Sustaining Natural Resources—Light on Some Indigenous Soil Management Concepts

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ABSTRACT

Sustainability is the attempt to provide the best outcomes for the human and natural environments both for the present and the future. The Brundtled Commission defined sustainable development as a development that "meets the needs of the present without compromising the ability of the future generations to meet their own needs". The technologies that are generated out of farmers own knowledge and experience in dealing with day-to-day problems are called Indigenous Technical Knowledge (ITK). Different authors have the opinion that these technologies are low cost, locally applicable and most importantly, sustainable in nature; and at present it is well recognized that these technologies are also in vogue at field level. The present study was undertaken in a lateritic area in the district of Birbhum of West Bengal, India. The paper documented different indigenous criteria/ indicators for assessing the physical quality of soil and thereby assessing the change of soil quality over time. The paper also documented different indigenous practices to maintain the physical and chemical characters of soil and compared these techniques with respect to sustainability on an emic *perspective. Finally, the authors strongly recommend incorporating these practices into the modern evaluation study solely or in combination to generate a pool of sustainable technology for maintaining natural resources.*

Key Words: *Sustainable development; Indigenous knowledge; Soil management; Indigenous sustainability;*

Sustainability is the attempt to provide the best outcomes for the human and natural environments both for the present and the future. Protection of soil quality under intensive land use and fast economic development is a major challenge for sustainable resource use in the developing world (*Doran et al., 1996*). The basic assessment of soil health and soil quality is necessary to evaluate the degradation status and changing trends following different land use and smallholder management interventions (*Lal and Stewart, 1995*). In Asia, adverse effects on soil health and soil quality arise from nutrient imbalance in soil, excessive fertilization, soil pollution and soil loss processes (*Zhang et al., 1996; Hedlund et al., 2003*).

The World literature on farming systems Research recognized that the traditional subsistence farming farmers throughout the tropics maintain a deep understanding of their local ecosystems, play an important role in developing more sustainable farming systems (*Talawar and Rhoades, 1998*). The complementary role that indigenous knowledge plays to scientific knowledge has been increasingly acknowledged (*Sandor and Furbee, 1996*).

Based on experience with local soil and land types over several generations, farmer's store of practical knowledge can be of tremendous benefit to the soil scientists and other researchers in the formulation of research strategies and interventions. Soil scientists acquire knowledge in their study areas within a relatively short time by conducting quick surveys, sampling and classification of the soil according to some national and international standard (*etic* perspective). In contrast, local people acquire soil knowledge from their vast experience generated from day-to-day interaction with area specific problems and environments which are also transmitted from generation to generation and encoded in local language in a tacit form (*emic* perspective). Indigenous knowledge (LK) is increasingly being recognized as crucial in agricultural research, extension and development in general (*Guarino (1995*). Local soil knowledge is very useful because making soil inventory by indigenous classification is often much faster than conventional scientific method; it facilitates easy communication between farmers and it also offer important insight into land use considerations of farmers (Sikana, 1993; Warren, 1992; Tabor, 1990 and Dialla, 1993).

In this backdrop, the present study was undertaken with the following objectives:

1. To document indigenous soil classes, their characteristics, management constraints if any and indigenous practices if any to overcome such constraints.
2. To identify and document indigenous criteria/ indicators for soil health and classification.
3. To study the farmers' perception of change of soil health over time in respect to different indigenous and modern practices.

METHODOLOGY

Study area : The study was conducted in a riverside, remote, tribal populated area (with two contiguous villages) in the district of Birbhum, West Bengal, India. The area was purposively selected where there is no institutional sources of agricultural information present within 15 kms from the village.

Selection of respondents: Studies on indigenous knowledge sometimes require respondents of special characters (Parasar, 1994; Pal, 1998). To document and analyse ITK on soil sustainability and classification, respondents with 20-25 years of farming experience and having good knowledge about the historical background of the area were selected.

Collection and assessment of farmers' knowledge: The respondents after selection in each step, were interviewed individually or in groups (as Laird, 1985) to identify individual criteria of soil health and classification and their perception regarding the sustainability of soil health. To quantify the indigenous indicators a five-point scale was used with the statements and scores as *definitely improved (score=+2), improved (score=+1), no change (score=0), deteriorated (score=-1), definitely deteriorated (score=-2).*

Comparison of different practices with respect to sustainability: The farmers are not capable of providing information on individual practices regarding their findings on sustainability. But they can provide a general trend regarding a group of practices. They are also not aware regarding the analytical methods to draw conclusion on sustainability. To draw conclusions from their general idea, the researchers used to employ scorecards to place the whole range of fields along a continuum from 'least exposed to modern agricultural technology' to 'most exposed to modern agricultural technology' fields in a number of sub-practices. Boro rice fields and kitchen gardens were identified as 'most exposed to modern agricultural technology' and 'least exposed to modern agricultural technology' respectively and mutually compared with in respect of indigenous indicators.

RESULTS AND DISCUSSIONS

Indigenous soil classes—characteristics, constraints and indigenous remedies :

The people of the study area divided the soil as *bastu, maath, poli* and *kankure* according to the origin of the soil. The *maath* soil again texturally classified as *bele, doansh, metel, entel and bagha-entel*. A brief account of soil characteristics of all these classes is presented in the following section.

Baastu soil: The soil is originated from the habitation areas and mostly the residue of mud wall of broken houses. It is a whitish and friable soil, less retentive of moisture. Vegetables can be grown if manured well. Non-fertility is the common problem of such soils. The people of the study areas allow a flock of sheep to stay overnight on such fields or apply sufficient amount of FYM and ash or cultivate sunhemp for three consecutive years to rejuvenate such soils. The dropping of sheep is very useful manure and contains 3 per cent nitrogen, 1 percent phosphorus and 2 percent potash on an average. Moreover urines are also added by this method. [N.B. In spring and summer some migratory shepherds used to come to this district from other states with their flocks of sheeps. They have 300-800 sheeps per flock and these could be kept on any field with a nominal charge. For this easy accessibility and application, this low cost practice is very popular in this district.]

Maath soil: These soils are actually regarded as the cultivable land soils and are again sub-divided into different textural classes as follows:

(a) Bele soil: A whitish, loose and friable soil, not retentive of moisture. It is a poor soil. Vegetables can be grown only if manured and irrigated well. High sand content. May be matched with sandy soil of standard

class.

(b) Doansh soil: A mixture of clay and sand in perfect proportion, forming a brownish, loose and friable soil. It is poor in soil moisture retention. Most of the crops can be grown in this soil except paddy. However it requires frequent irrigation. May be matched with loam soil of standard class.

(c) Metel soil: A rich in clay, retentive of moisture, somewhat sticky and fertile soil. All sorts of crops can be successfully grown in this soil. As per the opinion of the farmers, it is the most ideal for cultivation of crops. May be matched with clay-loam of standard class.

(d) Entel soil: A brown soil very rich in clay. Becomes very sticky when wet and produce cracks in long fissures when dry up. It is not as good as metel soil for crop cultivation. Paddy can be successfully grown in this soil, however it requires manuring well. May be matched with clay soil of standard class.

(e) Bagha-entel soil : A reddish soil, sticky and tenacious. Other characters and crops are same as *entel*. It may also be matched with clay soil of standard class.

As all textural types of soils are the members of this group, *maath* soils suffer from different types of problems. In bele soils erosion of top layer of soils after heavy rain is a common problem. To overcome such problems, farmers allow weed growth when fallow in such type of lands. Hardening of soil or hardening of top layer with a moisturous soft layer at its bottom or clod formation at the time of land preparation for rice transplanting are common managerial problems faced in the metel and entel type of soils. Farmers of the study areas also manage these problems by their rich heritage of indigenous knowledge systems.

To overcome soil hardening problems, in summer, they dig the soil upto one foot depth and turn it upside down, dry the land, then apply sufficient FYM and ash and plough thoroughly. The problem of hardening is mostly seen in a field where rice-rice cropping system is followed. Soil structure is purposefully destroyed in rice cultivation by puddling to avoid percolation loss of water. During puddling operation, the individual soil particles viz. sand, silt and clay are separated. The soil layer with high moisture below the plough sole is compacted due to the weight of the plough. The soil particles separated during puddling settle later. The sand particles reach the bottom, over which silt particles settle and finally clay particles fill the pores, thus making an impervious layer over the compacted soil. This soil after being dry becomes hard. But this compaction is created within 5?-6? layer. Soils below 6? have their own structure and this layer is not so hard. Turning upside down is thus helpful in rejuvenating the soil structure. Moreover, adding FYM and ash helps in structure formation. The compacted lower layer regains its structure within several months of microbial activities.

To rejuvenate the field from the problem like top layer hardening with a moisturous soft layer at its bottom, they use to drain the water out from the field, make some cris-cros drenches and allow drying up and after good drying, they plough the land thoroughly. The problem of hardening of top layer of soil is generally found in coastal areas. In coastal areas, the soils are salt affected. By evaporation, the salts are accumulated in the pore spaces of the top layer which inhibits further evaporation of water from the bottom layer. This condition creates such problems. But in Birbhum this problem sometimes found in puddled soils when after puddling a severe dry spell occurs. It is described in the previous paragraph that in puddling soil structures are broken down and soil particles are arranged layer after layer according to particle diameter. This creates an impervious top layer which does not allow water of the lower layers to lose by evaporation; and thus when the top layer dries up in hot sun, the problem is created. The cris-cros drench break the top hard layer and drain out and evaporates the moistures of the bottom layers. Ploughing after that mixes different soil layers thoroughly.

To reduce the size of clods at the time of preparatory tillage or puddling, the indigenous people apply water and undecomposed cowdung or water and oilcake or water only in the field and allow the soil to decompose. Clods are formed by aggregation of soil particles. This is due to soil consistence. Soil consistence is a term used to describe the resistance of a soil at various moisture levels to mechanical stresses or manipulations. It is a composite expression of cohesive and adhesive forces that determine the ease with which a soil can be reshaped or ruptured. Aggregate stability is a measure of resistance of aggregates to breakdown against potentially disruptive processes. On wetting by applying water, the aggregates collapse due to weakening or solubility of bonds or due to swelling. The practising farmers believe that if undecomposed cowdung or oilcake is applied in standing water, the process of aggregate collapse hastens, but this is subject to experimental verification in research stations.

Polee Soil: It is a deposit of silt in the bed of a river or in areas subject to river inundation and is loose, friable and yellowish in colour. Optimum in soil water retention capability. Sugarcane, pulses, potato, vegetables and other sorts of crops can be grown here. Soil loss due to flood and stream bank erosion is a common problem in such type of fields. plant *Saccharum spp*. along riverside. *Saccharum spp.* act as vegetative barrier against stream bank erosion.

Kankure soil: A reddish, loose and friable gravelly soil mostly originated near the lateritic hillocks found abundant in the areas. It is not retentive of moisture and also not fit for cultivation. Fruit orchards can be established on these soils with good managerial practices.Indigenous soil types *Balu, Poli* and *Athail* as reported by Das and Das (2005) in Barak Valley of Assam; *Bele, Aintel* and *Pali mati* as reported by *Ali (2003)* in Bangladesh and *Balia, Kelua* and *Dorosa* as reported by *Kshirsagar and Pandey (1996)* in Orissa show significant similariries in their characteristics with the indigenous soil types of *Bele, Entel* and *Polee* identified in this study.

Indigenous basis for textural classification : The farmers have some basis or indicators by which they identify major textural classes of soils, i.e. *entel, metel, doansh* and *bele*. Table-1 presents these criteria, concluding relationship with the textural classes followed by a discussion to explain these. Soil consistence is a factor which determines the amount of pressure to be employed to break a clod and is a composite expression of cohesive and adhesive forces. Size of clods in summer/preparatory tillage is determined by the consistence of the soil. Time taken to come into '*jow*' condition is determined by the movement and retention of soil water which is again determined by the adhesive and cohesive forces. Volume change in application of water is due to the swelling and shrinkage of the soil. All those characters e.g. consistence, cohesive and adhesive forces and swelling increase with the decrease of the particle size. As stated in Stoke's Law, time to sediment is inversely proportional to the square of the particle diameter. So, lesser the particle size more the time taken to sediment.

Table 1. Indigenous criteria of Classification

Criteria	Concluding relationship
The extent of pressure to be employed by hand to disintegrate a small clod.	Increasing from Bele to Entel through Doansh and Metel
Size of clods formed during summer ploughing/preparatory tillage.	-do-
Time taken to come into '*jow*' (optimum moisture condition, fit for tillage) condition after heavy rain.	-do-
Volume change occurred by applying water in dust samples.	Negative in Bele, no change in doansh, increase in metel and entel.
Stickiness of the soil.	Increasing from Bele to Entel through Doansh and Metel
Time taken in sedimentation of particles in a soil water solution.	-do-

Macharia and Ng'ang'a (2005) has also reported some indigenous criteria as colour, texture, coarseness, hardness, erodibility, drainage, cracking and fertility characteristics as the basis of classification.

Indigenous criteria for assessing soil health and sustainability: The perception of soil health and sustainability of the farmers are different from the perception of the scientific world. They measure sustainability on a holistic manner based on their years of experience. Table-2 presents some indicators which they use to assess the health of a soil, and measure sustainability according to the change of these indicators.

Table 2. Indigenous criteria of Soil health and sustainability

Criteria	Concluding relationship
Population of earthworm	More the population, better the quality
Root mass found	More the mass, better the quality
Presence of termite crust	More the crust, better the quality
Weed growth and vigour	Better the growth, better the quality
Volume change after water application	More the volume change, better the quality
Water retention and drainage	Optimum retention and drainage is preferred
Workability	Better the workability, better the quality
Weight of a handful of soil	More the weight, worse the quality

Soil health and quality indicators are forwarded by different authors as soil structure, stability and nutrient retention (*Carter, 2002*) Retention and mobility of water and nutrients; habitat for macro and micro fauna (*Bengtsson, 1998; Swift et al., 2004*) Soil biological and chemical activity thresholds; plant available nutrients (*Doran and Jones, 1996)* etc. Presence and interaction of these factors jointly determine the soil quality and change over time. A balance of all these factors may indirectly be manifested by the indigenous factors mentioned above.

*Measurement of sustainability :*The authors have measured sustainability as per the perception of the farmers with the above mentioned indigenous quality criteria. Table-4 presented the summarised scores of their assessment study. Positive score indicates an improvement of the soil over time in respect of the soil quality sustaining factors and a negative score indicates deterioration of the same.From the sustainability point of view, it can be concluded from Table-4 that fields which are most exposed to modern agricultural practices (viz. with least use of indigenous knowledge) are deteriorated over time in respect of all its soil quality sustaining abilities/capabilities (overall mean score of deterioration is -0.75). Whereas, least exposed fields (viz. with high use of indigenous knowledge) on an average very marginally deteriorates (overall mean score of deterioration is -0.01) although some of the soil quality sustaining components (earthworm population, root mass, weed growth and vigour and water retention and drainage) must improved over time as per the perception of the farmers of the study area.

Table 4. Total and mean scores of sustainability indicators for most and least exposed fields (N= 30)

Indicators	Most exposed		Least exposed	
	Total Score	Mean Score	Total Score	Mean Score
Earth worm population	-48	-1.60	+01	+0.03
Root mass	-10	-0.33	+05	+0.17
Termite crust	-43	-1.43	-10	-0.33
Weed growth and vigour	-07	-0.23	+02	+0.07
Water retention and drainage	-21	-0.70	+02	+0.07
Workability	-09	-0.30	-01	-0.03
Weight of a handful of soil (-)	-20	-0.67	-01	-0.03
Overall Score	-158	-0.75	-01	-0.01

CONCLUSION

The study revealed that the farmers consider the soil as a living system and assess it from their own indigenous criteria. Although, they are not aware or capable of using analytical tools or instruments for measurement of soil quality but they always try to view soil on a holistic manner. It can also be concluded that their practice help to sustain soil system on a long run. Soil scientists should recognise and use such local knowledge and should incorporate these into formal research and development studies to assess sustainability of soil and land. Since farmer's knowledge is based mainly on experience and observation, the analytical methods used by research could complement this knowledge system.

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