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Irrigation and Agricultural Development in Malaprabha River Basin, Karnataka State: A Geographical Study on Progress and Determinants

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Abstract: ***Water is the real elixir of life; irrigation is the font of civilization, and is one of the most essential inputs next only to land for the agricultural development. Agriculture plays an essential role in the process of economic development of less developed countries like India. Besides providing food to nation, agriculture releases labour, provides saving, contributes to market of industrial goods and earns foreign exchange. Agricultural development is an integral part of overall economic development. Only rainfall is the natural source of water for irrigation, but rainfall is the most unreliable and is marked by wide variations in different parts of the nation and also variation from year to year in its quantity, incidence, and duration. Thus irrigation is a dynamic and decisive factor in Indian agriculture due to inadequacy and high variability of rainfall. Therefore, the present study is made to analyze the role and impact of irrigation on the agriculture development in the talukas of Malaprabha River Basin, which includes the appreciation of the sources of irrigation and specifically focused on how agrarian development has changed due to irrigational facilities. Keeping this view in mind this paper pursues the land use pattern, population and agricultural work forces, and cropping pattern and finally the Kendall's Ranking Co - efficient technique is used to assess the progress by means of agricultural land use efficiency equipped for the river basin area. The river basin area is a one of the natural regions with agriculture being the lifeline of the inhabitants of the area. In the study area the variations of an annual rainfall from year to year is fairly large. The rainfall is irregular and uncertain in the study area; here agriculture is the gambling with monsoon. Droughts and famines are part of life of the people in basin area. If the rainfall is scare, it results into crop failure. For the assured agriculture practices, irrigation is a basic input in dry and semidry climates. Thus irrigation is the harbinger for change and development in the Malaprabha River Basin.***

Keywords: Irrigational facilities, Rainfall variations, Cropping Pattern, Land Use Efficiency Regions and Agriculture Development

1. Introduction

Man has been using water for irrigation since ancient times. Historically, Mesopotamia, Egypt, 'Zana' Valley of the Andes Mountains in Peru, Indus Valley in Pakistan and North India and other important civilizations of the world have been dependent on development of irrigated agriculture to provide agrarian basis of a society and to enhance the security of people. Thus irrigation is an age old art. It is an artificial means of watering the crops or plants or an art of supplying water to the crops. In the absence of rainfall, supply of water to land by artificial means of growth of plants and for increasing productivity is irrigation. Agriculture plays an essential role in the process of economic development of less developed countries like India. Besides providing food to nation, agriculture releases labour, provides saving, contributes to market of industrial goods and earns foreign exchange. Agricultural development is an integral part of overall economic development. Only rainfall is the natural source of water for irrigation, but rainfall is the most unreliable and is marked by wide variations in different parts of the nation and also variation from year to year in its quantity, incidence, and duration. Thus irrigation is a dynamic and decisive factor in Indian agriculture due to inadequacy and high variability of rainfall. It is more as in arid, semi - arid and sub - humid regions of the country which are prone to drought and famine conditions due to partial failure and delayed arrival or early withdrawal of the monsoon. Therefore, constant efforts are made to develop and improve irrigation system to mitigate this problem as much as possible.

In India organized and planned efforts towards irrigation development began in 1951, the year in which is First Five Year Plan was launched. Thereafter the agriculture picked up. Extension of irrigation facilities to drought affected areas of the nation received special attention during the successive plan periods. Irrigation development and improved farm practices have tackled the basic problems of low agricultural productivity, inferior cropping pattern, substance agriculture and rural poverty in rain fed farming areas. Rightly, the plan accorded priority to programmes of agricultural development through irrigation a policy which gives excellent dividends. Agriculture still being backbone of the national economy, its stability and development depends on the availability of perennial supply of water for irrigation. As result of this Govt. of India launched a Centrally Sponsored Scheme of Command Area Development Programme in 1974 - 75, to bridge the gap between the irrigation potential created and that utilized through increase in irrigated areas and for the development of adequate delivery system of irrigation water up to farmer's field with an objective to enhance water use efficiency and production and productivity of crops per unit of land and water for improving socio - economic condition of farmers in the Malaprabha River Basin. Therefore, the present study is made to analyze the role and impact of irrigation on the agricultural development in the Malaprabha River Basin, which includes the appreciation of the sources of irrigation and specifically focused on how agrarian progress has changed due to irrigational facilities. Keeping this view in mind this paper pursues the land use pattern, population and agricultural work forces, and cropping pattern and finally the

Kendall's Ranking Co - efficient technique is used to assess the progress by means of agricultural land use efficiency equipped for the Malaprabha River Basin.

2. Study Area

The Malaprabha River Basin of Karnataka state is approximately triangular shape, located in the extreme western part of the Krishna basin. It lies between 15^0 05^l 02^{ll} to 16^0 20^l 19^{ll} N. latitudes and 74^0 05^l 43^{ll} to 76^0 05^l 33^{ll} E. longitudes, covering an area of 11549 sq. km, out of which 3880 sq. km in Belgaum (33.59%), 1950 sq. km in Bagalakot (16.89%), 2739 sq. km in Dharwad (23.72%), 2657 sq. km in Gadag, 220 sq. km in Koppal and 103 sq. km in Haveri District (23.01%) [Fig - 1]. Topographically the Malaprabha river basin presents the two important divisions, viz. Western Ghats and typical of the eastern part of Deccan/Karnataka plateau with the distinct characteristics. The plateau has two natural sub divisions, the Semi - Malnad and the Northern Maidan, which include the northern upland or the Deccan trap of the state. An exhumed structure with superimposed drainage is also responsible for the sharp relief in the Kaladgi sandstones in which Ghataprabha forms a waterfall near Gokak and the Malaprabha, a gorge near Saundatti (Spate and Learmonth, 1967). The river Malaprabha is the most important right bank tributary of the river Krishna. The Benni hall, Hire hall and others are the principal tributaries of the Malaprabha River.

The entire river basin experiences semi - arid type of climate, spread in Hilly, Northern Dry and Northern Transition Zone of Agro - Climatic Zones of Karnataka State, and it is very warm during summer, especially in April and May, with temperature ranging between 35^0 to 40^0C in eastern part of river basin. The annual normal rainfall of the Malaprabha basin area is over 759 mm spread over 50 days, which receives monsoon rainfall as much as our nation with slight variations. Deep black cotton soils are ubiquities in basin area. Jowar besides other drought - resistant inferior small millet crops is traditionally predominant crop. Geographically ubiquities deep black cotton soils, Unpredictable monsoonal rainfall, Droughts and famines are part of life of people in the study region. The present study is a natural region and occupies 6.02% area of the Karnataka state. As per 2011 census, the population of Malaprabha River Basin is 3.38 million (5.53% of the state's total population) of which 77.66% is rural and 22.34% is urban inhabitants. The dominance of rural population makes the regional economy mainly agrarian. The basin's 68.37% of the workforce (61.75% of males and 79.55% of females), however, is still dependent on the agriculture and its allied activities for their livelihood. The economic development and prosperity of the masses depend mainly on agricultural base.

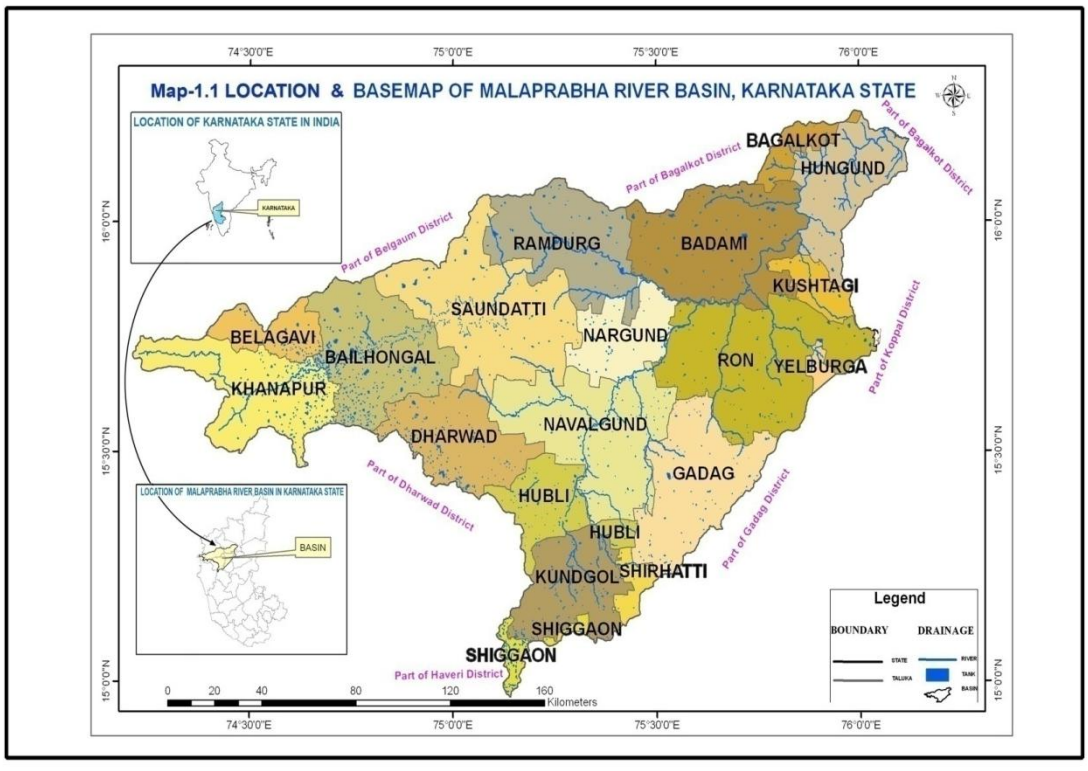


Figure 1: Location of Study Area in India and in Karnataka Stateand Talukas in Malaprabha River Basin

3. Objectives

The present paper is extensively evaluates the role and impact of irrigation on agricultural development in Malaprabha river basin. In this context, the study has been undertaken with the following specific objectives:

- To examine the sources of irrigational facilities for evaluating the progress of agriculture by means of changes in land use pattern, population and agricultural workforces and cropping pattern in the talukas of the river basin (1974 - 2014);

- To find out the determinates of agricultural land use efficiency by using Kendall's Rank Order Correlation approach & verifies the results of agricultural development in the study area (1974 - 2014);
- To suggest appropriate strategies to sustainable development for future with minimum affect on environs of the study area.

4. Methodology

The present study is mainly based on the secondary sources of data. Data for the present analysis has been obtained mainly from Directorate, Department of Economic and Statistics, Bangalore, District Statistical Offices of Belgaum, Dharwad, Gadag & Bagalakot districts and District Census C. D's of Belgaum, Dharwad, Gadag and Bagalakot districts of 1971 to 2011 Census from Directorate of Census Operations, Bangalore Karnataka State; besides this, data were also collected from various government offices and websites. Presently the taluka has been considered as the smallest unit of analysis. To achieve the objectives mentioned above the relevant method of quantitative analysis has been employed. For the identification of taluka level agricultural land use efficiency, raw data is converted into the percentage and after that, with the help of values of Kendall's Rank Order Correlation analysis, all the talukas are arranged into five categories of very high, high, medium, low and very low efficiency areas. At last results were presented with of suitable diagrams.

5. Results and Discussion

Agricultural land use efficiency largely depends upon the inputs applied and the methods adopted. In India, "while population grows, the land surface is fixed and of this only a certain proportion is available for cultivation" (Planning commission, 1961). Further scope for bringing extra land under the plough is limited. If more production is to be got out of this existing area, the problem has to be tackled on a wide front. This can be done by applying inputs in a more intensive way and by adopting modern methods of cultivation through use of improved technology, besides making an adequate provision for institutional financing, better methods of marketing, etc. Technical factors, i. e., technology have received increasing emphasis and the recent breakthrough in agriculture is the outcome of these factors. These technological factors comprise i] irrigation; ii] Consumption of fertilizers and manure; iii] Improved seed, and iv] agricultural implements.

Water is the real elixir of life; irrigation is the font of civilization, and is one of the most essential inputs next only to land for the agricultural development. Only rainfall is the natural source of water in agriculture. But rainfall is the most unreliable and is marked by wide variations in different parts and also variation from year to year in its quantity, incidence, and duration. Therefore, only artificial supply of water through irrigation is the way to overcome the problem of deficiency of water. Irrigation water comes from two sources: surface water and ground water. Surface water is provided by the flowing water of rivers or the still water of tanks, ponds, lakes, and artificial reservoirs. The surface water is carried to the filed by canals, distributaries, and channels. Ground water is tapped by sinking wells where drought animals, diesel or electric power is utilized to take out water. In Malaprabha river basin area canals, tanks, wells including tubewells, lift and others are the principal sources of irrigation. Since the inception of CAD programme, considerable importance had been attached to the provision of canal irrigation and well irrigation in the study area. Even though 42 percent (in 1993 - 94) of irrigation is supplied by canals, now well irrigation has caught up rapidly irrigation by tube wells has been expanded considerably (40% in 2013 - 14). In the meantime, except other sources, tanks lift, and wells sources of irrigation are declining in importance in the study area (**see Table 1**).

Table 1: Source - wise Trend in Irrigated Area in Malaprabha River Basin, Karnataka State, 1973 - 74 to 2013 - 14 (Area in hectares)

Sl. No	Source of Irrigation	Net Irrigated Area in			Change of Volume		
		1973 - 74	1993 - 94	2013 - 14	1974 - 1994	1994 - 2014	1974 - 2014
1	Canals % of NIA	5724 **(16.75)**	83564 **(42.16)**	103033 **(32.83)**	+ 77840 **(+ 47.46)**	+ 19469 **(+16.84)**	+97309 **(+ 34.80)**
2	Tanks % of NIA	11184 **(32.72)**	8161 **(4.12)**	470 **(0.15)**	- 3023 **(- 1.84)**	- 7691 **(- 6.65)**	- 10714 **(- 3.83)**
3	Wells % of NIA	9197 **(26.91)**	27449 **(13.85)**	46140 **(14.70)**	+ 18252 **(+ 11.13)**	+18691 **(+16.16)**	+36943 **(+13.21)**
4	Tube/Bore Wells % of NIA	0 **(0.00)**	40462 **(20.42)**	126133 **(40.19)**	+ 40462 **(+ 24.67)**	+85671 **(+74.08)**	+126133 **(+45.10)**
5	Lift Irrigation % of NIA	0 **(0.00)**	**20282 (10.23)**	**1138 (0.36)**	+ 20282 **(+ 12.37)**	- 19144 **(- 16.55)**	+1138 **(+0.40)**
6	Others % of NIA	8074 **(23.62)**	18274 **(9.22)**	36922 **(11.76)**	+ 10200 **(+ 6.22)**	+18648 **(+16.12)**	+28848 **(+10.32)**
Total Net Irrigated Area		**34179 (100)**	**198192 (100)**	**313836 (100)**	**164013 (100)**	**115644 (100)**	**279657 (100)**
Irrigation Intensity %		**3.02**	**18.06**	**33.47**	**15.04**	**15.41**	**30.45**
Net Sown Area		**1132872**	**1097493**	**937773**	**- 35379**	**- 159720**	**- 195099**
Total Cropped Area		**1167756**	**1302991**	**1432103**	**+ 135235**	**+ 129112**	**+ 264347**

Source: *Annual Season & Crops Reports of (1973 - 74 to 2013 - 14) Belgaum, Bagalakot, Dharwad and Gadag Districts*

Table No; 1, shows that the net irrigated area has increasedfrom 34179 hectares (3.02%) in 1973 - 74 to 313836 hectares (33.47%) in 2013 - 14. This increment in irrigated area is very nominal and only 33.47 percent of net

sown area is irrigated area. This figure is very unsatisfactory and it is matter of concern that why only 33.47 percent of net sown area is irrigated area. It is also concerning matter that growth in gross irrigated area is also very nominal. Thus, there is scope to increase agricultural production by increasing both net and gross irrigated area.

Changing Agrarian Progress due to the Irrigational Facilities:

In this section we focused on how agrarian progress has changed due to the irrigational facilities in the study area. Keeping this view in mind, this section follows land use pattern, population and agricultural work force and cropping pattern.

Land Use Pattern:

The basic factor in agriculture is land. Knowledge about land use pattern is vital to understand whether the utilization of land in India is at its full potential or far from its full potential. In India the classification of land has had its roots in agricultural statistics. Till 1950, the land in India was broadly classified into five categories: [i] Area under forests; [ii] Area not available for cultivation; [iii] Uncultivated lands including current fallows; [iv]Area under current fallows; and [v] Net area sown. But then it was realized that such a classification did not give a clear picture of the actual area under different categories of land use required for agricultural planning. Hence, are classification was adopted from March1950. Under it, land in India now classified under nine different categories. These are as: [i]forests; [ii] barren and uncultivable lands; [iii] land put to non - agricultural uses; [iv]cultivable wastes; [v] permanent pastures and other grazing lands; [vi] miscellaneous tree crops and groves not included in the net area sown; [vii] current fallows; [viii] other fallows; and [ix] net sown area.

Only the first six of these nine categories such as, net sown area, current fallows, other fallows, cultivable wastes, permanent pastures and other grazing lands, miscellaneous tree crops and groves have been included in this inquiry as: (i) lands under the last categories (forests, non - agricultural uses, and barren and uncultivable lands) are rarely involved in agricultural use; (ii) lands under the first six categories are used for agriculture regularly at present as in the case of net sown area or fallow lands, or they were cultivated in the past and may be used in future again as cultivable waste, or they are used for some other agriculture - related activities as in the case of pastures and grazing lands and lands with miscellaneous trees and grows; and (iii) a shift of area from one type to another is considered more normal and frequent only among the last six categories.

Table 2shows changes in land use pattern in Malaprabha river basin areafrom1973 - 74 to 2013 - 14. Out of the total reporting area of the study area, 82.22% was classed as the arable land in the year 1973 - 74, whereas it decreased to 80.29% in the year 2013 - 14, the volume of change in the arable land is about - 2.47%. Out of the total geographical area, the net sown area is about 63.34 percent in 2013 - 14, that was 76.41 percent in 1973 - 74. The net sown area has also decreased by 17.22 percent from 1973 - 74 to 2013 - 14. Both the current fallows land and other fallows land have also decreased during this period. But even today 14.52 percent of total reporting area is available as a fallows land and less than 1 percent of total reporting area is other fallows land. This indicates that there is scope to increase the net sown area by at least 5 to 10 percent by improving both types of fallows land.

Table 2: Trends in Agricultural Land Use Pattern in Malaprabha River Basin from 1973 - 74 to 2013 - 14 (Area in hectares)

Sl. No	Land use Category	Land Use Pattern					
					Change of Volume (%)		
		1973 - 74	**1993 - 94**	**2013 - 14**	1973 - 74 to 1993 - 94	1993 – 94 to 2013 - 14	1973 – 74 to 2013 - 14
I	**Total Geographical Area**	**1482598**	**1480631**	**1480631**	**- 1967 (- 0.13)**	**- -**	**- 1967 (- 0.13)**
II	**Arable Lands**	**1218989 (82.22)**	**1194629 (80.68)**	**1188831 (80.29)**	**- 24360 (- 1.54)**	**- 5798 (- 0.39)**	**- 30158 (- 2.47)**
A	**Net Sown Area**	**1132872 (76.41)**	**1097493 (74.12)**	**937773 (63.34)**	**- 35379 (- 2.29)**	**- 159720 (-10.78)**	**- 195099 (-17.22)**
B	**Fallow Land (i + ii)**	**51481 (3.47)**	**73418 (4.96)**	**225620 (15.24)**	**+21937 (+1.49)**	**152202 (10.28)**	**+ 174139 (+338.26)**
i	Current Fallow	35175 (2.37)	61452 (4.15)	215050 (14.52)	+26277 (+1.78)	145398 (10.37)	+ 179875 (+511.37)
ii	Other Fallow	16306 (1.10)	11966 (0.81)	10750 (0.71)	- 4330 (- 0.29)	- 1216 (- 0.10)	- 5556 (-34.07)
C	**Other Uncultivated Land**	**34636 (2.34)**	**23718 (1.60)**	**25438 (1.72)**	**- 10918 (-0.74)**	**1720 (0.12)**	**- 9198 (-26.56)**
i	Cultivable Waste	10922 (0.74)	6574 (0.44)	6574 (0.44)	- 4348 (- 0.30)	- -	- 4348 (-39.81)
ii	Permanent Pasture and Other Grazing	21978 (1.48)	16269 (1.10)	16293 (1.10)	- 5709 (- 0.38)	24 (0.00)	- 5685 (-25.87)
iii	Miscellaneous Trees and Groves	1736 (0.12)	875 (0.06)	2571 (0.71)	- 861 (-0.06)	1696 (+0.11)	+ 835 (+48.10)
III	**Non – Arable Lands**	**263609 (17.78)**	**286002 (19.32)**	**291800 (19.71)**	**22393 (1.54)**	**- 5798 (- 0.39)**	**+ 28191 (+10.69)**
D	**Forest**	**188824 (12.74)**	**186514 (12.60)**	**186524 (12.60)**	**- 2310 (-0.14)**	**10 (0.00)**	**- 2300 (-1.22)**

E	**Land not Available for Cultivation (i + ii)**	**74785 (5.04)**	**99488 (6.72)**	**105276 (7.11)**	**24703 (1.68)**	**5788 (0.39)**	**+ 30491 (+40.77)**
i	Land put to Non - Agricultural Uses	29740 (2.01)	62798 (4.24)	68586 (4.63)	33058 (2.23)	5788 (0.39)	+ 38846 (+130.62)
ii	Barren and Un - cultivable Land	45045 (3.04)	36690 (2.48)	36690 (2.48)	- 8355 (-0.56)	- -	- 8355 (- 18.55)
IV	**Area Sown More Than Once**	**34884 (3.08)**	**205498 (18.72)**	**494330 (34.52)**	**+170614 (+15.64)**	**+ 288832 (+15.80)**	**+ 459446 (+1317.07)**
V	**Total Cropped Area**	**1167756**	**1302991**	**1432103**	**+135235**	**+129112**	**+ 264347 (+22.64)**
VI	**Cropping Intensity**	**103%**	**119%**	**153%**	**16%**	**34 %**	**+ 50% (+48.54)**

Source: *Annual Season & Crops Reports of (1973 - 74 to 2013 - 14) Belgaum, Bagalkot, Dharwad and Gadag Districts*

The area under potentially arable lands has decreased from 34636 hectares (2.34%) to 25438hectares (1.72%) during the study period. The net area under this category has also decreased by - 26.56 percent from 1973 - 74 to 2013 - 14. Total cropped area was 1167756 hectares in 1973 - 74 and it has increased to 1432103 hectares in 2013 - 14. This shows that only 3.08 percent of net sown area was used for more than one crop in 1973 - 74 and this figure increased to 34.52 percent in 2013 - 14. This point out that total cropped area can be increased by 22.64 percent of net sown area through intensive cropping. The cropping intensity of the region as a whole recorded 103% in the year 1973 - 74 and it increased to 119% in 1993 - 94 and further it set up to 153% in the year 2013 - 14.

Population and Agricultural Work Force:

We look at changing structure & structural transformation of agriculture in study area in terms of growth of population both total and rural, and workforce including farm and non - farm sector. Population size is one of the key determinants of the work force and its participation rates. According to 2011 Census, the population of River Basin is 33.83 lakhs comprising of 17.13 lakhs males and 16.71 lakhs females population, which works to be 976 females per thousand males. This ratio is higher than the average for the state (968). The River basin accounted for a meager share of the total population of Karnataka state (5.53%), the slight higher its share in 2001 (5.81%).

The decadal growth of total and rural population of Malaprabha River Basin over the decade from 1971 to 2011 is given in the **Table - 3**. During the year 1971 the study area had about 19.01 lakhs of population (share of rural population; 80.87%). In the year 1981, which is the base year of study, it had increased to 23.08 lakhs (share of rural population; 78.95%) with a decadal growth rate of 21.44 percent. In the year 1991 the study area had 27.10 lakhs of population (share of rural population; 79.55%) and decadal growth rate had declined to 17.41 percent. During the 2001 decade, the absolute population increased to 30.71 lakhs (share of rural population; 79.12%) with a remarkable decline in the growth rate of decadal population (13.32%). Further during the present decade i. e.2011, the population of river basin has increased to 33.83 lakhs (share of rural population; 77.66%) and by in absolute terms 3.12 lakhs persons, thus yielding a growth rate in terms of percentage; it has registered a decadal growth of 10.18 percent, which below the state average of 15.67 percent and the national average of 17.64 percent. This growth rate is 5.31 percent and 7.46 percent lower than that of the state (15.67 percent) and national average (17.64percent). At the same time, the working population of the study area is also increased from 7.29 lakhs or WPR is 38.33% in 1971 to 15.64 lakhs or WPR is 46.21% in 2011.

Table 3: Population & Its Growth and Agricultural Work Force in Malaprabha River Basin Area, Karnataka State since 1971 to 2011

Components		Census Years				
		1971	**1981**	**1991**	**2001**	**2011**
Total Population (In Lakhs)		**19.01**	**23.08**	**27.10**	**30.71**	**33.84**
Decadal Growth Rate (%)		- -	21.44	17.41	13.32	10.18
Rural Population (In Lakhs)		**15.37**	**18.22**	**21.65**	**24.30**	**26.28**
Share of Rural Population (In %)		(80.87)	(78.95)	(79.55)	(79.12)	(77.66)
Decadal Growth Rate (%)		**- -**	**18.56**	**18.31**	**12.71**	**8.14**
Total Workers (In Lakhs)		**7.29**	**9.14**	**11.07**	**14.56**	**15.64**
(In % to total population)		(38.33)	(39.61)	(40.83)	(47.40)	(46.21)
F A R M	**Cultivators** (In Lakhs)	**2.71**	**3.46**	**3.98**	**4.92**	**4.51**
	(In % to total workers)	**(37.26)**	**(37.85)**	**(35.93)**	**(33.77)**	**(28.86)**
	% to Farm Workers	**49.54**	**50.14**	**47.27**	**46.81**	**42.19**
	Agricultural Labourers (In Lakhs)	**2.75**	**3.44**	**4.44**	**5.69**	**6.18**
	(In % to total workers)	**(37.78)**	**(37.64)**	**(40.11)**	**(38.45)**	**(39.51)**
	% to Farm Workers	**50.46**	**49.86**	**52.73**	**53.19**	**57.81**
	Total (In Lakhs)	**5.47**	**6.90**	**8.42**	**10.51**	**10.69**
	(In % to total workers)	**(75.04)**	**(75.49)**	**(76.05)**	**(72.22)**	**(68.37)**
N O N	**Household Industry Workers** (In Lakhs)	**0.55**	**0.56**	**0.42**	**0.68**	**0.56**
	(In % to total workers)	**(7.51)**	**(6.07)**	**(3.84)**	**(4.71)**	**(0.56)**
	% to Non - Farm Workers	**30.22**	**25.00**	**15.85**	**16.83**	**11.31**

-	**Other Workers (**In Lakhs)	**1.27**	**1.69**	**2.23**	**3.36**	**4.39**
F	(In % to total workers)	**(17.45)**	**(18.44)**	**(20.12)**	**(23.08)**	**(28.07)**
A	**% to Non - Farm Workers**	**69.78**	**75.00**	**84.15**	**83.17**	**88.67**
R	**Total (**In Lakhs)	**1.82**	**2.24**	**2.65**	**4.04**	**4.95**
M	(In % to total workers)	**(24.96)**	**(24.51)**	**(23.95)**	**(27.78)**	**(31.63)**

Sources*:** District Census Handbooks of Belgaum, Bagalakot, Dharwad and Gadag Districts 1971 to 2001 and Final Census Reports of 2011 [Note***: In bracket figures are in percentages]

The agriculture sector in study area has undergone significant structural changes in the form of decrease in share of farm sector from 75.04 percent in 1970 - 71 to 68.37 percent by 2010 - 11 and at the same time, share of non - farm sector increases from 24.96 percent in 1970 - 71 to 31.63 percent by 2010 - 11 indicating a shift from the traditional agrarian economy towards a non - agrarian dominated one (Table - 3). This decrease in agriculture's contribution to population growth has not been accompanied by a matching reduction in the share of agriculture in employment.

About 68.37% of the total workforce is still employed by the farm sector which makes more than 2/3rd of the basin areas population dependent on agriculture for sustenance. In 2011, among agricultural workforce about 57.81 percent are registered as agricultural labourers and the rest, i. e., 42.19 percent as cultivators, while 50.46 percent was registered as agriculture labourers and the rest i. e.49.54 percent as cultivators in 1970 - 71. This indicates that agricultural workforce shifted from cultivators to agricultural labourers (Table - 3). However, within the rural economy, the share of income from non - farm activities has also increased.

Cropping Pattern:

Cropping pattern means the proportion of area under different crops at a particular period of time. A change in cropping pattern means a change in the proportion under different crops. **Table 4** indicates that the area under other than cereals as a proportion of the total cropped area is increasing but still there is dominance of cereals. During the year 1973 - 74 in river basin, 48.20 percent land was put under cereals crops, 24.32 percent under cash crops, 16.32 percent under oil seeds, 9.34 percent under pulses and about 1.82 percent on spices, fruits and vegetables. By 2013 - 14, area under food crops had come down to 34.65 percent, 23.98 percent under pulses 15.86 percent under cash crops, 16.69percent under oil seeds, and area under spices, fruits and vegetables has increased to 8.82 percent. This shift in the allocation of area from cereals crops to other non - cereals crops reflect a change from subsistence cropping to commercial cropping.

Table 4: Changes in Cropping Pattern in Malaprabha River Basin during 1973 - 74 to 2013 - 14

Sl. No.	Crops	Area under Crops in			Change of Volume		
		1973 - 74	1993 - 94	2013 - 14	1973 - 74 to 1993 - 94	1993 – 94 to 2013 - 14	1973 – 74 to 2013 - 14
1	**Cereals**	562916 **(48.20)**	538965 **(41.36)**	496277 **(34.65)**	- 23951 **- 17.71%**	- 42688 **- 33.06%**	- 66639 **- 25.21%**
2	**Pulses**	109089 **(9.34)**	149657 **(11.49)**	343446 **(23.98)**	40568 **+30.00%**	193789 **+150.09%**	234357 **+88.66%**
3	**Cash Crops**	283961 **(24.32)**	210307 **(16.14)**	227105 **(15.86)**	- 73654 **- 54.46%**	16798 **+13.01%**	- 56856 **- 21.51%**
4	**Oil Seeds**	190593 **(16.32)**	296244 **(22.74)**	239044 **(16.69)**	105651**) +78.12%**	- 57200 **- 44.30%**	48451 **+18.33%**
5	**Spices, Fruits & Vegetables**	21197 **(1.82)**	107818 **(8.27)**	126231 **(8.82)**	86621 **+64.05%**	18413 **+14.26%**	105034 **+39.73%**
	Gross Cropped Area	**1167756 (100.00)**	**1302991 (100.00)**	**1432103 (100.00)**	**135235 (100.00)**	**129112 (100.00)**	**264347 (100.00)**

Source: *Annual Season & Crops Reports of (1973 - 74 to 2013 - 14) Belgaum, Bagalkot, Dharwad and Gadag Districts*

This shifting of land from cereals crops to non - cereals crops was mainly influenced by the prevailing price in market and profitability per hectare. Similarly, here it can also be concluded that, the volume of cropping pattern has changed significantly. Among the all crops, there is preponderance of cereals; about +88.66, +39.73 and +18.33 percent of net area is increased area under pulses, spices, fruits & vegetables and oil seeds respectively while - 25.21 and - 21.51%percent of the net area is decreased for the cultivation of cereals and cash crops during the study period. Though, the area under pulses, vegetables and oil seeds is increasing but the rate of increase in area under pulses is greater than that of others. It means whatever cropped area increased as a result of irrigation facilities, chemical fertilizer, and high yielding varieties of seeds, a greater part of it is devoted to food grains. Within cereals, area under coarse cereals is gradually declining during the period. This is due to fact that coarse cereals are inferior goods.

Agricultural Land Use Efficiency

A systematic and scientific evaluation of agricultural land resources is of paramount importance in regional agricultural land use planning. The interaction of physical, socio - economic and technological factors determine the efficiency and effective use of agricultural land resource in an area to a great extent.

Agricultural land use efficiency is a complex and dynamic concept. Any change in socio - economic and agro - technology input application brings corresponding change in the efficient utilization of the natural quality and availability of arable land. It represents the degree of optimal use and

performance of cultivated as well as cultivable land (Reddy and Ramanaiah, 1985). Therefore, the agricultural land use efficiency is an integrated system which considers both the spatial spread of this land resource and the effective ways and means of agronomic practices ranging from single to multiple cropping, extent of irrigation, type of crop etc,. of which this resource is being utilized at optimum level. The term 'efficiency' is used here to denote the overall performance and optimum use of agricultural land as manifested by the positive and negative agronomic variables besides the management of land at an optimum productive level by bringing harmony among the physical, socio - economic and technological factors.

Since the evaluation of the efficiency of agricultural land is related to different variables, its quantification is very much required to know this concept into more tangible, comprehensive, precise and objective. Quantification of agricultural land use efficiency provides a conceptual framework and objective measures to examine the degree of efficiency that the land with certain natural characteristics under a given technological level and socio - economic setup is put to optimum use.

6. Methodology

Here an attempt is made in the present study to know and find the agricultural land use efficiency by adopting Kendall's Ranking Co - efficient Method by taking seven variables namely i] Net sown area, ii] Current and other fallow lands, iii] Area sown more than once, iv] Uncultivated lands, v] Waste lands vi] Irrigation intensity, and vii] Cropping intensity (Appendices No: I, II& III). This analysis is very simple in calculation but is the most appropriate in its results. Accordingly the taluka wise ranks for each variable are awarded vertically and summed up horizontally. The total rank score of each taluka is divided by seven which gives an average score. Thus the results obtained for both the study periods are classed which gives five groups of agricultural land use efficiency areas and has been presented in Table No; 5 and 6. Further in order to know the changes of agricultural land use efficiency the results of both the phases are compared. These results are again arbitrarily grouped to know the variations and presented in the Table No; 7.

Spatial Pattern of Levels of Agricultural Land Use Efficiency:

An important finding that emerges from Table No; 5 is that agricultural land use efficiency in the Malaprabha river basin was not uniform dimensional. This would be clear when we examine the taluka wise ranking co – efficient indices of agricultural land use efficiency given in the table below and depicted in Fig - 2, and which give a comparative picture of the levels of changes in agricultural land use efficiency of all the talukas of the river basin over a period of 40 years at interval of 20 years, i. e. from 1973 - 74 to 2013 - 14.

Table No: 5; Agricultural Land Use Efficiency in Malaprabha River Basin, Karnataka State during 1973 - 74 to 2013 - 14

Talukas	1973 - 74		1993 - 94		2013 - 14		Variations in Ranking Co – efficient Indices		
	Ranking Co – efficient Indices	Rank	Ranking Co – efficient Indices	Rank	Ranking Co – efficient Indices	Rank	1974 - 1994	1994 - 2014	1994 - 2014
Khanapur	7.43	**8**	8.71	**12**	9.23	**12.5**	+1.28	+0.52	+1.80
Bailhongal	4.29	**1**	7.14	**9**	6.43	**6**	+2.85	- 0.71	+2.14
Saundatti	7.14	**6**	6.86	**5.5**	4.00	**1**	- 0.28	- 2.86	- 3.14
Ramdurga	7.43	**8**	5.86	**4**	6.00	**5**	- 1.57	+0.14	- 1.43
Badami	8.43	**11**	7.07	**8**	8.57	**11**	- 1.36	+1.50	+0.14
Hunagund	7.43	**8**	7.86	**10**	7.57	**8.5**	+0.43	- 0.29	+0.14
Naragund	8.71	**12.5**	5.57	**3**	5.71	**2**	- 3.14	+0.14	- 3.00
Ron	6.86	**4.5**	8.43	**11**	7.71	**10**	+1.57	- 0.72	+0.85
Gadag	6.86	**4.5**	9.14	**13**	9.23	**12.5**	+2.28	+0.09	+2.37
Dharwad	4.43	**2**	5.43	**2**	7.14	**7**	+1.00	+1.71	+2.71
Hubli	5.43	**3**	5.07	**1**	5.86	**3.5**	- 0.36	+0.79	+0.43
Navalgund	7.86	**10**	6.86	**5.5**	5.86	**3.5**	- 1.00	- 1.00	- 2.00
Kundagol	8.71	**12.5**	7.00	**7**	7.57	**8.5**	- 1.71	+0.57	- 1.14

Source: derived after the ranking co - efficient indices of the talukas by researcher

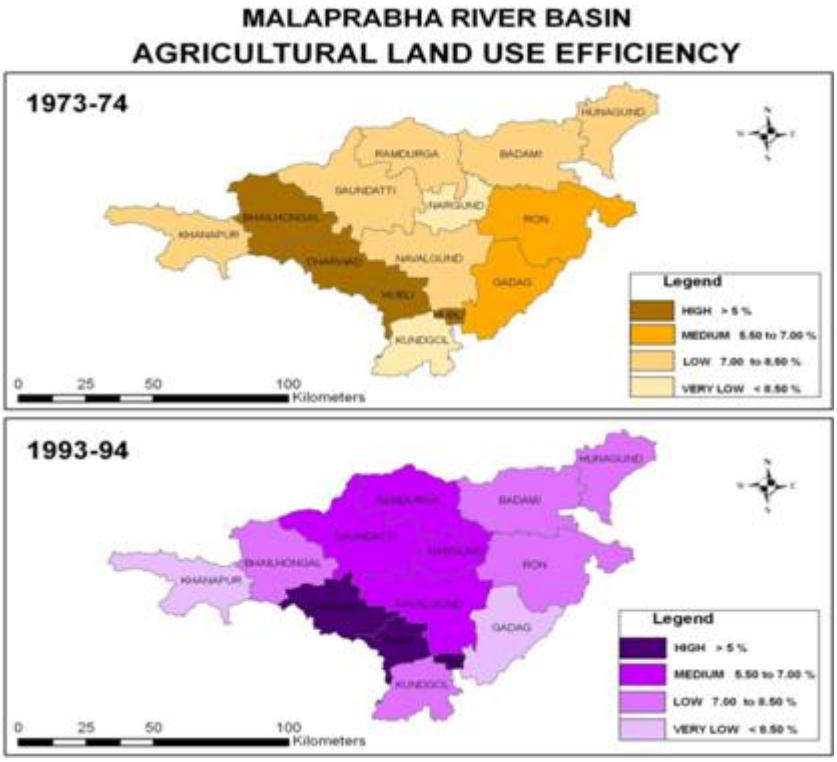
During the year 1973 - 74 there was not a single taluka observed under the category of very high agricultural land use efficiency, whereas under the high category, there was three talukas namely Bailhongal, Dharwad and Hubli (Table No: 5 & 6). Ron and Gadag were under medium category of agricultural land use efficiency. The six talukas viz. Saundatti, Khanapur, Ramdurga Hunagund Navalgundand Badamiwere under low category of agricultural land use efficiency. The remaining two talukas Naragund and Kundagol were under very low category of agricultural land use efficiency. During this period (1973 - 74), Bailhongal, Dharwad and Hubli talukas had high irrigation intensity and high share of current and other fallows land which has a more binding impact of its high agricultural land use efficiency.

Table 6: Classifications of Talukas on the Levels of Agricultural Land Use Efficiency in Malaprabha River Basin Area, Karnataka State during 1973 - 74 to 2013 - 14

Category	Ranking Co - efficient Indices	1973 - 74		1993 - 94		2013 - 14	
		No of Talukas & its area (in %)	Name of the Talukas	No of Talukas & its area (in %)	Name of the Talukas	No of Talukas & its area (in %)	Name of the Talukas
Very High	< 4.00	- -	- -	- -	- -	- -	- -
High	4.00 to 5.50	3 (23.08)	Bailhongal Dharwad Hubli	**2 (15.38)**	Hubli Dharwad	**1 (7.69)**	Saundatti
Medium	5.50 to 7.00	2 (15.38)	Ron Gadag	**4 (30.77)**	Naragund Ramdurga Saundatti Navalgund	**5 (38.46)**	Naragund Hubli Navalgund Ramdurga Bailhongal
Low	7.00 to 8.50	6 (46.16)	Saundatti Khanapur Ramdurga Hunagund Navalgund Badami	**5 (38.46)**	Kundagol Badami Bailhongal Hunagund Ron	**4 (30.77)**	Dharwad Hunagund Kundagol Ron
Very Low	> 8.50	2 (15.38)	Naragund Kundagol	**2 (15.38)**	Khanapur Gadag	**3 (23.08)**	Badami Khanapur Gadag
		13 (100.00)		**13 (100.00)**		**13 (100.00)**	

Source: Classification derived after ranking of the talukas

During 2013 - 14, the taluka - wise status of agricultural land use efficiency has observed with greater variations. In case of very high category of efficiency, the same trend is continued. The only Saundatti taluka is noticed with high category of agricultural land use efficiency. Naragund, Hubli, Navalgund, Ramdurga and Bailhongal talukas which were under medium category, but Dharwad, Hunagund, Kundagol and Ron talukas confined to low category of agricultural land use efficiency during 2013 - 14. The remaining three talukas namely Badami, Khanapur and Gadag are witnessed under very low category of agricultural land use efficiency, while Gadag taluka which was under medium group and Khanapur and Badami talukas which was under low category during 1973 - 74 further come down to very low group during 2013 - 14. Water in the drier part of the study area happens to be a vital factor of agricultural land use efficiency. This must have had some impact on the agriculture of Saundatti taluka. Therefore, its position as low efficiency of agricultural land use in 1973 - 74 upgraded to high category of efficiency of agricultural landuse in 2013 - 14.



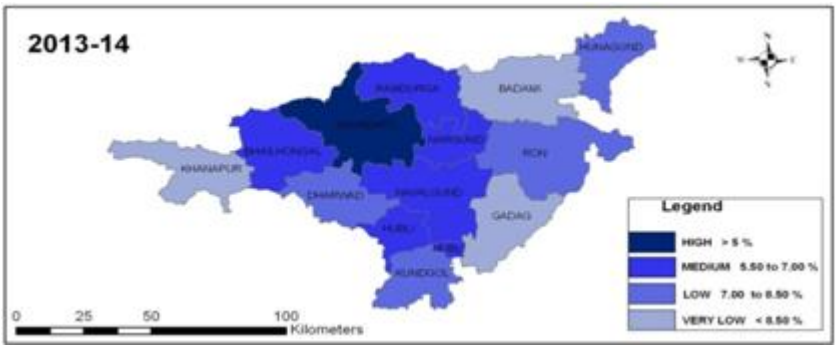


Figure 2

Changes in Levels of Agricultural Land Use Efficiency 2001 - 02 to 2011 - 12

The combined impact of the selected indicators reveals that (Table No: 5&7), Naragund and Saundatti, talukas under very high category of agricultural land use efficiency have changed. Because of greater adaptation of technological factors and more impact of irrigational intensity in these talukas, they are progressing with very high change in agricultural land use efficiency category. High change of agricultural land use efficiency is found in Kundagol, Ramadurga and Navalgund talukas. The medium change is noticed in Hubli, Badami and Hunagundtalukas, Bailhongal, Khanapur and Ron talukas falls under low change of agricultural land use efficiency. Dharwad and Gadag talukas falls under very low change of agricultural land use efficiency.

Table 7: Changes in levels of Agricultural Land Use Efficiencyin Malaprabha River Basin, Karnataka State during 1973 - 74 to 2013 - 14

Category	Ranking Co – efficient Indices	Changes between 1973 - 74 to 2013 - 14		
		Name of the Talukas	No of Talukas &its area (in sq. kms)	% of command area to total area
Very Low	> + 2.25	Dharwad Gadag	2 (1517.80)	15.38
Low	+ 2.25 to + 0.75	Bailhongal Khanapur Ron	3 (1290.90)	23.08
Medium	+ 0.75 to - 0.75	Hubli Badami Hunagund	3 (737.10)	23.08
High	- 0.75 to - 2.25	Kundagol Ramdurga Navalgund	3 (2516.50)	23.08
Very High	> - 2.25	Naragund Saundatti	2 (3894.40)	15.38
			13	100.00

Source: derived after the ranking co - efficient indices of the talukas by researcher

7. Conclusion

This paper evaluates the role and impact of irrigation on agricultural development in Malaprabha river basin. In this context, this paper analyzes sources of irrigational facilities for the progress of agriculture by means of changes in land use pattern, population and agricultural workforces and cropping pattern in the study area over the period 1973 - 74 to 2013 - 14. The study highlights that only 33.5 percent of net sown area is irrigated area in 2013 - 14. This figure is very unsatisfactory and it is matter of great concern. In the meantime, Out of irrigated area, 40.2 percent of area irrigated by tube wells followed by canals which is about 32.8 percent of area and except other sources (27%) tanks, lift and well sources of irrigation are declining in importance in the river basin. After evaluating the changes in land use pattern, population and agricultural workforces and cropping pattern, this paper point outs some points. These are: The study also indicates that there is scope to increase both net sown area and total cropped area, agricultural workforce shifted from cultivators to agricultural labours, the dependency ratio and literacy rates have both increasing trend, with predominance of cereals, volume of cropping pattern has changed significantly and this specified through the area under cereals crops shifted towards non cereals crops, with the rate of increase in area under non cereals is greater than the cereals crops in the study area. We use the Kendall's Rank order Correlation test to analyze agricultural land use efficiency approach for the determinants of impact of irrigation on agricultural development in Malaprabha river basin over the period 1973 - 74 to 2013 - 14. It is also observed in this study that agricultural land use efficiency was not homogeneous among the talukas in the study area. A total of seven talukas have low and very low criterion efficiency (More than 53.85% of river basin). This is indeed a situation of great concern. It points towards the failure of the overall agricultural dispersion mechanism from the high to the very low efficiency areas. Hence proper developmental measures assume crucial importance.

Appendices No; I Agricultural Land Use Efficiency in MalaprabhaRiver BasinBy Kendal's Ranking Co - Efficient Method; 1973 - 74

Talukas	NSA %	Current & Other Fallow Land	Area Sown More Than Once	Uncultivated Land	Waste Land	Irrigation Intensity	Cropping Intensity	Total Ranks	Ranking Co- efficient
Khanapur	28.66 (13)	9.10 (1)	0.09 (13)	4.51 (2)	4.01 (9)	11.46 (1)	100.32 (13)	52	7.43
Bailhongal	81.36 (8)	3.25 (6)	4.99 (3)	1.55 (6)	6.79 (3)	6.87 (2)	106.13 (2)	30	4.29
Saundatti	78.83 (9)	4.67 (3)	1.65 (8)	2.72 (5)	5.50 (6)	0.66 (11)	102.10 (8)	50	7.14
Ramadurga	76.57 (10)	1.95 (9)	1.12 (11)	3.44 (3)	6.32 (4)	3.22 (5)	101.46 (10)	52	9.43

Badami	66.30 (12)	2.04 (8)	1.27 (10)	0.73 (9)	8.51 (2)	1.80 (9)	101.91 (9)	59	8.43
Hunagund	85.78 (7)	0.83 (13)	2.20 (6)	0.85 (7)	5.30 (7)	2.86 (6)	102.57 (6)	52	7.43
Naragund	94.19 (2)	0.97 (12)	0.18 (12)	0.48 (11)	4.35 (8)	5.88 (4)	100.19 (12)	61	8.71
Ron	92.03 (4)	1.47 (11)	2.44 (4)	0.58 (10)	5.71 (5)	0.98 (10)	102.65 (4)	48	6.86
Gadag	89.88 (5)	3.48 (5)	2.36 (5)	2.74 (4)	1.73 (12)	0.50 (12)	102.13 (5)	48	6.86
Dharwad	71.33 (11)	4.03 (4)	6.94 (1)	8.47 (1)	3.22 (10)	6.62 (3)	109.73 (1)	31	4.43
Hubli	86.74 (6)	1.87 (10)	5.03 (2)	0.75 (8)	8.69 (1)	1.82 (8)	105.80 (3)	38	5.43
Navalgund	94.06 (3)	2.81 (7)	2.11 (7)	0.06 (13)	3.07 (11)	2.61 (7)	102.24 (7)	55	7.86
Kundagol	94.37 (1)	4.80 (2)	1.28 (9)	0.47 (12)	0.35 (13)	0.29 (13)	101.36 (11)	61	8.71

Appendices No; II Agricultural Land Use Efficiency in Malaprabha River Basin By Kendal's Ranking Co - Efficient Method; 1993 – 94

Talukas	NSA %	Current & Other Fallow Land	Area Sown More Than Once	Un cultivated Land	Waste Land	Irrigation Intensity	Cropping Intensity	Total Ranks	Ranking Co - efficient
Khanapur	34.09 (13)	4.43 (5)	1.19 (13)	3.99 (1)	4.69 (10)	23.62 (6)	103.50 (13)	61	8.71
Bailhongal	78.68 (8)	2.55 (9)	9.34 (9)	1.30 (5)	10.42 (2)	18.69 (7)	111.87 (10)	50	7.14
Saundatti	74.41 (9)	3.92 (7)	5.73 (12)	2.73 (3)	10.44 (1)	24.85 (4)	107.70 (12)	48	6.86
Ramadurga	60.35 (12)	18.73 (1)	12.48 (7)	0.98 (8)	7.53 (6)	31.25 (2)	120.68 (5)	41	5.86
Badami	63.76 (11)	3.34 (8)	8.58 (10)	1.01 (6.5)	9.48 (3)	26.15 (3)	113.45 (8)	49.5	7.07
Hunagund	83.12 (6)	2.50 (10)	15.17 (6)	0.86 (10)	6.30 (7)	8.51 (9)	118.26 (7)	55	7.86
Naragund	78.87 (7)	16.14 (2)	20.87 (4)	0.13 (12)	4.86 (9)	91.29 (1)	126.46 (4)	39	5.57
Ron	92.76 (3)	0.65 (12)	11.92 (8)	0.62 (11)	5.75 (8)	14.41 (8)	112.85 (9)	59	8.43
Gadag	93.63 (2)	1.67 (11)	7.24 (11)	1.38 (4)	1.73 (13)	2.50 (12)	107.73 (11)	64	9.14
Dharwad	71.67 (10)	4.77 (4)	21.55 (3)	3.12 (2)	8.20 (5)	4.84 (11)	130.07 (3)	38	5.43
Hubli	83.28 (5)	4.40 (6)	27.18 (2)	1.01 (6.5)	8.55 (4)	6.07 (10)	132.64 (2)	35.5	5.07
Navalgund	89.91 (4)	6.96 (3)	18.20 (5)	0.06 (13)	3.07 (12)	24.48 (5)	120.26 (6)	48	6.86
Kundagol	95.80 (1)	0.11 (13)	61.63 (1)	0.91 (9)	3.19 (11)	0.24 (13)	164.34 (1)	49	7.00

Appendices No; III Agricultural Land Use Efficiency in Malaprabha River Basin By Kendal's Ranking Co - Efficient Method; 2013 - 14

Talukas	NSA %	Current & Other Fallow Land	Area Sown More Than Once	Uncultivated Land	Waste Land	Irrigation Intensity	Cropping Intensity	Total Ranks	Ranking Co - efficient
Khanapur	29.08 (13)	9.27 (8)	0.32 (13)	4.16 (1)	4.70 (10)	28.75 (7)	101.11 (13)	65	9.23
Bailhongal	68.93 (7)	10.91 (7)	29.10 (10)	2.48 (4)	10.64 (1)	28.79 (6)	141.89 (10)	45	6.43
Saundatti	34.25 (12)	43.99 (1)	38.59 (7)	2.74 (3)	10.52 (2)	90.26 (2)	212.65 (1)	28	4.00
Ramadurga	42.67 (11)	36.39 (2)	34.30 (8)	0.99 (8)	7.54 (7)	88.53 (3)	180.37 (3)	42	6.00
Badami	61.78 (10)	5.30 (10)	14.79 (12)	1.02 (7)	9.48 (4)	48.29 (5)	123.94 (12)	60	8.57
Hunagund	81.00 (4)	2.13 (12)	41.30 (6)	0.86 (10)	8.78 (5)	15.71 (8)	150.99 (8)	53	7.57
Naragund	80.53 (5)	14.49 (5)	53.88 (3)	0.12 (12)	4.86 (9)	137.92 (1)	166.91 (5)	40	6.71
Ron	92.37 (1)	1.03 (13)	48.80 (4)	0.64 (11)	5.75 (8)	12.71 (10)	152.83 (7)	48	6.86
Gadag	92.14 (2)	2.90 (11)	26.46 (11)	1.39 (5)	1.97 (13)	4.45 (12)	128.71 (11)	65	9.23
Dharwad	63.89 (9)	12.15 (6)	31.47 (9)	3.12 (2)	8.60 (6)	14.74 (9)	149.25 (9)	50	7.14
Hubli	64.49 (8)	21.95 (4)	44.17 (5)	1.05 (6)	9.75 (3)	9.80 (11)	168.49 (4)	41	5.86
Navalgund	70.17 (6)	26.53 (3)	57.49 (1)	0.06 (13)	3.23 (12)	52.79 (4)	181.93 (2)	41	5.86
Kundagol	89.39 (3)	6.10 (9)	56.17 (2)	0.93 (9)	3.58 (11)	0.26 (13)	162.84 (6)	53	7.57

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