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Importance of Carbon Sequestration and Conservation Agriculture in Hilly Region

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ABSTRACT: Agriculture acts as both the sink and sources of the greenhouse gases .Conservation agriculture play significant role in soil organic carbon sequestration by increasing soil carbon sinks, reducing GHG emission , and contributing biomass feed stocks for energy use .Adoption of Conservation Agriculture with use of crop residues , mulch and no till farming helps to conserve moisture reduces soil erosion and enhances soil Organic consentration .Sequestering the carbon in the soil plant system through site specific management practice may help to mitigate impact of climate change.

Keywords: Agriculture; Hill Region

Introduction:

The Earth's average surface temperature increased 1.3 degrees Fahrenheit over the past century, and is projected by the Intergovernmental Panel on Climate Change to increase by an additional 3.2 to 7.2 degrees over the 21st century (IPCC, 2007a).Global warming and climate change has entirely threatened the agricultural sectors. Its consequences are much more notable on the hill agriculture due to its topographical feature like steep slope, fragile soil, vulnerability to erosion heavey rainfall etc. Different global and regional climate change models have predicted the range of increase in mean annual global temperature varying from 1.1-6.4^{o}C as reported by the intergovernmental panel on Climate Change (IPCC).Climatic Variability Climatic variability can pose the serious impacts on crop production, occurrence of drought and floods. Three greenhouse gases (GHG5) viz., carbon dioxide, methane and nitrous oxide are responsible/ considered for increasing the atmospheric temperature. In 2005, agriculture accounted for from 10 to 12 percent of total global human caused emissions of greenhouse gases, according the Intergovernmental Panel on Climate Change (IPCC, 2007b).

Fossil fuel consumption, rigorousmanipulation of soil, land use change and deforestation increases the concentration of carbon dioxide while methane and nitrous oxide are evolved mostly due to use of nitrogenous fertilizers, paddy cultivation and livestock. Non-scientific agricultural practices are considered responsible for depletion of soil organic carbon. Use of large quantity of agricultural inputs (seeds, fertilizers, pesticides, groundwater, diesel & electricity) are also directly or indirectly responsible for emission of greenhouses gases. The global atmospheric concentration of carbon dioxide has increased from a pre-industrial value of about 280 ppm to 379 ppm in 2005. Similarly, the global atmospheric concentration of methane and nitrous oxides, other important GHGs, has also increased considerably. Inspite ofthese contributions of greenhouses gases from agriculture, agriculture sector is one of the major sink which can remove the part of the CO_2 fromatmosphere throughphotosynthesis. Agricultural soils play a major role in the global carbon budget because they contain more carbon than the atmosphere and plant biomass combined. Agricultural soils have great potential to sequester far more carbon if properly managed. Conservation tillage, along with efficient management and judicious use of irrigation, fertilizer, and pesticides, may increase soil organic carbon by increasing yields and subsequent organic matter additions to the soil or by decreasing the rate of loss of soil organic carbon.

Management of soil and crop in hill agriculture now and in the future may play the significant role of organiccarbon for sustainable agriculture. Improved package of practices for crop cultivation, soil health improvement and soil moisture conservation may help to enhance the agricultural productivity and restores the environmental health of hill region. The site specific management practices for hill agriculture includes conservation tillage, crop rotation, mulching, low cost soil conservation structures and modern irrigation techniques. Use of low cost bamboo playhouses and gravity drip irrigation system, use of plastic mulching on terrace farming of Sikkim are very economical to increase the productivity of vegetable crops. Use of locally available bamboo and timber are being used for the control of soil erosion and prevention of small rills on the hill slopes.

CO_2Level in atmosphere

Carbon dioxide is mainly responsible for heating the global atmospheric temperature. The concentration was about 280 ppm in 19th century and at present it is 380 ppm and expected to rise by 550 ppm at the end of 21st century.

Carbon is stored on our planet in the following major pools

• Biotic: as organic molecules in living and dead organisms found in the biosphere

• Atmospheric: as the gas carbon dioxide in the atmosphere

• Pedologic: as organic matter

• Geologic: in the lithospheres fossil fuels andsedimentary rock deposits such as limestone, dolomite and chalk

• Oceanic: in the oceans as dissolved atmospheric carbon dioxide and as calcium carbonate shells in marine organisms.

Role of carbon and Carbon Sequestration

Carbon in contact of oxygen forms carbon di-oxide which is a major heat trapping greenhouse gas responsible for global warming. Carbon is found in all living organisms and is the major building block for life on Earth. It is present in many forms, predominately as plant biomass, soil organic matter, and as the gas carbon dioxide. ($C0_2$) in the atmosphere and dissolved in seawater. Carbon sequestration is the long-term storage of carbon in oceans, soils, vegetation (especially forests), and geologic formations. Although oceans store most of the Earth's carbon, soils contain approximately 75 per cent of the carbon pool on land three times more than the amount stored in living plants and animals. Therefore, soils play a major role in maintaining a balanced global carbon cycle.

Process of carbon sequestration in agriculture

Agriculture can play an important role in mitigating the greenhouse gases through in soilscarbon sequestration. Through the process of photosynthesis, plants take in carbon and return some of it to the atmosphere through respiration. The carbon that remains as plant tissue is then consumed by animals or added to the soil as litter when plants die and decompose. The primary way that carbon is stored in the soil is as soil organic matter. It is a complex mixture of carbon compounds, consisting of decomposing plant and animal tissue, microbes (protozoa, nematodes, fungi, and bacteria), and carbon associated with soil minerals. Carbon can remain stored in soils for millennia, or be quickly released back into the atmosphere. Any practice that moves plant material down into the soil extends the period that carbon is sequestered. Agricultural practices can also sequester carbon above ground in the form of woody material. Climatic conditions, natural vegetation, soil texture, and drainage all affect the amount and length of time carbon is stored.

Benefits of carbon sequestration

1. Farm level benefits: Carbon sequestration builds soil fertility, improves soil quality, improves agronomic productivity, protect soil from compaction and nurture soil biodiversity.

2. Off- farm level benefits: it is also helpful in the protection of streams, lakes, and riversfrom sediment, runoff from agricultural fields, and enhanced wildlife habitat. Instead of these major role is in mitigating GHG's emissions.

The U.S. Department of Agriculture released a report in May 2008 that focused on the effects of climate on agriculture, specifically on cropping systems, pasture and grazing lands and animal management (Backlund et al., 2008). The following findings are excerpted from the report with increased carbon dioxide and higher temperatures, the life cycle of grain and oilseed crops will likely progress more rapidly.

Conservation Agriculture:

Conservation Agriculture is a concept for resource-saving agricultural crop production that strives to achieve acceptable profits together with high and sustained production levels while concurrently conserving the environment.

Conservation agriculture definition (FAO)

1. Minimal Soil Disturbance:

Disturbed area must be less than 15 cm wide or 25 per cent of cropped area (whichever is lower). No periodic tillage that disturbs a greater area then aforementioned limits.

2. Soil cover: Ground cover must be more than 30 per cent.

3. Crop rotation: Rotation should involve at least three different crops. However, mono cropping is not an exclusion factor.

Conservation Agriculture (CA) aims

• To conserve, improve and make more efficient use of natural resources
• To integrate the management of available soil, water and biological resources combined with external inputs.
• It contributes to environmental conservation as well as toenhanced and sustained agricultural production.
• It can also be referred to asResource-efficient / resource

Different managementApproaches are suitable for sequestering atmospheric carbon to soil plant system in agriculture. This can be achieved either through maximizing the carbon input or through reducing the carbon loss from the soil. Conservation agricultural and adoption of site specific management practices sequester more carbon in the soil-plant system are listed in Table 1.

Table 1: Various forms of conservation agriculture suitable for hill agriculture are

• Minimum, reduced or no tillage • Erosion control • Irrigation management • Fertility management • Integrated nutrient management (INM) • Integrated pest management (1PM)	• Crop rotation and diversification • Agro-forestry and alley cropping • Contour and terrace farming & strip cropping • Organic and biodynamic farming • Cover and green manure cropping • Mulch cropping

SOURCE; Indian Farmer Digest

Recent reports have investigated the potential of organic agriculture to reduce greenhouse gas emissions (Rodale Institute, 2008). Organic systems of production increase soil organic matter levels through the use of composted animal manures and cover crops.

Generally, conservation farming practices that conserve moisture improve yield potential and reduce erosion and fuel costs also increase soil carbon. Examples of practices that reduce carbon dioxide emissions and increase soil carbon include direct seeding, field windbreaks, rotational grazing, perennial forage crops, reduced summer fallow and proper straw management (Alberta Agriculture and Rural Development, 2000).

Benefits of conservation agriculture:

• Increased soil organic matter and fertility

• increased profitability by reducing costs for soil preparation

• Possibility to have two crops in warmer climates

As Mazza (2007) has remarked, "creating farm and forestry systems with strong incentives

For growing soil carbon could well be at the center of climate stabilization."

Difficulties in adoption of conservation agriculture in hilly region

• Challenging technological changes

• Challenges to manage weeds

• Increased cost for herbicides (at least initially)

• Challenges to update farm machinery

• Difficulty to handle crop residues

Conclusions

Agricultural acts as both the sink and sources of the greenhouse gases. Conservation agriculture play significant role in soil organic carbon sequestration by increasing soil carbon sinks, reducing GHG's emissions, and contributing biomass feed stocks for energy use. Adoption of Conservation Agriculture with use of crop residues, mulch and no till farming helps to conserve moisture reduces soil erosion and enhance soil organic carbon concentration. Rate and amount of soil organic carbon sequestration differ with soil types, depths; land use and land cover and adopted conservation practices greatly from one region to another. Sequestering the carbon in the soil-plant system through site specific management practice may help to mitigate the impact of climate change.

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