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Recycling of tank silt for improving soil health and crop productivity in Telangana

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ABSTRACT

The present study was conducted to investigate the effect of tank silt application on soil health, soil texture and productivity of the crops in Warangal and Khammam districts of Telangana state in southern India. Tank silt was applied to the agricultural fields during desiltation of tanks. The soil samples and other data were collected separately from the fields with and without silt application during 2018-19. These soil samples were analysed for EC, pH, OC, N, P, K and soil texture. Hydrometer method was used for analysing the percentage of sand, silt and clay in the inorganic fraction of soil. The crop productivity data of paddy, cotton and chillies for both *kharif* and *rabi* seasons were collected from crop cutting experiments in 208-19. The Electrical conductivity (EC) and pH of silt applied fields decreased upto 15.91% and 1.19% respectively. The organic carbon (OC), nitrogen (N), phosphorous (P) and potassium (K) of a soil increased upto 10.13%, 41.38%, 76.58% and 46.70% in silt applied fields respectively. The percentage of sand decreased from 44.83 to 32.03 and clay increased from 38.93 to 51.87 in silt applied fields. The crop productivity increased upto 30-36% in Paddy, Cotton and Chillies. Therefore the EC, pH and percentage of sand of a soil decreased in silt applied fields due to the application of silt; OC, N, P, K, percentage of silt and clay increased due to application of silt, as it has high porous, fertile and biological materials in it. This study concluded that the tank silt application helped in improving the soil health and storage capacity of the tanks. The groundwater levels also increased after tank desiltation works thereby increasing the cultural command area and crop productivity.

1. INTRODUCTION

The rainfed regions of Telangana are characterized by aberrant behaviour of monsoon rainfall, eroded and degraded soils with water and nutrient deficiencies, declining ground water table and poor resource base of the farmers. The runoff generated from cultivable lands in rainfed areas that get merged at different places, becomes concentrated and passes through natural channels or drains at greater velocity (Rao *et al.,* 2015). The major constraint is low and unstable yields in rainfed areas with large yield gap. In addition to these, climate variability including extreme weather events resulting from global climate change poses serious threat to rainfed agriculture. Rainwater harvesting both *in-situ* and *ex-situ* is the panacea for mitigating the constraints of rainfed farming.

Community tank systems were used for rural livelihoods *i.e.* drinking, irrigation and other household use etc. from several centuries in India. The tanks are mainly depends on the monsoon rainfall only and are filled with the runoff water from the catchment. The runoff contains a large amount of silt from the agricultural fields. These sediments are deposited in the water ponds / tanks and cause eutrophication of the ponds, reduce the storage capacity of the tanks and ground water recharge and also reduce the crop productivity. The grass based bio filters are able to reduce the sedimentation of downstream water bodies (Rao *et al.,* 2015, 2022). Desilting of tanks and application of silt to agricultural fields increases the soil health which helps in increasing the crop growth and productivity (Sharma *et al.* 2015) and also increasing storage capacity and groundwater recharge. Silting of tanks is caused by the lack of catchment treatment techniques. The restoration and rejuvenation are being taken through renewed efforts of desilting and recycling like in "*Mission Kakatiya*" of Telangana state, Sujala-III in Karnataka and National Project for Repair, Renovation and Restoration of Water Bodies (RRR) of Ministry of Water Resources, Government of India (Osman *et al.,* 2001). Very few studies are conducted on tank silt application, desilting of tanks etc. However a detailed study on impact of desiltation of ponds needs to be studied for enhancing the soil health with application of tank silt.

2. MATERIALS AND METHODS

Study Area

The study areas were located in Warangal, and Khammam districts of Telangana state, southern India. Total eight tanks were selected from the two districts namely Oora Kunta, Sammayya Kunta, Venkatadri Kunta, Yellayya Kunta, Aamudala Cheruvu, Thalla Kunta, Gaddi Kunta and Parashuram Kunta. The normal annual rainfall of this zone is 800-1150 mm. The minimum and maximum temperatures of Warangal and Khammam are about 21-25°C and 22-37°C. The most predominant soils are black (Vertisols) in Warangal and black & red (Alfisols and Vertisols) in Khammam. Cotton, rice, maize, green gram and mango are important cultivated crops in this area. There are two cropping seasons in the area *viz., kharif* season (Monsoon season: July to October) and *rabi* season (Irrigation season: November to April). *kharif* season receives major portion of annual rainfall with occasional long dry spell and *rabi* season gets scanty rainfall causing heavy demand for irrigation water. The locations of the tanks were mentioned in the Fig. 1.

Methodology

Based on the availability of the data, eight desilted tanks were selected randomly. The data on various parameters of soil health, soil texture and crop productivity were collected separately from the selected fields with silt application and control fields (without silt application). The details are mentioned below:

Soil health

The desiltation of tank works was taken up under the scheme *Mission Kakatiya* during 2014-18 for restoring all the minor irrigation tanks and lakes in Telangana state, India. The silt was applied to the agricultural fields during and after completion of the desiltation works in the summer season (March-June). The soil samples were collected from both fields with silt application and without silt applications from a depth of 15-30 cm under each tank during 2018-19. Soil health is evaluated by electrical conductivity (EC), pH, nitrogen (N), phosphorous (P) and potassium (K) contents of soil present in it.

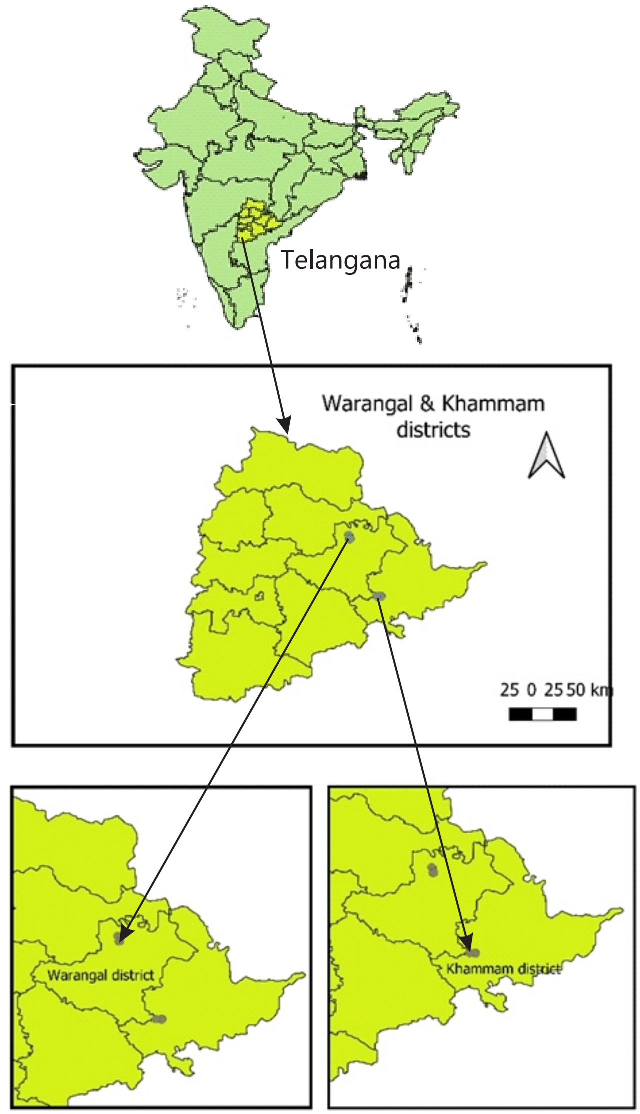


Fig. 1. Location map of the study area

The EC of the soil was measured by using a standard conductivity meter. The pH was measured using a standard pH meter. OC present in the soil was estimated by using Walkley and Black method. The available nitrogen present in soil was determined by using Kjeldahl assembly. The available phosphorous presents in soil is done by using a Spectrometer. The amount of potassium available in soil was done by using a flame photometer, mechanical shaker and pH meter.

Soil texture

Tank silt was applied to the agricultural fields @ 50-150 loads of tractor trailer per hectare based on size of the land. For conducting the soil texture analysis, the soil samples were collected from both fields with silt application and without silt applications from a depth of 0-30 cm. Total 10 soil samples were collected under each tank. In each 5 soil samples were collected from silt applied fields and remaining from fields in which silt was not applied. Hydrometer method was used for analysing the percentage of sand, silt and clay in the inorganic fraction of soil.

Crop productivity

The crop yield data of paddy, cotton and chillies grown in silt applied fields and control fields were obtained from crop cutting experiments with help of Agricultural officials for both *kharif* and *rabi* seasons. Fields were selected randomly for conducting crop cutting experiments. These crop cutting experiments were done for recording yield under unit area 10 m × 10 m for paddy, cotton and chillies crops. The yield data were converted into kg per hectare.

Statistical analysis

Statistical analysis was done for EC, pH, OC, N, P, K, percentage of sand, silt and clay and crop productivity of paddy, cotton and chillies by using t test and means were compared at 0.05 probability level.

3. RESULTS AND DISCUSSION

The effect of tank silt application on soil health, soil texture and crop productivity is presented below:

I. Effect of Tank Silt Application on Soil Health

(I) Electrical Conductivity (EC)

The EC of a soil having a normal value ranges from 0.15 to 0.93 millimhos cm^{-1}. From Fig. 2, the highest EC of a soil was recorded at Venkatadri Kunta (0.65 millimhos cm^{-1}) and lowest value was recorded at Gaddi Kunta (0.24 millimhos cm^{-1}) in non-silt applied fields. Whereas, the highest value is observed at Yellayya Kunta (0.48 millimhos cm^{-1}) and lowest at Thalla Kunta (0.17 millimhos cm^{-1}) in silt applied fields. From Table 1, the EC of a soil has decreased from 0.44 millimhos cm^{-1} to 0.37 millimhos cm^{-1} (15.91%) in silt applied fields compared with non-silt applied fields. Therefore, the EC of a soil was decreased in silt applied fields due to the application of silt.

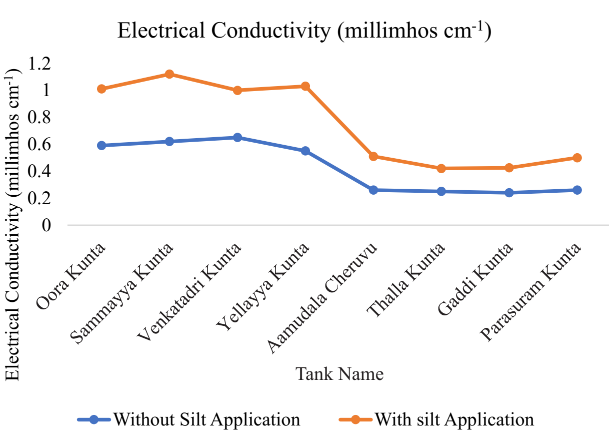


Fig. 2. Effect of tank silt application on electrical conductivity

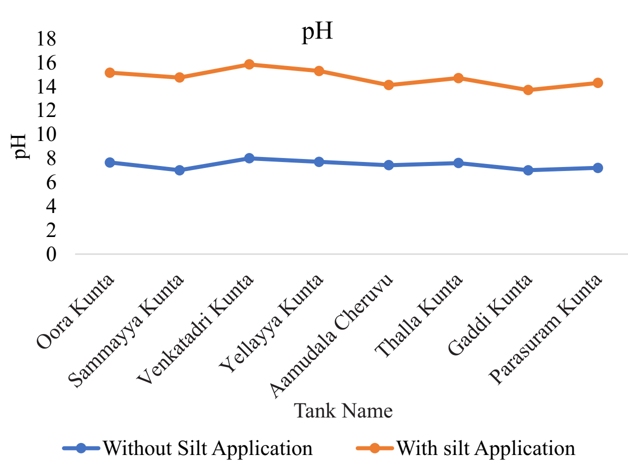
(ii) pH

The pH of a soil having slightly alkaline to moderately alkaline ranges from 6.22 to 8.3. From Fig. 3, the highest pH of a soil was recorded at Venkatadri Kunta (7.85 and 8.0) in silt applied and control fields respectively. The lowest value was recorded at Sammayya Kunta and Gaddi Kunta (7.0) in control fields. Whereas the lowest was observed at Aamudala Cheruvu and Gaddi Kunta (6.7) in silt applied fields. From Table 1, the pH has decreased from 7.52 to 7.43 (1.19%) in silt applied fields compared with control fields. The pH also decreased in silt applied fields due to application of silt.

Table: 1
Effect of tank silt application on soil health, soil texture and crop productivity

S.No	Parameter	With silt	Without silt
1.	Soil health		
	EC (millimhos cm^{-1})	0.37(18.92)*	0.44
	pH	7.43(1.21)*	7.52
	Organic carbon (%)	0.87(10.23)*	0.79
	Nitrogen (kg ha^{-1})	0.41(41.38)*	0.29
	Phosphorus (kg ha^{-1})	70.63(76.58)*	40.00
	Potassium (kg ha^{-1})	194.38(46.69)*	132.50
2.	Soil texture		
	% Sand	32.03(39.96)*	44.83
	% Silt	16.10(4.34)*	15.43
	% Clay	51.87(33.07)*	38.98
3.	Crop productivity (kg ha^{-1})		
	Paddy	6540(36.25)*	4800
	Cotton	3190(30.20)*	2450
	Chilly	4489(30.57)*	3438

**Means based on't' test at 0.05 probability level; There is a significant difference in soil with silt application and without silt application; Values in parenthesis indicates % of increase or decrease over controlled fields.*



Note: Oora Kunta, Sammayya Kunta, Venkatadri Kunta and Yellayya Kunta located in Warangal district; and Aamudala Cheruvu, Thalla Kunta, Gaddi Kunta and Parasuram Kunta located in Khammam district of Telangana

Fig. 3. Effect of tank silt application on pH

(iii) Organic Carbon (OC)

The OC of a soil having low to high values ranges from 0.25% to 1.44%. From Fig. 4, the highest OC of a soil is recorded at Sammayya Kunta (1.16 and 1.05%) both in silt applied and control fields. The lowest value was recorded at Venkatadri Kunta (0.65%) in with out silt and Thalla Kunta and Gaddi Kunta (0.75%) with silt application. From Table 1, the OC has increased from 0.79% to 0.87% (10.13%) with silt application compared to control fields. Therefore the OC has increased due to application of silt, as it has a high porous and biological materials in it.

(iv) Nitrogen (N)

The nitrogen (N) of a soil having very low to high values ranges from 0.96 to 3.56 kg ha^{-1}. From Fig. 5, the highest Nitrogen of a soil was recorded at Venkatadri Kunta and Gaddi Kunta (0.35 kg ha^{-1}) and lowest value was recorded at Oora Kunta (0.2 kg ha^{-1}) in non-silt applied fields. Whereas the highest value was observed at Venkatadri Kunta and Aamudala Cheruvu (0.5 kg ha^{-1}) and the lowest value was observed at Sammayya Kunta (0.3 kg ha^{-1}) in silt applied fields. From Table1, the N has increased from 0.29 kg ha^{-1} to 0.41 kg ha^{-1} (41.38%) in silt applied fields compared with control fields. Therefore, the N of a soil has increased due to application of silt, as it contains more fertile materials in it.

(v) Phosphorous (P)

The P of a soil is having low to high values ranging from 22.24 to 378.07 kg ha^{-1}. From Fig. 6, the highest P of a soil is recorded at Yellayya Kunta (60 kg ha^{-1}) and lowest value recorded at Parasuram Kunta (25 kg ha^{-1}) in silt not applied fields. Whereas the highest value is observed at Oora Kunta (140 kg ha^{-1}) and lowest at Aamudala Cheruvu and Gaddi Kunta (35 kg ha^{-1}) in silt applied fields. From Table 1, the P of a soil is increased from 40 to 70.63 kg ha^{-1} (76.58%) in silt applied fields compared with silt not applied fields due to application of tank silt.

(vi) Potassium (K)

The K of a soil having low to high values ranges from 95.14 to 896.99 kg ha^{-1}. From Fig. 7, the highest K of a soil was recorded at Aamudala Cheruvu (230 kg ha^{-1}) and lowest value was recorded at Gaddi Kunta (60 kg ha^{-1}) in non-silt applied fields. Whereas the highest value was observed at Oora Kunta (280 kg ha^{-1}) and lowest at Parasuram Kunta (110 kg ha^{-1}) in silt applied fields. From Table 1, the K of a soil has increased from 132.50 to 194.38 kg ha^{-1} (46.70%) in silt applied fields compared with Non-silt applied fields due to application of silt.

From the Table 1, EC and pH of a soil has decreased; whereas the OC, N, P and K have increased due to the application of silt in agricultural fields. These parameters were statistically significant (Table 1). Similar results were

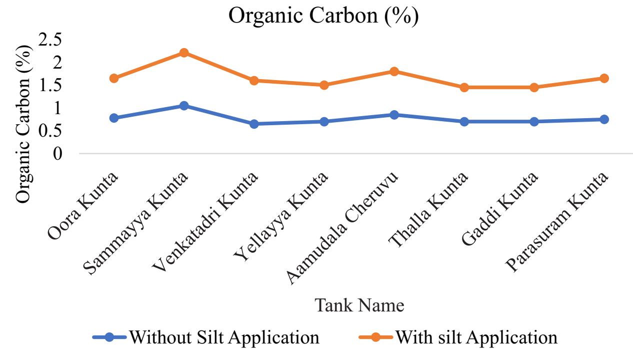


Fig. 4. Effect of tank silt application on organic carbon

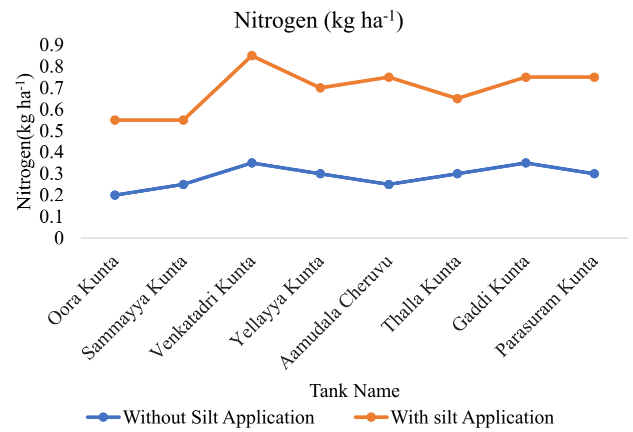


Fig. 5. Effect of tank silt application on nitrogen

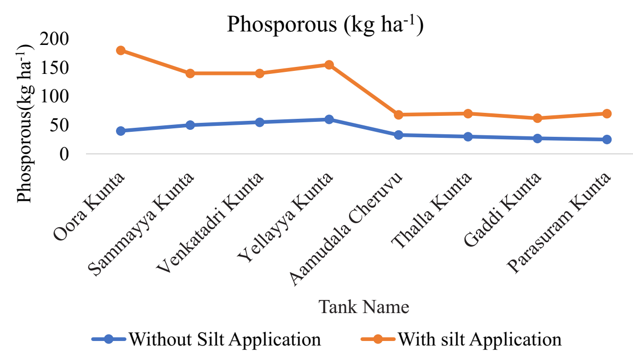


Fig. 6. Effect of tank silt application on phosporous

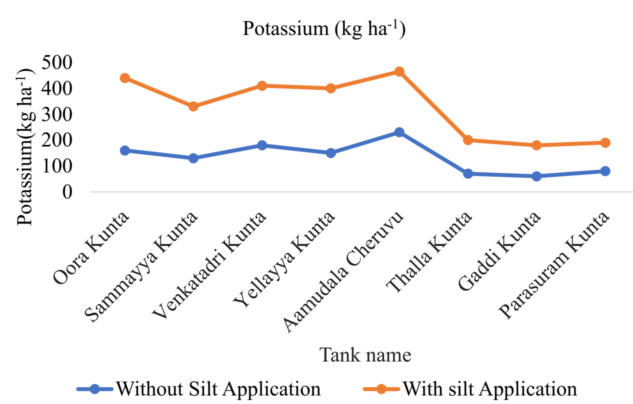


Fig. 7. Effect of tank silt application on potassium

also reported by Sankalpa and Kadalli (2018); Ramachandrappa *et al.,* (2015); Theresa *et al.,* (2016); Sharma *et al.* (2015) etc.

II. Effect of Tank Silt Application on Soil Texture

The textural analysis was done for randomly collected samples. From Fig. 8, it is shown that the percentage of sand was less in silt applied fields (32.03%) than the control applied fields (44.83%). The percentage of silt and clay was more in silt applied fields (16.1& 51.87%) than the control fields (15.43 and 38.93%). The textural parameters statistically significant (Table 1).

III. Effect of Tank Silt Application on Crop Productivity

The results revealed that the yield has increased from 4800 kg ha^{-1} to 6540 kg ha^{-1} (36.25%) in paddy; 2450 kg ha^{-1} to 3190 kg ha^{-1} (30.20%) in cotton and 3438 kg ha^{-1} to 4489 kg ha^{-1} (30.57%) in chillies in silt applied fields compared with fields without silt application shown in Fig. 9 and these were statistically significant at 5 percent probability level (Table 1). The crop productivity of paddy, cotton and chillies has increased after silt application in agricultural fields compared with control fields both in Warangal and Khammam districts due to application of silt, which increased the soil health (*i.e.* OC, N, P and K), available water content, moisture retention capacity of soil and also an increase in the number of irrigations to the crop by recharging of wells due to the desiltation of tanks under the command area of the tanks. Similar results were also reported by Paul and Panigrahi (2017); Vaidya and Dhawan (2015); Osman *et al.* (2015); Sharma *et al.* (2015); Deivalatha *et al.* (2014); Bhanavase *et al.* (2011); Ram and Singh (2009); Ranade *et al.*(2002); Gireesh *et al.* (1997) and Babu *et al.* (1996).

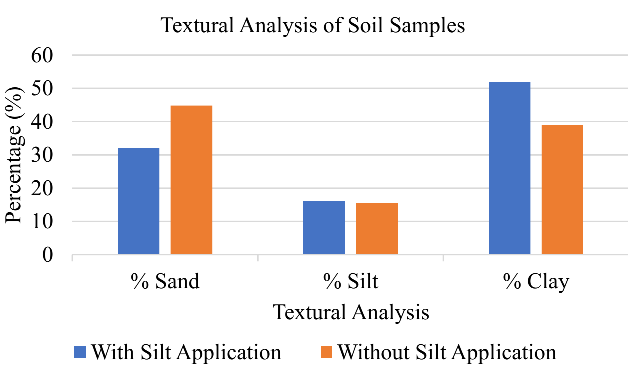


Fig. 8. Effect of tank silt application on textural class

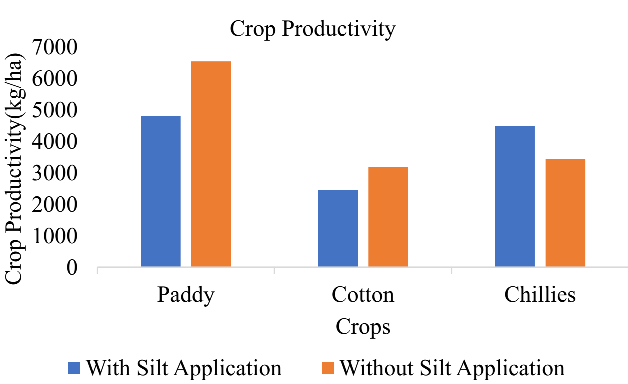


Fig. 9. Effect of tank silt application on crop productivity

4. CONCLUSIONS

The EC and pH of a soil has decreased from 0.44 millimhos cm^{-1} to 0.37 millimhos cm^{-1} (15.91%); 7.52 to 7.43 (1.19%) in silt applied fields, respectively. The OC, N, P and K of a soil has increased from 0.79% to 0.87% (10.13%); 0.29 kg ha^{-1} to 0.41 kg ha^{-1} (41.38%); 40 kg ha^{-1} to 70.63 kg ha^{-1} (76.58%) and 132.50 kg ha^{-1}to 194.38 kg ha^{-1} (46.70%) in silt applied fields, respectively. The percentage of sand has also decreased from 44.83 to 32.03 in silt applied fields; percentage of silt has increased from 15.43 to 16.1% and the percentage of clay has increased from 38.93 to 51.87% in silt applied fields. The yield has increased from 4800 kg ha^{-1} to 6540 kg ha^{-1} (36.25%) in paddy; 2450 kg ha^{-1} to 3190 kg ha^{-1} (30.20%) in cotton and 3438 kg ha^{-1} to 4489 kg ha^{-1} (30.57%) in chillies in fields with silt application compared without silt application. It was concluded that the tank silt application helped in changing the physical and chemical properties of the soil; also desiltation of tanks enhanced the storage capacity of the tanks and groundwater levels thereby increased the cultural command area and crop productivity.

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