Bridging gaps between farmers' and scientists' soil classification: Revisiting the methodology used in documentation and analysis of farmers' knowledge[1].

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Abstract

In the majority of the studies on farmers' local knowledge about soil classification, a great variation in farmers' soil classification has been reported not only between two regions of a country but also between the farmers of the same locality and village. The main reason for such variation has been attributed to the continuous nature of soil medium, as opposed to discrete categories of other farm resources, while a little attention has been given to the methodology used in the study of farmers' soil classification. Many of these studies also shows that a good regularity is found in farmers' explanation or description of soil properties across locations suggesting that, despite difference in terminology used for local soil classification, farmers have good knowledge about soil properties of different soil types or classes. However, scientists rarely use such knowledge to establish the scientific basis of farmers' soil classification. As a result problems have been experienced in correlating farmers' soil classification with that of scientists', and in establishing a common ground and medium for communication between farmers and scientists. The experience of the present study in the Middle Hills of Nepal shows that, with the use of an objectively structured framework, a more systematic farmers' soil classification can be obtained that not only confirms with the scientific soil classification but also generates a common farmers' soil classification across locations as well as between farmers. Beyond identification of the labels used for local soil classes, it is important to understand a broader context of local terminology about soils in order to learn about local soil classification and discern regularities across locations as well as to recognise local particularities. Getting the methodology right is, therefore, important in order to bridge gaps between farmers' and scientists' soil classification and facilitate integration of local knowledge into global scientific assessment.

Key words: local soil classification, local soil knowledge, scientific soil classification, soil taxonomy, classification methodology, middle hills, Nepal.

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1. Introduction

Local soil classification has been the central focus of majority of the studies undertaken worldwide to understand farmers' local knowledge about their soils. According to the bibliography of Barrera-Bassols and Zink (2000), over half of the ethnopedology studies focus on soil classification (Niemeijer and Mazzucato, 2003). Talawar and Rhoades (1998) suggest that this is likely because early ethnographers looked at soil classification as means in a broader effort to understand the internal working of local culture and the early ethnopedology – much like the more established ethnobotany – was mainly an attempt to uncover cognitive aspects of unfamiliar cultures through the analysis of rules, plans, schemes, symbols, and categories. For a variety of reasons, the focus on local soil classification continues to be the main feature of the recent studies on local soil knowledge.

Firstly, there has been increasing recognition of farmers' local soil knowledge, and practical benefits of local soil classification (Niemeijer, 1995; Talawar and Rhoades, 1998; Niemeijer and Mazzucato, 2003). Local soil classifications are faster and cheaper compared to the traditional scientific soil surveys; it can offer important insights into local use and perceptions of soils in relation to agricultural production; and it can considerably facilitate communication between farmers, development workers and researchers (Niemeijer, 1995). Secondly, local soil classifications or nomenclatures have been very convenient entry point in understanding local soil knowledge (Niemeijer and Mazzucato, 2003). It provides useful reference when discussing with farmers about their local soil knowledge. Thirdly, increased interest of researchers and development professionals from a wide range of disciplines including soil scientists, agronomists and socioeconomists, has added new dimensions – scientific validation and utility - to the study on local soil classification.

Despite wider recognition of the value of local soil knowledge and classification, the recent reviews and critiques (see Niemeijer, 1995; Talawar and Rhoades, 1998; WinklerPrins, 1999; Niemeijer and Mazzucato, 2003) argue that for a number of reasons its use in agricultural planning and development has remained poor and problematic. These problems can be summarised into three main categories. The first is related to collection, organisation, interpretation and treatment of local soil taxonomies or classifications. A variety of local soil nomenclatures and/or classifications continue to emerge making it difficult to interpret and generalise across farming communities. This is largely attributed to the nature of the soil media and disciplinary background of researchers and methods used. Local soil classifications have often been treated as synonymous as well as static representation of local soil knowledge (Niemeijer and Mazzucato, 2003). The second category of problem is related with the difficulties in scientific validation and comparison of local soil classification with that of scientific ones. The third, on the other hand, is associated with the difficulties in effective use of local soil classifications in agricultural research and development. Inadequate insights into the concepts, theories and explanations behind local ways to characterise and use of soils, and ignorance to the local frame of reference have been attributed to this problem (Niemeijer and Mazzucato, 2003).

These three categories of problems, however, are intimately linked to each other and the first sets of problems appear to be the likely cause of the other problems. Getting local soil classification right – both in terms of framework and content – is, therefore, foremost important aspects of any study on this subject. It is equally important to analysis the underlying reasons of these problems. The reviews and critiques, mentioned earlier, have discussed various such reasons.

Firstly, the continuous nature of soil medium, with fuzzier physical boundaries compared to plant or animal species, makes distinct categorisation of soils more difficult (Talawar and Rhoades, 1998). At the same time, the composition and properties of soils are not fixed and these can easily change with changes in hydrology, crops and vegetations, and land use and management practices resulting into high soil variability even within a small locality. Because of this, a variety of nomenclatures or names are given by farmers to depict a particular state of the soil, and often the same soil is given different names. This causes additional confusion and difficulties in standardising local soil classification. It also makes taxonomic relations often nonexclusive (WinklerPrins, 1999; Niemeijer and Mazzucato, 2003).

Secondly, a variety of terms; depicting local soil conditions, production systems, and local language and vocabulary; are used to name different soils found in different locality which make it difficult to generalise and derive a standard soil classification scheme. The use of symbolic terms has further complicated the situation.

Thirdly, a detailed and multi-perspective analysis of local soil classification and knowledge requires a good deal of methodological rigour that combines ethnographic methods with technical methods from the discipline of soil, hydrology and agronomy. The researchers involved neither have time available nor are adequately equipped with necessary methodologies often enticing them to use PRA-based quick methods (Niemeijer and Mazzucato, 2003). The resulting local soil classification are, therefore, in many cases are poorly understood and are often subject to misinterpretation.

Finally, the disciplinary background of researchers has also contributed to a large variation in local soil classifications (Talawar and Rhoades, 1998; Niemeijer and Mazzucato, 2003). The disciplinary foci and methodological approaches of these researchers have led to the use of different classification schemes and this in turn has resulted into different sets of local soil classifications, which are often difficult to compare. The anthropological approaches of ethnopedologist reveal emic perspectives of local soil classifications but makes it too context and location specific and limits generalisation. Whilst technical approaches of natural scientists introduce etic perspectives in the interpretation of local soil classification useful for generalisation but makes it equally doubtful whether the resulting soil classification is truly local (Niemeijer, 1995; Talawar and Rhoades, 1998; Niemeijer and Mazzucato, 2003). The integration of two approaches and perspectives has rarely been seen in practice.

Because of the complications in construction and interpretation, and difficulties in using for research and development purpose, many recent critiques have started to argue for shifting the focus of investigation from merely describing local soil classification to understanding how different ethnolinguistic soil categories are related to crops, climate, socio-cultural behaviours and soil management practices (Talawar and Rhoades, 1998; WinklerPrins, 1999; Niemeijer and Mazzucato, 2003). Though this may not imply ignoring study of local soil classification systems, it will certainly shift emphasis away from such studies and leave the problems in the use of local soil classifications intact.

The paper argues in line with Niemeijer (1995) to deepen our understanding of local soil classifications and complications which they entail. Part of the problem also lies in over-emphasis on the nature of the soil medium as cause of the complications in local soil classification whilst methodological issues, which could play critical role in explaining such complications, have received little attention. The paper argue for the use of more systematic and multi-perspective methods that recognise existing diversity in soil nomenclatures as a reflection of variation in soils and use of ethnolinguistic terms, document underlying knowledge of soil properties, recognise differences between soil nomenclature and classification, recognise various ways of classifying soils, and identify bases and frameworks helpful in comparing and contrasting local soil classifications. To illustrate these arguments, case studies of three villages in the middle hills of Nepal is presented in the paper.

2. Research area and methodology

The field research was carried out in three separate villages: Landruk in Kaski district; Bandipur in Tanahun district and Nayatola in Palpa district. These villages are located in the middle hills of the Western Development Region (WDR) of Nepal, and represent the range of diverse and contrasting ecological environments and socio-cultural settings found in the middle hills (Figure 1). Landruk represents farming communities in upper parts of the middle hills with high rainfall, bench terraced *bari* land, good access to forest, a high level of integration of livestock, and limited access to services and market. Bandipur and Nayatola both represent lower parts of the middle hills and have low to medium rainfall but have two different *bari* land features - former with bench terraces and latter with outward sloping terraces. The access to forest and integration of livestock in these two villages is low to moderate while access to services and market is moderate to high. The detailed ecological features of these villages are presented in Table 1.

Table 1. Details of the research sites selected for participatory technology development.

Description	Landruk	Bandipur	Nayatola
District	Kaski	Tanahun	Palpa
Village Development Commmittee (VDC)	Lumle	Bandipur	Kusumkhola
Ward No.	9	3 and 6	4 and 5
Altitude (metres asl)	1500-1800	550-1000	1000-1500
Rainfall (annual mean)*	3524 mm	1620 mm	1591 mm
Longitude/Latitude	28° 22.080' N 83° 49.536' E	27° 56.312' N 84° 24.454' E	27° 50.899' N 83° 26.977' E
No. of households	119	164	70
Major ethnic groups	Gurung, Brahmin, Magar and Kami	Brahmin, Magar, Newar and Kami	Magar, Chhetri and Kami
Terrace type	Bench	Bench	Sloping
Major crops and cropping systems in *bari* land	Maize intercropped with fingermillet, or bean, cowpeas or soybeans, and followed by wheat or barley in winter in the alternate years.	Maize as sole crop as well as intercropped with fingermillet, or bean, cowpeas or soybeans, followed by winter fallow. Orange orchards intercropped or sole with maize.	Maize as sole crop as well as intercropped with *ghaiya* (upland rice) fingermillet, or bean, cowpeas or soybeans followed by winter wheat intercropped with winter legumes and mustard.

*Note: Mean over three years from 1997 to 1999.

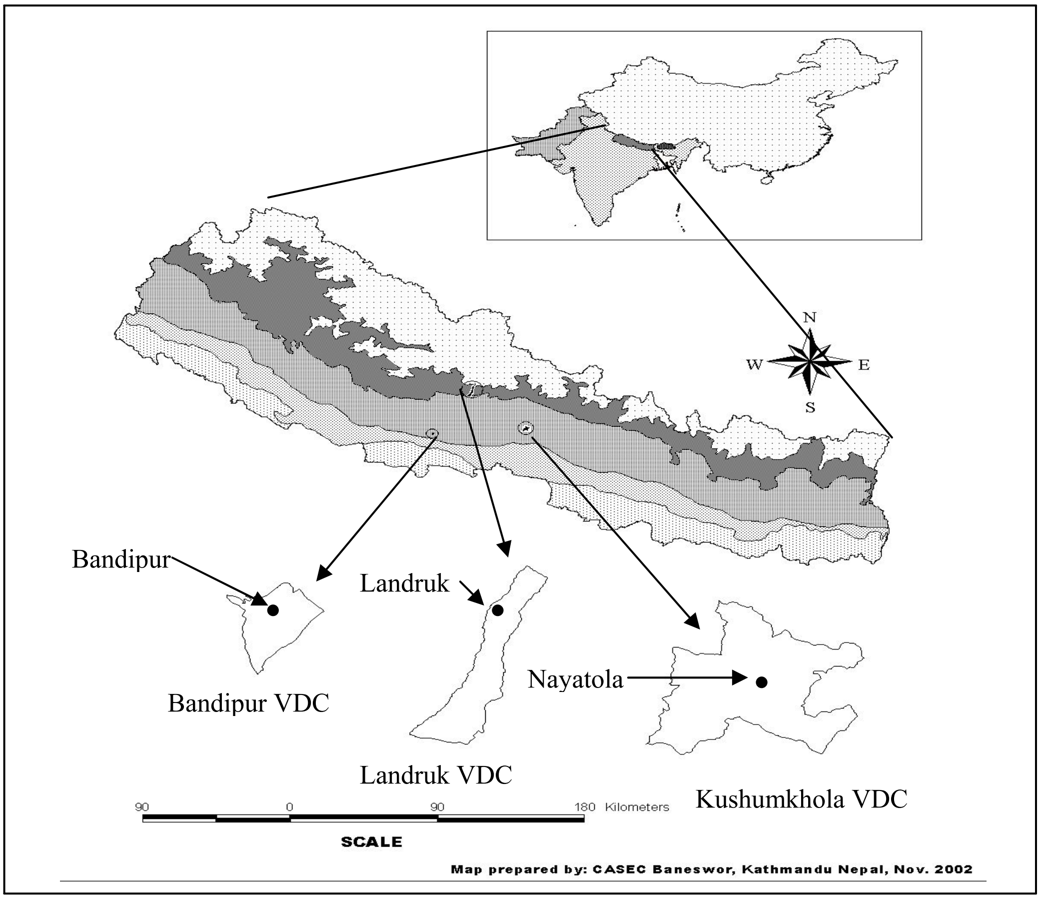


Figure 1. Map showing location of the three research villages in the western hills of Nepal.

Information on local soil classification was collected during elicitation of local soil knowledge from farmers of the research villages. A combination of methods was used to elicit the local soil knowledge of which method adopting knowledge-based systems (KBS) approach was most intensively used. It involved knowledge elicitation techniques that were adapted from the field of anthropology and ethnography and were combined with features of the knowledge engineering paradigm from the field of artificial intelligence (see Walker, *et al.* 1995b; Kendon, *et al.* 1995; Joshi, 1997; Sinclair and Walker, 1998; Walker and Sinclair, 1998). Enquiry on farmers' soil knowledge was focussed around *bari* land (unirrigated upland) as the problem of soil degradation and management concerns are high in this production environment (Carson, 1992; Sherchan and Gurung, 1992; Vaidya, *et al.*, 1995; Turton, *et al.*, 1996; Tripathi, 1997, Shrestha, 2003). The field research in the three research villages was carried out between January and March 2000 and a total of 63 farmers – just above 20 farmers in each village – representing different wealth class, ethnicity and gender were interviewed individually.

The knowledge elicitation was done using repeated and semi-structured open (unrestricted) discussion with the individual farmer, following the threads of reasoning for how a particular person saw, interpreted and understood soils and soil processes. Knowledge documented during individual interview was supplemented with information collected though participant observation of farmers' actions and practices in soil management, and focus group discussion with groups of knowledgeable men and women farmers.

The second method of documenting local soil knowledge involved focus group discussion with separate groups of men and women farmers with direct and visual reference to a large number of topsoil samples, representing largest possible soil variations, collected from different parts of the village. It involved discussing with farmers about the way they recognised variation in soils, their knowledge about the nature and properties of these soils, and the framework or basis they adopted in grouping similar soils in different soil categories.

The fieldwork lasted for about three weeks in each village and during this period researchers stayed with the farmers in the same village. This provided researchers a good opportunity to build rapport, engage in informal interaction and observation, and get insiders' perspectives on local soil knowledge.

3. Results and Discussion

3.1. Knowledge about variations in soil and soil nomenclature system

Farmers at all three research villages were quite knowledgeable about the variation in soils found in their *bari* land as well as that found around the village. They observed and noted minute details of variation and identified several soil types even within the same terrace. They were found to use about seventeen physical properties and other soil features to recognise variation between the *bari* soils (Table 2). About eight of them were identifying and/or classifying attributes that were used to label or name and classify soils into identifiable soil types while the rest were used to describe their properties - property attributes.

Table 2. Soil attributes recognised and used by farmers in identifying/classifying soils and describing their properties.

Categories of soil attributes	Soil attributes	Terms and values used to describe attributes
Classifying attributes	1. Soil colour	*Kalo* (black), *Rato* (red), *Pahenlo* (yellow), *Seto* (white), *Khairo* (brown) and so on
	2. Soil texture	*Matyaul*, *Domat* and *Balaute*
	3. Soil structure	*Katmero* (hard/clumpy), *Burbure* (friable), *Halka*(loose)
	4. Dry consistency	*Kitaha/Katyaha* (hard), *Khukulo* (loose)
	5. Wet consistency	*Chimtya/Chimtyailo/Lesailo* (sticky), *Khukulo* (loose)
	6. Workability	*Garungo* (heavy), *Halka*§ (light or loose)
	7. Soil fertility	*Malilo, Rukho*
	8. Stone content	*Chiure*, *Khahare*, *Gargare/Gagrato/Gagreto* (stony)
Property attributes	9. Water infiltration	High, Medium, Low
	10. Water retention	High, Low
	11. Drying rate	High, Medium, Low
	12. Wetting rate	Fast, Slow
	13. Water requirement	High, Medium, Low
	14. Manure requirement	High, Medium, Low
	15. Manure absorption capacity	High, Low
	16. Erodibility	High, Medium, Low
	17. Crop suitability	Examples: *Rato mato* (red soil) good for large type long duration maize, ghaiya (upland rice), and ginger; *Kalo* (black) and Phusro (light grey) *mato* and other light soils good for winter crops and potato; Chiure and *Khahare mato* (stony soil) and other low fertile soil allocated to small type short duration maize

§ The term *halka* means 'light' but is also used broadly to refer to 'loose' as looseness makes soil light.

Of the identifying/classifying soil attributes, soil colour was most commonly used to identify and name the *bari* soils followed by soil texture, structure, consistency and stone content. Using combinations of attributes in naming a particular soil was also very common. These attributes appeared to be of two categories: a) soil specifying attributes that included soil colour, structure, consistency and stone content (exclusively used to identify and name specific soil types) and b) soil generalising attributes that included workability and soil fertility (mainly used to aggregate soil types into certain soil categories). Some attributes such as soil texture and stone content were used for both purposes. Farmers also possessed a good knowledge about the ways in which identifying/classifying attributes affected soil fertility, soil water, and soil and nutrient losses.

Farmers' nomenclature or naming of the *bari* soils was studied in order to understand the ways farmers identify, name and communicate about soil variations. Two methods were used. Firstly farmers were asked to name the soil types they recognised on their own *bari* land and provide information about their associated properties during the individual interview with them. Farmers in each research village consistently named a small number of about four to five similar and distinct soil types. The names of the majority of these soil types were based on colour whilst, in a few cases, a combination of colour and texture or stone content was used (Table 3). Some of these soil names and their stated properties were similar in all three villages while considerable variations were also observed. For example, evident from the property descriptions, *rato mato* (red soil) mentioned at Landruk were quite different than *rato mato* of other villages. Farmers, however, had similar explanatory knowledge of the various properties of these soils. The soil names were very broad and appeared to have been used to distinguish different soil types present in the area by using the terms common in the locality rather than using any systematic framework of soil nomenclature.

Table 3. *Bari* soil types and their properties reported by farmers of three research villages.

Village/soil types (Nepali vernacular names)	Literal English translation	Colour	Fertility	Manure requirement	Water requirement	Drainage	Erodibility
Landruk:							
Kalo mato	Black soil	Black	High	Low	Low	High	High
Halka rato mato	Light red soil	Red	Medium	Medium	Low	Medium	Medium
Chimtailo rato mato	Sticky red soil	Red	Medium	Medium	High	Medium	Medium
Kamere mato	Calcareous soil	Whitish	Low	High	High	Low	Low
Jogi mato	Jogi soil	Dark brown	Very low	High	High	Low	Low
Dhainse mato	Dhainse soil	Yellowish Brown	Low	High	High	Low	Low
Bandipur:							
Rato mato	Red soil	Red	High	High	High	Low	Low
Kalo mato	Black soil	Black	High	Low	Low	High	High
Halka phusro mato	Light grey soil	Light grew	Medium	Medium	Low	High	High
Chimtya phusro mato	Sticky grey soil	Light yellow	Medium	Medium	Medium	Medium	Low
Nayatola:							
Rato mato	Red soil	Red	High	High	High	Low	Low
Kalo mato	Black soil	Black	High	Low	Low	High	High
Khahare mato	Khahar soil	Light brown	Medium	Medium	Low	High	High
Chiure mato	Chiure soil	Light brown	Medium	Medium	Low	High	High
Phusro mato	Grey soil	Light brown	Medium	Medium	Low	Medium	Medium
Pahenlo mato	Yellow soil	Yellow	Very low	High	High	Low	Low
Kamere mato	Calcareous soil	Light grey/ whitish	Low	High	High	Low	Low

A different picture of the farmers' knowledge of soil variation and naming of soil types emerged when separate groups of knowledgeable male and female farmers were asked to identify and name *bari* soil samples collected from different parts of the village and to provide scores for different soil properties. Farmers recognised minute variations in the large number of soil samples given to them – 11 at Landruk, 7 at Bandipur and 8 at Nayatola, and identified a relatively large number of soil types compared with that obtained by asking farmers verbally without reference to soil samples. Farmers treated a large number of soil samples as distinct types and gave specific individual names to reflect variations in soil attributes (Table 4).

Some soil samples having distinct appearance in terms of colour and texture were given similar names by different groups of male and female farmers. This included *kalo mato* and *jogi mato* at Landruk; *rato mato* at Bandipur; and *kalo mato, rato mato, chiure mato* and *balaute mato* at Nayatola (Table 4); clearly indicating that farmers were aware about the concept of soil classification and aggregating soils based on common physical properties of soils. Many soil samples were also named differently and, in the case of some samples, farmers were unable to find appropriate names but still separated them as distinct soil types. This was more often found with female farmers. A difference in the name of a soil given by farmers from different groups occurred more frequently when the soil colour was not distinct or when the soil displayed a gradation of texture. In such cases, the soil name reflected how farmers perceived the colour, texture and other physical appearance of a particular soil, and the terminology or words they used in their daily communication.

Table 4. Specific names and classification of soils by separate groups of men and women farmers at Landruk.

Soil samples	Soil textural class names (USDA)[§]	Soil colour[†]	Soil class names by men group1[‡]	Soil class names by men group2[‡]	Soil class names by women group[‡]
1	SL (66:20:14)	Yellowish brown	*Rato khairo mato*[1]	*Kalo mato III*[1]	– (not named)
2	SL (76:10:14)	Yellowish brown	*Rato Dhainse mato*[2]	*Rato mato*[2]	– (not named)
3	SL (71:15:14)	Strong brown	*Jogi mato*	*Jogi mato*	*Jogi mato*
4	SL (71:17.5:11.5)	Strong brown	*Rato Dhainse mato*[2]	*Rato mato*[2]	*Khairo mato*
5	SL (76:12.5:11.5)	Strong brown	*Rato Dhainse mato*[2]	*Rato mato*[2]	– (not named)
6	SL (66:20:14)	Olive brown	*Kalo rano mato*	*Kalo mato I*[3]	*Phul mato*
7	SL (66:20:14)	Greyish brown	*Kalo baluwa mato*	*Kalo mato II*[4]	– (not named)
8	SL (66:20:14)	Dark greyish brown	*Kalo kano mato*[3]	*Kalo mato I*[3]	– (not named)
9	SL (76:12.5:11.5)	Light grey	*Kamere mato*	*Kamere mato*	*Chiure mato*
10	SL (62.5:25:12.5)	Olive brown	*Kalo kano mato*[3]	*Kalo mato II*[4]	– (not named)
11	SL (62.5:25:12.5)	Light olive brown	*Rato khairo mato*[1]	*Kalo mato III*[1]	– (not named)

[§] Based on USDA classification system (source: Brady and Weil, 1996).
[†] Colour description derived using *Munsell Colour Charts.*
[‡] Translation of Nepali terms used in naming soils: *mato* = soil; *rato* = red; *jogi* = dark brown colour similar to the colour of the cloth worn by Jogi; *kalo* = black; *rano* = queen bee; *baluwa* = sand; *khairo* = brown; *kamere* = calcareous; *phul* = flower; *chiure* = soil with flat stones shaped similar to *chiura* (beaten rice). Exact translation of *dhainse* and *kano* were not available. The soil types with same superscripted number were grouped together by the farmers in each group.

Differences in soil names also occurred as a result of the use of some terms with functional or symbolic meaning. For example, the terms *rano* with literal meaning 'queen bee' and *phul* with literal meaning 'flower' were used at Landruk to name a kind of black soil which was light, loose, soft and very fertile as *kalo rano mato* or *phul mato*. At Nayatola, the term *kope*, derived from the word *kopya* (a person who does not speak easily), was used to name a soil, which was very hard to plough as *pahenlo kope mato*. Other such terms used were *kitaha* for a 'very tightly held hard soil', *jogi* for a soil with reddish or dark brown colour similar to khaki coloured cloth worn by a Jogi, *chiure* for a stony soil containing stones in the shape of *chiura* (beaten rice – a local food preparation of rice).

Despite some variation in the naming of soils, farmers were able to describe differences in soil properties such as fertility, manure requirement, moisture retention, infiltration and erodibility. They were able to score them in order to quantify differences between soils in relation to these properties. Although some irregularities were seen, male and female groups of farmers showed similar patterns in scoring the majority of soils properties. There was a positive correlation between the scores given by groups of male and female farmers as well as between the two male groups at the three villages. The correlation was high as well as highly significant at Landruk and Nayatola (Table 5). Similarly, laboratory analysis showed a positive correlation between farmers' scores for soil fertility and soil organic matter content (see Appendix 3.1 for details).

Table 5. Rank correlation (r^2) and its significance[§] for scores given to soil fertility of different *bari* soils between groups of men and women farmers.

Research villages	r^2 for male and female groups of farmers	r^2 between two groups of male farmers
Landruk	0.878***	0.905***
Bandipur	0.519 ns	na[†]
Nayatola	0.731**	na

§ ns = non-significant, **p<0.01, ***p<0.001
† na = information not available

The findings discussed above shows that farmers possess good knowledge about variations in soils and name them to reflect such variations. However, the naming and classification of the *bari* soils depended on the nature of the enquiry. During the individual interviews, farmers mentioned few but distinct soil types based on clearly identifiable attributes such as colour and texture, as the purpose of the enquiry perceived by the farmers was to communicate their knowledge of soil types rather than of variation. However, the same farmers were able to identify variation in about fifteen soil samples. They identified them as distinct soil types based on their soil attributes, gave them more specific names and specified their individual soil properties. However, the names of some of these specific soil types varied between farmers depending on their vocabulary and use of symbolic terms, quite natural when individuals are given the opportunity to use their own words. Name variation was also found in soils having less distinct colour and texture. In a study covering Western, Central and Eastern Development Regions of Nepal, Chadwick and Seeley (1996) found that accuracy of giving common names to similar soils was better in soils with one dominant characteristic than in soils where two or more characteristics were used. Joshi *et al.* (1995) recognised that inconsistency in nomenclature was more likely in the case of colour-based classification, as different intensity of the same colour was referred to using different vernacular names.

Nomenclature or naming of soil is simply a process of tagging individual identity to soils and the terms used of this could vary depending on nature of enquiry, locations and communities and nature and conditions of soils. The soil nomenclature, therefore, should not as such be treated as synonymous to soil classification as the latter involves certain level of aggregation. A large number of diverse and varying soil names, as is usually produced in majority of soil studies involving multiple communities (see Vaidya and Floyd, 1997, and Shrestha, 2003), should not be treated as problematic. It only reflects the ethnolinguistic aspects of the soil nomenclature which could be useful for researcher and development professionals to establish effective communication with the local farmers.

The findings further show that local soil names may not exactly reflect, even more so when different symbolic terms are used, the actual properties of soil. Soils of different locality or even from the same locality should not be compared merely on the basis of their names. Chadwick and Seeley (1996) have reported similar analysis. A large majority of past studies on local soil classification have failed to recognise this simple logic and instead have raised doubts on the reliability of local soil knowledge. Similar logic applies to comparing laboratory-based chemical properties of different soil types. Scientific validation is useful to understand chemical basis of farmers' understanding of soil properties but any comparison between different soil types on the basis of such results should be restrained.

3.2. Framework for local soil classification systems

While discussing with farmers about their knowledge of different soil types and the associated properties, they were often found to aggregate soils into certain groups and generalise their properties. For example, *garungo mato* (heavy soil) and *halka mato* (light soil) or clayey and sandy soils, the former requiring high amount of manure and water than the latter to produce a good crop. Farmers, therefore, clearly had concept of soil classification and were using it to base their soil management decisions. This was also evident when farmers were asked to group similar soil samples into common groups. As shown in Table 5, farmers also aggregated (grouped) some soils into different groups or classes and gave a common name to each group of soil. While doing so farmers were found to test the soil texture by rubbing soil between forefinger and thumb (similar to the 'feel' method used in scientific investigation) to classify soil by textural properties.

Different groups of farmers aggregated some soils into exactly the same soil classes but they also aggregated some soils into separate classes, indicating that some variation in soil classification could exist depending on how farmers perceive and value minute variations in soils. Men tended to group soils more often than women. Female farmers often preferred to recognise small variation in soils by referring to them as separate soil types and this was observed at all three research villages. There was a tendency for soils to be aggregated based on soil texture and stone content rather than on soil colour. Farmers appeared to use soil colour to represent dominant soil types but not to differentiate variation within soils. This showed that farmers were aware of the concept of classification and were using specific frameworks in classifying *bari* soils. Based on this observation and on the information obtained during acquisition of farmers' knowledge four such soil classification frameworks commonly expressed by farmers were identified. These were:

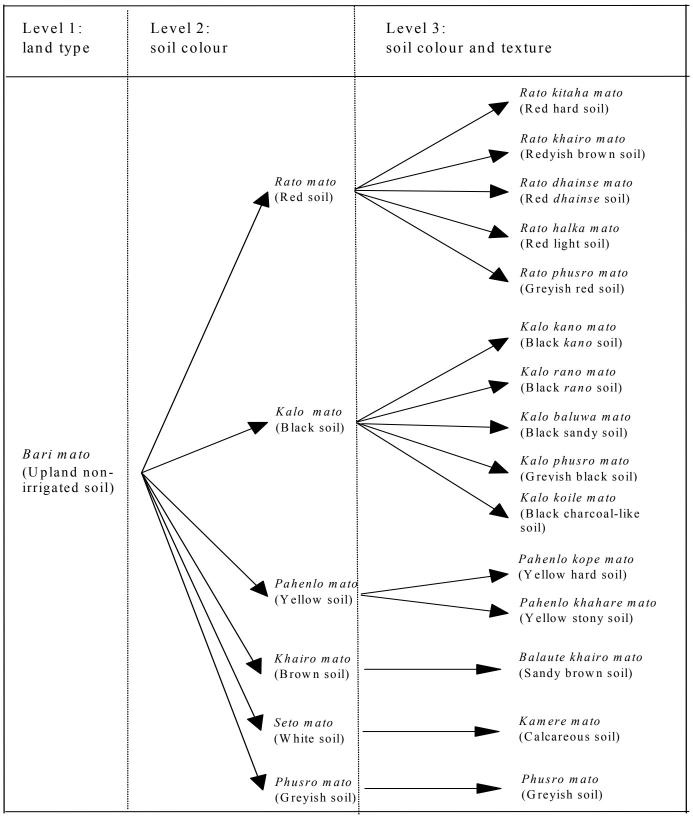
1. **Colour-based soil classification**: This system of classification was commonly used especially in day-to-day communication and was easily constructed from the names given to soils by farmers (Figure 3.4). It gave an indication of soil fertility status and identified or located a particular soil in an area but did not provide any systematic basis for understanding other associated soil properties. It was hierarchical only when colour attribute was combined with soil texture.

2. **Texture-based soil classification**: This was based on the texture and stone content of the soils and was derived from the farmers' practice of grouping soils into common textural classes (Figure 3.5). Under this system all *bari* soils were classified into four broad classes: *matyaul mato* (clay-rich soil), *domat mato* (literally meaning 'two soil', i.e. mixture of clay-rich *matyaul mato* and sandy *balaute mato* (sandy soil), and *gagreto mato* (stony soil). Unlike the colour-based classification, the construction of this classification

required detailed information from the farmers about the properties of each soil. This framework was very similar to the scientific textural classification systems and provided a systematic basis for understanding the soil properties of each soil class.

3. **Workability-based soil classification**: This system was derived from the workability of soil, as experienced by the farmers while tilling soil. There are usually two broad categories: *garungo mato* (heavy soil) and *halka mato* (light and loose soil). However, a third category of *gagreto mato* (stony soil) was also included as stones make tillage operations very difficult (Figure 3.6). This system made use of soil texture and consistency attributes as these greatly influence the workability of soils.

4. **Resource-based soil classification**: This system was based on the resource demands of various soils for crop production and was reported by Nayatola farmers. The broad class names: *thulo mato* (big soil) and *sano mato* (small soil) were symbolic in meaning. *Thulo mato* was like a 'big shot', a rich and influential person, and not only required high input in terms of labour (land tillage), manure and water but was also capable of digesting and withstanding excess of these inputs and gave a higher crop yield than other soils. *Sano mato*, on the other hand, required fewer inputs and yielded even under low input conditions. Soils of this class were said to be intolerant to high doses of manure, resulting in crop lodging due to excessive growth. They were susceptible to soil and nutrient loss with high rainfall. *Thulo mato* was similar to *garungo mato* and *sano mato,* resembling *halka mato*. They are therefore shown in the same classification system.



Farmers' classification of *bari* soils on the basis of soil colour.

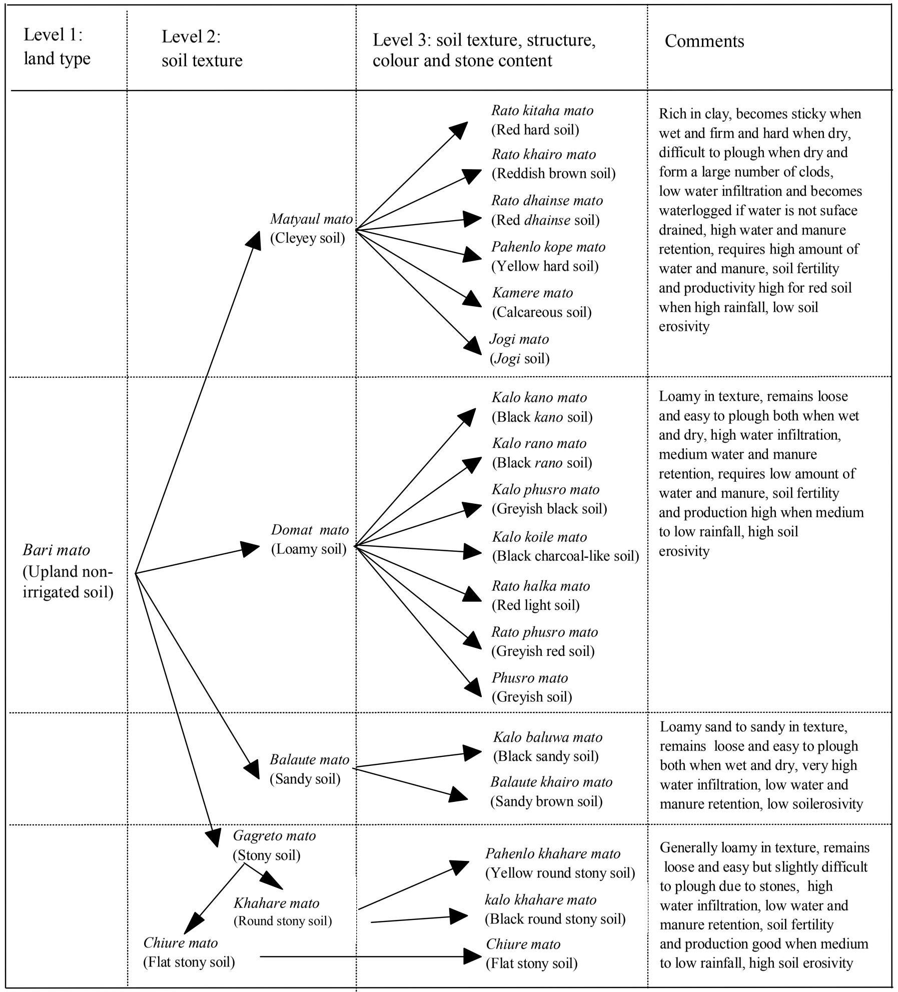


Figure 3.5. Farmers' classification of *bari* soils on the basis of soil texture.

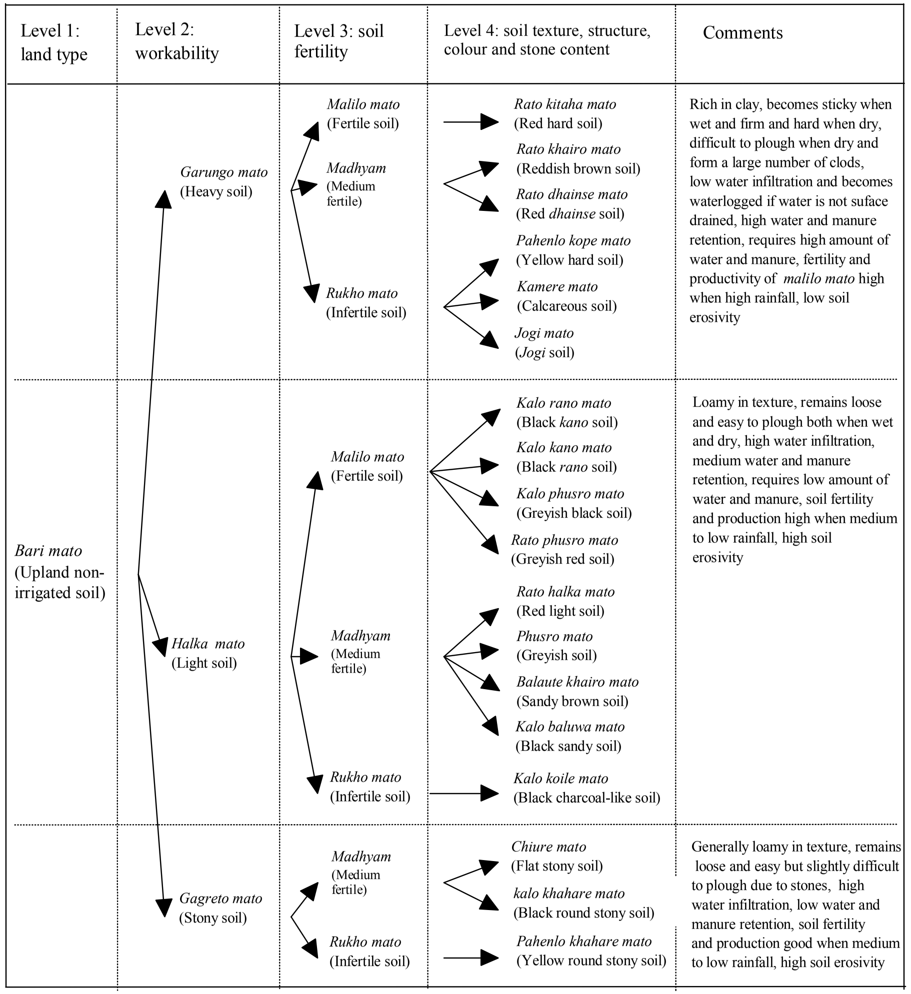


Figure 3.6. Farmers' classification of *bari* soils on the basis of soil workability.

In addition to the four farmers' soil classification systems described above, Nayatola farmers also mentioned a category of *bari* soil based on the suitability of soils for the planting of an early season maize. Stony soils such as *chiure mato*, *khahare mato* and other light soils were termed '*chaite mato*' as maize is planted early in the season in the month of *chaitra* (Nepali month running from mid-March to mid-April). These soils were light, loose and easy to plough and sow even in the absence of rainfall. Farmers were also found to use a *malilo* (fertile) to *rukho* (infertile) soil classification system, but this is not presented as a separate system as it could easily be integrated with the first three systems, indicating that fertility is a property attribute, derived in part from various classifying attributes, rather than a useful general classifier.

Although farmers used a large number of different terms to differentiate variation and to identify soils, they had a good knowledge of the associated properties of these soils and they were able to use a systematic framework for classifying a variety of soils found in their area. Diversity and variation in local soil classification not necessarily mean that the classification system is imperfect rather it reflects the diverse ways farmers perceive and manage soils. Variation in nomenclature of soils as well as in systems of classification is also been found in scientific soil classification systems (Dulal, 1968; Hallberg, 1984).

The local soil classifications discussed above may not exist in its full form and structure but have been constructed from the information on farmers' knowledge about soil properties and the way farmers aggregate different soils around certain soil attributes or combination of soil attributes. Researchers' interpretation of farmers knowledge and perspectives has also been used and this may often be required if full understanding of farmers' local soil classification is desired. This demonstrates the usefulness of integrating emic and etic perspectives to disentangle the existing complication of collecting and interpreting local soil classification.

Conclusions

Despite some variation in nomenclature, the present study shows that a more systematic local soil classifying system was discernable (common to a variety of locations and cultures) by identifying generic concepts underlying such classifications. For example, the use of texture and workability was more consistent than the use of soil colour in different locations. It is critical therefore that, in addition to documenting the local nomenclature of soil types, underlying knowledge of properties and characteristics of soils is properly understood. A link should be established between these properties and characteristics and local soil classification. There is also a need to make a distinction between soil nomenclature and soil classification, often treated as synonymous. The former is simply the labelling or naming of soil types whilst the latter involves aggregating or grouping them based on common attributes or properties. Failure to take note of underlying soil characteristics used by the farmers, but not expressed explicitly, results in misinterpretation and/or inadequate explanation of farmers' knowledge of local soil classification. Getting the methodology right is, therefore, critical to study of local soil classification and knowledge. Instead of mere listing of soil types, their detailed characteristic features and properties should be collected. This information should then be used to aggregate or classify soil based on practical unit of aggregation used by the farmers in managing their soils. If the purpose of the classification is making comparison between soil classifications of farmers of different groups or communities, or between farmers' and scientists' soil classification, then a common basis of classification should be used. Combining farmers' and scientists' knowledge and perspectives of soil classification may be useful in this direction.

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