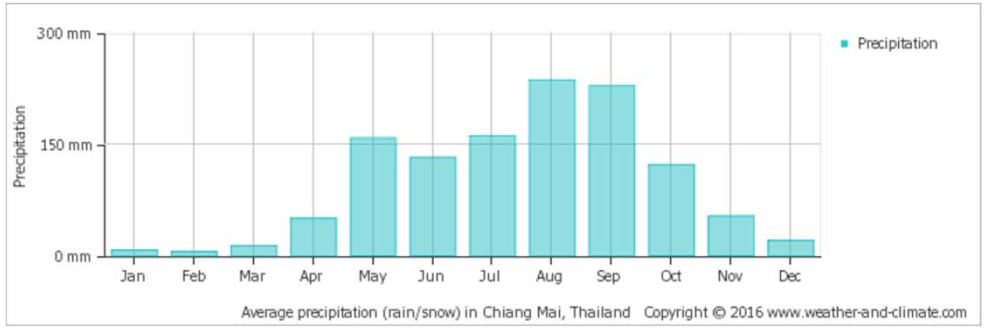
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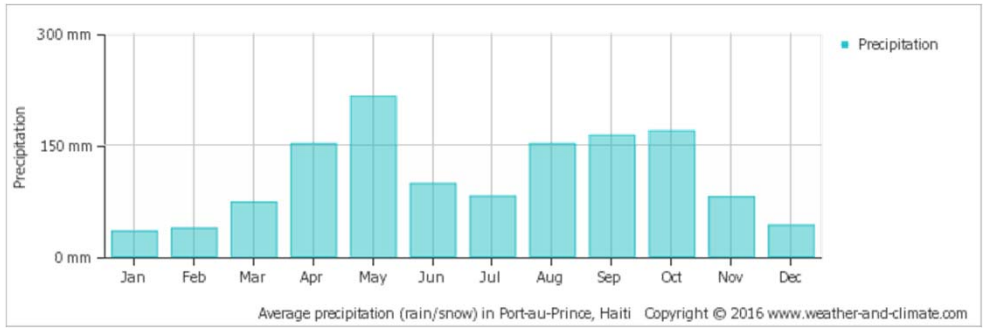
Precipitation
Average precipitation (rain/snow) in Chiang Mai, Thailand Copyright © 2016 www.weather-and-climate.com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Precipitation
Average precipitation (rain/snow) in Port-au-Prince, Haiti Copyright © 2016 www.weather-and-climate.com