Policies for sustainable plant nutrient management

Michiel Keyzer

Centre for World Food Studies
VU University Amsterdam
www.sow.vu.nl

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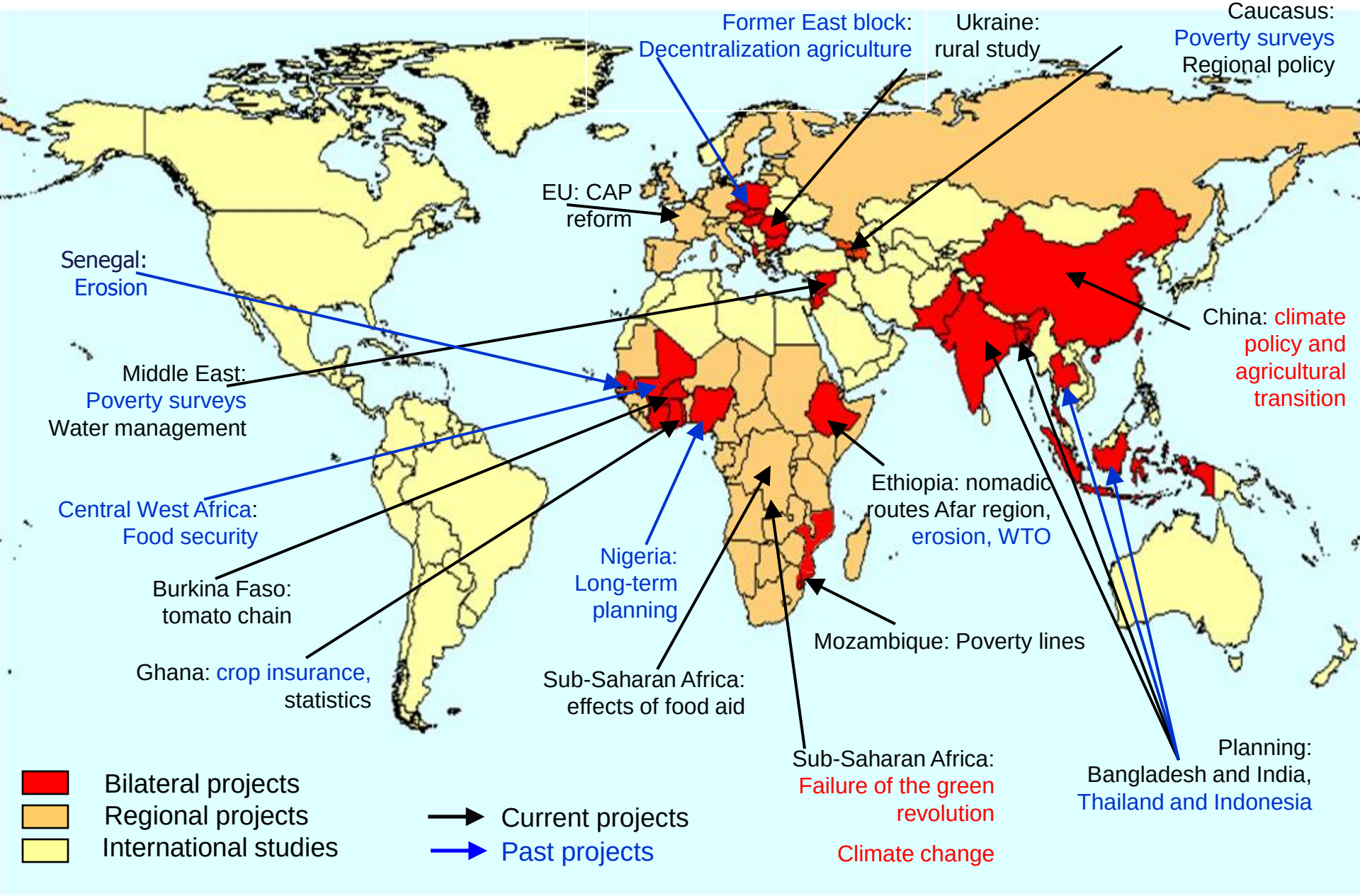
SOW-VU: mandate

- Foundation located at VU University, Amsterdam
  - Established in 1977, as follow up of a world food study started in 1972 for the Club of Rome
  - Until recently floor funding from Netherlands ministries of Foreign Affairs, Economic Affairs and Agriculture (Economic Affairs)
  - Currently project financed, largely of foreign origin

- Aim
  - To do research into causes of poverty and malnutrition
  - To formulate and evaluate policies on food, agriculture and development so as to help alleviate poverty and malnutrition

- Multidisciplinary, quantitative approach involving
  - Economics
  - Earth sciences and hydrology
  - Agronomic and ecological sciences
  - Nutrition sciences
  - Mathematics, statistics and systems analysis

SOW-VU: past projects (blue) and current: NPK (red) and others (black)



Introduction:
The need for sustainable plant nutrient policies

- Macronutrients Nitrogen (N), Phosphorus (P), Potassium (K) and Calcium (Ca) and micronutrients (Zinc, Copper, …) are essential to plant growth
  - no substitute ever
  - to feed world population is expected to rise from 7 billion now to 9 billion in 2050
  - to supply it with animal feeds, fiber and (hopefully not too much) fuel

- Scarce plant nutrients are key in closing yield gap in developing countries
  - should be available and affordable in rural areas

- Pollution/contamination is also an issue
  - excess use of N and P major source of pollution in China and Vietnam
  - chemical P and K fertilizers carry many heavy metals
  - organic fertilizer carries germs

- But so is the loss of precious raw materials such as Uranium

- For many years, SOW-VU has been actively pushing NPK-related issues
  - JRC-publication, IIAE-OECD …

Main issues

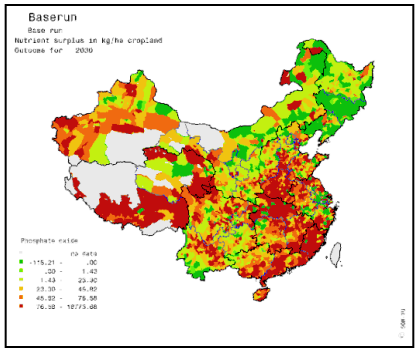
Issue 1: NPK might get too scarce to be affordable for poor countries

- NPK they have large and fast-growing needs, high import and transportation costs
  - needs can be reduced by precision agriculture but African soils are in particular often NPK and micronutrient deficient
- this might create political tension, particularly since Africa has major deposits of P
- Africa might be well advised to try developing ruminant sector

Issue 2: Micronutrient scarcity

- Zinc and Copper are too scarce to be added in pure form to chemical fertilizer of in food via biofortification
- bulk products such as olivine sand & stone-meal contain useful micronutrients as well
  - applying micronutrients in this way is easier than through biofortification
- for human nutrition livestock development is effective option (“eat an egg”)

Issue 3: NP overuse and K deficit (China, Vietnam)



- demand growth also unsustainable environmentally
  - NP surpluses pollute air and water and reduce biodiversity
  - P surpluses cause micronutrient deficiency
  - whereas K deficit mines soils
- overuse motivated by inappropriate composition of NPK; national emphasis on security; and sanitary problems with organic nutrients
- policy of biofuel production on marginal lands only lifts NPK demand further

Main issues (2)

Issue 4: Mineral rocks are not without contaminants

- Uranium, Cadmium and other heavy metals
- PK production generates contaminated phosphogypsum
  - huge quantity 1.45 mt gypsum/mt P-rock used in construction of roads and buildings
    - Radon radiation in buildings
- some are valuable:
  - until 1960s all nuclear bombs of US were obtained from Phosphate rock

Issue 5: Labels on fertilizer bags only tell part of story: about 98% of the mass

- illusion is kept that bag contains N, P, and K plus only some harmless calcium
- potentially beneficial micro-nutrients are not on the label
- Uranium, Cadmium, Radium, Thorium, Cesium etc. even less
- enters crops, livestock and the human body
- European labeling regulation is in the pipeline to cover 100% of fertilizer bag

Issue 6: Use of organic fertilizer problematic

- polluted and full of germs
- psychological barrier
- distance from production to consumption sites rising, due to trade and urbanization

Implementing purity and mixing requirements

- Purity requirements on P,K are trigger for change
  - available U extraction technique could be used to extract other pollutants
  - clean Phosphogypsum also as its stacking in unpurified form is costly and dangerous
  - raises the import price of chemical NPK
  - also yields valuable U and controlled U-distribution to avoid proliferation
  - recycling itself avoids inflow of impurity
- Higher cost makes organic substitutes and hence recycling more competitive creating a win-win situation
  - recycling via:
    - reliance on livestock:
      - livestock allows to concentrate nutrients from pastures to fields
      - essential for developing countries: manure contains the necessary micronutrients, is of assured quality, and available locally
    - end of chain recovery:
      - water treatment plants and biogas facilities left with bulky fertilizer, and wastes
      - excrements should be looked at as precious resource, not as “dirty sludge”
  - but incentive too weak as long as P,K mineral prices remain low, hence need for regulation
    - the higher costs also can lead to breaching of environmental regulations
      - e.g radioactivity Thermphos Zeeland
- Mixing organic with chemical turns N-fertilizer into innocent material
  - IRA car bombs, 1995 Oklahoma city bombing, 2001 Shijiazhuang bombings, Taliban car bombs, 2011 Oslo bombing

Impediments to implementation of win-win with purified, mixed organic/chemical nutrients

- Farmers:
  - purity requirements increase cost of plant nutrients
  - risk-aversion raises NP use
    - partly due to poor extension services (also by NPK suppliers!)
  - use of chemical fertilizer has social status

- Fertilizer industry:
  - purity standards raise production costs
  - heterogeneity of organic fertilizer might raise costs as well
  - in many countries industry has always been close to military
    - N peacetime conversion of ammunition supply
    - U recovery procedures belong to classified information at Westinghouse (anti-proliferation)

- Public:
  - psychological barriers to use of manure and even more to use of human excrements
    - partly justified in past but technically unnecessary after processing by chemical industry
  - awareness lacking
    - P,K scarcity is not too stringent, continuous upward corrections of reserves
    - unlike fossil fuels, P,K and micronutrients remain on Earth, somewhere
    - no one knows “what in the bag of fertilizer?”

Summing up

- P, K scarcity critical in the long run
  - no substitute

- Priority for:
  - recycling NPK and micronutrients
  - P, K purification close to mines
  - joint processing organic-chemical
  - precise application of plant nutrients (and of animal feed supplements also!)

- Industry interest will partly depend on future of nuclear energy
  - IAEA and EC-Environment are busy preparing regulation
  - the win-win mechanism would promote recycling further

- However,
  - in the short term regulation raises costs of plant nutrients
  - N, P, K scarcity not too pressing in short run

=> Top priority: public awareness, particularly of contamination