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Beyond local knowledge and institutional reach: micronutrient disorders in Hill agriculture.

Summary:
Soil deficiencies of micronutrients, especially boron and zinc, have been found in several areas in the Nepalese Hills, and they may be more restricting to agricultural productivity than macronutrients. The mobility of technical solutions in the sense of mineral supplements is dependent on the mobility of knowledge. Local knowledge has not internalized the micronutrient issue. Scientific knowledge on micronutrients is yet imperfect, based on limited research, and affected by lack of information on the quality of chemical fertilizers as well as compost/farmyard manure. The institutional scene related to agricultural extension is complex, and scientific knowledge is hardly reaching the levels in contact with the farmers. The paper attempts to analyze the interface between scientific and local knowledge on micronutrient deficiencies.

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Beyond local knowledge and institutional reach: micronutrient disorders in Hill agriculture.

Introduction.

At least since 1982 it has been scientifically established that micronutrient deficiencies, especially of boron and zinc, are found probably quite widely in Nepalese soils (Sillanpää 1982; Tripathi & Shah 1986; Gupta et al. 1989; Carson 1992; Kiff et al. 1995). In Terai, Zn supplements are generally recommended to farmers growing improved varieties of rice. The same recommendations are not given to Hill farmers. Maybe it is assumed that the soil micronutrients are highly variable, and that farmers predominantly grow local varieties likely to be more tolerant of deficiencies, or efficient in uptake under marginal conditions. However, Gupta et al. (1989) found that Zn deficit was affecting citrus groves in Koshi Hills, and indicated a substantial problem.

In 1999, I carried out a rapid field survey on an arbitrarily chosen mid-Hill ridge at Siduwa-Jitpur-Manmaya in Koshi Hills. 102 soil samples were taken and 63 farmers interviewed about fertilization and other farming practices. The study area is linked to markets and institutions by road transport. In terms of social and ecological conditions, it is in a relatively good situation compared to Middle Hills in general.

The results showed that 86 % of the samples were deficient (< 0.5 ppm hot water extractable) in B, and 34 % deficient (< 0.6 ppm DPTA extractable) in Zn. Deficiency is defined as a theoretical 100 % yield response to supply. In more than half the samples, B was found non-detectable (< 0.05 ppm). The frequency and severity of the deficiencies indicate that improvement of the micronutrient status of the soils may be more cost-effective than supplying more macronutrients. Besides, a better Zn balance will probably improve human nutrition locally (Rengel et al. 1999). The main explanations for micronutrient deficiencies may be the young age of the soils, and low bedrock content.

The survey showed that farmers were highly interested in soil and nutrient problems, but also that local knowledge did not include an understanding of mineral problems and their remediations. The institutions and markets the farmers are relating to, do neither reach the farmers with scientific knowledge, nor with farming inputs related to micronutrient problems. The purpose of this paper is to present the interface between local and scientific knowledge, and discuss how to deal with the micronutrient issue.

Local knowledge.

Increasingly through the last decades, the concepts *Indigenous Knowledge Systems, Local Knowledge Systems* or just *Local Knowledge* have been highlighted in development research, often as a consequence of shipwrecked attempts to introduce Green Revolution or other means of modernisation (Murdoch & Clark 1994). Interesting findings from Nepal are presented by Tamang et al. (1993), and a large part of the general literature critically discussing land degradation in Himalaya is also referring to sound logic and good adaptations to the local environment in "traditional" Hill agriculture. However, it has also often been demonstrated that local knowledge may be far from "harmony" with nature (Murdoch & Clark, Ibid.). Agrawal (1995) tries to downplay the distinction between scientific and traditional knowledge, and finds that the attempts to introduce new technology from outside fail because they are just as anchored in a different socio-political-cultural context, as the local technology it tries to replace. Local knowledge is dynamic, and is incorporating new solutions from outside. One obvious example is the number of "local" varieties of maize and potatoes, latin american crops, found in Nepalese Hill agriculture.

The field survey found a surprising lack of local knowledge in the study area in several respects. Not one of the 63 farmers used any herbal or similar treatment of pests and diseases, although scientifically well known natural pesticides easily could be obtained from for instance *neem* trees found in the area. A few farmers used sealed mud pots for storage, or woodash to repel insects from stored grain. Several used a commercial insecticide named *Ghun* to protect stored seed grain, or treated seeds with kerosene. But by and large, the farmers adopted a rather fatalist view, and accepted substantial losses of crops and storages.

As to fertilization, all farmers but two used compost/FYM (farmyard manure), and most of them did in also apply varying amounts of chemical fertilizers. If there is a body of local knowledge related to compost/FYM management, it appears to be superseded by pragmatic factors related to labour and resource availability. The *white grub* pest is widespread because of poor composting

techniques, which rarely permit the compost to reach the thermophilious stage, at least not the whole stack. Compost heaps are produced as haphazard stacks, and management like pit-digging, fencing, turning, addition of wood ash, moisturing etc., vary widely between the farmers. The main distinction in the sample is between farmers who apply animal bedding all year, and those who do so only during the monsoon season. This divide is clearly reflected in general soil parameters in the survey, particular in Zn status. B is a regional deficit, not influenced by the use of compost/FYM. The local perception is that compost/FYM - *maal* - is superior to chemical fertilizers which are not seen as real *maal*. Most of the farmers using urea complained that it makes the soil hard and cloddy and difficult to till, likely due to a more rapid breakdown of soil organic matter. Tamang (1993) demonstrates how Hill farmers have a ranking of the nutrient value of manure from different animals, from bat to buffalo, which corresponds well with a scientific ranking, based on macro-nutrients. However, the farmers' ranking is based on a general "power" concept, and the local knowledge does not include concepts which can link the quality of *maal* to specific soil problems.

In addition to chemical fertilizers, farmers who grow vegetables as cash crops more or less by chance apply various growth conditioners, containing minor amounts of trace elements and/or amino acids or growth hormones. Such substances are given the common name *vitamin*. They are successful in the sense they it may reduce the symptoms of B or Zn deficits and make the vegetable look pleasantly green when arriving at the market. Shortly after the transplantation of rice, many farmers observe that the young plants first become yellow, then red, and finally green again. The symptoms indicate that one or more elements become unavailable for a period after the flooding of the fields. Some farmers react by draining the field, which could be seen as local knowledge, and some add chemical fertilizer, which could be termed scientific knowledge, except that none of the farmers understand why the phenomenon occurs or why the treatments work. Many farmers in the field survey had tried improved varieties of staple crops, but only a few continued to do so, as the results were discouraging. However, when it came to farmers growing vegetables as cash crops, all of them planted imported hybrid seeds.

Scientific knowledge.

As pointed out in the introduction, it has been known for some decades that some Hill soils have micronutrient deficiencies. However, the study initiated by FAO (Sillanpää 1982; Tripathi & Shah 1986) has not been followed up for the Hill areas, and there is a lack of knowledge about how deficiencies are related to geology, landscape and farming system parameters, as well as tolerance or efficiency of local varieties. Even in Terai, deficiencies of B and S are known, but the extent and

their implications for productivity still need more investigation (Gill 1995). In order to make general recommendations, the state extension system needs scientific evidence based on trials with specific crops and varieties. Imperfect knowledge of the quality of fertilizers presents a problem for issuing general recommendations, as will be discussed below. In addition, a literature survey shows that no information on micronutrient quality of compost/FYM has been published since Lewis (1979).Although key researchers and officials in the research system, and in some NGOs, are familiar with micronutrient deficiency symptoms, the knowledge is generally not transferred to field staff in contact with farmers. The farmers may acquire soil tests at a subsidized price. The standard tests deal with macronutrients and pH, and the results are accompanied by recommendations for the use of fertilizer and lime for the main crops. Micronutrient testing is in principle available, but the farmers do not ask for it as they do not know what to ask for. Chemical fertilizers may be portered several days from the roads, as the farmers have some knowledge of the benefits of these. However, the field survey found a clear gradient in fertilizer use at a portering distance of as little as 4-6 hours. Micronutrient supplies are in theory less sensitive to transport due to the smaller amounts required, but their reach is restricted by lack of knowledge, and hence, markets.

Fertilizer quality.

The introduction of scientifically based solutions to farm nutrient problems presupposes knowledge of the quality of inputs. Presently, this knowledge is not common in Nepal. Until recently, chemical fertilizers were supplied by a parastatal monopoly, AIC (Agricultural Inputs Corporation), with some additional supplements traded across the open border from India. It appears to be a common view that AIC has been inefficient and corrupted, and several farmers accused AIC staff of creating superficial supply crisises to hike prices on the black market, i.e. by not stealing enough from the stores. Since 1997, a gradual liberalisation of the fertilizer market has taken place, and in 1998 and 1999, the supplies have by and large been satisfactory, but a common claim from the farmers interviewed in the field survey was that the quality of the fertilizer had gone down. In the western world, micronutrient deficiencies are at times ascribed to the intensive use of "high-analysis fertilizers" containing very limited amounts of desirable or undesirable trace elements. The fertilizers available to Nepalese farmers fall far from this description.

Basnyat (1999) studied the quality problem and found that farmers in general have better faith in AIC supplies than those from the private traders. In fact, empty fertilizer bags from AIC are traded at good prices to private traders who refill them with inferior brands. Basnyat (Ibid.) presents

results of laboratory analyses of fertilizer samples collected from various importers and retailers. They show that the content of N in urea generally is satisfactory. Ten samples of diammonium phosphate (DAP) should have contained 18 % N and 46 % P as P2O5, but the N content ranged from only 0.14 % to 16.4 %, and the P content anywhere between 3.37 % and 46.02 %. The study found that AIC generally provided much better quality than the private traders. The chemical analyses were restricted to the concentrations of macronutrients.

Two more questions remain: do the fertilizers contain undesirable elements, and do they contain useful amounts of trace elements found deficient in the soils? To get an indication of this, I had two samples of DAP analysed for a number of elements. The samples were obtained from a private trader in the major trading centre Hile, and from a farmers' cooperative in Siduwa. They were said to derive from AIC imports from China, and India. It was found that the samples contained the promised amounts of N and P, and that none of the most toxic elements, Pb, Hg and Cd, were found in significant concentrations. The content of Zn, 24 and 61 mg/kg respectively, was too low to have any real impact on deficient soils, given the amounts the farmers participating in the field survey are applying (average: 31.15 kg/ha). However, one of the samples contained no less than 2 % Mn. This indicates that DAP fertilizers in some cases may contain significant amounts of impurities of desirable or undesirable elements.

In theory, the authority to excercise control of fertilizer quality has been with the District Councils, but in reality, they have not had capacity nor expertise to do their job. In 1999, the Government has established a fertilizer control system under the auspices the Fertilizer Unit at Ministry of Agriculture (MoA), to keep an eye on the deregulated fertilizer market (Banyat 1999). However, as the Indian and Nepalese market appears to be flooded with spurious and adulterated fertilizers, and as the budgetary situation for the Nepalese state institutions generally is difficult, it remains to be seen how effective the control will be. To conclude, scientific knowledge and recommendations have to rely on highly imperfect knowledge due to the quality of the fertilizers.

The institutional scene.

If seeking scientific knowledge, the farmers can approach a number of different institutions. The extension service offered by MoA is one. It works through a network of extension officers, and is also producing radio programmes for the farmers. The two formerly UK funded research stations, PAC and LARC, have carried out important research for some decades, and have also provided extension services in their command areas in the Hills. They have recently been handed over to

Nepalese state funding under NARC, with the effect that about half the scientific and technical staff has left, because NARC is unable able to pay wages which are competitive. In addition, budgets for blue-collar staff have crumbled. A good deal of the academic and technical staff have gone to the more attractive payrolls of foreign employers: bilateral aid organisations and international NGOs. These organisations also set up local institutions which the farmers may or may not relate to, depending on the availability of a "project" in the area. Furthermore, farmers may relate to a wealth of local NGOs, receiving international support or not. And finally, the farmers can relate to AIC, other state institutions (DCs, VDCs), retailers, schools, bypassing expatriate researchers etc., in addition to the traditional sharing of knowledge with neighbours and relatives.

The field survey showed that the affiliations of the farmers varied highly geographically. None of the farmers interviewed had regular contact with the state extension officers, nor with the nearby PAC. All the farmers living close to the road in Siduwa had frequent contact with the CEAPRED cooperative, from where they received seeds, fertilizers and other inputs, plus various forms of information. However, the leadership of the cooperative does not have comprehensive knowledge of nutrient problems. Presently, a pilot project on borax application to cash crops has been scheduled, but unfortunatelt the project does not include staple crops.

Around Jitpur Bazaar, three to four hours' walk from the road, some were getting inputs and information from the Siduwa cooperative, and one farmer had approached the state extension service for soil testing. None of the interviewed farmers had regular contact with the local extension officer who was said to be overworked with other tasks (afforestation), and, besides, he was mainly a livestock specialist.

At Manmaya, six to seven hours' walk from the road, sharing of knowledge with neighbours was predominant. The following example shows the fragility of this source of knowledge dissemination: The field survey found severe deficits of B and Zn in nearly all soil samples in this area. The farmers complained over poor yields of winter wheat due to sterility, most likely influenced by B deficit. One farmer had obtained a *vitamin* from a son working in the Terai city Biratnagar, described as "a white, crystalline substance, like finegrained sugar", most likely borax. Several farmers applied the *vitamin* for some seasons with very satisfactory results, but as the contact person moved from Biratnagar, the source disappeared, and the treatment discontinued as noone knew what to order, or where to get it.

The suppliers can be divided into AIC, private traders and cooperatives. They are able to provide mineral supplements, but as there is no knowledge about trace elements among the farmers, there is no market, and neither borax nor zinc compunds are kept in stock. The role of Farmers' Clubs, political parties and schools has not been studied. But since many farmers are in frequent contact with these institutions, they should not be forgotten when strategies for dissemination of scientifically based information to the farmers are developed. Some farmers suggested that soil test results and recommendations should be handled by the VDCs, indicating that this institution has some local credibility.

Discussion and conclusion.

This paper is based on a rationalist assumption: If local knowledge can be matched or interfaced with scientific knowledge, it might be possible to address micronutrient problems in the Hills. If that challenge is met, it has the potential to improve agricultural productivity as well as human nutrition in the Hills in a cost-effective manner.

The study has shown that local knowledge on the issue largely takes the passive form of growing local varieties which may be tolerant or efficient in terms of micronutrients, and that management of compost/FYM mainly is determined by labour and resource availability. Scientific knowledge has been demonstrated to be imperfect, with important research still to be done, and with serious uncertanties about the quality of commercially available fertilizers. Although some scientific knowledge is found centrally in the institutions, it is rarely disseminated to the field level. The mobility of technological improvements requires mobility of knowledge to go with it. The institutional scene is complex, and the competition over scientific and technical staff has negative effects. The state system and the local NGO's have their capacities restrained by lack of funds and skilled staff. Researchers from the outside world are mainly doing basic research, and their findings are returned to the farmers only to a limited extent. The interface between agricultural extension institutions and farmers varies highly geographically, and in many cases it is absent.

Several conclusions can be drawn from the study. The first: that more research on plant-soil issues is needed, is obvious, but not satisfactory in itself. Strategies for establishing meeting points between local and scientific knowledge must be developed, linked to work within institutions as well as between institutions. Cooperatives, schools, farmers' clubs and VDCs should be regarded as complementary to the more formal institutions. During the course of deregulation, the role of fertilizer retailers may have to be taken into account as well.

References.

Agrawal, A. 1995: Dismantling the divide between indigenous and scientific knowledge. Development and Change, vol. 26: 413-439.

Basnyat, B.B. 1999: Meeting the fertilizer challenge: a study on Nepal's fertilizer trade liberalisation programme. Winrock Research Report Series no. 41. Winrock, Kathmandu. 51 pp.

Carson, B. 1992: The land, the farmer, and the future. A soil fertility management strategy for Nepal. ICIMOD Occ. Paper no. 21. Kathmandu. 74 pp.

Gill, G.J. 1995: Fertilizers and foodgrains in the Nepal Tarai. Winrock Research Report Series no. 31. Winrock International, Kathmandu.

Gupta, R.P., Pandey, S.P. & Tripathi, B.P. 1989: Soil properties and availability of nutrient elements in mandarin growing areas of Dhankuta District. PAC technical paper no. 113. Pakhribas Agricultural Centre, Dhankuta. 23 pp.

Kiff, E., Turton, C., Tuladhar, J.K. & Baker, R. 1995: A review of literature relating to soil fertility in the hills of Nepal. LARC/NRI, Pokhara/Chatham. 64 pp.

Lewis, R. 1979: Making and using compost. Results from experiments conducted at PAC and discussion of methods applicable to Nepali Hill farmers. Mimeo. Pakhribas Agricultural Centre, Dhankuta.

Murdoch, J. & Clark, J. 1994: Sustainable knowledge. Geoforum vol. 25, no. 2: 115-132.

Rengel, Z., Batten, G.D. & Crowley, D.E. 1999: Agronomic approaches for improving the micronutrient density in edible portions of field crops. Field crops research 60: 27-40.

Sillanpää, M 1982: Micronutrients and the nutrient status of soils: a global study. FAO Soils Bulletin 48. Rome. 444 pp.

Tamang, D. 1993: How hill farmers manage their soils. P. 164-181 in: Tamang et al. (1993).

Tamang, D., Gill, G.J. & Thapa, G.B. (eds.) 1993: Indigenous management of natural resources in Nepal. Winrock International, Kathmandu. 375 pp.

Tripathi, B.P. & Shah, R. 1986: Status and effects of micronutrients on the yield of paddy in different agro-climatic regions of Nepal. P. 325-334 in: Joshi, S.C. (ed.): Nepal Himalaya. Geo-ecological perspectives. Himalayan Research Group, Tallital, India.