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Improved Agricultural Practices to Reduce Greenhouse Gas Emission

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ABSTRACT

Climate change, along with increasing population is a major challenge for food availability, accessibility, security in developing countries. The present day climate is actually the after effect of exploited use of natural resources in the past. Even agriculture sector played a role in it by changing the heterogeneous environment to a manmade homogenous area for crop cultivation. Conservation agricultural practices are developed to reduce the severity of these issues. An attempt is made to understand the concept; through structured literature review to identify the ideas associated. Increase in greenhouse gas emissions resulted in increase in global temperature and decreased fresh water availability. Agriculture practices like burning of litter, anaerobic decomposition of organic matter, rice grown under flooded conditions etc. releases carbon dioxide, methane and nitrous oxides to atmosphere. Cultivation using improved varieties, efficient cropping system, conservation tillage, proper crop residue management, cover crops and increased nutrient use efficiency tends to reduce the effect. Precision farming, use of slow release fertilizers, proper water management in rice fields, substitution of fossil fuels with crop residues, use of dung and energy crops, need specific agro forestry and grazing management practices have a profound effect on reducing greenhouse gas emission. Bio char produced from pyrolysis of plant and animal biomass sequestrates carbon, improves soil fertility, reduces pollution and enhances crop residue recycling. The data collected using CEAP and GRACE net efficiently depicted the long term and positive effects of these conservation measures to mitigate climate change. Proper cultivation practices thus reduces greenhouse gas emitted and it's after effects.

1. Introduction

Agriculture emits greenhouse gases (Cole *et al*., 1997; Paustian *et al*., 2004; IPCC, 2001, Chakravarty *et al*., 2014) into air. Microbial decay and burning of litter emits carbon dioxide (Cole *et al*., 1997; Mosier *et al*., 1998; Desjardins *et al*., 2001, 2005; McCarl and Schneider, 2001; Smith 2004; Lokupitiya and Paustian, 2006; Johnson *et al*., 2007; Verge *et al*., 2007; Smith *et al*., 2008, Cerri *et al*., 2010). Methane is produced from fermentative digestion (Mosier *et al*., 1998). N_2O is emitted due to transformation of nitrogen by microbes (Cole *et al*., 1997; Mosier *et al*., 1998; Desjardins *et al*., 2001, 2005; McCarl and Schneider, 2001; Smith and Conen, 2004; Oenema *et al*., 2005; Lokupitiya and Paustian, 2006; Johnson *et al*., 2007; Verge *et al*., 2007; Smith *et al*., 2008; Cerri *et al*., 2010). In this paper, modern methods are used to make agricultural GHG estimates. Soil acts as an onset and outset for CO_2, with small flux. Improved land manipulation and reinstating abased lands with organic soils mitigate greenhouse gas (GHG) emissions (Sauerbeck, 2001; Dalal *et al*., 2003). Mitigation potential is shown by management of water, agro forestry, livestock and manure. Interchange of fossil fuels for energy fabrication reduces GHG emission (Sauerbeck, 2001; Dalal *et al*., 2003; Chakravarty *et al*., 2014).

2. Reduction Technologies and Exercises

Decreasing GHGs include reducing, enhancing and avoiding emissions (Sauerbeck, 2001; Dalal *et al*., 2003; Chakravarty *et al*., 2014). Irregularity of gas emissions can be decreased by well organised flows of carbon and nitrogen in ecosphere (Sauerbeck, 2001). Adding N efficiently to crops suppress N_2O emission (Sauerbeck, 2001; Dalal *et al*., 2003; Bouwman, 2001). Proper livestock management to use feeds suppress methane made (Clemens & Ahlgrimm, 2001). Proposals to lessen gas releases depend on surroundings (Sauerbeck, 2001; Dalal *et al*., 2003). Agricultural ecosystems reserves carbon as (IPCC, 2001) soil organic matter. We lost 50 Pg carbon (Lal, 1999, 2004a), but recovered through sequestration (Batjes, 1998; Sauerbeck, 2001). Many studies have shown that carbon can be stored (Albrecht and Kandji, 2003; Lal, 2004a). Agricultural areas oxidise methane from airspace (Cole *et al*., 1997; Mosier *et al*., 1998; Desjardins *et al*., 2001, 2005; McCarl and Schneider, 2001; Smith and Conen, 2004; Lokupitiya and Paustian, 2006; Johnson *et al*., 2007; Verge *et al*., 2007; Smith *et al*., 2008; Cerri *et al*., 2010). Crops and residues can be used as fuel (Cannell, 2003; Schneider and McCarl, 2003; Chakravarty *et al*., 2014). Net welfare of bio energy feedstock's to air equals fossil-derived emissions (Sauerbeck, 2001; Dalal *et al*., 2003). Emissions can be avoided by cultivation of new lands (Sauerbeck, 2001; Dalal *et al*., 2003; Foley *et al*., 2005). Net advantage depends on the amalgamated effects on gases (Schils *et al*., 2005). Temporal pattern vary the whole effect (Marland *et al*., 2003a; Six *et al*., 2004).

3. Cropland Management

Agronomic exercises that increase crop provoke higher loads of remnant carbon (Follett, 2001; Chakravarty *et al*., 2014). Using improved varieties, crop successions with perennial crops allocate more carbon and avoid fallows (Cole *et al*., 1997; Mosier *et al*., 1998; Desjardins *et al*., 2001, 2005; McCarl and Schneider, 2001; West and Post, 2002; Lal, 2003, 2004a; Freibauer *et al*., 2004; Lokupitiya and Paustian, 2006; Johnson *et al*., 2007; Verge *et al*., 2007; Smith *et al*., 2008; Burney *et al*., 2010; Cerri *et al*., 2010). Proper nutrient management promotes soil carbon (Schlesinger, 1999; Alvarez, 2005; Gregorich *et al*., 2005). Less intensive cropping systems reduce use of agrichemicals (Paustian *et al*., 2004; Burney *et al*., 2010). Rotations with legumes (Izaurralde *et al*., 2001; West and Post, 2002, Rochette and Janzen, 2005) reduce N inputs. Temporary vegetative cover between crops add carbon to soil (Barthes *et al*., 2004; Freibauer, *et al*., 2004; Burney *et al*., 2010) and extract plant-available N. Nitrogen applied as fertilizers is not used properly (Cassman *et al*., 2003; Galloway *et al*., 2003). Upgrading productivity of nutrients decrease emissions (Schlesinger, 1999; Sauerbeck, 2001; Dalal *et al*., 2003). Application of slow-release forms, urease inhibitors, polymer-coated fertilizers, avoiding time delays, placing N precisely, avoiding excess applications give positive results (Cole *et al*., 1997; Paustian *et al*., 2004; Dalal *et al*., 2003; Monteny *et al*., 2006; Akiyama *et al*., 2009). Minimal tillage or no till practices are better (Cole *et al*., 1997; Cerri *et al*., 2004, 2010). Soil disturbance stimulates soil gas emissions (Cole *et al*., 1997; Mosier *et al*., 1998; Desjardins *et al*., 2001, 2005; Marland *et al*., 2001; McCarl and Schneider, 2001; Sauerbeck, 2001; West and Post, 2002; Cassman *et al*., 2003; Dalal *et al*., 2003; Smith and Conen, 2004; Alvarez, 2005; Gregorich *et al*., 2005; Helgason *et al*., 2005; Ogle *et al*., 2005; Li *et al*., 2005; Lokupitiya and Paustian, 2006; Johnson *et al*., 2007; Verge *et al*., 2007; Smith *et al*., 2008; Cerri *et al*., 2010). Crop residues incorporation, m mechanizing of harvest (Cole *et al*., 1997; Cerri *et al*., 2004) avoids emissions (Sauerbeck, 2001; Dalal *et al*., 2003). Expanding area of cropping using irrigation measures enhance sequestration (Batjes, 1998; Follett, 2001; Sauerbeck, 2001; Lal, 2004a; Millennium Ecosystem Assessment, 2005, Burney *et al*., 2010). Drainage of agricultural lands suppresses emissions (Sauerbeck, 2001; Dalal *et al*., 2003; Reay *et al*., 2003; Monteny *et al*., 2006). Lowland paddy soils release CH_4 (Pathak and Wassmann, 2007). Drainage reduces methane emissions (Cole *et al*., 1997; Yagi *et al*., 1997; Mosier *et al*., 1998; Wassmann *et al*., 2000; Cai *et al*., 2000, 2003; Aulakh *et al*., 2001; Desjardins *et al*., 2001, 2005; McCarl and Schneider, 2001; Sauerbeck, 2001; Kang *et al*., 2002; Dalal *et al*., 2003; Xu *et al*., 2003; Smith and Conen, 2004; Lokupitiya and Paustian, 2006; Johnson *et al*., 2007; Verge *et al*., 2007; Smith *et al*., 2008; Cerri *et al*., 2010). Incorporating organic materials in summer decrease emissions (Sauerbeck, 2001; Dalal *et al*., 2003; Cai and Xu, 2004). Dressing the remnants reduce the gas spill into atmosphere (Wang and Shangguan, 1996; Wassmann *et al*., 2000). Planting trees improves carbon concealment (Batjes, 1998; Sauerbeck, 2001; Guo and Gifford, 2002; Albrecht and Kandji, 2003; Paul *et al*., 2003; Oelbermann *et al*., 2004; Mutuo *et al*., 2005). Encouraging reversion of cropland are effective in this regard (Follett, 2001; Ogle *et al*., 2003; Falloon *et al*., 2004; Freibauer *et al*., 2004; Lal, 2004a). Converting cropland to grassland cause increase of soil carbon and less emissions (Paustian *et al*., 2004; Sauerbeck, 2001; Dalal *et al*., 2003; Chakravarty *et al*., 2014).

4. Pasture Improvement

Grazing lands have areas more than cropped areas (FAOSTAT, 2006), which can be managed effectively. The schedule of pasture growth and grazing influence carbon accumulation in soil (Conant *et al*., 2001, 2005; Conant and Paustian, 2002; Freibauer *et al*., 2004; Reeder *et al*., 2004). Carbon content is higher on grazed areas (Liebig *et al*., 2005). Net effects may vary due to regional differences (Schuman *et al*., 2001; Derner *et al*., 2006). Proper nutrients management improves soil carbon content (Conant *et al*., 2001; Schnabel *et al*., 2001). Irrigation promotes carbon sequestration in soil (Batjes, 1998; Conant *et al*., 2001; Sauerbeck, 2001). Practices to solve nutrient deficiencies reduce gas releases (Follett *et al*., 2001; Sauerbeck, 2001; Dalal *et al*., 2003; Oenema *et al*., 2005). Drainage in organic soils declines emission so that the in situ organic carbon is preserved as such (Kasimir-Klemedtsson *et al*., 1997; Sauerbeck, 2001; Dalal *et al*., 2003). Refurbishment of degraded areas improves carbon pool in soil and reduces emission (Paustian *et al*., 2004; Batjes, 1999; Bruce *et al*., 1999; Lal, 2001, 2003, 2004b; Sauerbeck, 2001; Olsson and Ardo, 2002; Dalal *et al*., 2003; Foley *et al*., 2005).

5. Livestock and Manure Management

Ruminants are sources of CH_4, with 18 per cent of global emissions (Murray *et al*., 1976; Kennedy and Milligan, 1978; Crutzen, 1995; Dalal *et al*., 2003; US-EPA, 2006; Chakravarty *et al*., 2014). CH_4 emissions can be decreased by providing concentrates (Blaxter and Clapperton, 1965; Johnson and Johnson, 1995; Dalal *et al*., 2003; Lovett *et al*., 2003; Beauchemin and McGinn, 2005). Oils in food (Machmulller *et al*., 2000; Kulling *et al*., 2003; Jordan *et al*., 2004); improving pasture quality (Leng, 1991; McCrabb *et al*., 1998; Alcock and Hegarty, 2005) and proper protein intake reduces emissions (Sauerbeck, 2001; Dalal *et al*., 2003; Clark *et al*., 2005). Including ionophores (Benz and Johnson, 1982; Rumpler *et al*., 1986; Van Nevel and Demeyer, 1995; McGinn *et al*., 2004); anti methanobacter halogenates (Wolin *et al*., 1964; Van Nevel and Demeyer, 1995); probiotics (McGinn *et al*., 2004); propionate precursors (Newbold *et al*., 2002, 2005) in diet reduces emissions (Sauerbeck, 2001; Dalal *et al*., 2003). Emissions are decreased in cool stored (Paustian *et al*., 2004; Clemens and Ahlgrimm, 2001; Sauerbeck, 2001; Dalal *et al*., 2003; Monteny *et al*., 2001, 2006; Chadwick; 2005) and anaerobically digested manure (Clemens and Ahlgrimm 2001; Pattey *et al*., 2005, Clemens *et al*., 2006). Using manures in solid form prevents CH_4 emissions (Paustian *et al*., 2004; Sauerbeck, 2001; Dalal *et al*., 2003). Animals excrete in field which cause less emissions as it get dried quickly (Gonzalez-Avalos and Ruiz-Suarez, 2001; Sauerbeck, 2001; Dalal *et al*., 2003; Chakravarty *et al*., 2014).

6. Conclusion

Opportunities for GHG mitigation can be achieved by surpassing the hardships. We have to improve the existing ways to mitigate green house gases through land based agricultural practises without compromising the food production (Cole *et al*., 1997; Mosier *et al*., 1998; Desjardins *et al*., 2001, 2005; McCarl and Schneider, 2001; Lokupitiya and Paustian, 2006; Johnson *et al*., 2007; Verge *et al*., 2007; Smith *et al*., 2008; Cerri *et al*., 2010; Smith, 2013; Chakravarty *et al*., 2014) and economic prosperity of farmer (McCarl, 2000).

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