Success Story

SOIL HEALTH IMPROVEMENT USING BIOCHAR APPLICATION IN SIKKIM: A SUCCESS STORY

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ABSTRACT
Farmers of Sikkim are quite unaware about different innovative modern organic input, techniques of soil health management and innovative technologies they are bound to cultivate agricultural crops in traditional manner. Farmers of Sikkim generally don't know how the soil health can be improved. This study was conducted during the period of 2015-16. After distributing the inputs under Tribal Sub Plan (ICAR-TSP) to tribal farmers in Sikkim survey was conducted to assess the impact of such organic input. The addition of biochar + RD of organic manure increased maize yield by 24% as compared to RD of organic manure. Biochar addition @ 5.0 t/ha increased the specific root length and decreased both root diameter and root density, indicating fine root proliferation which favours the resource acquisition by increasing biochar-root interaction and the organic input efficacy. Application of biochar reduced overall cumulative losses of NO_3^--N via leaching at 0-15 cm by 14.7%. The cost of biochar produced by farmers using the biomass created during/after harvest and/or from other economical sources comes to around Rs 3-5 a kg. If anyone wishes to prepare commercially from woody substances, it is also available for Rs 9-12 a kg. But, biochar prepared from locally available weed biomass will be available at zero cost. Thus, the input distribution was very much successful and now the farmers are getting more yields using our technology and they are now trying to do the technology in their own farm land.

BACK GROUND INFORMATION

Sikkim enjoys a wide range of climate, physiographic, geology and vegetation that influence formation of different kinds of soils. Percentage area under Zn deficiency (<0.6 mg kg^{-1}) in Sikkim is 15.69% (202.35 sq. km) of the geographic area having highest Zn deficiency in South Sikkim district (82.07 sq. km, 19.1% of TGAD) followed by East (56.84 sq. km, 13.3% of TGAD), West (48.91 sq. km, 15.7 of TGAD), and North (14.53 sq km, 11.8% of TGAD). Percentage area under Mn deficiency (<3.5 mg kg^{-1}) in Sikkim is 10.16% (131.02 sq. km) of the geographic area having highest Mn deficiency in South Sikkim (48.72 sq. km, 11.3 of TGAD) followed by East (34.52 sq. km, 8.1% of TGAD), North (28.82 sq. km, 23.13% of TGAD) and West (18.96 sq. km, 6.1% of TGAD). Biochar, an ancient soil conditioner or zero waste, is nothing but a carbon rich charcoal-like substance which is formed by heating the biomass in a limited oxygen condition, in a process known as pyrolysis. . It acts in the removal of CO_2 from the atmosphere and increases the level of long wave radiation leaving the planet; hence it is also considered as a long wave *geoengineering* option for climate change mitigation. Application of higher amounts of biochar to the soil may increase the carbon credit benefit to the farmers. Carbon which is applied to the field in the form of biochar could provide the farmer carbon credits that could be sold in a C credit market for additional income[5]. Increasing the C sink in soil will help to reduce the amounts of CO_2, CH_4 and N_2O emission in environment. Indian government initiatives may allow the farmers and land managers to earn carbon credits by reducing greenhouse gas emissions and storing carbon in vegetation and soil through changes in agricultural and land management practices (carbon farming).

INSTITUTIONAL INVOLVEMENT

Farmers of Sikkim don't know the use of biofertilizers and other organic inputs sources. They apply nutrients at very low dose into soil which results in low production and productivity in most of the crops. Besides they don't use dolomite or biochar for soil acidity management which has a great role in soil acidity management as well as yields of crops. ICAR-National Organic Farming Research Institute, Tadong, Gangtok, Sikkim-737102 distributed different inputs like organic biofertilizers (mixture of N fixer, P solubilizer and K mobilizer), organic plant nutrient foliar spray, dolomite, mixed

compost, phospho-compost, rock phosphate, neem cake, vermicompost, sea weed extract granules and biochar under Tribal Sub Plan project.

SPECIAL INVOLVEMENT

Six weeds species abundant in the Research Farm *viz.*, *Ageratum* spp., *Lantana* spp., *Artemisia vulgaris*, *Chromolaena odorata*, *Bidens* spp., *Neyraridia* spp. and utilized their biomass to prepare biochar. Charring was carried out in a pit ($2\times2\times3$ ft^3) to keep the process simple, quick and low cost having production efficiency 13.2, 23.2, 15.1, 16.4, 14.6 and 19.6%, respectively. Organic biofertilizers was purchased from market. The biofertilizers were mixed @ 10 kg/ha with different manures like FYM, goat manure, poultry manure, pig manure, sheep manure and vermicompost. Then they were applied in the field as we do for organic nutrients. The recommended dose of biofertilizers was 25 kg/ha. Furrow application of dolomite/limestone (agricultural lime) having 80 mesh size @ 250-400 kg/ha every year is economical than a relatively higher dose. But furrow application needs every year application in fields. In broadcasting we can also apply 1-2 t/ha. But in dolomite can be applied in alternate year. Phospho-compost was made @5-10 rockphosphate along with compost depending upon situation. Waste material like FYM, poultry manure, pig manure or goat manure mixed properly with rock phosphate. Rock phosphate + raw animal waste + water are used to prepare enrich P-compost. We can also add different weeds/fresh crop residue produced in the farm. Add water to the heap so that moisture remains about 60 to 70%. Cover the heap with soil or polythene and add water 15-20 day interval to avoid dryness in the compost. Phosphocompost was prepared within 60 days during summer and 90 days during winter.

SUCCESS POINTS / RESULTS

Study was conducted by incubating acidic soil of pH 5.4 with biochar upto 180 days. The biochar prepared from weed biomass and dolomite were applied at three rates (0, 2.5, and 5.0 t/ha). Application of *Lantana* spp. biochar had shown relatively larger increase in soil pH (initial 5.4 to final 6.7) followed by *Ageratum* spp. (6.5), *Neyraridia* spp. (6.3), *Artemisia vulgaris* (6.1), *Bidens* spp. (6.0), *Chromolaena odorata* (5.9). Biochar is basic in nature (pH > 7.0). It can react similarly as agricultural lime does *i.e.*, by increasing soil pH. Rates between 5 to 10 t/ha (0.5-1 kg sqm) have beneficial effect on soil properties and crop yield. Application of biochar along with the recommended dose of organic nutrients (@ 5.0 t biochar/ha) increased/improved soil moisture retention, nutrient use efficiency, CEC and crop productivity by nearly 20%, 15%, 35% and 30%, respectively. It increased grain yields (≥15%) by decreasing leaf SPAD value at sites with low P availability in upland rice. The addition of biochar + RD of organic manure increased maize yield by 24% as compared to RD of organic manure. Biochar addition @ 5.0 t/ha increased the specific root length and decreased both root diameter and root density, indicating fine root proliferation which favours the resource acquisition by increasing biochar-root interaction and the organic input efficacy. Application of biochar reduced overall cumulative losses of NO_3^--N via leaching at 0-15 cm by 14.7%. The cost of biochar produced by farmers using the biomass created during/after harvest and/or from other economical sources comes to around Rs 3-5 a kg. If anyone wishes to prepare commercially from woody substances, it is also available for Rs 9-12 a kg. But, biochar prepared from locally available weed biomass will be available at zero cost. Apart from this, low-cost portable biochar kiln along with smoke-free stove costing Rs. 500-550, that produces biochar during cooking and smoke is reduced by 75 per cent as against the traditional chullah. Fuel energy produced during burning of biomass used for cooking and cost of fuel energy nullified by labour cost and thus production cost of biochar depends on only biomass cost. Thus, from weeds its zero cost, from crop residue Rs. 3-5 and woody substance 9-12.

OUTCOME/EXTENSION ASPECTS

If we properly adopt the technology like organic biofertilizers (mixture of N fixer, P solubilizer and K mobilizer), organic plant nutrient foliar spray, dolomite, mixed compost, phospho-compost, rock phosphate, neem cake, vermicompost, sea weed extract granules as well as biochar we can easily manage the entire soil of north east for higher production. Assuming that the science of biochar addition in soil is 'unambiguously beneficial', the soil scientists support the view that agriculture should be rewarded for carbon sequestration through biochar. Different training programme through soil input support system has been organized at Singhik, North Sikkim on 28th Oct. 2014; Chungthang, North Sikkim on 30th Oct.2014; Dzumsa Lachen, North Sikkim on 30th Oct.2014; Naga, North Sikkim on 1st Nov. 2014; lower Sadam, South Sikkim on 17th Dec. 2014; Ravitar, West Sikkim on 18th Dec. 2014; Perbing, West Sikkim on 19th Dec. 2014; ICAR Sikkim Centre on 1st July and 13th Oct., 2015; Tempyem, East Sikkim on 15th Dec., 2015; Hee-Gyathang, North Sikkim during 3rd to 5th Feb., 2016; Ringhim, North Sikkim on 21st April, 2016; Salghari GPU and Poklok GPU, South Sikkim on May 10 and 11, 2016. Various necessary inputs like organic biofertilizers (mixture of N fixer, P solubilizer and K mobilizer) 12,000 kg, organic plant nutrient foliar spray 300 pieces (100 ml), dolomite (1000 kg), rock phosphate 200 kg, neem cake 1000 kg, sea weed extract granules 700 kg and vermibeds 15 nos. has been distributed among the tribal farmers of different district of Sikkim. Under this project more than 1000 tribal farmers were benefited. Farmers got good results by using the soil inputs and they told that they are getting more production and productivity by using these soil inputs. It was found that application of recommended dose of all the soil inputs increases nutrient use efficiency upto 10-15%, CEC upto 30-35%, soil organic carbon 2-5% from initial value (0.81%), soil pH 25-35%, and crop productivity upto 20-

30% along with increases in grain yields upto 12-15% in major crops of Sikkim. Besides all the macro and micro nutrient content also increases 10-35% after application of such soil inputs. Under this project 250 soil samples were collected from farmers' field of different villages namely; Tempyem, Sajong, Sajong-Rumtek, Rumtek, Lossing, Samlik-marchak and Namin villages (1150-1450m above MSL) of East Sikkim District. Geo-reference soil samples were collected, processed, analyzed and soil health card prepared and distributed to the farmers. Soil health card was distributed by the Hon'ble Union Minister of Agriculture and Farmers Welfare Shri Radha Mohan Singh during his visit at ICAR Sikkim Centre, Gangtok on 17th January, 2016.

Potential for entrepreneurship development

Biochar prepared from locally available weed biomass will be available at zero cost. Fuel energy produced during burning of biomass used for cooking and cost of fuel energy nullified by labour cost and thus production cost of biochar depends on only biomass cost. Weed problems can also be solved in organic agriculture. The technology has a potential to remediate the soil acidity in Sikkim as well as it can also increase the production and productivity of major hill crops in Sikkim. Thus it can develop entrepreneurship or has expert potential.

CONCLUSION

It is ecologically viable and economically acceptable technology. Adopting this technology in Sikkim among hill farmer's will facilitate proper soil health management and sustainable production in organic system. If we distribute low cost biochar kiln to farmers we can generate energy as fuel and produce biochar which can manage the soil acidity in entire north east India with low investment.

Fig. 1. Input distribution and demonstration of technology to farmer's

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