# Indigenous Agricultural Land and Soil Classifications

P. B. Shah
Mountain Resource Management Project, International Centre for Integrated Mountain Development (ICIMOD), Kathmandu, Nepal

## 1. OVERVIEW

The indigenous knowledge of rural farmers in the Himalayas regarding soil classification and management has been transferred verbally over many centuries. This knowledge can often be applied within socio-economic and spatial boundaries of a society or ethnic group. It has been preserved, communicated and used to overcome problems related to agricultural land management and production activities. A number of projects have been carried out to document indigenous management techniques (Gill, 1991; Tamang, 1991), but indigenous agricultural land and soil classification systems have not been documented in any depth, and few details are available for use in developing an integrated approach to soil management problems. Documentation of how farmers perceive and classify soil types can improve communication between technical personnel and farmers. Integration of knowledge developed by farmers over centuries, combined with modern science, can bring about positive changes in the implementation and design of development programs that could provide innovative and useful insights to modern research and extension activities. It is hoped that this documentation of indigenous knowledge on agricultural land and soil classification systems in the Jhikhu Khola Middle Mountain Watershed can serve as a prototype for regional and national centres interested in applying indigenous knowledge for improving management scenarios of small scale production systems by incorporating new scientific technology into the existing knowledge at the grass root level.

Given the intricate and sophisticated terraced agricultural systems which have been under agricultural use for centuries, the need to document the indigenous system has become more and more apparent. The socio-economic surveys provided a good forum for documentation of some of the indigenous classification systems. The information provided by the 200 farmers who participated in the soil fertility survey in the Bela-Bhimsenthan study area was used to document the local system. It also provided an opportunity to calibrate the system using laboratory analysis of the soils. The following is a first attempt at documenting the indigenous soil and land classification scheme in the Jhikhu Khola.

## 2. INDIGENOUS CLASSIFICATION OF SOIL AND AGRICULTURAL LAND

Farmers have a systematic criteria for distinguishing soils according to landform position, which are based on slope, elevation, and drainage. Top soil colour, texture and terrace type are the most dominant criteria for local land classification and soil fertility management. The farmers also use broad climatic regimes to differentiate climatic conditions. These are based on elevation and aspect, which relate to temperature, and which is in turn one of the most important factors influencing the choice of crops to be used in the rotation sequence, crop production and length of the growing season. The broad classes, with their native vegetation types, are illustrated in Table 1.

### 2.1. Khet and Bari Land Classification

Irrigated khet and rainfed bari terraces are classified according to landform position and slope. The classification system developed by the farmers forms the basis for land management and agronomic cultural practices. Tables 2 and 3 list the terminology used by the farmers for classifying the khet and bari lands in the

Jhikhu Khola watershed and provide information on terrace types and the management limitations of khet and bari lands. The farmers have adjusted the terrace system to the different sites by changing the size and height of the riser and the width of the terrace to obtain maximum stability, drainage and performance. These classes are well recognized by the local farmers and reflect their experience and adjustment to environmental conditions.

Table 1. Indigenous climatic regimes.

| Climatic Regimes | Altitude (m) | Mean Annual Air Temp.(degree C) | Dominant Forests |
|---|---|---|---|
| Awal | < 1200 | 20-25 | *Shorea robusta, Pinus roxburghii* |
| Kchard | 1200-1600 | 15-20 | *Pinus roxburghii*, mixed broad leaf forest |
| Lekh | 1600-2200 | 1-10 | Oak (Quercus) mixed forest |

## 3. INDIGENOUS SOIL CLASSIFICATION SYSTEM

Farmers have a distinct and systematic criteria for soil classification. Soil are differentiated on the basis of colour, topsoil texture, depth and consistency. These factors, in combination with slope, provide information on infiltration, drainage, soil moisture retention capacity, organic matter content and stability.

### 3.1. Soil Colour

Soil colour can be used as a key distinguishing criteria by farmers. Some of the colour differences relate to the age of the soil, the origin or parent material, and the carbon content. The major topsoil colours used by the farmers to differentiate soils are shown in Table 4 alongside the scientific classification.

The colour categories noted by the farmers are a partial indication of organic matter content in the soil. At higher carbon content the soil colours are usually darker, the moisture content and cation-holding capacity are higher, and the structural stability of soil aggregates is greater. In addition, the very old soils in Nepal are deeply weathered and contain significant portions of Fe and Al. The former gives rise to the red soils which have a significant portions of kaolinite and distinct physical properties. Because of the long leaching processes, the red soils are generally low in phosphorus.

### 3.2. Texture

Among the most important physical properties of soils considered by farmers is soil texture. Soil texture involves the size of individual particles and arrangement of soil particles into groups or aggregates. These properties determine nutrient-supplying ability of soil solids and the supply of water and air necessary for plant root development activities. The size of particles in mineral soil (texture) is not readily subject to change, and remains constant. The farmers are aware of the fact that the texture of a given soil can be changed only by mixing it with another soil of different textural class. Farmers incorporate large quantities of sand and silt through irrigation water to improve the physical properties of red clay soils for potato cultivation. The textural classes differentiated by farmers in the field are listed in Table 5 below and their equivalent USDA soil texture classes are also provided. The farmer's textural classifications are used primarily for crop selection and soil management. Heavy textured (chimte) soils require higher labour inputs than light textured (domat) soils for ploughing and other agronomic activities. Moisture content in relation to texture is also used as an index for workability of the soil.

Table 2. Local khet land classification.

| Names | Landform Position | Slope (degree) | Terrace type | Management limitations |
|---|---|---|---|---|
| Bagar khet | Valley bottom, floodplain | 1-3° | Pata < 1m terrace risers | Prone to frequent flooding |
| Khola khet | Stream banks, stream terraces | 5-10° | Ghara <1m terrace risers | Stream bank erosion |
| Sim khet | Head hollows, foot slopes of colluvial slopes Spring or seepage areas | 3-10° | Ghara/Pata < 1m terrace risers | Poor drainage, high water table during monsoon |
| Ghol khet | Valley floor depressional | 1-3° | Pata/Ghara < 1m terrace risers | Poor drainage, high water table during monsoon |
| Khadi Daldale khet | Valley floor swamp | 1-3° | Pata/Ghara < 1m terrace risers | Poor drainage, high water table |
| Gairi khet | Valley floor, intermediate terraces or foot slopes | 1-3° | Pata/Ghara <1m terrace risers | Imperfectly drained, high water table during monsoon |
| Tari khet | Old river terrace/fans (TARS) | 1-5° | Pata/Ghara <1m terrace risers | Irrigation water, low fertility status, prone to surface wash and gullying |
| Pakho/ Tadi khet | Ridge Tops/Fan | 1-5° | Pata/Ghara <1m terrace risers | Irrigation water, low fertility status, prone to surface wash and gullying |
| Ghara khet | Moderately/gently sloping hillside (colluvial slopes) | 10-15° | Ghara, <1m terrace risers | Low terrace maintenance cost and surface erosion problems |
| Kanle khet | Steeply sloping hillside | 15-25° | Kanle, >1m terrace risers | High terrace risers, High terrace maintenance, severe surface erosion |
| Phagata khet | Steeply sloping hillside | 25-30° | Kanle, >1m terrace risers short narrow terraces | High terrace risers, bullocks cannot be used for ploughing, high terrace maintenance cost, severe surface erosion |
| Surke khet | Very steep Hillside | >30 | Kanle >1m terrace risers, long narrow terraces | High terrace risers, bullocks cannot be used for ploughing, high terrace maintenance cost, severe surface erosion |

Table 3. Local bari land classification.

| Name | Landform Position | Slope (degree) | Terrace Type | Management Limitations |
|---|---|---|---|---|
| Tar Pata Bari | River terraces (TARS) Fans, Ridge tops | 1-5 | Pata <1m terrace risers, wide sloping terraces | Low fertility status, surface wash and gullying, moisture deficiency |
| Pata Bari | Moderately sloping hillside | 10-20 | Pata, >1m terrace risers, sloping terraces | Severe surface erosion and mass wasting with slope disturbance |
| Ghar Bari | Gently sloping hillside, FANS, TARS Accordant Ridge Tops | 5-10 | Pata, <1m terrace risers, wide sloping terraces | Surface wash and gullying |
| Kanle Bari | Moderately to steeply sloping hillside | 20-25 | Kanle, >1.5m terrace risers, sloping or nearly level terraces | High surface erosion and mass wasting with slope disturbance, high soil fertility requirement |
| Surke Bari | Strongly sloping hillside | 25-30 | Kanel, >1.5m terrace risers, sloping terraces, long narrow terraces | High surface erosion and mass wasting with slope disturbance. Narrow terraces, bullocks can't be used, low fertility status. Marginal areas |
| Khoriya Bari | Strongly sloping hillside | 25-30 | Kanel, >1.5m terrace risers, sloping terraces, long narrow terraces | High surface erosion and mass wasting with slope disturbance. Narrow terraces, bullocks can't be used, low fertility status. Marginal areas |
| Khar Bari | Moderately to strongly sloping hillside | 20-30 | Kanel, >1.5m terrace risers, sloping terraces, long narrow terraces | Marginal areas for thatch grass producing |
| Karalo Bari | Gently sloping hillside, FAN | 5-10 | Pata, >1m terrace risers, wide sloping terraces | Surface wash, gullying low fertility status |
| Gagrine Bari | Gently to moderately sloping colluvial slope | 5-20 | Pata >1m terrace risers, sloping or level terraces | Severe surface erosion and mass wasting with slope disturbance. Coarse gravelly terraced, high leaching & infiltration capacities |

### 3.3. Soil Depth

Soil depth has been one of the most important criteria used by farmers in selecting land for farming. Deep soils (gahiro) generally have higher moisture-retention capacities than shallow ones. Shallow soils restrict the

penetration of plant roots and affect the soil's moisture-retention capacity. Deep soils (>1m depth) do not restrict the distribution of roots in the soil profile and plants are able to absorb a considerable proportion of their moisture requirement from the soil layers. Farmers prefer soils with a good rooting depth of more than one metre, and are aware of the factors governing the uptake of nutrients and use of soil moisture by plants.

Table 4. Local soil colour classification system.

| Local Colour Classification | Munsell Soil Colour Chart |
|---|---|
| Kalo (black) | 10 YR 3/1-4/1 dark greyish brown-very dark greyish brown |
| Rato (red) | 2.5 YR 4/6-5/6 - red |
| Huluka Rato mato (light red) | 5 YR 5/6-6/6 Yellowish red- reddish yellow |
| Khairo mato (brown) | 7.5 YR 4/2-5/2 Brown - dark brown |
| Physro (grey) | 10 YR 5/1-5/2 grey - greyish brown |
| Kharani mato (light grey) | 7.5 YR 7/ 10 YR 7/7 - light grey |
| Jogi mato (yellow) | 10 YR 6/6 - 7/6 - 8/8 brownish yellow - yellow |

Table 5. Indigenous terms for texture classification.

| Local Name | USDA Texture Class |
|---|---|
| Pango | Silty loam/silt |
| Balaute | Sand |
| Domat | Loam |
| Balaute Domat | Sandy loam |
| Balaute Chimte | Sandy clay loam |
| Domat Chimte | Clay loam |
| Chimte | Clay |
| Gagren | Gravelly |
| Masino | Fine |
| Kharso | Coarse |

### 3.4. Soil Consistency

Soil consistency has important significance for soil tillage and land management systems. Farmers do not have many distinguishing criteria, but know that wet red clay soils are sticky and slippery while sandy soils are non-sticky and non-slippery. "Rato mato chiplo bato" a term used to note that red soils are slippery has significance to farmers in that these soils have poor infiltration capacities. Major local terms used for classifying consistency are provided in Table 6. The terms used for classifying soil consistency may be simple, but are meaningful and easily understood by farmers for management practices.

Table 6. Soil consistency classes and scientific equivalents.

| Local | USDA | Soil Texture |
|---|---|---|
| Chipplo (chap-chape) | Sticky, plastic | Clay (fine) |
| Khasro | Loose, non-sticky, non-plastic | Sands (coarse) |
| Lasailo | Slightly sticky, slightly plastic | Loams (medium) |

## 4. RELATIONSHIPS BETWEEN INDIGENOUS CLASSIFICATION AND SOIL NUTRIENTS

A set of 200 soil samples were available to compare the indigenous classification with the scientifically measured results. First, the differences in the soil colour classes recognized by the farmers were compared, and secondly the land classification and terrace systems favoured by the farmers were compared against the inherited soil chemical conditions.

### 4.1. Comparison Between Indigenous Soil Colour Classes and Soil Chemical Conditions

All soil samples were sorted into three broad colour classes well recognized by the local farmers. The chemical properties of the soils falling into the three classes were then analyzed and compared. As was shown in a previous paper by Shah et al. (1995), elevation, parent material and land use all affect the soil composition. A stratification based on elevation (< 1200m, > 1200m) and agricultural land use (irrigated vs. rainfed) was made before separating soil colour. The results, shown in Table 7, indicate that significant differences could be discerned in a number of cases. The dark greyish soils usually have the best pH in all high elevation sites while the light grey-yellowish class had the lowest pH, in all sites regardless of use. In contrast available phosphorus values were consistently lower in all red soils. All light grey to yellow soils had the lowest cation exchange capacity and exchangeable Ca content. This reveals that the farmers are well aware of the unique differences between soil colour and its associated properties. The chemical variables displayed in Table 7 are to a great extent related to inherent differences in soil parent materials but the impact of management is also evident.

### 4.2. Comparison Between Indigenous Agricultural Land Classes and Soil Chemical Conditions

The 200 soil samples originating from the Bela-Bhimsenthan test area were sorted according to the twelve indigenous khet and bari classes and the results were compared statistically for a number of nutrients. The indigenous land categories listed in Tables 3 and 4 were grouped into three categories: very desirable sites, moderate sites, and poor sites for crop production. We then sorted all soil samples according to these three classes and determined the relationships or differences in selective soil nutrient conditions (Table 8). The best differentiation was found in terms of cation exchange capacity and exchangeable Mg and, to a lesser extent, in exchangeable K. Most of these are at least in part related to differences in parent materials.

Although there is some overlap in the range of conditions the separation between classes is sufficient to suggest that there is a reasonable relationship between the indigenous classification and the associated chemical conditions related to parent material. Since organic carbon is low in all soils in the watershed, the cation exchange capacity is primarily inherited from the parent material. The rate of weathering and the differences expressed in the indigenous classification is at least partially reflected in the scientific data. Exchangeable cations are usually influenced by management particularly by the application of chemical fertilizers. Since few farmers apply lime or use potassium fertilizer, K and P also reflect inherited conditions. Variables that are more easily influenced by management (N, P, Ca, pH) did not show a significant relationship.

Table 7. Comparison between indigenous soil colour classification and soil chemical conditions.

| Soil Colour | Munsell Soil Colour Class | Land Use | Elevation (m) | pH | Avail. P (mg/kg) | Cation Exch. Capacity (meq/100 g) | Exch. Ca (cmol/kg) |
|---|---|---|---|---|---|---|---|
| Dark greyish | 10 YR 3 | khet | > 1200 | 5.8 | 19.6 | 14.8 | 10.1 |
| Red - reddish yellow | 2.5 YR 5-6 5 YR 5-6 | khet | > 1200 | 5.4 | 5.6 | 12.3 | 5.1 |
| Light grey - yellow | 7.5 YR 4-7 10 YR 5-7 | khet | > 1200 | 5.0 | 28.2 | 9.4 | 4.4 |
| Dark greyish | 10 YR 3 | khet | < 1200 | 5.1 | 84.3 | 6.2 | 2.5 |
| Red - reddish yellow | 2.5 YR 5-6 5 YR 5-6 | khet | < 1200 | 5.6 | 10.8 | 13.8 | 5.8 |
| Light grey - yellow | 7.5 YR 4-7 10 YR 5-7 | khet | < 1200 | 4.8 | 34.4 | 9.1 | 3.9 |
| Dark greyish | 10 YR 3 | bari | > 1200 | 5.2 | 36.6 | 10.9 | 5.6 |
| Red - reddish yellow | 2.5 YR 5-6 5 YR 5-6 | bari | > 1200 | 4.9 | 13.3 | 14.3 | 4.1 |
| Light grey - yellow | 2.5 YR 5-6 5 YR 5-6 | bari | > 1200 | 4.7 | 37.1 | 7.9 | 3.2 |
| Dark greyish | 10 YR 3 | bari | < 1200 | 4.7 | 14.1 | 12.1 | 3.5 |
| Red - reddish yellow | 2.5 YR 5-6 5 YR 5-6 | bari | < 1200 | 4.8 | 7.2 | 12.4 | 3.1 |
| Light grey - yellow | 7.5 YR 4-7 10 YR 5-7 | bari | < 1200 | 4.6 | 18.1 | 8.6 | 2.8 |

Table 8. Possible relationships between indigenous soil classification and soil chemical conditions.

| Land Use | Indigenous Names | Quality | CEC (cmol/kg) | Exch. Mg (cmol/kg) | Exch. K (cmol/kg) |
|---|---|---|---|---|---|
| khet | Ghol, Gairi, Ghara | Most desirable | 8.6-14 | 1.4-2.2 | 0.15-0.35 |
| khet | Kanle, Phagata, Surke | Moderate | 10-12 | 0.95-1.49 | 0.17-0.25 |
| khet | Bagar, Khola, Sim, Khadi Daldale, Tari, Pakho/Pata Tadi | Least desirable | 9-11 | 0.7-1.3 | 0.1-0.21 |
| bari | Pata, Ghar | Most desirable | 10-12.1 | 1.5-1.8 | 0.3-0.4 |
| bari | Tar Pata, Surke | Moderate | 9-12.7 | 1.2-1.5 | 0.3-0.5 |
| bari | Kanle, Khoriya, Khar, Karalo, Gagrine | Least desirable | 6-10.1 | 1.1-1.2 | 0.11-0.3 |

The calibration of the indigenous physical properties of the soils has not yet been completed but is expected to show similar trends suggesting that the experience in soil management gained by the farmer has validity and can be very useful in extension work, particularly when dealing with the introduction of new crops or alternative management methods.

## 5. CONCLUSIONS

This paper documented the prevailing indigenous soil and classification system used in the watershed. Farmers have vast long term experience and recognize soil and site conditions that relate to crop performance and workability. These conditions are often difficult to measure scientifically. The key features in the indigenous land classification system in the watershed are landform type, topographic setting and drainage regime. The type of terrace constructed is well adjusted to the conditions and is cognisant of slope stability, drainage regime, seepage conditions and texture.

When the indigenous land classification scheme was grouped into three types, ranging from the most to the least desirable, a good relationship was found between the quality of the land and the extent of the cation exchange capacity and selected exchangeable cations, particularly those that are not readily affected by fertilizer and manure management.

The soil classification system used by the farmers is based on soil colour, texture, consistency and depth. Most of the indigenous classes can readily be converted into the commonly used scientific classification schemes. These conversion tables facilitate communication between the subsistence farmers and the scientifically trained extension personnel. More documentation and calibration is needed, particularly in the area of physical properties and soil performance in terms of biomass production. Additional research is needed to better document the indigenous knowledge on soil workability, soil performance and soil quality, all of which are notoriously difficult to measure scientifically. These are the most fruitful research directions since the potential benefits are great, particularly when new management techniques and new crops are being introduced into the indigenous farming system.

## 6. REFERENCES

Gill, G. J. 1991. Indigenous erosion control techniques in the Jhikhu Khola watershed. In: P. B. Shah, H. Schreier, S. Brown, and K. Riley (eds.) Soil fertility and erosion issues in the Middle Mountains of Nepal. Workshop Proceedings, Jhikhu Khola Watershed. IDRC, Ottawa, pp.152-164.

Shah, P. B. and H. Schreier. 1995. Maintaining soil fertility in agriculture and forestry. In P. B. Shah et al. (eds.) Challenges in Mountain Resource Management in Nepal: Processes, Trends and Dynamics in Middle Mountain Watersheds. Workshop Proceedings, Jhikhu Khola Watershed, 10-12 April, 1995. ICIMOD, IDRC and UBC. Kathmandu. pp. 171-182.

Tamang, D. 1991. Indigenous soil fertility management systems in the Jhikhu Khola watershed. In: P.B . Shah, H. Schreier, S. Brown, and K. Riley (eds.) Soil fertility and erosion issues in the Middle Mountains of Nepal. Workshop Proceedings, Jhikhu Khola Watershed. IDRC, Ottawa, pp. 135-151.