Thursday, 28th February 2013 11.15 am to 1pm in room H2037

MES & Agriculture

---

*„Systems are needed that enhance sustainability while maintaining productivity in ways that protect the natural resource base and ecological provisioning of agricultural systems“**

On this background our session sheds the light upon the potentials of microenergy systems to close anthropo-natural cycles by effective and efficient use of the by-products of energy production such as fermentation residues and charcoal. These products contain not only carbon but valuable nutrient resources such as phosphorus and nitrogen. By realizing an energy-system integrated in agricultural practices in particular the continuous decrease in soil organic matter, which is the major building block of a fertile soil, can be targeted. At the same time soil fertility is improved by recycling nutrients and an additional “productive use” is created which contributes directly to food sovereignty and possible income generation.

*IAASTD (2009) International Assessment of Agricultural Knowledge, Science and Technology for Development, Synthesis Report, Island Press, Washington, DC, ISBN 978-1-59726-550-8, 106pp.

The opening speech focused the session's topic on the question on „how to realize food security or souvereignity and energy autonomy at the same time by using low-tech technology?“.
After a short Introduction round, when all participants briefly introduced themselves and their interest in this session, we started with three so-called „Introductive Talkes“, short inputs to get an overview and the relevance of the topic of „Microenergy-Systems & Agriculture“ for everybody in the room.

1) Martin Kaupenjohann: „*Open Cycles at different scales – focusing plant nutrients*“

Import topics talked and discussed:

- **Currently element cycles are open**: Humanity is digging giant wholes (mining) and at the same time producing vast piles (waste).
- Globally extractable phosphorous (P) stock in mines may last for 120 to 370 years.
- Global arable soils contain similar stocks of P like mines.
- **Open Cycles on Continental Scale with the example of soybean trade:** 6,5 Million Tons of Soy was imported in 2009 from Brazil to Germany containing 45.000 tons of P which will not be brought back to Brazil --> shift of natural stock between continents through trading!
- **Open Cycles on Regional Scale with the example of interactions between urban and rural areas:** While agricultural and horticultural fields in rural areas demand continuously P as fertilizer, urban areas are in fact “phosphorus hotspots” accumulating food waste and human excreta that contain P. Up to now less than 1/3 of the P which goes from agriculture to cities is returned! Returning the P to the fields and thus close the loop to a certain extent would participate to fullfill the demand for fertilizer in agricultural practices.
- **Open Cycles on Lacal Scale with the example of subsistence agriculture in Africa:** Soils loose 10 to 30% of their total P stock within only one to two generations if the excreta of the small holders are not returned to the fields.
- **Learning from history:** Permanent agriculture in China, Korea and Japan (King, 1911): “Sustainability is mainly based on closed nutrient cycles through the use of “night soil”.”
- The highest phosphorus content was found in the “Terra Preta do Indio”, a anthropogenic tropical soil (25 kt P per ha)

- Plaggenesch soil – an historic European anthropogenic soil has 2-3 times phosphorus content when compared with the natural soil from the same region and climate.
- **From history to future:** Develope appropriate techniques to close the P-cycles at all scales

2) Ariane Krause, Julia Klomfass*: „Energy and Food from the soil – competitors and/or synergists?“*
Including an overview about microenergy-systems related with agriculture

What does it mean to have a **competition** for soil? It can be...

1) *Quantitative* concerning the amount of land used → impact now
2) *Qualitative* depending on the way of using of land now → use of soil now directly influences future possibilities to use this land (e.g. loss of soil fertility due to open cycles, soil compaction due to heavy harvesting machines...)

In this presentation practical examples of Microenergy Systems (MES) were introduced by going along the life-cycle of an agricultural product; starting shortly with systems creating open cycles, then continueing with systems realizing closed cycles.
Examples related with **open cycles** are mostly also examples of **competitors** (in the case of this presentation):

- **Production** (e.g. Bio-fuels): Comes along with problems such as
    - Land-Grabbing → open cycles on global scale & unequal power and rights to use the land

  → „Access to productive resources is a key element of the human right to food“ (FIAN, 2012)
    - Soil Degradation → destroying productivity of soil in the long-run
    - Food Speculation → hunger

  → Bio-Fuel production can not be considered as MES!
- **Consumption** (e.g. Biogasplant): Mayor problems are depending on the size of the plant and the integration in the energy system – maybe seen as MES; those plants using maize as substrate mostly practice cultivation with intensive use of herbicides and pesticide → stronger regulations are needed to ensure environmentally friendly production otherwise this is a clear case of competiotion because in the medium-term the natural environment (and not only the soil fertility, also impact on bee population as one example) is in danger.
- **Waste:** More research needs to be done on using waste materials such as harvest residues and kitchen waste for biogas production; challenges are e.g. to gain process stability by using inhomogenous materials; research work is tackling this (e.g. TU Berlin, ATB Potsdam-Barnim, TU Hamburg-Harburg).
- **Environmental Pollution:** A Report of the Working group of the United Nations Environment Programme (UNEP) states that:

1) *„Agriculture and food consumption are identified as one of the most important drivers of environmental pressures, especially habitat change, climate change, water use and toxic emissions“* (UNEP, 2010)
2) Main global problems for the health of our Eco-System are caused by Pollution mainly with nitrogen and phosphorus! (That means that we are not only wasting valuable resources (such as phosphorus) or resource that are further produced with high energy demand (such as nitrogen) but also use them to polute our natural environment in actual practices.)

→ We have to find new solution to **decouple** economic grownth from the use of resources and also from increasing damage to the environment: *„Reducing resource use and material losses at each stage in the life cycle is the most powerful strategy to reduce undesirable environmental impacts.“* (UNEP, 2011)
The *UN Special Rapporteur of the Right to Food* also adds that industrial farming and large-scale monocultures not only destroy the environment (one-third of man-made greenhouse-gas emissions) but also small-scale, family farming. So we will have to move towards agro-ecological ways of production if we really want to feed the world, fight rural poverty and global climate change at the same time (SRFOOD, 2013).

So let's turn our attention to the life-cylce of agricultural products and **MES implemented in combination aiming at efficient use of resources.**
We focused especially on small-scale and low-tech energy systems that are within our micro-perspective because in our opinion there are synergists as they can not only support contribution to close natural cycles but are also lowtech-engineering, which means that they are adopted to the specific area of implementation and are possibly available to many people (concerning base of knowledge, socio-economic values, available materials...).

- **Production**
    - Greenhouse-heating using heat as by-product from electricity production (e.g. by burning biogas) (from MES to agriculture)
    - Compost heating (using heat from agriculture in MES)
    - PV-Panel and Solar-Pump as MES used for irrigation (example from Ethiopia)
    - Multi-Purpose Use of Land, such as Windmills within agricultural plots or Agro-Forestry
- **Distribution/Transport** → to reduce energy demand (=fuel consumption) for transportation by doing agriculture within the city („urban gardening“, „urban agriculture“, „urban horticulture“) and to catch up with the global trend of urbanization.
    - Urban Farming
    - Vertical Farms: recylce water and nutrient and doesn't use pesticides BUT still have the disadvantage of a relatively high demand for energy; thus here the combination with a Solar-MES needs to be investigated further.
- **Consumption and processing**
    - Solar-Dryer (for better storage)
    - Solar-Cooker (for preparation of food)
    - Mixer (after the open source lowtech-design „Maya Pedal“)
    - Parabol-Pan
- **Waste**
    - Micro-Gasifiers: using dry harvest residues (e.g. Coffee husks or saw dust) → produce heat for cooking and charcoal that can be burned, too, or used as soil amendment to improve soil quality (structure and fertility) after the principles of Terra Preta
    - Biogas-plants: using wet harvest residues and kitchen waste → produces heat for cooking (when bioga is burned) and nutrient rich biogas-slurry that can be used as fertilizer
    - Another type of waste being part of the life-cycle of agricultural goods are human excreta. The products of human metabolism also contain nutrients that were taken off the soil before while harvesting and thus shall be recyled to the soil. To avoid health risks of this practice special attention is needed to the process of sanitation. This is another field of implementation of MES which can be used for example to realize thermal treatment and thus sanitation of human faeces. One complex but quite holistic approach which is also part of one of our presentations later looks like this and will be explained more in detail within another presentation later.

Another important issue which is relevant to the topic of competition for arable land and soil is the following: Animal products are particular important in this matter due to their indirect consumption of a large proportion of the world’s crops, resulting in high land use as a consequence. „Agriculture, particularly meat and dairy products, accounts for 70% of global freshwater consumption, 38% of the total land use and 19% of the world's greenhouse gas emissions“ (UNEP, 2010)

A substantial reduction of impacts would only be possible with a substantial worldwide diet change, away from animal products. And there is even no technology or extra investment needed for this. Unlike fossil fuels, it is difficult to look for alternatives: people have to eat. But we can choose what we eat!
This is not only relevant for competition about land use but also important coming back to the question „What can we do to get the GHG emissions down to a level were global temperature is assumed to raise only little?“ (which was asked at one of the opening speeches).
→ **Global vegan diary would therefor also result in less land-use and thus less stress on competition between food and energy production from arable land.**

Sources:

- FIAN 2012: http://www.fian-deutschland.de/online/index.php?option=com_content&view=article&id=68&Itemid=176; visited at 26th Feb. 2013.
- UNEP 2011: Decoupling natural resource use and environmental impacts from economic growth, A Report of the Working Group on Decoupling to the International Resource Panel. Fischer-Kowalski, M., Swilling, M., von Weizsäcker, E.U., Ren, Y., Moriguchi, Y., Crane, W., Krausmann, F., Eisenmenger, N., Giljum, S., Hennicke, P., Romero Lankao, P., Siriban Manalang, A.
- UNEP 2010: Assessing the Environmental Impacts of Consumption and Production: Priority Products and Materials, A Report of the Working Group on the Environmental Impacts of Products and Materials to the International Panel for Sustainable Resource Management. Hertwich, E., van der Voet, E., Suh, S., Tukker, A, Huijbregts M., Kazmierczyk, P., Lenzen, M., McNeely, J., Moriguchi, Y.
- SRFOOD 2013: United Nations Special Rapporteur of the Right to Food; http://www.srfood.org/ visited 26th Feb. 2013
- Gordon Graph: http://walrusmagazine.com/blogs/2011/10/24/graff-and-the-beanstalk/
- “Kopsalat aus dem 3. Stock” Le monde edition 10, p. 95
- Dickson Despommier: Vertical farms
- http://www.motherearthnews.com/organic-gardening/heating-a-greenhouse-zmaz86jazgoe.aspx?page=3#axzz2Lckgd5

3) Anja Müller: *Demand for nutrients and soil condition to get ´good quality´ food products – perspective of plant nutrition*

Environmental stress factors influencing the yield:
1. cultivation method: fertilization, plant protection
2. abiotic stress factors: climate, soil
3. biotic stress factors: diseases-pests, competition among the plants

Liebig's Law: *„The availability of the most abundant nutrient in the soil is only as good as the availability of the least abundant nutrient in the soil“*
when all other environmental conditions are optimal (water, light, temperature etc.)

Important nutrient uptakes from soil into plant tissues:

- Macro nutrients: N K P Mg Ca S
- Micro nutriens: Fe Cl Mn B Zn...

The nutrients demand changes during plant development; vegetative growth rate requires most of the nutrients.

Nutrient losses: plant removals, gaseous emissions, fixation and immobilisation, leaching, surface erosion

Conclusion **-->** **Application of organic matter** has positive effect.

Hands-on: how to predict **nutrient demand and availability**?!

Then three more presentations followed and students and practitioners gave some insights in there work in the field of MES related with agriculture. Each presentation was about 15 minutes and afterwards there was 10 minutes to answer some questions.

4) Dennis Melzer: *Nutrient management in peri-urban horticulture in Nepal (Masterthesis)*

Urban Agriculture is a potential to ensure nutrition security especially in developing countries. Little is known about the fertilization of small scale farmers in these regions so far. Hence, a master thesis was conducted to investigate the nutrient management of urban vegetable farmers in the small city Bhaktapur, near Kathmandu. Therefore, the nutrient management of 16 farmers has been determined via questionnaires. Further on, we analysed the plant-available nutrient status of the farm topsoils.

The average ratio of mineral fertilizers on the investigated fields is more than 70%. Organic fertilization is marginal. Nitrogen fertilization greatly exceeds the demand of the produced crops (Ø = 522 kg N ha^{-1} a^{-1}) without increasing the yields significantly. Similar surpluses are visible for the Phosphorous fertilization (Ø = 337 kg P ha^{-1} a^{-1}). Due to the fact that Potassium is only added via organic fertilization, the soils have a Potassium deficit of -106 kg K ha^{-1} a^{-1} in average.

The described fertilization manner is also visible in consideration of the soil nutrient status. An acidification of the alluvial soils, due to high nitrification rates, is indicated by very low pH levels (3.9 – 6.2; Ø = 5.0). Therefore an improved nutrient management seems strictly essential due to ecological and economic reasons.

Questions and answers:

1, What are you going to use the results for?

- The result will be utilized by the NGOs .The researcher has contact with the farmers but does not know how to go about it. The project was done with the support of a NGO and the farmers will be informed further by the NGO.

2, What is the quality of the fertilizers? (what are the components of the fertilizers?)

- The fertilizers were not analysed.

3, Has fertilizer quality is also being tested? (Has the quality of the fertilizers been confirmed?) Because in Africa, the fertilizer is mixed with sand, so that the seller will have more profit.

- There is an unsteady quality of the fertilizers. Government assumes that the governmental fertilizer quality is good but the quality of fertilizers from informal sources is poor. Farmers do not see any differences in governmental or informal fertilizer quality.

4, What is the effect of industrialization on the soil?

- Decrease of land (There will be inavailability of space) – land use hence fields are getting smaller. The research is yet to be completed.

Notation by Krause: good correlation between two presentations, too much nitrogen and potassium deficit --> nitrogen overdose will not compansate the deficiency.

5, Does the high content of charcoal in the soil show any effects similar to terra preta?

- Carbon content of the soil is high. Farmers burn the wheat straw and put it back to the soil.

Comments by Kaupenjohan:

The initial study was to investigate the soil pollution, but then found the problem with the nutrient content in the soil. The real nutrient content of the fertilizer (quality) will be further investigated.

5) Anna Friedrich: *The Potential of Using Reclaimed Bio-Slurry as Fertiliser (Bachelorthesis)*

Biogas technology has become a widespread and recognised possibility to produce environmentally friendly energy in *Nepal*. However, relatively little attention is devoted to the nutrient rich by-product, the bio-slurry. In the rural village *Changunarayan*, located in the *Kathmandu Valley*, bio-slurry from existing biogas plants was found to be underutilised and to be flowing haphazardly into the landscape. This study was conducted to determine whether reclaiming bio-slurry would be suitable to be integrated into agricultural practices in *Changunarayan* in order to close local nutrient cycles and maintain soil fertility. With the help of a Material Flow Analysis the site-specific bio-slurry's potential to meet nutrient and carbon requirements in crop cultivation was investigated. The local nutrient, carbon flows and their converting processes were identified and quantified among the biogas plant owning households. The nutrient and carbon demand in cropping was compared to its supply of bio-slurry. In *Changunarayan*, human, buffalo and cattle excreta are used for generating biogas and biogas slurry. An average household was found to comprise six humans, one cow and 0.5 buffalo. The resulting available nutrients in bio-slurry amount annually to 38.4 kg nitrogen, 23.1 kg phosphorus and 22.5 kg potassium, the carbon accounts for 205.3 kg. The total demand in cropping was determined to be 65.4 kg nitrogen, 18.7 kg phosphorus, 60.7 kg potassium and 253.5 kg carbon annually. Hence 59 % of the nitrogen, 124 % of the phosphorus, 37 % of the potassium and 89 % of the carbon demand could be potentially covered in *Changunarayan* by bio-slurry. Reclaiming and integrating the underutilised bio-slurry into the agricultural practices appears to be a viable and sustainable opportunity to recirculate nutrients and utilise carbon.

Questions and answers:

1, Why are many of the biogas system broken?

- Some were just because of small problem, e.g. broken valve, but since it was broken, the system could not be used. And in other cases, the users were illiterate; they could not read the manual, needed for workshop.

Solution: there is no technical cooperation in the village. However, (The cooperation of women is now being enjoyed in the village)

2, Big number of biogas plant was not working, About 80% of biogas plant was not working; is the value for specific for this area or general?

- Only for this specific area.

3, Who gave the subsidies?

- Netherland Company and organization, the families just have to pay half. In this case study, it was funded by World Vision.

4, How about the acceptance?

- Knowledge and caste, lower caste is the one who is allowed to deal with faeces/waste.

Comments by Krause: gap of communication and gender issues are highly relevant in this casse: during the building phase all information about the plant was given to the man in the village, but the women were responsible to use the plant.

5, Are there feedback to world vision to create room for further implementation?

- Not yet, but thanks for the suggestion; it will be done!

6) Adam Bitakwate: *Local plant nutrient recycling from anthropogenic waste – sharing the experience from field plant experiment in Tanzania (Practitioner)*

This practitioners' presentation provided information about experiences from field plant experiments done in Northern Tanzania within the project "*Carbonization and Sanitation*" (CaSa). The CaSa project realizes an integrated approach to address the issues of resource protection, improvement of energy supply and sanitation services. Furthermore, it strongly follows the community participatory approach in development of technologies. One of the expected final results is the improvement of soil quality to ensure long-term food security for the rural population of Kagera region. Thus a new alternative combination of technologies was developed and tested within a pilot project. Field trials are also conducted to evaluate the system's impact on plant growth and soil quality which started in September 2012. The first results of the general observation show a benefit of the new approach during to plant growth concerning size of the plants, health of the plants (esp. During period of stress due to draught) and amount as well as quality of the harvested maize and beans. Nevertheless the collected data does not show clear correlation between data and treatment. A big challenge was to protect the field trials from animals and thus losses of plants and harvest may also influence the quality of the data. To get more evidence of the data more field trials need to be conducted.

Questions and answers:

1, Suggestion: This is a very practical approach that should be published and shared.

2, How could crops be protected from animals? e.g. birds

- Share with the bird, protected from cows. For data collection: mark some plants for takingthe measurements and observe them for animal attacks, only take unafacted plants into account.

3, Did the people use the toilet?

- At the beginning it was different; some did not want to use it, some did. For some weeks we even had the problem that too many people used the toilet; sometimes we had to encourage people to use the toilet to have enough urine for fertilizing. But the situation is improving and also depending on how many people live near the project area at the time (as this varies).

4, Do you have any experience with using Morringa Tree?

- Not in the particular area. But generally in Tanzania, Morringa tree is in use for medicine.

5, Do you introduce materials from elsewhere or just material produced locally?

- Only a thermometer for the oven was brought from Germany. All other materials were organized at the region. The concept is based on lowtech-desgin so it is possible to build all technologies with materials that are locally available and with the expertise of the local community.