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Study on Cropping Pattern and Major Crop Yield Performance in Watershed Areas of Koppal District in Karnataka

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ABSTRACT: The biggest crisis that the world faces in the 21st century is the crisis of water. Water is indeed a renewable resource but, in any given year, it is not inexhaustible. The crisis of water has affected the lives of millions of the farmers who constitute sizeable portion of the population. As per the water scarcity map published by International Water Management Institute (IWMI), major part of India is going to face physical water scarcity while, the remaining part is going to experience economic water scarcity by 2025. Indian economy and rural employment are mainly dependent on agriculture, as it contributes about 13.50 per cent to the country's GDP and 60 per cent to the employment. The quality of natural resources in the rainfed ecosystem is gradually declining due to over exploitation, and suffer from bio-physical and socio-economic constraints affecting the productivity of crops and livestock. To provide stability to farm income during drought and to utilize the marginal lands, different alternative land use systems like agro-forestry, silvi-pasture, rainfed horticulture and tree farming systems were evolved and demonstrated on watershed basis. Hence, the study was focused on the cropping pattern and yield performance of major crops grown in watershed area of Koppal district of Karnataka state in India. cotton, bajra, chickpea, ground nut and sunflower were major crops grown by the farmers in the study area and the yield performance of these crops were found economically feasible. Karl pearson's product movement correlation co-efficient was employed to assess the relation between crop yield as dependent variable and soil depth and soil nutrient status. Hence the farmers in watershed areas chosen to adopt those crops which fetched them the most in terms of prices rather than on the soil depth and nutrient status which is also an indicator for the crop choice.

Keywords: Watershed, Major crops, Performance, Feasible, soil depth and soil nutrient status.

INTRODUCTION

The world population is expected to touch 9.19 billion by 2050. Most of the increase in population is expected in developing countries like Asia and Africa (5.33 and 1.66 billion, respectively). Increasing water scarcity over large parts of the world and increased withdrawal of water for agriculture from 2,500 km^3 in 2000 AD to 3,200 km^3 by 2025 AD has not only attracted the attention of policy makers and researchers but challenged them in their effort to achieve food and water security. The biggest crisis that the world faces in the 21st century is the crisis of water. Water is indeed a renewable resource but, in any given year, it is not inexhaustible. The crisis of water has affected the lives of millions of the farmers who constitute sizeable portion of the population. As per the water scarcity map published by International Water Management Institute (IWMI), major part of India is going to face physical water scarcity while, the remaining part is going to experience economic water scarcity by 2025 (Seckler and Amarasinghe, 2000). In order to achieve food security, minimize the water conflicts and to reduce poverty level, it has become essential to increase productivity of rainfed systems by harnessing the existing potential in production (Wani *et al.*, 2003).

India's population of 1300 million is growing at the rate of 2.11 per cent annually. Addition of over 17 million people each year makes additional demands on the country's natural resources and under cuts the gains of development (Itnal *et al.*, 2008). Due to population rise and diversion of land to non-agricultural purposes, the availability of cultivable land in India has declined from 0.53 hectare per capita in 1951 to less than 0.20 hectare by end of the decade of this century. This small piece of land per individual, not only required to produce required quantity of food for every individual in the past, but also to produce in future much more than that to provide for the increased demand resulting from the improved standard of living as well as increase in the population. India's agricultural growth has been sufficient to move the country from severe food crises of the 1960s to aggregate food surpluses today. Underlying this growth were massive public investments in irrigation, agricultural research and extension, rural infrastructure, farm credit, subsidy and rural development programmes. Indian economy and rural employment are mainly dependent on agriculture,

as it contributes about 13.50 per cent to the country's GDP and 60 per cent to the employment. The quality of natural resources in the rainfed ecosystem is gradually declining due to over exploitation, and suffer from bio-physical and socio-economic constraints affecting the productivity of crops and livestock. In this context a number of economically viable rainfed technologies have been evolved. These include soil and rainwater conservation measures, efficient crops and cropping systems matching to the growing season, suitable implements for timely sowing and saving of labour, integrated nutrient and pest management (INM and IPM). To provide stability to farm income during drought and to utilize the marginal lands, different alternative land use systems like agro-forestry, silvi-pasture, rainfed horticulture and tree farming systems were evolved and demonstrated on watershed basis. Out of the total geographical area of 329 million hectares, 143 million hectares is under cultivation, 108 million hectares is under rainfed (75 per cent) contributing 44 per cent to food basket and supports 40 per cent of population (Itnal *et al.*, 2008). Thus dry land farming holds great prospect for contributing substantially to country's food production and unless the production from these areas increases, the real breakthrough in agriculture is not possible (Pushpendra *et al.*, 2012).

The annual degradation rate of land is as much as 2.50 million hectares, about 1.50 million hectares due to deforestation and the rest because of flood waters, glaciations, wind action, over cropping, agriculture impact, river sedimentation and salinity hazards. The soil and water conservation division of Ministry of Agriculture accounted the waste lands in the country as 146 million hectares in 1985 while, the present extent is spelt to be at 165 million hectares, which is more than half of the geographical area of the country. The flood alone carries away 12 billion tones of soil annually, which works out to be 36.50 tonnes per hectare (Murthy, 1998).

Watershed development is one among the flagship programmes of rural development that assist in rural poverty alleviation, predominantly in marginal semi-arid, rainfed areas. These areas house a large share of the poor, food insecure and vulnerable populations in the country. Moreover, as the productivity growth in the more favored green revolution areas is already showing signs of slowing down or stagnation (Pingali and Rosegrant, 2001), future growth in agricultural production and food security is likely to depend on improving the productivity in the semi-arid rainfed areas (Fan and Hazell, 2000).

Thus, in the light of the above, the present study attempts to use the socio-economic data generated in the selected districts and analyze the overall socio-economic profile of all the farmers in the rainfed areas in Koppal district of Karnataka along with the detailed study on the farming systems, livelihood, cropping systems, migration, employment, credit worthiness etc. The proposed research provides inputs to the policy reforms in development of agriculture in the rainfed areas.

The watershed project under Sujala III aims to enhance productivity in rainfed areas in the state. A scientific approach has been planned and initiated to investigate the characterisation of soils and other natural resources before interventions in these watersheds in the selected districts along with existing socio economic conditions of farmers. The very focus of Sujala-III project is to implement various watershed interventions that are planned based on the research findings on the existing constraints in the rainfed areas with respect to natural resources and socio-economic status of farmers and considering the needs of the local community. Hence, the present study is an attempt to cropping pattern and crop yield performance in watershed area of Koppal district.

METHODOLOGY

A. Description of the study area

An assessment of any development activity can be made effectively with the detailed understanding of the physical and natural characteristics and socio-economic status of the region. Hence an attempt has been made to describe the physical, natural and socio-economic features of Koppal district where this study was conducted with envisaged objectives. The study mainly focuses on Koppal district of Karnataka State for an in-depth analysis. Koppal district is located in the Northern part of Karnataka. It is situated between 15° 09' to 16° 03' 30" North Latitude and 75° 47' 30" to 76° 48' 10" East Longitude. It is composed of four talukas, *viz.,* Koppal, Gangavati, Kushtagi and Yalburga. The soils of the district are partly red sandy and black cotton soils suitable for growing wide variety of agricultural and horticultural crops. The total geographical area of Koppal district is 5,52,495 ha. The total population of Yalburgataluk is 2.66 lakh (2011 Census) of which 2.52 lakh (94.73 %) are residing in rural area and 0.14 lakh (5.27 %) in urban area. The total geographical area of Yalburgataluk is 1,47,830. Ha (Anonymous, 2014-15).

B. Nature and source of data

The study made use of both primary and secondary data. The secondary data on area, production, productivity of crops in Koppal district is collected from Directorate of Agriculture and Directorate of Economics and Statistics, Government of Karnataka, Bengaluru and various other published sources.

The primary data were be collected from selected sample farmers using well structured and pretested schedule through personal interview method. The primary data for the study includes information on various parameters such as demographic characteristics like age, education, family type and composition, landholding ownership, yield of crops and other farm enterprises, input utilization, migration, pattern of borrowing, various livelihood approaches adopted by sample farmers and pattern of marketing of output produced and various constraints of farmers with respect to production and marketing**.** While, selecting the sample farmers, weightage was given to select farmers from different reaches in the watershed area.

C. Sampling design

The present study was conducted in the selected watershed areas in Koppal district. The district was selected purposively for the study, under the Sujala-III

project titled "Support for improved integration in rainfed areas of Koppal district of Karnataka" along with other districts namely Gadag and Vijayapura. The project was funded by the World bank and implemented in association with the Government of Karnataka. The project aims to develop science based watershed interventions (multi disciplinary approach) in the drought prone-areas for conservation of soil and water resources in order to enhance the productivity, incomes and also greater opportunities of livelihoods specially to the small holders in the rainfed areas through sustainable management of natural resources. The design of science based watershed intervention under Sujala-III approach involved multi-disciplinary tasks in order to identify the existing farming practices, opportunities and constraints in the management of soil and water resources in particular at the farmers level and sustainable natural resource management in general involving the community under the identified micro-watersheds in the district.

As part of the studies undertaken on characterisation of resources in the micro watersheds, the project also analysed the existing socio-economic status of the farmers under the rainfed conditions with respect to various aspects such as farming practices, productivities of crops, livelihood opportunities etc. as an important input in developing a sound watershed planning for implementation of these interventions at a later period for the overall development of the rainfed areas in general and socio-economic conditions of the farmers in particular.

Hence, the present study in Koppal district initiated wherein, in the first stage, three sub watersheds namely Bedwatti sub-watershed, Chanur sub-watershed and Belgeri sub-watershed were chosen initially and the survey in these sub-watersheds (resource characterisation and socio-economic) were initiated early in the district. The criteria of selecting these sub watersheds on the basis of the initiation of the survey was only to pave-way for integrating the socio-economic information collected from farmers with that of the soil inventory parameters measured such as on the soil depth, nutrients, soil units etc..

D. Analytical tools employed

Tabular analysis. The data collected from primary sources were presented in tabular form to facilitate easy and effective comparison. The tabular presentation with the help of percentages and averages were employed for estimating land use pattern, cropping pattern, cropping intensity, migration, pattern of credit, livelihood opportunities cost and returns and input utilization pattern under rainfed agriculture in watershed areas for meaningful interpretation of the results.

Correlation co-efficient. Karl Pearson's product movement correlation co-efficient (Simple correlation co-efficient) was employed as to assess the relationship between the dependent and independent variables.

The correlation co-efficient was computed by using the following formula

$$r = \frac{n\Sigma xy - (\Sigma x)(\Sigma y)}{\sqrt{(n\Sigma x^2 - (\Sigma x)^2 (n\Sigma y^2 - (\Sigma y)^2)}}$$

Where,

Y = Dependent variable (yield)
X = Independent variable (Soil depth, and Soil nutrients)
r = Simple correlation co-efficient
Σx = Sum of x values
Σy = Sum of y values
Σx^2 = Sum of square of x value
Σy^2 = Sum of square of y value
$(\Sigma y)^2$ = Square of sum of y value
Σxy = Sum of xy values
N = Number of pair of observation

RESULTS AND DISCUSSION

A. Cropping pattern of crops based on soil depth

An analysis of cropping pattern was carried out based on different soil depths chosen in the selected watershed areas. The results are presented in Table 1. It was observed that at a soil depth of 25-50 cm, hybrid maize (48.66 %), sunflower (14.13 %) and green gram (6.06 %) were dominant crops grown in *kharif* season along with other crops such as Bt. cotton, hybrid bajra, and hybrid sorghum while, in *rabi* chickpea (7.97 %) was grown along with other crops (12.42 %) such as horse gram, safflower and *rabi* sorghum. The total cropped area per farm in *kharif* season was 4.00 acres while, in *rabi* it was only 1.05 acres resulting into a low cropping intensity of 126.25 per cent.

Similarly, at the depth of 50-75 cm It was observed that at the depth of 50-75 cm hybrid maize (31.00 %), hybrid bajra (19.19 %) and sunflower (19.12 %) were dominant crops grown in *kharif* season along with other crops such as Bt. cotton, groundnut, green gram, and hybrid sorghum while, in *rabi season* chickpea (5.37 %) was grown along with other crops (3.47 %) such as horse gram, safflower and *rabi* sorghum. The total cropped area in *kharif* season was 4.30 acres while, in *rabi* it was only 0.42 acres resulting into a low cropping intensity of 109.76 per cent.

It was observed that at the depth of 75-700 cm hybrid maize (35.92 %), hybrid bajra (16.28 %), sunflower (15.13 %) and green gram (11.08 %) were dominant crops grown in *kharif* season along with other crops such as Bt. cotton, green gram and hybrid sorghum while, in *rabi* chickpea (5.47 %) was grown along with other crops (5.84 %) such as horse gram, safflower and *rabi* sorghum. The total cropped area in *kharif* season was 3.92 acres while, in *rabi* it was only 0.49 acres resulting into a low cropping intensity of 112.50 per cent.

Further, at the depth 100-150 cm, it was observed that hybrid maize (39.09 %), green gram (11.08 %), hybrid bajra (13.87 %) and sunflower (13.53 %) were dominant crops grown in *kharif* season along with other crops such as Bt. cotton, and hybrid sorghum while, in *rabi* chickpea (3.12 %) was grown along with other crops (3.29 %) such as horse gram, safflower and *Rabi* sorghum. The total cropped area in *kharif* season was 4.53 acres while, in *rabi* season it was only 0.31 acres resulting into a low cropping intensity of 106.84 per cent.

Finally, at the depth 150 cm and above, it was observed that hybrid maize (48.80 %), hybrid bajra (12.74 %) sunflower (10.50 %) and groundnut (8.92 %) were dominant crops grown in *kharif* season along with other

crops such as Bt. cotton, and hybrid sorghum while, in *rabi* chickpea (2.31 %) was grown along with other crops (5.57 %) such as horse gram, safflower and *rabi* sorghum.

Table 1: Cropping pattern based on soil depth in selected watershed area.

Depth	Season	Crop	Area (Acre)	Percentage
25-50	*Kharif*	Hybrid maize	2.44	48.66
n=32		Hybrid bajra	0.19	03.90
		Sunflower	0.71	14.13
		Bt cotton	0.13	02.14
		Green gram	0.30	06.06
		Hybrid sorghum	0.23	04.67
	Total		**4.00**	**79.59**
	Rabi	Chickpea	0.40	07.97
		Others	0.65	12.42
	GPA		5.05	100.00
	Cropping intensity		126.25	
50-75	*Kharif*	Hybrid maize	1.46	31.00
n=61		Hybrid bajra	0.90	19.19
		Groundnut	0.31	06.58
		Sunflower	0.91	19.12
		Bt cotton	0.24	05.07
		Green gram	0.26	05.66
		Hybrid sorghum	0.20	04.33
	Total		**4.30**	**90.97**
	Rabi	Chickpea	0.25	05.37
		Others	0.17	03.47
	GCA		4.72	100.00
	Cropping intensity		109.76	
75-100	*Kharif*	Hybrid maize	1.59	35.92
n=81		Hybrid bajra	0.72	16.28
		Groundnut	0.22	05.05
		Sunflower	0.67	15.13
		Bt cotton	0.15	3.60
		Green gram	0.49	11.08
		Hybrid sorghum	0.07	01.59
	Total		**3.92**	**88.68**
Depth	**Season**	**Crop**	**Area (Acre)**	**Percentage**
	Rabi	Chickpea	0.24	05.47
		Others	0.25	05.84
	GCA		4.41	100.00
	Cropping intensity		112.50	
100-150	*Kharif*	Hybrid maize	1.77	39.09
n=72		Hybrid bajra	0.67	13.87
		Groundnut	0.31	06.39
		Sunflower	0.65	13.53
		Bt cotton	0.17	03.69
		Green gram	0.86	17.82
		Hybrid sorghum	0.08	01.67
	Total		**4.53**	**93.57**
	Rabi	Chickpea	0.15	03.12
		Others	0.16	03.29
	GCA		4.84	100.00
	Cropping intensity		106.84	
>150	*Kharif*	Hybrid maize	2.03	48.80
n =44		Hybrid bajra	0.53	12.74
		Groundnut	0.37	08.92
		Sunflower	0.43	10.50
		Bt cotton	0.20	04.90
		Green gram	0.14	03.36
		Hybrid sorghum	0.11	02.86
	Total		**3.84**	**92.10**
	Rabi	Chickpea	0.09	02.31
		Others	0.23	05.57
	GCA		4.16	100.00
	Cropping intensity		109.18	

The total cropped area in *kharif* season was 3.84 acres while, in *rabi* season it was only 0.32 acres resulting into a low cropping intensity of 109.18 per cent. Similar results were obtained from Arati (2018).

B. Cropping pattern based on the nutrient content in the soil in watershed area

The cropping pattern based on the nutrient status of the soil was analyzed and the results are presented in Table 2.

Table 2: Cropping pattern based on nutrient content in soil in the watershed area.

Soil nutrient (NPK) Content (kg/ha)	Season	Crop	Area (Acres)	Percentage
313.12 to 449.51	*Kharif*	Hybrid maize	1.68	36.30
n=33		Hybrid bajra	1.08	23.38
		Groundnut	0.08	01.78
		Sunflower	0.64	13.84
		Greengram	0.23	04.97
		Bt. Cotton	0.17	03.65
		Sorghum	0.20	04.69
		Total	4.13	88.64
	Rabi	Chickpea	0.22	04.76
		Others	0.36	06.58
		Total	**0.58**	**11.36**
	GCA		4.71	100.00
	Cropping intensity		114.04	
449.52 to 585.90	*Kharif*	Hybrid maize	1.98	47.36
n=65		Hybrid bajra	0.39	09.31
		Groundnut	0.22	05.41
		Sunflower	0.09	02.27
		Greengram	0.69	16.43
		Bt. Cotton	0.24	05.82
		Sorghum	0.07	01.85
		Total	3.71	88.54
	Rabi	Chickpea	0.14	03.36
		Others	0.33	08.91
		Total	**0.47**	**11.46**
	GCA		4.18	100.00
	Cropping intensity		112.66	
586 to 772.29	*Kharif*	Hybrid maize	1.56	39.08
n=98		Hybrid bajra	0.65	15.31
		Groundnut	0.34	08.08
		Sunflower	0.57	13.27
		Greengram	0.40	09.52
		Bt. Cotton	0.08	01.93
		Sorghum	0.07	01.75
		Total	**3.82**	**88.98**
	Rabi	Chickpea	0.24	06.33
		Others	0.20	04.67
		Total	**0.44**	**11.02**
	GCA		4.26	100.00
	Cropping intensity		111.51	
772.3 to 908.69	*Kharif*	Hybrid maize	1.55	38.24
n=31		Hybrid bajra	0.81	19.98
		Groundnut	0.19	04.80
		Sunflower	0.36	08.89
		Greengram	0.22	05.47
		Bt. Cotton	0.13	03.42
		Sorghum	0.26	06.84
		Total	**3.55**	**87.67**
	Rabi	Chickpea	0.25	06.16
		Others	0.25	06.16
		Total	**0.50**	**12.33**
	GCA		4.05	100.00
	Cropping intensity		114.08	
908.70 to 1045.09	*Kharif*	Hybrid maize	0.80	25.90
n=13		Hybrid bajra	0.31	10.12
		Groundnut	0.35	11.30
		Sunflower	0.30	09.80
		Greengram	0.21	07.00
		Bt. Cotton	0.28	09.05
		Sorghum	0.06	02.20
		Total	**2.34**	**75.33**
	Rabi	Chickpea	0.20	06.67
		Others	0.56	17.98
	GCA		3.10	24.66
	Cropping intensity		132.47	100.00

The findings of the study revealed that hybrid maize (36.20 %), hybrid bajra (23.38 %), and sunflower (13.84 %) were grown along with other crops like groundnut green gram, sorghum and Bt. cotton in *kharif* season in the soil containing the nutrients (NPK) in the range between 313.12 and 450 kg/ha. While, in soils with same nutrient status, chickpea (4.76 %) and other crops (6.58 %) like horse gram, safflower and *rabi* sorghum were the predominantly grown *rabi* crops in the watershed area.

The total cropped area in *kharif* was 4.13 acres while, in*rabi* it was 0.58 acres accounting to a total of 4.71 acres. Further, cropping intensity was computed as a ratio of gross cropped area to the net cropped area. it was observed that cropping intensity was found to be 114.04 per cent in this range of nutrients status in the soils.

Similarly, hybrid maize (47.36 %), green gram (16.43 %), and hybrid bajra (9.31 %) were grown along with other crops like groundnut, sunflower, sorghum and Bt. cotton were in *kharif* season in the soil containing the nutrients (NPK) in the range between 451 and 585.90 kg/ha. While, in soils with same nutrient status chickpea (3.36 %) and other crops (8.91 %) like horse gram, safflower and *rabi* sorghum were the prominently grown *rabi* season in the watershed area. The total cropped area in *kharif* was 3.71 acres while, in *rabi* it was 0.47 acres accounting to a total of 4.18 acres resulting in a cropping intensity of 112.66.

Further, hybrid maize (39.08 %), hybrid bajra (15.31 %) and sunflower (13.27 %) were grown along with other crops like groundnut, green gram, sorghum and Bt. cotton in *kharif* season in the soil containing the nutrients (NPK) with the range between 586 and 772.30 kg/ha. While, in soils with nutrient status chickpea (6.33 %) and other crops (4.67 %) like horse gram, safflower and *rabi* sorghum were the predominantly grown *rabi* crops in the watershed area. The total cropped area in *kharif* was 3.82 acres while, in *rabi* it was 0.44 acres accounting to a total of 4.26 acres resulting in a cropping intensity of 111.51.

Similarly, hybrid maize (38.24 %), hybrid bajra (19.98 %) and sunflower (8.89 %) were grown along with other crops like groundnut, sunflower, sorghum and Bt. cotton were predominantly grown in *kharif* season in the soil containing the nutrients (NPK) with the range between 772.31 and 908.70 kg/ha. While, with the same nutrient status chickpea (6.16 %) and other crops (6.16 %) like horse gram, safflower and *rabi* sorghum were the prominent grown *rabi* crops in the watershed area. The total cropped area in *kharif* was 3.55 acres while, in *rabi* it was 0.50 acres accounting to a total of 4.05 acres resulting into a cropping intensity of 114.08.

Finally, hybrid maize (25.90 %), hybrid bajra (10.12 %), groundnut (11.30 %) and sunflower (9.80 %) were grown along with other crops like green gram, sorghum and Bt. cotton in *kharif* season in the soil containing the nutrients (NPK) in the range between 908.71 and 1045.10 kg/ha. While, in soil with same nutrient status, chickpea (6.77 %) and other crops (17.98 %) like horse gram, safflower and *rabi* sorghum were the prominently grown as *rabi* crops in the watershed area. The total cropped area in *kharif* was 2.34 acres while, in *rabi* it was 0.56 acres accounting to a total of 2.90 acres resulting in a cropping intensity of 123.93.

C. Overall cropping pattern adopted by farmers in watershed area

The findings on cropping pattern adopted in the study area comprising of watershed area predominantly depends on rainfed condition. The results presented in the Table 3 provide an insight into the nature and composition of crops. In the cropping plan of the farmers on his farm (per farm). The overall cropping pattern was analysed without considering soil depth and soil nutrient in the watershed area. It could be seen from the results that cropping pattern in the watershed area is dominated by *kharif* crops (89.64 %) while,*rabi*crops occupy only (10.36 %) of the gross cropped area. Thus the annual cropping intensity was found to be very low at 116.20 per cent.

Among the *kharif* crops hybrid maize occupied a largest area (38.57 %) to the gross cropped area.

Table 3: Overall cropping pattern adopted by farmers in the watershed area (Per farm in acres).

Crop	Area (acres)	Percentage (%)
Kharif		
Hybrid maize	2.16	38.68
Hybrid Bajra	0.77	13.76
Sunflower	0.84	14.98
Bt. Cotton	0.21	03.68
Green gram	0.57	10.14
Groundnut	0.32	5.70
Hybrid sorghum	0.15	02.67
Sub-total	**5.02**	**89.63**
Rabi		
Chickpea	0.27	4.77
Rabi sorghum	0.27	4.82
Safflower	0.03	0.53
Horsegram	0.01	0.22
Sub-total	**0.58**	**10.37**
Gross Cropped Area	5.60	100.00
Net Cropped Area	5.00	
Cropping intensity		116.20

This was followed by crops that occupied relatively smaller area like sunflower (15.00 %), hybrid bajra (13.75 %), green gram (10.18 %), the other crops that constituted less than 10 per cent of gross cropped area were groundnut (5.71 %), Bt. cotton (3.75 %) and Hybrid sorghum (2.68 %).

Among the *rabi* crops *rabi* sorghum and chickpea occupied 4.82 per cent area each followed by very insignificant area under crops like safflower (0.54 %), and horse gram (0.18 %). Similar results were obtained from Nirunkusha (2015).

D. Yield performance of major crops in the watershed areas in Koppal district

Performance of crops yields based on depth of soil. An attempt was made in this study to analyse the nature of association between the depths of soil (cm) and the yields of major crops in the watershed areas under rainfed condition. It could be seen from Table 4 that interestingly with the increase in the depth of the soil the yields also increased as indicated by correlation value.

For the purpose of measuring the nature of association between crop yields and various depths of soils, five ranges of soil depth were considered namely 25-50 cm, 51-75 cm, 76-100 cm, 101-150 cm and > 150 cm.

In the case of hybrid maize the average yield per acre at a soil depth between 25 to 50 cm was 7.12 q while, it increased to 7.68 q at a depth of more than 150 cm with the correlation value of 0.70.

Similarly, in the case of hybrid bajra the average yield per acre was 3.52 q at the soil depth of 25 to 50 cm while, it increased to 3.58 q at a depth of more than 150 cm indicating a positive association between depth (cm) and yield (q) which can be confirmed with the positive correlation value of 0.65.

In the case of chickpea the average yield per acre was 3.42 q at the soil depth of 25 to 50 cm while, it increased to 3.65 q at a depth of more than 150 cm indicating a positive association between depth (cm) and yield (q) which can be confirmed with the positive correlation value of 0.74. In the case of groundnut the average yield obtained increased slightly from 3.95 q per acre at a depth range of 50-75 cm to 4.15 q at the depth of more than 150 cm indicating a positive association between depth (cm) and yield (q) which can be confirmed with the positive correlation value of 0.64.

Further in the case of sunflower the average yield per acre was 3.25 q at the soil depth of 25-50 cm while, it increased to 3.42 q at a depth of more than 150 cm indicating a positive association between depth (cm) and yield (q) which can be confirmed with the positive correlation value of 0.71.

Table 4: Performance of crop yields based on depth of soil.

	Depth (cm)	Average yield (q/acre)	Correlation co-efficient (r- value)
Hybrid maize	25-50	7.12	0.70
	50-75	7.24	
	75-100	6.82	
	100-150	7.62	
	>150	7.68	
Hybrid bajra	25-50	3.52	0.65
	50-75	3.38	
	75-100	3.48	
	100-150	3.62	
	>150	3.58	
Chickpea	25-50	3.42	0.74
	50-75	3.46	
	75-100	3.32	
	100-150	3.58	
	>150	3.65	
Groundnut	25-50	-	0.64
	50-75	3.95	
	75-100	3.63	
	100-150	4.10	
	>150	4.15	
Sunflower	25-50	3.25	0.71
	50-75	3.38	
	75-100	3.28	
	100-150	3.54	
	>150	3.42	

Performance of crop yields based on soil nutrient content. An attempt was made in this study to analyse the nature of association between the nutrient content of soil (kg/ha) and the yields of major crops in the watershed areas under rainfed condition. It could be seen from the Table 5 that interestingly with the increase in the depth of the soil the yields also increased as indicated by correlation value.

For the purpose of measuring the nature of association between crop yields and nutrient status, various ranges of nutrient statuses were considered namely 313.12 - 449.51, 449.52 to 585.90, 586.00 to 772.29, 772.30 to 908.69 and 908.70 to 1,045.09 kg/ha (NPK together).

In the case of hybrid maize, the yield per acre obtained was 7.42 quintals within the nutrient status of 313.12 - 449.52 kg/ha. While, it increased to 7.62 quintals within

the nutrient status of 908.70 - 1,045.09 kg/ha with a correlation value of 0.63.

Similarly, in the case of hybrid bajra, the yield per acre obtained was 3.32 quintals within the nutrient status of 313.12 - 449.52 kg/ha. While, it increased to 3.65 quintals under the nutrient status of 908.70 - 1,045.09 kg/ha with a correlation value of 0.64.

In the case of groundnut, the yield per acre obtained was 4.62 quintals under the nutrient status of 313.12 - 449.52 kg/ha. While, it increased to 4.73 quintals under the nutrient status of 908.70 - 1,045.09 kg/ha with a correlation value of 0.50.Further, in the case of chickpea, the yield per acre obtained was 3.28 quintals under the nutrient status of 313.12 - 449.52 kg/ha. While, it increased to 3.56 quintals in the nutrient range of 908.70 - 1,045.09 kg/ha with a correlation value of 0.71.

Finally, in the case of sunflower, the yield per acre obtained was 3.28 quintals within the nutrient range of 313.12 - 449.52 kg/ha. While, it increased to 3.68 quintals in the nutrient range of 908.70 - 1,045.09 kg/ha with a correlation value of 0.64. Similar results were obtained by Nayak Mahantesh (2000).

Table 5: Performance of crop yields based on soil nutrient content.

Crop	Nutrient status	Average yield (q/acre)	Correlation co-efficient (r- value)
Hybrid maize	313.12-449.51	7.42	0.63
	449.52-585.90	7.42	
	586.00-772.29	7.35	
	772.30-908.69	7.92	
	908.70-1045.09	7.62	
Hybrid bajra	313.12-441.51	3.32	0.64
	449.52-585.90	3.58	
	586.00-772.29	3.29	
	772.30-908.69	3.72	
	908.70-1045.09	3.65	
Groundnut	313.12-441.51	4.62	0.50
	449.52-585.90	4.26	
	586.00-772.29	4.35	
	772.30-908.69	4.68	
	908.70-1045.09	4.73	
Chickpea	313.12-441.51	3.28	0.71
	449.52-585.90	3.53	
	586.00-772.29	3.36	
	772.30-908.69	3.59	
	908.70-1045.09	3.56	
Sunflower	313.12-441.51	3.28	0.64
	449.52-585.90	3.65	
	586.00-772.29	3.49	
	772.30-908.69	3.52	
	908.70-1045.09	3.68	

E. Productivities of crops in the watershed area

The present study also focused on the analysis of productivities of crops cultivated in the watershed area in the district. This was taken up mainly to understand the existing per acre productivities of crops under adverse conditions of production dominated by erratic monsoon and poor soil and water regimes. The results on the crop yields in the area are presented in Table 6 revealed poor performance of crops measured by their average productivities in the study area. The productivities of hybrid maize was 7.68 quintal per acre, followed by 4.49 quintal per acre for hybrid sorghum, 4.30 quintal per acre for groundnut, 4.27 quintal per acre for *rabi* sorghum, 3.65 quintal per acre for hybrid bajra, 3.63 quintal per acre for chickpea, 3.43 quintal per acre for sunflower, 2.62 quintal per acre for Bt. cotton and 2.12 quintal per acre for green gram. The co-efficient of variation was calculated to analyse the stability in the productivities of crops. The co-efficient of variation was observed very high for Bt. cotton (35.79 %), green gram (35.66 %), hybrid sorghum (34.99 %), chickpea (31.99 %), and hybrid maize (31.38 %), which indicated that the productivity of these crops was highly unstable.

Table 6: Productivities of major crops in the watershed area.

Season	Crop	Productivity (q/acre)	S.D (%)	Co-efficient of variation (%)
Kharif	Hybrid maize	7.68	2.41	31.38
	Hybrid bajra	3.65	1.06	29.04
	Groundnut	4.30	1.07	24.64
	Sunflower	3.43	0.80	23.23
	Bt. Cotton	2.62	0.92	35.79
	Green gram	2.12	0.74	35.66
	Sorghum	4.49	1.57	34.99
Rabi	Chickpea	3.63	1.16	31.99
	Rabi sorghum	4.27	0.93	21.89

While, the co-efficient of variation was comparatively lower for hybrid bajra (29.04 %), groundnut (24.64 %) sunflower (23.23 %) and *rabi* sorghum (21.89 %). The productivity of these crops was highly unstable in the study area, as the area under cultivation was purely rainfed, which has resulted in the low productivity of these crops. Similar results were obtained from Gaddi *et al.,* (2002).

CONCLUSION

The study was focused on cropping pattern and performance of the major crops cultivated in watershed areas of Koppal district of Karnataka Cropping pattern on various basis were studied such as soil depth and soil nutrient content of the soil. The crops like Hybrid maize, hybrid bajra, chick pea, groundnut and sunflower were identified as the major crops. It can be concluded from the result obtained that the Hybrid maize, bajra, chickpea and sunflower were showed better yield performance at higher depth more than 150 cm and also showed positive significant with respect to increased range of nutrients content in soil but in terms of productivity Bt cotton, greengram, hybrid maize and hybrid sorghum were highly unstable. Hence, care should be taken in these crops.

FUTURE SCOPE

Future scope of study on status of the soil nutrients changes in cropping pattern , cost of the inputs change and productivity which enlighten the policy makers for making good reliable policy for the watershed area.

Conflict of interest. The results obtained in the study were for the period of survey done for the research. The nutrient level of the soil and cropping pattern were dynamic with regards to time and place. Hence, the results of the study was restricted to time period and climate of the study area of research done. Hence, there is a lot of scope for the updating the study.

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