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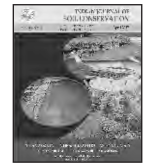

Traditional soil and water conservation practices by the tribal farmers in Koraput district of Odisha

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ABSTRACT

The traditional soil and water conservation (SWC) methods practised by the tribal farmers of nine villages of Semiliguda block in Koraput district were analysed based on information collected through schedule survey, group discussion and field visit. Farmers have been adopting and practising cost effective agronomic and structural measures since time immemorial for conserving soil and rain water. Contour cultivation, mixed cropping, mulching, agri-horti system, stone bunding, *Jhola kundi* and vegetative bund of *sambuta* grass are the most commonly found indigenous SWC measures in the cultivated fields. The rate of adoption of these measures vary between 23% for pitcher irrigation and 83% for mixed cropping. This variable adoption rate of these measures indicates that the farmers have wisdom and high social value towards the natural resources particularly soil, water and vegetation, and continue to conserve these resources through cost effective traditional techniques for their livelihood security.

1. INTRODUCTION

Land and water are the basic natural resources, support life in all forms. However, the ever-burgeoning human population, modernization of technologies, changing life pattern have invited many problems with respect to these natural resources (Das *et al.*, 2012). Soil erosion and water scarcity are very important among them and becoming a serious cause for human society to worry. As the days pass, water is becoming scarce even in the area where it was plenty, and fertile land is gradually diminishing. In hilly and undulating areas, soil erosion is a significant issue due to both its on-site and off-site effects (Mullan, 2013). A loss of productivity and shortfall in both food and cash crops are the immediate impacts of soil and water erosion (Mishra and Rai, 2013). Water pollution, silting and decrease in storage capacity of reservoirs due to displaced soil are some of the off-site effects of soil erosion and it has both socio-economic and environmental consequences. Unfortunately, erosion is often far more severe in developing countries than in developed countries due to lack of financial, technical and institutional capacity (Tebebu, 2010). In a developing country like India, soil erosion due to water causes damage to 82.6 Million ha (M ha) of land, which is nearly 68.4% of the degraded lands of the country and threatening productivity and fertility of the soil (Maji, 2007).

Eastern Ghats region (19.8 M ha) of India is severely affected by erosion (Sikka *et al.*, 2000). This region comprises of hillocks, sloping lands and fertile flat lands. Koraput district of Odisha is one of those areas of Eastern Ghats where soil and water erosion is a serious problem due to rolling topography, high rainfall and deforestation (Adhikary *et al.*, 2016). Apart from this, shifting cultivation is prevalent in this tribal dominated district on a wide scale (Dash, 2006) which aggravate the condition. Though efforts are being made to wean off the farmers from shifting cultivation to settled agriculture, but are not easy to eliminate this practice since it is linked with socio-economic condition of the people and prevalence of complex land tenure system (Dash, 2006).

However, over the ages, tribal farming community developed some potential indigenous technologies to conserve soil and water and increase water use efficiency (WUE) of traditional crops grown in this region (Adhikary *et al.*, 2015) using their ingenuity and skill. These traditional technologies are entirely based on local needs, prepared from locally available resources and the knowledge handed down from generation to generation, and locally managed and maintained. So, there is an urgent need to understand and document the indigenously developed traditional SWC measures available in this region. Therefore, the present study was conducted in nine villages of Semiliguda block, Koraput district with the aim to find out and document the indigenous technologies developed by the tribal farmers to conserve and utilize natural resources efficiently.

2. MATERIALS AND METHODS

Study Area

The district Koraput lying between 81°05´ to 83°5´ East longitude and 18°4´ to 19°5´ North latitude is popularly known as the land of aboriginals due to its sizeable population which acts as the natural laboratory for the documentation of traditional knowledge (Raut *et al.*, 2013). The district is the home to as many as 25 different tribal communities (Dash, 2006). Semiliguda block is 20 km away from the district headquarter with a geographical area of 535.4 km^2 and elevation varying between 842 to 1658 m above msl (Fig. 1). About 55% of the population are scheduled tribes and 84% resides in the villages. The climate is warm and humid with mean maximum and minimum temperatures of 30.6°C and 17.0°C, respectively. The normal rainfall of the block is 1540 mm, with maximum rainfall occurring during August and September (Adhikary *et al.*, 2015). The topography consists of undulating surface of high hills and flat river valleys. The brief description of terminologies used in the context of farming system/farm land in the study area is presented in

Fig. 1. Location map of the study area

Table 1. The general topographic feature of the study area is classified in to five types, locally known as *Dongar* (high slope rainfed up land), *Pada* (rainfed medium land), *Beda* (rainfed medium land), *Saria* (flat medium land) and *Jhola* (creek fed low land having good moisture availability throughout the year). Agricultural practices extend from valley bottom (*Jhola* land) to hilltop (*Dongar*). The agricultural production system in the area is mostly rainfed and mono-cropped. *Pada* and *Beda* lands are used for upland paddy (*Oryza sativa*), maize (*Zea mays*), little millet (*Panicum sumatranse*) and finger millet (*Eleusine coracana*) during *kharif* (rainy season), whereas niger (*Guizotia abyssinica*) and mustard cultivated during *rabi* (winter season). *Saria* land is used for vegetable cultivation throughout the year based on availability of water. The *Jhola* land is used for cultivation of paddy throughout the year.

Data Collection and Validation

For collecting information on indigenous SWC technologies, schedule survey, field observation and group discussions were conducted in nine selected villages (*Chalanput, Mukhibidai, Podagad, Doliamba, Kokoriguda, Patraput, Rajput, Dudhari and Bilaput*). Simple random sampling method was used to select 45 numbers of households for schedule survey from each village. The information regarding SWC practices was collected through Participatory Rural Appraisal (PRA) technique such as transect walk and direct question and answer with the respondent in the presence of key informants. The accuracy of the answers has been checked through field visits. The degree of adoption and diversity of practices, however vary from one village to another, depending on socio-economic condition of the villagers and biophysical characteristics of their lands which was calculated using the structured response by the farmers. The available literatures were also reviewed to fine tune the results and photographs of important activities were taken from farmer's field to characterize the systems.

Table: 1
Brief description of terminologies used in the context of farming system/farm land

Terminologies	Description
Jhola land	Irrigated paddy field in the valley floors and foot hills
Saria land	Medium land used for vegetable cultivation, banana on field bund
Beda land	Homestead used for cultivation of fruits, maize, ginger, pigeon pea, millet, vegetable and banana on field bund
Pada land	Land between *Beda* and *Donger* used for cultivation of upland paddy, finger millet, niger, pigeon pea and vegetables
Donger land	Land on the hill slopes for shifting cultivation [finger millet, niger, little millet (suan)].

3. RESULTS AND DISCUSSION

Realizing the problem of soil erosion, the people of this region has been practising many indigenous technologies for natural resource conservation. The types of SWC measures practised by the farmers of the block are grouped in to two classes: a) agronomical measures, and b) mechanical measures and presented in Table 2.

Agronomic Measures of Soil and Water Conservation

Contour cultivation

Contour cultivation consists of carrying out agricultural operations like ploughing, seeding, tillage and inter-cultivation very nearly on the contour across the slope (Fig. 2a). During field survey and group discussion, it was observed that about 28% of the cultivated land is under contour cultivation (Table 2). This is mainly practised by medium and large farmers on individual basis. Farmers use either their own country plough or hired tractor drawn cultivator for contour cultivation. It was also observed that the households with larger plots and more fertile lands are more practising contour cultivation than those having small and scattered parcel of land. The cause may be attributed to inconvenience with respect to intercultural operations in small plots. Lack of awareness and adequate knowledge regarding contour line is also retarding its large scale adoption (Table 3). This practice helps in reducing slope length, creating barriers for soil and water flow, enhancing soil moisture status in the field, and thereby increasing crop yield (Stevens *et al.*, 2009; Sharma and Singh, 2013). It requires no additional cost and is a non-monetary conservation practice, considered as an effective conservation measure in rainfed agriculture.

Mixed cropping

Mixed cropping is one of the traditional, very old and most popular practices among the farmers of this region. Two or more crops are simultaneously grown on the same piece of land (Fig. 2b), locally known as *mayeda chasa*. Mixed cropping is practised in all types of farm lands except *Jhola* land, and about 83% of farmers do mixed cropping to diversify production and assure yield of at least one of the crops (Table 2). The type of crops varies from farmer to farmer due to difference in land type and socio-economic condition. During *kharif* (rainy) season, apart from paddy and finger millet, farmers grow maize, cow pea (*Vigna unguiculate*), french bean (*Phaseolus vulgaris*) and vegetables like pumpkin (*Cucurbita maxima*), cucumber (*Cucumis sativus*), bitter gourd (*Momordica charantia*) as mixed crop. Cropping of ginger and pigeon pea (*Cajanus cajan*) is practised in a wide scale, where ginger is the main crop and pigeon pea grown on the field bund. The farmers are getting about ₹ 0.1-0.125 million net income from one acre of ginger field within a short period of 120 days and most of the farmers used pigeon pea only for their household consumption. Some farmers also grow *Dahlia hybrida* on the field bund, which indicates the proper use of bund also. On an average, a plant of Dahlia produces 5-7 kg of flower year^{-1} and market price is ₹ 3/- flower^{-1}. From the group discussion, we also observed some of the farmer's keen interest towards bee keeping, along with flower cultivation. In winter also, they used to grow mustard (*Brassica juncea*), brinjal (*Solanum melongena*), cauliflower (*Brassica oleracea var. botrytis*) and cabbage (*Brassica oleracea var. capitata*) in the main field and wheat on the field boundary.

This cropping system gives good land cover, proper utilization of moisture and soil nutrient from different soil layers. The products and refuse from one crop help in the growth of the other crop and *vice-versa*. This cropping system is also considered as an insurance against crop failure under rainfed/abnormal weather condition. Other advantages of this method include a) reduction in runoff, b) less or no weed growth and c) minimum attention to the crops. However, the limitations of this system are like, if the crops are not chosen properly, there are chances of competition

Table: 2
Brief description of SWC measures practised by tribal communities and their adoption rate

Type of measures	Practices	Description	Adoption rate* (%)
Agronomical	Contour cultivation	Cultivation along the contour and across the slope	28
	Mixed cropping	Growing two or more crops in the same field	83
	Mulching	Application of any plant residues or other materials to cover the top soil surface	43
	Green manuring	Application of leaves of green manuring plant	32
	Growing of *Sambuta* grass on field bund	*Sambuta* grass grown on the field boundary	74
Structural	Stone bunding	Construction of stone bund	82
	Loose boulder check dam	Barrier constructed across gully using stone	37
	Brush wood check dam	Barrier constructed across gully by using locally available materials	46
	Jhola kundi	Water harvesting structure in lowland areas	58
Irrigation practices	Pitcher irrigation	Irrigate the plant through small droplets of water	23
	Water conveyance system	Water conveyance through bamboo and tree trunk	44

*The adoption rate is the average of 405 farmer households of nine villages of the study area.

Fig. 2. Traditional SWC measures: (a) Potato cultivation on contour, (b) Mixed pigeon pea with ginger, (c) Green manuring using *Gliricidia*, (d) *Sambuta* grass in paddy field. (e) Agri-Horti system: Pigeon pea and pine apple on the bund, (f) Crop residue incorporation, (g) Stone bunding in the field, (h) Stone cum vegetative bunding, (I) Brush wood check dam, (j) Traditional water harvesting structure *Jhola kundi*, (k) Water conveyance through palm trunk, and (l) Pitcher irrigation in mango plantation.

between the crops for nutrients and secondly, it reduces the fertility of soil as many crops are grown in the field at a time (Table 3).

Line sowing behind the plough

This is one of the age old practices and has been evolved as the birds eat away the seeds which are sown by broadcasting method. It helps to have better crop stand and facilitates the intercultural operation. There is better utilization of soil moisture especially during dry spells. This practice is carried out by country plough and some farmers attached a funnel to it for sowing so that the seeds can be shown simultaneously. The cost involved in line sowing behind the plough is very marginal and ranges between ₹ 100-150 acre^{-1} and for attaching the funnel ₹ 200-250 acre^{-1}. From survey, it was found that this method increases yield by 20-30%. By adopting this method, inter-culture operation, application of fertilizer and pesticides and harvesting is

Table: 3
Evaluation of indigenous SWC practices, their limitations and future scope of research

Type of measures	Effectiveness		Limitation	Research scope
	SWC	Yield		
Contour cultivation	+	+	Small land holding, less concentration towards up land, lack of awareness	-
Mixed cropping	+	+	Only used local varieties	Introduction of high yielding crop varieties, Optimum ratio and proportion of crops
Mulching and incorporation of crop residues	+	+	-	Quantification of soil and water conserved and yield advantage due to crop residues
Green manuring	+	+	Low moisture residue in the soil, time of cultivation is not suitable, cold climate	Economic evaluation of the system
Growing of *Sambuta* grass on field bund	+	+	Root system is suitable for rat habitation	-
Stone bunding	+	+	Loose holding sometimes does not serve the purpose, periodic maintenance required	Design of size and shape of the bund depending on site condition
Loose boulder check dam	+	+	Loose holding sometimes does not serve the purpose, periodic maintenance required	Design of size and shape of the bund depending on site condition
Brush wood check dam structure depending on site	+	+	During heavy rainfall, it washed out	Design of size and shape of the brush wood condition, and identification of new plant species
Jhola kundi	+	+	Siltation of *kundi*	Design of *Jhola kundi*
Pitcher irrigation	+	+	Less durable, Delicate to handle	-
Water conveyance by splitted tree trunk	-	+	Less durable	-

+ Positive effect, - No effect

made easier; however, the maintenance of shear point as per the need is required.

Green manuring

This practise helps in increasing organic matter content in the soil, controlling weed, acts as a barrier to soil erosion, and in increasing crop yield. Only 32% of farmers used to grow green manuring trees like G*liricidia sepium*, *Leucaena leucocephala* on the field bund and green manuring crops like dhaincha (*Sesbania aculiata*), sunhemp (*Crotalaria juncea*), cow pea and rice bean (*Vigna umbellate*) in the field (Table 2). *G. sepium* is a fast growing, tropical, leguminous tree, locally known as *khata* plant, used for manuring (leaves) at maximum vegetative growth after 1 year of planting/sowing (Fig. 2c).

Research revealed that growing *Gliricidia* at a close spacing of 75 cm on farm bunds could provide 28-30 kg N ha^{-1} yr^{-1} in addition to valuable organic matter (Wani *et al.*, 2009) and the application of 1 t ha^{-1} *Gliricidia* leaf manure provides 21 kg N, 2.5 kg P, 18 kg K, 85 g Zn, 164 g Mn, 365 g Cu, 728 g Fe besides considerable quantities of S, Ca, Mg, B, Mo under rainfed systems with 700-800 mm rainfall (Rao *et al*, 2011). Other advantages of using *Gliricidia* includes plants grown as live fence (hedge), stems used as fuel wood, plants serve as support for other plant species, mixture of ground leaves or bark and cooked seeds of *Gliricidia* used as poisonous bait for rats, leaves used as insecticide and insect repellent. *Gliricidia* grown as hedgerow increases the soil carbon sequestration potential to the tune of 0.69 t ha^{-1}yr^{-1} due to its barrier effect (Adhikary *et al.*, 2016). Main limitations of farmers not adopting green manuring in *Donger* and *Pada* lands is due to low moisture residue in the soils of these lands.

Growing of *Sambuta* grass on field boundary

This vegetative barrier is used for conserving soil and water, apart from strengthening the earthen bund in 5-10% slopping land. As *Sambuta* grass (*Saccharum spp,* locally named as *Sumo* grass) is easily available in this region and continuous rainfall creates conducive condition for its rapid and dense growth, many farmers grow this grass (Table 2.). The grasses are either grown in the entire field or on the field boundary (Fig. 2d). This is practised by farmer, mostly in *Jhol*a and *Saria* land because of water availability throughout the year.

The grasses which are cut from the field are also used for thatching the houses by drying the grass. Farmers find it very effective and economical for them. This is also a non-monetary practice and has been proved to be ideal for SWC. Experiments carried out at Research Centre of ICAR-Indian Institute of Soil and Water Conservation, Koraput revealed that *Sambuta* grass can reduce runoff by 64%, sediment yield by 69% and increase finger millet yield by 64% (Sudhishri *et al.*, 2008). The decrease in runoff and sediment yield definitely attributed to the fact that vegetative filter strips obstruct runoff, increase opportunity time and thereby encourage the infiltration of water into the soil. Apart from this, the grass remains add organic matter to the soil, thus improving the soil structure.

Agri-horti system of mango, pigeon pea and pineapple

This is practised both for enhancement of income per unit area and strengthening of bund. Farmers grow pigeon pea (locally called *kandul*) on the bunds after the mango plantation is over. They dibble pigeon pea seeds on the bund after the soil attains optimum soil moisture for germination and plant pineapple on downstream side of the bund. This method of cultivation does not need any intercultural operation. No additional or extra fertilizer is used. Pulse crops are grown on the two sides of the bund leaving a small space in between for movement of the farmers (Fig. 2e).

The farmers use the pigeon pea and pineapple for their consumption and also some farmers used those for selling purpose. In this practice no intercultural operation is taken up. The vacant areas on the bunds are gainfully utilized and the farmers get substantial income without any investment except the cost of seeds. This process strengthens the bund considerably. As 6-10% of the cultivable land is lost due to bunding (Adimassu *et al.*, 2012), utilisation of these lands for productive purpose will enhance the adaptability of technology and provides protection from erosion.

Mulching and incorporation of crop residues

Mulching is defined as the application of any plant residues or other materials to cover top soil surface. Application of sal (*Shorea robusta*) leaves to ginger and turmeric fields has been a traditional practice of many farmers in the study area. Also some farmers preferred paddy straw, finger millet straw, and *Gliricidia* leaves for mulching. However, in this region, it is a traditional practice of cutting upper part of the finger millet, and keeping rest of the finger millet crop in the field, which will be incorporated in the soil during ploughing (Fig. 2f).

These mulches not only conserve the moisture but also reduce the fluctuation of soil temperature, protect the soil from rain drop impacts and hold the excess surface water in contact with the soil, so as to increase the infiltration rate and thereby reducing the runoff and soil erosion. During the day hours these mulches also absorb as much insulation as bare soil does, but little energy is conducted downward, resulting the surface of mulch becomes hot and the soil remains cool. The use of locally available organic mulch is a no-cost practice, having many beneficial effects with respect to soil. However, sometimes there is problem in doing the cultural practices, apart from termite problem.

Mechanical Measures of Soil and Water Conservation

Stone bunding

These are small embankments constructed along the field boundary and sometimes across the slope. This practice checks both soil erosion and siltation. Besides prevention against erosion, it acts as a barrier for animals to enter into the field. This is practised by all types of farmers on individual basis (Table 2.) and constructed manually. At some places, farmers construct suitable outlet to remove excess water (Fig. 2g). They used stone size of 15-20 cm to construct the bund. The width and height of the bund varies between 0.3-0.5 m, and 0.5-1.5 m; and the length varies according to the field size. From the group discussion, it was found that about 20 man-days are required for bunding one ha of land. In general, stone available inside the field are collected and used in making stone bunds, which indirectly improves the soil physical condition due to removal of stones.

It helps in reducing soil loss, avoids formation of rill and gully, improves the soil moisture content around the structure and thereby increases crop yield. It is reported that on an 11% slope plot, stone bund (0.3 m height and width) helped in reducing runoff by 54%, soil loss by 60%, increased production of finger millet by 56-114% than no bund (Sudhishri *et al.*, 2008). Main limitation of this practice involves periodic maintenance of the bund, ill effect of concentrated runoff towards the downstream side of the field.

Stone-cum-vegetative bunding

The main aim of constructing stone-cum-vegetative bund is to demarcate the boundary, protect the crop from the animal and control runoff and soil erosion. In this practice, tribal farmers first make stone bunds in their field and to stabilise them, they plant some shrubs along the bund (Fig. 2h). Occasional maintenance is required in this, and it is a very efficient practice for SWC. This is easy to follow and socially acceptable. Due to this practice there is an appreciable increase in yield to the tune of 20% over no such practice. The cost involved in this practice depends on the size of the bund. It helps in SWC and the vegetation/grasses on the bund reduce the maintenance cost of the bund.

Brush wood structure

It is a temporary structure used for gully control, SWC and safe disposal of runoff. It is constructed across the gully to retard the velocity of water and reduce erosion; in addition, it retains some quantities of sediment and moisture which help in establishment of vegetation. In general, two types of constructions are made, a) single row brushwood structure, and b) double row brushwood structure. In the study area, normally farmers preferred single row brush wood structure, where gully depth found to be less than 1 m, and the double row brush wood is constructed when gully depth is up to 2 m, width varies between 6 and 7 m, and the expected runoff is more. The average slope for this is about 2-3% and structure height is up to 1-1.5 m. *Ipomoea carnea* (locally called *amari*) is generally used for binding and strengthening of the structure and to arrest the soil (Fig. 2i). Other species which are used for brush wood structure includes a) *G. sepium,* b) *Lantana camara,* c) Bamboo (*Dendrocalamus strictus*) *etc.* The variation in cost depends upon the type and size of the structure. The approximate cost is ₹ 100 structure^{-1} as the materials used are locally available and free of cost. This structure prevents soil loss and helps in conserving water. However, periodic maintenance and establishment of plant species in the initial stage is required.

Jhola kundi

Jhola kundi is a low cost water harvesting structure of circular shape, dug manually with depth varying from 2 to 4 m and diameter of 3 m approximately (Sharda *et al*, 2009) (Fig. 2j). It is constructed in *Jhola* land for storage of water which can be utilised for cultivation purpose. These lands are at 1 to 1.5 m lower elevation than the adjoining medium and uplands. The soil removed from the *Jhola kundi* is deposited around the structure at a distance of 0.5-1.0 m away for forming a bund. This helps in preventing the entry of surface runoff water to the *Jhola kundi* and thereby, preventing its siltation.

In the medium lands, which are located at higher elevations adjacent to *Jhola* lands, remunerative vegetables such as tomato, cabbage, cauliflower, brinjal, pepper *etc.* are cultivated using water from *Jhola kundi*. One person is required at a time for operating the water lifting device and for irrigation on plot to plot basis. Woman can also operate the water lifting devices conveniently. Cost of excavation for a *Jhola kundi* of capacity of 30 m^3 is approximately ₹ 2,000 only, *i.e.* ₹ 65 m^{-3} of earth work. In vulnerable places, stone packing is practised. As such the *Jhola kundi* water harvesting technology is almost maintenance free. Only precaution required is not to allow surface runoff water to enter into the *Jhola kundi* and thereby prevent siltation and avoid sliding of slope by doing stone packing of side walls.

Water conveyance system

Farmers use the trunk of the tree (Bamboo, Date palm *etc.*) to convey the water from one field to another having slope 5-10%, and generally practised by farmers having small and medium land holdings. It is put in the downstream area of the sloppy land where the water concentrates. These are also used for conveying water from channel to the field and field to field where the gully is developed or some other obstructions are present (Fig. 2k). For small distance they use splitted bamboo of 1-2 m length to convey the water from one field to another. The length of the tree trunk generally varies between 2-4 m and velocity of flow in the trunk is 1.5 m sec^{-1}. The trunk is replaced either in every 5-6 months or in one year depending on the functionality of the used material. As trees and bamboo are easily available in the locality, farmers find it very suitable and cost effective.

Pitcher irrigation

Generally, this is practised in sloppy areas mainly in small and medium mango (*Mangifera indica*) and cashew (*Anacardium occidentale*) orchard, where pumping of water is difficult. Farmers use a small mud pot or the waste bottle for this practice. They make a small hole on bottom of the pot, (inserting cotton in the hole) and fill that pot and put it under the plant (Fig. 2l) so that the plant gets water as small droplet. The cost of each mud pot is ₹ 20/- and the water holding capacity of each pot varies between 2-5 litres. The moisture content at the root zone is always maintained through this practice. The chance of runoff is zero.

Evaluation, Limitations and Future Research Scope of Indigenous Practices

Not only the farmers of the Semiliguda block, but of whole district widely used indigenous SWC practices. Different conservation measures practiced by the farmers were evaluated by their effectiveness with respect to SWC and enhancing crop yield. It was found that most of the practices receive an overall positive remark. However, these practices have to overcome certain limitations before successful results and widespread adoption can be achieved (Table 3). In the adjoining Gajapati district of Odisha, Sahoo *et al.* (2017) also noticed the variable adoption of different soil and water conservation measures. It was also observed that most of the framers gave their view in adopting both agronomical and structural measures to combat problem of soil erosion, and to improve the agricultural production. As blending of traditional and modern technologies is important, there is a need of further research to overcome the limitations of the existing indigenous SWC measures by modifying them and adding new cost effective, socially acceptable and eco-friendly conservation alternatives. The ecological conditions in the study area vary even with a short distance, due to its hilly and undulating topography. Farmers are not aware of chemical properties of soils but they are well aware of the productive value and problems associated with all types of soils, and have adopted appropriate conservation measures to control the degradation of land.

4. CONCLUSIONS

Soil erosion is a significant socio-economic and environmental issue in Eastern Ghats Region of Odisha. It can create serious on-site problems, while a large proportion of the negative environmental consequences of soil erosion are associated with off-site damages. Land being the major source of the food supply, majority of the farmers in the Semiliguda block of Koraput district has pursued affords to enhance land productivity, conserve soil and water, and increase soil fertility to cope with shrinking land holdings caused by the population growth and family fragmentation. In this regard, they used a wide range of traditional SWC measures. These knowledges need further validation and standardization to improve their efficacy and reduce cost.

REFERENCES

Adhikary, P.P., Hombegowda, H.C., Barman, D., Jakhar, P. and Madhu, M. 2016. Soil erosion control and carbon sequestration in shifting cultivated degraded highlands of eastern India: performance of two contour hedgerow systems, *Agroforest. Syst*., doi: 10.1007/s10457-016-9958-3.

Adhikary, P.P., Madhu, M., Dash, J., Sahoo, D.C., Jakhar, P., Naik, B.S., Hombegowda, H.C., Naik, G.B. and Dash, B. 2015. Prioritization of traditional tribal field crops based on RWUE in Koraput district of Odisha, *Indian J. Tradit. Know.*, 14(1): 88-95.

Adimassu, Z., Mekonnen, K., Yigra, C. and Kessler, A. 2012. Effect of soil bunds on runoff, soil and nutrient losses, and crop yield in the central highlands of Ethiopia. *Land Degrad. Dev.*, 25(6): 554-564.

Das, A., Ramkrushna, G.I., Choudhury, B.U., Munda, G.C., Pate, D.P., Ngachan, S.B., Ghosh, P.K, Tripathi, A.K., Das, S. and Kumar, M. 2012. Natural resource conservation through indigenous farming systems: wisdom alive in North East India. *Indian J. Tradit. Know.*, 11(3): 505-513.

Dash, B. 2006. Shifting cultivation amongst the Tribes of Odisha. Odisha Review. http://Odishagov.nic.in/e-magazine/Odishareview/july2006/engpdf/76-84.pdf, (Assessed on 30-11-2013).

Maji, A. 2007. Assessment of degraded and wastelands of India. *J. Ind. Soc. Soil Sci.,* 55: 427-435.

Mishra, P.K. and Rai, S.C. 2013. Use of indigenous soil and water conservation practices among the farmers in Sikkim Himalaya. *Indian J. Tradit. Know.*, 12(3): 454-464.

Mullan, D. 2013. Soil erosion under the impacts of future climate change: Assessing the statistical significance of future changes and potential on-site and off-site problems. *Catena*, 109: 234-246.

Rao, Ch. S., Venkateswarlu, B., Babu, M.D., Wani, S.P., Dixit, S., Sahrawat, K.L. and Kundu, S. 2011. Soil health improvement with *Gliricidia* green leaf manuring in rainfed agriculture on farm experiences. Bulletin No-2/2011, Central Research Institute for Dryland Agriculture, Hyderabad, Andhra Pradesh, India. 16 p.

Raut, S., Raut, S., Sen, S.K., Satapathy, S. and Pattnaik, D. 2013. An Ethnobotanical survey of Medicinal Plants in Semiliguda of Koraput District, Odisha, India. *Res. J. Recent Sci.*, 2(8): 20-30.

Sahoo, D.C., Madhu, M., Adhikary, P.P., Dash, Ch. J., Sahu, S.S. and Devi, S. 2017. Adoption behaviour of different soil and water conservation measures among tribal farmers of Gajapati, Odisha. *Ind. J. Soil Cons.,* 45(1): 112-116.

Sharda, V.N., Dogra, P. and Prakash, C. 2009. Potential technologies for resource conservation and productivity enhancement. Bulletin No.T-57/D-36, Central Soil and Water Conservation Research and Training Institute, Dehradun, Uttarakhand, India. pp. 89-91.

Sharma, N.K. and Singh, R.J. 2013. Agronomic Practices for Erosion Control. *Popular Kheti*, 1(3): 57-60. (Available online at www.popularkheti.info).

Sikka, A.K., Singh, D.V., Gadekar, H. and Madhu, M. 2000. *Diagnostic survey and zonation of Eastern Ghats for natural resource conservation and management*, Central Soil and Water Conservation Research and Training Institute, Research Center, Ootacamund, India. 82 p.

Stevens, C.J., Quinton, J.N., Bailey, A.P., Deasy, C., Silgram, M. and Jackson, D.R. 2009. The effects of minimal tillage, contour cultivation and in-field vegetative barriers on soil erosion and phosphorus loss. *Soil Till. Res.*, 106(1): 145-151.

Sudhishri, S., Dass, A. and Lenka, N.K. 2008. Efficacy of vegetative barriers for rehabilitation of degraded hill slopes in eastern India. *Soil Till. Res.*, 99: 98-107.

Tebebu, T.Y., Abiy, A.Z., Dahlke, H.E., Easton, Z.M., Zegeye, A.D., Tilahun, S.A., Collick, A.S., Kidnau, S., Moges, S., Dadgari, F. and Steenhuis, T.S. 2010. Surface and subsurface flow effect on permanent gully formation and upland erosion near Lake Tana in the Northern Highlands of Ethiopia. *Hydrol. Earth Sys. Sci. Discussions*, 7: 5235-5265.

Wani, S.P., Sreedevi, T.K., Rockström, J. and Ramakrishna, Y.S. 2009. Rainfed Agriculture-Past trend and future prospectus, In*: Rainfed agriculture: Unlocking the Potential. Comprehensive Assessment of Water Management in Agriculture Series*. (Wani, S.P., Rockström, J. and Oweis, T. Eds.) CAB International, Wallingford, pp. 1-35.