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Increasing soil organic carbon and enhancing soil moisture holding capacity through tank silt application to adapt climate change

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Abstract
Climate change pose serious negative impact on farming communities in India in the form of variations in seasonal rainfall and rainy days. The drastic reduction of organic carbon in the soil due to over use of inorganic fertilizer and top soil erosion in rainfed lands highly challenging the farmers to ensure crop productivity hence the soil moisture holding capacity reduced at alarming level. The change in the onset of monsoon and increased dry spell resulted drying of early stage crops in dryland rainfed farming. Farmers have no other option than farming resowing the seeds with increased cost of cultivation due to less moisture in the soil. To enhance the organic carbon content and soil moisture retention capacity an action research has been undertaken in semi-arid tropics with the support of GIZ in Madurai district. Indigenous practice of tank silt with combination of goat/sheep penning were applied. It increases the moisture holding capacity of the soil. Over all, this intervention increased the physical and chemical properties of soil in the treatment plots compare with control and water storage capacity in the traditional water bodies (tank).

Keywords: Tank silt, climate change, dry spell, organic carbon, moisture holding capacity

1. Introduction

Climate change is a reality in many parts of the globe and it posing serious negative impact on farming communities in India in the form of variations in seasonal rainfall and rainy days. Especially, rainfed lands are facing challenges like season change (*pattam mattram)* and increased dry spell could not provide adequate moisture for crops resulted crop failure and re-sowing of crops. The continued increased use of chemical fertilizers on land resulted changed the soil physical and chemical properties and made it hardening of top soil. As a result of this the soil not able to absorb rain water to its full capacity, in-turn the water runoff eroded the top soil. The reduction of soil organic matter and moisture holding capacity increased the risk of small and marginal farming communities and increased the cost of cultivation. This leads the farmers to avoid cultivation of their land and reduced the employment through farming, food and nutritional insecurity in the villages.

2. Study area

To address the soil moisture holding due to climate change a demonstration were conducted in T.Kallupatti (77.89^0 E longitude and 9.75^0 N latitude) block of Madurai district, Tamil Nadu. Where soil type of the land is broadly classified by the local communities are *"pottal"* (clay with less moisture holding and fertility) and "*karisal"* (black cotton soil with high moisture holding capacity and good fertility). 55 percent of the agriculture lands soil type is *pottal* is weakness for their cultivation and it requires more input cost

for the crop cultivation. The effect of climate change join with the non-climatic factors of soil management significantly reduced the soil moisture holding capacity, which is crucial factor of crop success in rainfed dry lands. Indigenous practice of application of tank silt @ 50 Cubic Metre per acre with combination of goat/sheep penning were applied. Tank silt has significant amount of organic carbon (0.89), 50 Cubic meter of tank silt changed the organic carbon content of soil ranges from 0.03 to 0.40.

3. Tank silt application – Adaptation to climate change

Tank silt is a fine soil runs through runoff during rainfall from catchment area along with dried leaves, crop debris deposited as sediment in the tank water spread area and decomposed over a period time. This process enriches the soil organic content. Upto 2-3 feet sediment (tank silt) excavated and transported to agricultural field and spread in the filed and incorporated during ploughing practice is called tank silt application.

- Excavated tank silt of 50 Cubic metres (25 tractor tipper load) was applied to rainfed farm lands. Tank silt was applied to agriculture fields for 105 farmers in 104 acres.

- The tank silt was applied to the lands to change the physical characteristics of soil and nutrient enhancement too. Out of 31 samples studied, 6 samples were detailed analyzed for five times to see the changes like pH, Electrical Conductivity, Organic carbon.

- Tank silt was primarily applied to the *pottal* lands (73 acres for 74 farmers) which have low water holding capacity and saline nature and *Karisal (*31 acres for 31 farmers).

- Through this tank silt excavation 5200 Cu.M of additional water storage is created in Kilankulam tank. The pits are filled in the first rain and this storage acts as a dead storage and useful for the livestock and ground water recharge.

Pilot project implemented period has consecutive drought. The average annual rainfall of T.Kallupatti block is 806 mm. Analysis of long term rainfall data (1901-2004) shows that the district receives rainfall during NE monsoon (47%), SW monsoon (32%), summer (17%) and winter (4%). Out of the total rainfall, July to Sep month rainfall decides the farming because of rainfed farming. Generally during these period 258 mm rainfall received and it is highly sufficient for carry out all agriculture activities. But in the study period, pilot project area received 128 mm (15.9 %) and 94.5 mm (11.72 %) against the normal annual rainfall in the year 2012 and 2013 respectively.

Temperature

High temperature experienced only in the months of April, May and June. Now the high temperature is continuing upto August month. Also the temperature increased one to two degrees more compare with last 40 years. (Maximum 42 degree Celsius). Increased hot weather on crops requires more wetting/moisture to complete the crop cycle otherwise the crop is damaged (crop yield decrease or total crop failure)

The variation in the Southwest monsoon is 18.20% for 2013 and 2014. It clearly shows that climate is changed in rainfall aspects. Over all gap in the rainfall for year 2012 is 396 mm (49.13 %) and for 2013 is 313.40 mm (38.88 %). With this deficit rainfall the farmers have carried out their rainfed agriculture. It is very good opportunity to see the adaptation activities performance in the field.

4. Results of the action research

Table-1 Multiple uses of tank silt application		
Water storage	Nutrient cost	Adaptation
50,000 litres in tank	Nitrogen - INR.71	Physical properties of soil positively changed
Increase moisture holding capacity	Phosphorous - INR.32.50	Change of pH 0.5 to 1.0
Increased rate of ground water recharge	Potash –INR. 324	Reduction and control of GHG emission by not using inorganic fertilizer
	INR..427.50	

4.1 Tank silt application and organic carbon availability of soil

Tank silt has significant amount of organic carbon (0.89), 50 Cubic meter of tank silt changed the organic carbon content of soil ranges from 0.03 to 0.40. It increases the moisture holding capacity of the soil.

Table-2 . Soil organic carbon analysis

After	Before	Change
0.69	0.29	0.4
0.37	0.34	0.03
0.36	0.27	0.09
0.31	0.2	0.11
0.29	0.13	0.16
0.31	0.19	0.12

4.2 Tank silt application on soil Electrical Conductivity

It increases the moisture holding capacity of the soil. The field continuously irrigated by using ground water having salinity and excess use of inorganic fertilizer leads to increase in EC value of soil. Application of tank silt has resulted in reduction of EC in all agriculture fields. The reduction of EC ranges from 0.02 to 1.21. The yield of crops increased to 50 to 60 percentage in the deficit rainfall season compare with normal yield.

4.3 Tank silt application effect on crop yield

Table 3 - Tank silt application effect on crop yield

Crop	Control	Normal	Treatment	Increase of yield compare with normal %
Barnyard millet	100	700	1400	200
Maize	909	1400	1067	76
Paddy	2448	2880	3500	122
Pearl millet	328	600	417	70
Cotton	70	350	222	63
Chilly	100	650	625	96

5. Conclusions

- Tank silt application is a cost effective adaptation technique to climate change and environmental friendly having multiple benefits
- Government has to analyze silt and declare tank wise nutrient status and potential tanks for tank silt application for farm lands
- Tank silt to be considered as a substitute for the chemical fertilizer and subsidy given to fertilizers need to be allocated for tank de-silting and recycling of nutrients to farm lands.
- Traditional wisdom of farmers should be documented and scientifically evaluated and recommended for policy at state and national level.