

Original Research Article

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Crop Productivity Enhancement through Improved Technologies in North- South Transact of Bengaluru

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ABSTRACT

The crop productivity has been reached to the stagnation and there is no increase in the yield even at higher doses of fertilizers. The need of pacing up with the increase food demand with crop production is urgent for countries like India. To achieve this more focus is needed over the transition zone production system. In Bangalore north and south transact are at dynamic state in terms of production system and can be categorised as rural, urban and transition zone. The survey has been conducted in these areas regarding the present crop production practices and found unscientific practices were followed by the farmers and were convinced to follow the recommended practices of crop production. Total of 60 farmers have been selected who were growing finger millet, maize, field bean, tomato and brinjal, in both north and south transact villages and were availed the accurate amount of seeds of particular crops. They had adopted the scientific practices like timely sowing, weeding, fertilizers application, intercultural operations, efficient irrigation methods like drip irrigation and finally timely harvesting. The soil samples from the selected farmer's field have been collected and analysed and based upon the soil test results, fertilizers were weighed and distributed to each of the farmers to apply in time. The yield of the selected crops has recorded and found increase in yield in each of the selected crops compared to the control field. The increment of 6.85 to 20.83 per cent compared to control was observed in finger millet, 3.2 to 21.2 per cent hike was observed in maize crop, 9.1 to 17.5 in field bean and 18.5 % increment in brinjal crop have been observed in north transact. Similarly, in south transact the increment observed is 9.1 to 25.71 % in finger millet, 10 to 17.6 % in field bean, 8.33 to 13.16 in maize, 8.9 % increment in tomato and 10 -11% in brinjal have been observed. Thus, adoption of scientific process of cultivation and application of fertilizers based upon the soil testing results increment in the yield of the crops.

Keywords

Crop productivity,
Finger millet,
Timely sowing,
Weeding, Fertilizers
application

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Introduction

India's current population is 136.87 crores (Yearly change of 1.08 %). India is second most populated country in the world which is expected to overshoot China by 2021.

Bangalore comprises 12.34 million population. The rural-urban interface is increasingly gaining importance in many cities around the world, but particularly in African and Asian countries, where it contributes significantly to food and fodder

provision, job creation and other ecosystem services. In 2004–2005, the demand for cereals was 193×10^6 t, while in 2020–2021, the projected demand will be 262×10^6 t (Chand, 2007). To address the increased demand for food, agricultural programmes have doubled grain yields in irrigated land from 1.1 t ha^{-1} in 1960 to 2.5 t ha^{-1} in 2010. According to the Food and Agriculture Organization (FAO), urban and peri-urban farming supply food to 700 million city dwellers – about one quarter of the world’s urban population (Marcotullio *et al.*, 2008). Recent surveys indicate that urbanization almost inevitably triggers a rise in input intensity, changes towards new plant varieties with higher yield potential and harvest index and a move from subsistence crops (staple) to higher value vegetables for targeted consumer markets in order to use land and water more efficiently. Evidence also suggests that the opportunities to access profitable marketing channels depend on the level of education, technical knowledge / skills, and innovation of smallholder farmers. Soil fertility is a complex quality of soils that is closest to plant nutrient management. It is the component of overall soil productivity that deals with its available nutrient status, and its ability to provide nutrients out of its own reserves and through external applications for crop production. It combines several soil properties (biological, chemical and physical), all of which affect directly or indirectly nutrient dynamics and availability. Soil fertility quality is most commonly defined in terms of the ability of a soil to supply nutrients to crops (Watson *et al.*, 2002), and it has been drastically affected by human activities (Bi *et al.*, 2009; Huang *et al.*, 2007; Jiang *et al.*, 2006). Research indicated that soil fertility can be improved by appropriate agricultural practices such as tillage (Hussain *et al.*, 1999; Kong *et al.*, 2006), fertilizer application (Guo *et al.*, 2010), incorporation of crop residues into soil (Bi *et al.*, 2009)

Conversely, inappropriate human activities such as imbalanced inorganic fertilizer application negatively affect soil fertility, which in turn, can influence the sustainability of agricultural systems (Stamatiadis *et al.*, 1999; Vitousek *et al.*, 2009). It was estimated that 40 % of agricultural lands were affected by human induced land degradation (Oldeman *et al.*, 1990).

The production efficiency and total yield of the crops have been reduced or stagnated even after the application of chemical fertilizer in tremendous amount under the intensive agriculture in recent years (Yadav and Meena, 2009). Keeping these points in view, the present study was conducted in North and South transect of Bengaluru during 2016-17 and 2017-18. Keeping these points in view, the present study was conducted in North & South transect of bengaluru during 2016-2017 & 2017-2018.

Materials and Methods

Study area

The present study had been conducted in the north and south transect of Bengaluru. Several villages have been selected for preliminary survey and further selection of farmers has been done based upon the crop production system. In North (Kodihalli, Gandarajapura, Karanalu, Kachehalli, Rajaghatta, T. Hoshalli, Thimmasandra, and Kudaregere) and South (Gulikamale, Taralu, Hosagabbadi, Halegabbadi and Kaggalahalli) and categorised into rural, urban and transition area (Fig. 1).

Crop and cropping pattern identification

A basic survey have been conducted in both transects for the identification of present cropping system and cultivation practices adopted by the farmers through questionnaire

in 120 farmers representing urban, rural and transition. Among the crops Finger millet was found to have highest coverage in area followed by tomato, maize and pigeon pea while in fruit crops grapes occupied more area followed by flowers in north (Table 1 and 2). In south transact mango cultivation was highest followed by guava and finger millet crops. The lowest area coverage was by pigeon pea which account to 0.31 ha.

Collection of soil samples

Soil samples (0-15 cm) were collected at each of selected 60 farmers' field before and after the harvesting of crops during 2016-2017 and 2017-2018 which were geotagged.

Analysis of soil samples

The collected soil samples were air dried and processed for further analysis. These samples after processing were analysed for available nutrient content by standard analytical techniques. The pH and electrical conductivity of soil samples were determined following the method of Jackson (1973). The soil solution ratio 1:2.5 were selected and pH and EC were estimated.

Available nitrogen was analyzed by potassium permanganate method of Subbiah and Asija (1956). Available phosphorus, available potassium, were determined as per the standard procedures (Olsen *et al.*, 1954 and Bray's methods, Jackson, 1973). Available micronutrients (Fe, Zn, Cu, Mn) from the samples were estimated using the AAS by following the protocol of Lindsay and Norvell (1978).

Fertilizer recommendation

Based on the soil test results of the farmers field fertilizers were recommended and fertilizers were weighed and distributed to the farmers after calculation.

Results and Discussion

Soil chemical parameters

The pH of the soil in north transact varied from 5.27 – 7.72 among the selected 31 farmers in the same region from different villages as well as having different cropping system. Similarly, under south transact the pH of the soil varied from 5.35- 8.13 through different selected villages and 29 selected farmers. The soil in north transact is acidic to slightly alkaline while in south transact it also consist more alkaline soil. The EC of south transact varied from 0.007-0.30 ds/m while in north transact it varied from 0.007-0.41 ds/m among the different farmer's field (Table 4 and 5). The low pH of the soil is due the acidic parent material and the tendency of pH towards slightly basic nature might be due to use of basic fertilizers as supported by Ram *et al.*, 1999.

Available nutrients

Available nitrogen was low to medium (103.1-376.0 kg/ha), available phosphorus low to high (13-217 kg/ha) and available potassium was low in content (48-207 kg/ha) (Table 5) in North transact. In North transact out of 31 farmer fields, 16 % of soils were having low nitrogen and 84 % having medium in nitrogen content. Whereas in case of phosphorus, 61% having medium and 39 % were having high phosphorus content. Low potassium content was observed with 84% of soils and 16% soils having medium in potassium content. The lower availability of potassium is due to the negligence of the farmers to incorporate potassium while easy availability of phosphorus in market made the higher accumulation of the phosphorus in the soil. The micro nutrients were in sufficient quantity in most of the beneficiary fields. However, iron content ranges from 1.45 to 26.68 ppm, zinc is in the range of 0.20 to 9.10

ppm, 0.34 to 2.05 ppm of copper, 3.22 to 13.82 ppm of manganese and boron ranges between 0.02 to 0.74 ppm in the North transact while in south transact the range of micronutrients varied as iron 2.06-14.82, zinc 0.46 to 4.23, copper 0.34 to 1.12, manganese as 2.19 to 13.16 and boron varied as 0.04-0.46 ppm.

At South transact, available nitrogen was low to medium (281 – 369 kg/ha), available phosphorus low to high (24 to 130), K₂O was low to high (48-909 kg ha⁻¹), Exch. Na ranges from 0.20-0.99 cmol (p+)/ kg⁻¹ and micronutrients were in medium range (Table 4).

In South transact Bengaluru out of 29 farmer fields all the soils are medium in nitrogen and none of soils have low or high. Whereas in case of phosphorus 81% having medium and 19 % is having high phosphorus content. In case of potassium 56 % of soils low in potassium, 33 % soils having medium and 11 % soils have high potassium content. Excessive use of DAP without consideration of the soil test causes extra monetary burden on the farmers. Similar results have been founded by Ray *et al.*, (2000), Milap *et al.*, (2006) and Apoorva *et al.*, (2010) and concluded that application of fertilizers based on the soil test results in higher yield in one side and showed improved soil properties in other side.

Crop productivity

The selected 60 farmers in north and south transact have been provided by fertilizer after the evaluation of soil samples and based on this soil test result fertilizers have been provided and found out major hike in the yield of farmers. The yield of different crops and their respective increase in yield over control plots were recorded (Table 2 and 3). At North rural, yield of finger millet varied

from 17.3 to 35 q/ha and the % increase in yield ranged from 6.85 to 20.83. Whereas maize crop yield was between 74.1 and 98.84 q/ha with increase in yield from 3.2 to 21.2 percent. In field bean and Brinjal yield was 12-32.5 and 395 q/ha with 9.1-17.5 and 18.5 % increase, respectively. Similarly, in case of Tomato it ranges from 444.5 to 617 q/ha with increase in yield of 9.52-20.0%.

However at North transition, Tomato yield ranged from 370 to 691 q/ha with increase in yield of 10 to 21.7 % over control while in Brinjal it was between 345 to 494 q/ha with 12 to 17.6 % increase in yield over control. Similar kind of response were observed within south transact where the crop yield ranged from 22.73 to 271.81 q/ha among crops. At south rural, yield of finger millet ranged between 23 to 40 q/ha with increase of 9.1 to 25.71% yield. Similarly, in field bean yield ranged between 24.7 to 27.6 kg/ha with 10 to 17.6 % increase over control. Tomato and Brinjal yields were 196 and 271-450 q/ha with 8.9 and 10-11% increase over control, respectively.

The crop yields of south transition region were recorded and their % increase in yield over control plot was calculated. In case of Fingermillet, yield ranges from 22 to 36 q/ha with 10 to 22.7% increase over control. Similarly, in case of Maize and Avare 79-100 and 27-32.5 q/ha, yield was recorded respectively and the % increase in yield over control was 7.89-14.3 and 11.5-17.9, respectively. Demonstration on technologies like soil test and crop requirement, mulching and drip irrigation in vegetable crops helps in getting higher yields in-addition to water saving there by enhancing the productivity also profit of farmer by getting “per drop more crop”. Similar results were also reported by Singh *et al.*, (2014); Ramakrishna *et al.*, (2005) and Sharma and Singhal (2014).

Table.1 Crops, cropping pattern and per cent to the total area of the North & South transect of Bengaluru

Crop		<i>Kharif</i>		<i>Rabi</i>		Summer		Grand Total (ha)		% to the total area	
		N	S	N	S	N	S	N	S	N	S
Cereals	Fingermillet	21.89	10.85	-	0.20	-	-	21.89	11.05	45.51	16.95
	Maize	4.76	4.13	0.20	-	0.40	0.40	5.36	4.53	11.14	6.95
	Paddy	0.40	1.92	-	0.40	-	-	0.40	2.32	0.83	3.56
Pulses	Pigeon pea	1.42	0.20	-	-	-	-	1.42	0.20	2.95	0.31
	Field bean	0.40	-	-	-	-	-	0.40	-	0.83	
	Peas	0.40	-	-	-	-	-	0.40	-	0.83	
	Cowpea	-	0.40		-		-		0.40		0.61
Vegetables	Tomato	4.25	1.42	1.01	1.42	0.61	-	5.87	2.84	12.20	4.36
	Cauliflower	1.42	-	-	-	-	-	1.42		2.95	-
	Potato	1.01	-	-	-	-	-	1.01		2.10	-
	Capsicum	1.01	0.40	-	0.40	-	0.40	1.01	1.20	2.10	1.84
	Bottle guard	0.81	-	-	-	-	-	0.81		1.68	-
	Brinjal	0.81	0.04	-	0.20	-	-	0.81	0.24	1.68	0.37
	Carrot	0.40	-	0.40	-	-	-	0.80		1.66	-
	Ridge guard	0.51	0.61	-	0.73	-	-	0.51	1.34	1.06	2.05
	Cabbage	0.40	-	-	-	-	-	0.40	-	0.83	-
	Beet root	-	-	0.40	-	-	-	0.40	-	0.83	-
	Cucumber	0.20	-	-	-	-	-	0.20	-	0.42	-
	Fruits & flowers	Grapes	2.14	-	0.52	-	0.52	-	3.18	-	6.61
Mango		-	5.26	-	5.26	-	5.26	-	15.78	-	24.20
Guava		-	4.05	-	4.05	-	4.05	-	12.15	-	18.63
Jamun		-	2.02	-	2.02	-	2.02	-	6.06	-	9.29
Banana		-	1.11	-	1.11	-	0.61	-	1.72	-	2.64
Marigold		1.21	0.20	--	-	-	-	1.21	0.40	2.52	0.61
Mulberry		-	1.62	-	1.62		1.61	-	4.86	-	7.45
Chrysanthe mum		0.40	-	-	-	0.2	-	0.60	-	1.25	-
Grand Total	43.84 (91.14 %)	34.35 (52.69 %)	2.53 (5.26 %)	16.91 (25.93)	1.73 (3.59)	13.95 (21.39)	48.1	65.21	100.00	100.00	

Table.2 Crop wise yield range (kg/ha) and % increase in yield at North rural and North transition

Crop	North rural		North transition	
	Range 2016-2018 (Pooled data) (q/ha)	% increase	Range 2016-2018 (Pooled data) (q/ha)	% increase
Finger millet	17.3-35	6.85-20.83	35	14.29
Maize-	74.1-98.8	3.2-21.2	-	-
Field bean*	12-32.5	9.1-17.5	-	-
Tomato	444.5-617	9.52-20	370-691	10.0-21.7
Brinjal	160-395	18.5	345-494	12-17.6

* Field bean – Green pod yield

Table.3 Crop wise yield range (kg/ha) and % increase in yield at South rural and South transition

Crop	South rural		South transition	
	Range 2016-2018 (Pooled data) (q/ha)	% Increase	Range 2016-2018 (Pooled data) (q/ha)	% Increase
Finger millet	23-40	9.1-25.71	22-36	10-22.7
Maize	75-100	8.33-13.16	79-100	7.89-14.3
Field bean*	24.7-27.6	10-17.6	27-32.5	11.5-17.9
Tomato	196.0	8.9	550	13.64
Brinjal	271-450	10-11	-	-

* Fieldbean– Green pod yield

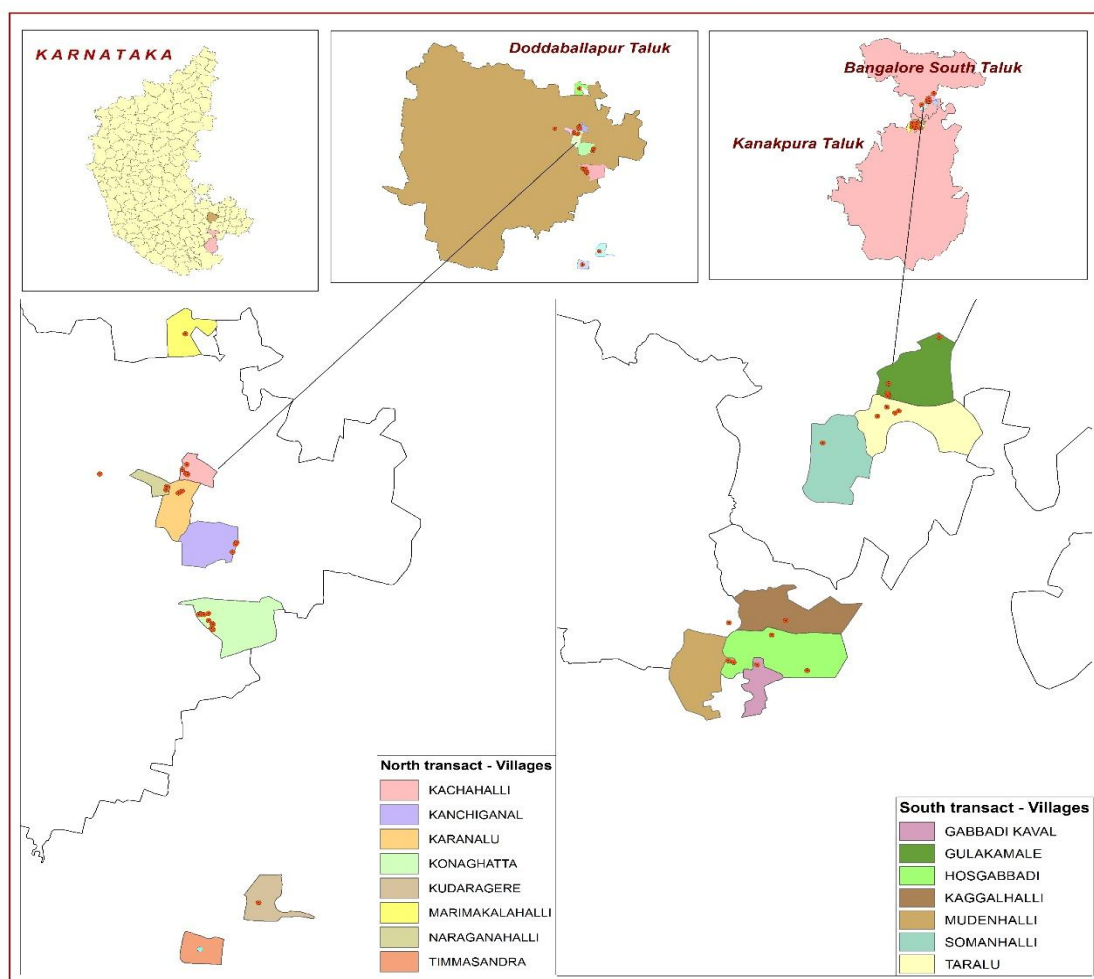
Table.4 Range of available nutrients along with physicochemical property in South transect Bengaluru

Parameters	Range
pH	5.35-8.21
EC (ds/M)	0.07-0.30
Available Nitrogen(kg ha ⁻¹)	281-369
Available Phosphorus(kg ha ⁻¹)	24-130
Available Potassium(kg ha ⁻¹)	48-909
Sodium cmol(p+) kg ⁻¹	0.20-0.99
Available Iron (ppm)	2.06-14.82
Available copper (ppm)	0.46-4.23
Available Zinc (ppm)	0.34-1.12
Available Manganese(ppm)	2.19-13.16
Boron (ppm)	0.04-0.46

Table.5 Range of available nutrients along with physicochemical property in North transact Bengaluru

Parameters	Range
pH	5.27-7.72
EC (ds/M)	0.07-0.41
Available Nitrogen(kg ha ⁻¹)	103-381
Available Phosphorus(kg ha ⁻¹)	13-217
Available Potassium(kg ha ⁻¹)	48-207
Sodium cmol(p+) kg ⁻¹	0.23-0.59
Available Iron (ppm)	1.45-26.68
Available copper (ppm)	0.20-9.10
Available Zinc (ppm)	0.34-2.05
Available Manganese(ppm)	3.22-13.82
Boron (ppm)	0.02-0.74

Fig.1 Location of farmer's field of North- South transact Bengaluru



In conclusion, studying of crop production system prevailing in both transect revealed the dominant cropping system and crop production practices among farmers. The soil test based application of fertilizers raises the yield of the crops compared to the control fields. Among the different nutrients the application of potassium is least one while phosphorus has been applied in excess amount which raises the cost of cultivation for the farmers. So, the judicious use of fertilizers based on the soil fertility test and adoption of best management practices increased the yield of the crops.

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