Building Contextual Knowledge: the Interface between Local and Scientific Knowledge

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Abstract

The purpose of this paper is to discuss the gap between the local knowledge of marginal farmers and scientific knowledge, based on cases from the Himalayan region. Local knowledge and local farming practices do present some solutions to micronutrient problems, but as the understanding of cause and effect is unclear, the solutions are suboptimal. Soil nutrients and human nutrition are described by people in terms such as 'power',' hot' or 'cold'; terms that do not reflect the underlying chemistry or biological processes. Equally, scientific knowledge, with its tradition of reductionist research, often has problems addressing the complexity of marginal farming systems. The knowledge gap on this side may relate to the physical environment (multiple micronutrient deficiencies), the bottlenecks of the farming systems, and the farmer/extension interface. The term ***contextual knowledge*** *seeks to combine the two sets of knowledge, local and scientific. All knowledge systems are dynamic, and the challenge is to develop strategies to improve scientific knowledge among farmers and contextual knowledge among scientists. An important step is to find a new orientation for the agricultural extension systems. Some of the new developments in Nepal may be indicators of such a change.*

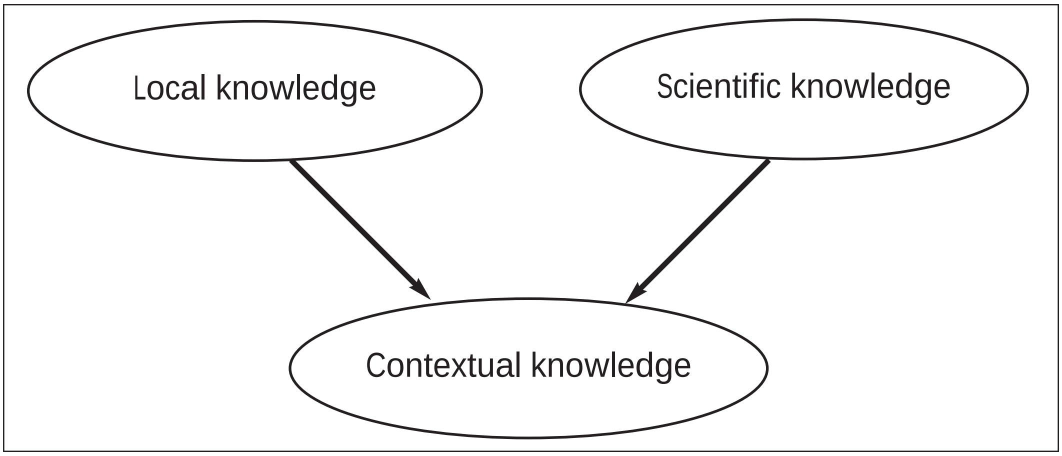
Introduction

The term 'local knowledge system(s)' (LKS) is one of several terms describing the sets of knowledge found among local people in a given region. Other terms are 'indigenous knowledge' or 'rural people's knowledge'. In my opinion the term 'local' is preferable to the term 'indigenous', as the latter may blur or be used to romanticise the concept. Although apparently easy to comprehend and define, LKS should be seen as dynamic, culturally and socially constructed, and often unevenly distributed between the 'locals' (Scoones and Thompson 1993).

Scientific knowledge system(s) (SKS) can be seen as the opposite, a positivist construction of the existing, established scientific frontier of knowledge. The traditional structure for agricultural modernisation is based on a top-down model of 'transfer-of-technology' (TOT) (Blaikie et al. 1997) which often fails because of its inability to match a complex social and natural reality – in the words of Arun Agrawal (1995) because:

> "..*the so called technical solutions are just as firmly anchored in a specific milieu as any other system of knowledge.*"

When I suggest the term 'contextual knowledge', it is not with the ambition to create a new buzzword, but merely to provide a basis for discussion of knowledge systems relevant to micronutrient problems in agriculture. Contextual knowledge will, compared to a standard SKS, provide a rich comprehension of the complexities of the natural environment, the farming systems, and the social and cultural fabric in a given location – at least rich enough



to contribute effectively to sustainable, self-perpetuating changes in nutrient management at farm level. In contrast to LKS in general, contextual knowledge about nutrient management will be a farmer's conceptualisation enabling the same sustainable, self-perpetuating changes referred to above. In addition, transfer of technology and knowledge is a necessary precondition for IPNM (integrated plant nutrient management) with respect to micronutrients, and thus this paper will conclude with a discussion of how such a process can be brought about.

Strong and Weak Sides of Local Knowledge Systems

Local knowledge systems have strength in that they focus on the whole farming system and how it relates to the natural conditions as well social systems on a trial-and-error basis. According to the promoters of LKS, such as Shiva (1991), their ability to handle complexity distinguishes them favourably from SKS.

LKS often have local soil classification systems that systematise the major relevant divisions from a local perspective, with colour and texture as major indicators. On the basis of this classification, farmers have empirically-based ideas of compost requirements and similar agricultural issues. Examples can also be found of local agricultural practices that address micronutrient disorders. In Arun Valley in Eastern Nepal, some farmers drain their newly-planted paddy fields if the plants turn yellow and red. This permits temporary oxidisation and release of zinc and other micronutrients, the fields are flooded again when the plants regain their green colour. However, some farmers add urea; and this demonstrates how LKS targets symptoms rather than causes.

The weaknesses of LKS are, of course, their limited specificity – as demonstrated by DeWalt (1994); it is easy to find cases where LKS have not been able to handle ecological complexity. One of DeWalt's examples, a pest problem in Honduras referred to as 'lagosta', required advanced laboratory equipment to arrive at an explanation and this was essential for developing protection measures. Without this help, LKS left the locals with no ability to cope.

In general, micronutrient disorders fall into this category. Although visual symptoms in plants can be used diagnostically, micronutrient disorders often produce symptoms so complex or so subtle that they are difficult to deal with without chemical testing of soils and/or plant tissue. Once disorders are diagnosed, correction may require application of purchased inputs, and this can only be done if one has the knowledge about what to buy. LKS response to nutrient problems may be passive; for example growing local, non-susceptible varieties (and accepting lower yields), or it may be fatalistic (live with low yields and malnutrition without knowing what to do).

Perceptions of Nutrients and Fertilisers

In LKS, soil nutrients and fertility are normally described in general terms of 'power' and 'heat' which has clear limits when it comes to balances between different nutrients. The farmers will often not be able to distinguish between plant symptoms relating to pests or to nutrient imbalances.

Hill farmers in Nepal generally divide fertilisers into three groups.

'Mal' – compost/farm-yard manure (FYM) is supposed to be the real thing. Locally, there will often be a ranking of 'mal' according to the animal species producing it. As a rule of thumb, small animals (bats, chickens, goats) provide the best manure, large animals (horses, mules, buffaloes) produce poor manure (Tamang 1993).

'Desi mal', or simply 'fertiliser', refers to chemical fertilisers. The fertilisers available for farmers in the hills are predominantly urea, DAP (di-ammonium phosphate), and MOP (muriate of potassium); potassium is rarely used (Basnyat 1999). Use of commercial fertilisers in Nepal is the lowest in South Asia. All too often farmers use the fertilisers available with only limited ideas of the needs of the plant. Hill farmers are often reluctant to use chemical fertilisers because of the cost, and the fact that according to their experience using them leads to acidification of soils.

'Vitamin' is a term used to refer to anything else added to the soil or sprayed on the plants to make them appear healthy. By and large, 'vitamins' are applied in a haphazard manner. They include a number of single- or multi-element micronutrients, expensive and/or harmless plant extracts, as well as other growth conditioners. Multi-element micronutrient fertilisers found in Nepal unfortunately often contain nitrogen, and this can enforce greening of leaves, concealing the actual deficiencies of the plant.

One simplistic assumption about integrated plant nutrient management (IPNM) strategies and LKS is that compost/FYM will provide all the micronutrients that are needed, hence IPNM becomes a mix of chemical macronutrient fertiliser and compost/FYM. However, even if large amounts of compost/FYM are available, regional deficiencies of boron (B) or other elements may be so severe that the concentration of nutrients in compost, as well as in the soil, is too low to make up for the deficiencies, as shown in a study from the Middle Hills by Andersen and Sandvold (2000) (Figure 1).

The quality of compost/FYM is extremely variable. Lewis (1979) described how there were clear visual symptoms of Zn deficiency in the mid hills despite large applications of compost/FYM, and he suggested that Zn was bound up in organic complexes.

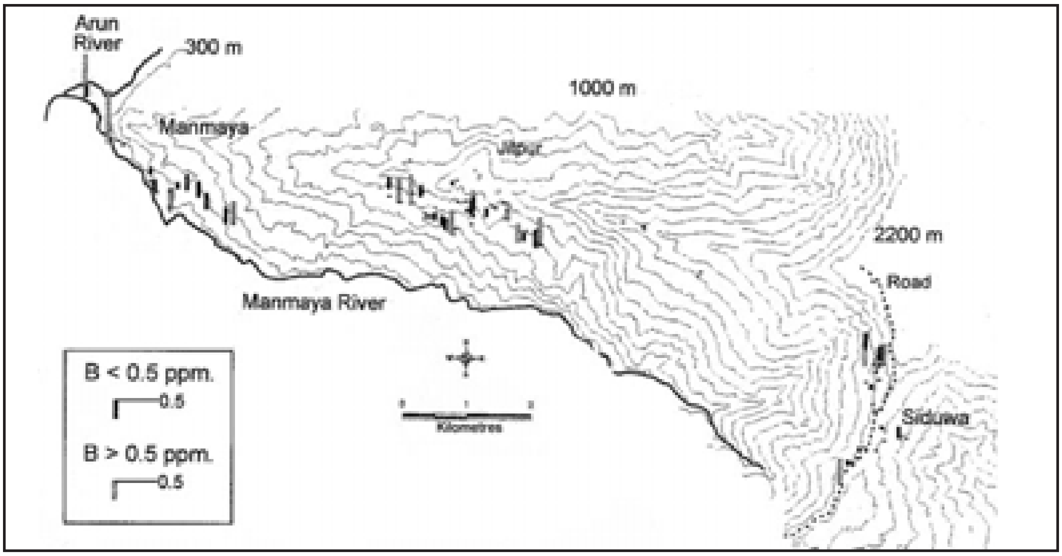


Figure 1: **Uniform pattern of boron deficiency in cultivated soils in the Arun Valley, Eastern Nepal (after Andersen & Sandvold 2000)** Note: Not even the most substantial amounts of compost/FYM applied to the soils in Siduwa village are sufficient to raise the concentration above deficiency level

Farmers may have other reasons for applying compost/FYM than providing nutrients. Using hand tools and draught animals that are often weak, it is important for farmers to keep the soil tillable, although it means maintaining the organic matter level at a higher degree than would be optimal for the availability of nutrients. Annual or biannual applications of as much as 20-30t FYM/ha have been observed particularly for potato or wheat cultivation at higher altitudes.

Scientific Knowledge

The importance of single elements for plant growth is a scientific discovery that dates back to the 1820s and 1830s, when the French scientist, Theodore de Saussure, and German scientists laid the basis for what later became known as the 'Law of the Minimum'. According to van der Ploeg et al. (1999), the original thoughts were clearly expressed by Carl von Sprengel (1828) and not, as widely believed, by Justus von Liebig. Scientific progress led to production of chemical fertilisers, which were improved through the use of rock phosphate and potassium. Gradually, scientific knowledge has progressed and now 17 elements are recognised as nutrients that are required by all higher plants (Welch 1995). Eight of these are the essential micronutrients boron (B), chlorine (Cl), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo), nickel (Ni), and zinc (Zn). Although a great deal of research is still needed, much is known about the requirements of plants for these elements, how they are affected by other growth parameters, and how interactions occur between various elements.

In this respect, it can be said that SKS have accumulated considerable knowledge about many issues concerning plant nutrients. Still, SKS are characterised and limited by certain important factors: firstly, the reductionist traditions in research (DeWalt 1994), and secondly the strong tradition of top-down approaches in the dissemination of research results and recommendations.

There are numerous examples of the problems of reductionism including recommendations to use chemical fertilisers in areas where they are inaccessible to farmers, to focus on labour-demanding compost-making methods in areas short of labour, and so on. Plant breeding, research on micronutrient issues is also at risk from reductionist approaches. Few, if any, breeding programmes address the multiple soil micronutrient deficiencies which most marginal farmers face in a systematic manner.

Much of the criticism of the Green Revolution (GR) highlighted what were perceived as reductionist solutions to complex problems, biased towards yields, profits, and NPK fertilisers (Shiva 1991). Of course, the researchers behind the GR are not at a stand-still. The visions from Conway's (1997) 'doubly green revolution', with their emphasis on environmental and social sustainability and new scientist-farmer partnership approaches, are probably supported by the majority of the Consultative Group on International Agricultural Research's (CGIAR's) researchers – at least in theory. Still, traditions concerning how good research is to be carried out are strong and difficult to change, as they dominate among both peer reviewers and bodies funding research.

The Traditional Top-down Extension System

The top-down structure in the traditional national agricultural extension system can be described briefly as follows: national or international research personnel carry out controlled trials which serve as a basis for development of 'recommendations'. The advice may be blanket recommendations or detailed suggestions for specific crops, soils, or regions. Next, the national authorities pass on this advice to a system of extension officers, who in turn pass it on to the farmers. Finally, the farmers adopt or reject the technology recommended.

Although various attempts have been made in reference to on-farm trials, farmers' groups, and other participation-oriented approaches, the top-down knowledge transfer structure predominates in Nepal as in many other countries. The problem is that this approach does not work, because it is based on ideal conditions that are not found in marginal farming areas.

International research does not always come up with relevant results for context-specific situations. National research bodies have neither the capacity to verify the suitability of international research results, nor to perform sufficient national research to meet the needs of local farmers. In the field of micronutrients, NARC in Nepal has only issued recommendations on the use of zinc sulphate for lowland rice and application of borax to winter wheat and cauliflower.

The resources in terms of extension officers available are normally far from satisfactory; in reality, farmers have little or no interaction with extension officers. Training of extension officers in Nepal is mostly inadequate; they have few resources and their work is subject to frequent changes in policies (Blaikie & Sadeque 2000). Evidence from the field suggests that in eastern Nepal few farmers are in regular contact with extension officers (Andersen 2000).

In theory, blanket recommendations and wide-ranging extension systems are sufficient for the intensively irrigated plains, whereas marginal, rainfed farming areas present a complexity that requires intensive agricultural extension inputs, with more officers and more site-specific recommendations than in the plains (Dobermann & White 1999; FAO/IFA 2000). In practice, the farmer/extension officer balance tends to be the opposite, leaving marginal farmers with an information gap.

Building Contextual Knowledge

In scientific knowledge systems, the development of contextual knowledge about micronutrient issues begins with the establishment of an in-depth understanding of local environments and the farming systems operating in them. One pertinent issue is the 'mapping' of soil characteristics (Andersen 2002). Mapping is a basic requirement for establishing whether or not there are spatial patterns that may impact the choice of strategies. It is often assumed that mountains and other upland areas exhibit a highly complex pattern of micronutrient disorders, meaning that blanket recommendations are difficult or impossible to issue (Dobermann and White 1999; FAO/IFA 2000). As shown in Table 1, this is not necessarily the case.

Table 1: **Micronutrient content in soil samples in three studies from the Himalayas (After Andersen 2002)**

	Zn deficit	Zn high	B deficit	B high
Andersen & Sandvold (2000) Arun Valley	34%	3-5%	86%	0
Sippola & Lindstedt (1994) Hills W + E of Kathmandu	56%	3-5%	94%	0
Singh et al. (1987) Himachal Pradesh , India	28%	3-5%	56-87%	0

Mapping from three different areas indicates that there are some spatial patterns that could be studied for the purpose of developing general strategies for the Himalayan region. The frequencies of high and low values are basically the same in all three studies. Zinc deficiency is widespread, but there are also a small but notable number of sites with high Zn values, and about half the soils contain satisfactory amounts of this element. The spatial distribution of these deficient and high content sites is patchy and partially controlled by geology (Figure 2). Therefore, it will probably not be feasible to recommend the use of Zn fertilisers on a general basis in hill areas; recommendations for use should be based on soil testing and/or visual symptoms, and of course on a crop basis.

Application of B-added fertilisers should be considered as a general recommendation, as the pattern appears to be one of uniform deficits. B toxicity may build up in irrigated lowland areas, but is not found in any of the three studies mentioned here. B-supplemented fertilisers may be a better option than adding pure borax or boric acid, as the major technical problem appears to be to spread it uniformly in order to avoid toxicity. Unfortunately, in general there are no B-supplemented fertilisers available to Nepalese farmers.

Some general questions about diagnosing micronutrient disorders also need addressing. Chemical analyses of soil samples are in theory available at heavily subsidised rates for many farmers, including marginal hill farmers in Nepal. In practice, few individual farmers use the service, and even fewer use the existing options for testing for micronutrients. Again, this underlines that transfer of knowledge is needed to improve micronutrient balances.

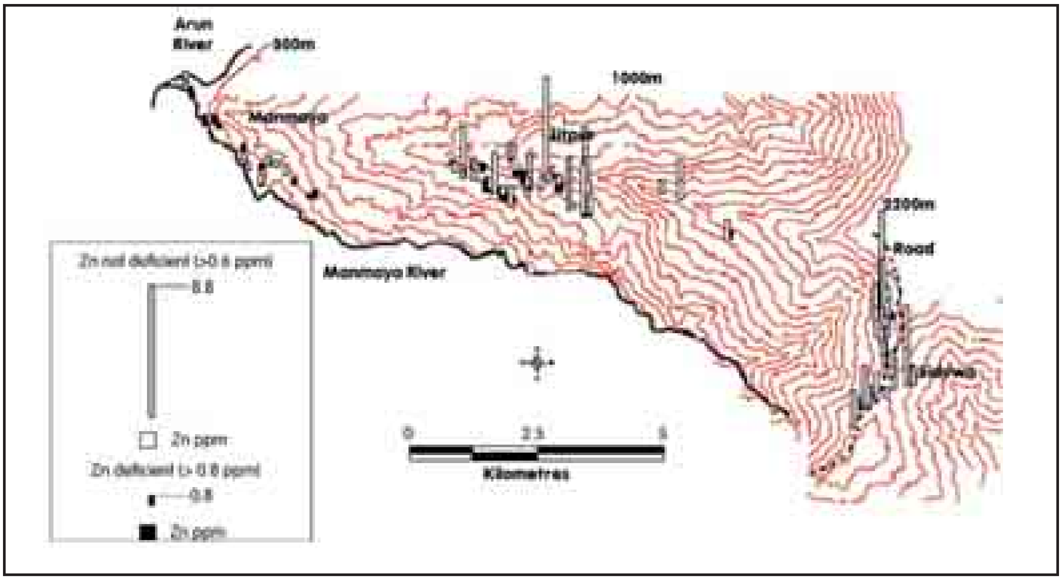


Figure 2: **Diethylene triamine pentacetic acid (DTPA) extractable zinc from soil samples (from Andersen 2002).** Note: The light bars indicate no deficiencies, black bars show deficient samples

Local knowledge systems will often use concepts that can be linked to visual symptoms of micronutrient disorders. Research on local conceptualisations of plant symptoms could be one of the first building stones for development of contextual knowledge. The advantage of visual symptoms for diagnosis is that they are cheap or free, and can also be used for a semi-literate population, using photographic information.

Public-private Partnerships: A New Model Evolving?

The criticism of traditional technology transfer does not imply that agricultural research is not important. Nor should it be implied that the state should not play a role in the dissemination of agricultural research and development (R & D). The crucial question is how to address the information gap between the present system and farmers in relation to issues related to plant nutrition and micronutrients.

Some recent developments may be a sign of new strategies developing. The Fertilizer Unit at the Ministry of Agriculture and Cooperatives issued a handbook in Nepali on fertilisers and plant nutrition in 2003; similarly the Soil Testing and Service Section (STSS) of the Department of Agriculture issued a translation of a Japanese handbook on vegetable production and plant nutrition. The latter is richly illustrated with pictures of visual symptoms of nutritional disorders, unfortunately mainly for crops that are important in Japan.

The publications have their shortcomings. They do not provide any general recommendations about what to do about micronutrient disorders once they are identified. However, they are a step forward in terms of naming and describing the problems, and furthermore, their target group includes fertiliser traders and other private actors in the agricultural sector.

In the old technology transfer regime, agricultural inputs in Nepal were supplied by the Agricultural Inputs Corporation (AIC), and private sector involvement was not organised. With liberalisation of the fertiliser market, steps have been taken to establish a new quality control system, as well as training and certification of private fertiliser traders. The new policy offers challenges, but also possibilities, because fertiliser traders and representatives of farmers' cooperatives represent some of the real interfaces between farmers and technology.

Other examples of methods of transferring knowledge should be considered: improvement of school curricula, informal education, pamphlets with pictures of visual symptoms, and suggestions about cultivation practices accompanying seeds, fertilisers, and micronutrients. The focus must be on strategies that do the following:

- identify the micronutrient issues relevant in the local context;
- suggest solutions that are feasible in the local context;
- address multiple, relevant communication interfaces with farmers; and
- stimulate the development of self-perpetuating experimentation and knowledge building among farmers.

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