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Resource Use Efficiency in Agriculture - A Critical Survey of the Literature

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Abstract

This paper surveys and critically reviews the major research works on resource use efficiency in agriculture. These papers analyse resource use efficiency, total economic efficiency and technical efficiency in various crops and various agricultural regions. The studies cover major farm inputs such as human labour, bullock labour, fixed capital, land, seeds, fertilizers and manure and irrigation. The studies fail to incorporate the ideologies of resource use efficiency in the context of head, mid and tail reaches of the channel irrigation. This research gap opens the new avenue of research for the study on economics of resource use efficiency in head, mid and tail reaches in cannel irrigation based agriculture.

Key Words: Resource use efficiency; Survey of Literature

Introduction

Agriculture in India has a significant history. Today, India ranks second worldwide in farm output. Agriculture and allied sectors like forestry and fisheries

accounted more or less 16 per cent to the GDP, about 50 per cent of the total workforce. The economic contribution of agriculture to India's GDP is steadily declining with the country's broad-based economic growth. Still, agriculture is demographically the broadest economic sector and plays a significant role in the overall socio-economic fabric of India. The development of agriculture sector has direct impact on level of farm income as well as national income of the country.

According to FAO world agriculture statistics, India is the world's largest producer of many fresh fruits and vegetables, milk, major spices, select fresh meats, select fibrous crops such as jute, several staples such as millets and castor oil seed. India is the second largest producer of wheat and rice, the world's major food staples. India is also the world's second or third largest producer of several dry fruits, agriculture-based textile raw materials, roots and tuber crops, pulses, farmed fish, eggs, coconut, sugarcane and numerous vegetables. India ranked within the world's five largest producers of over 80 per cent of agricultural produce items, including many cash crops such as coffee and cotton, in 2010. India is also one the world's five largest producers of livestock and poultry meat, with one of the fastest growth rates, as of 2011 (FAO, 2011; World Bank, 2011).

Therefore, the economist gives more importance to study the production and productivity trend in Indian agriculture from the independence onwards. Among the studies on Indian agriculture, the studies on Indian Farm Management explored various dimensions of Indian agriculture. In particularly, the studies mainly explored the resource use efficiency in Indian agriculture. Since, the resource efficiency in agriculture places

an important role to determine the farm production and income of the farm household. The agricultural sector uses various resources such as manure and fertilizers, irrigation facilities, manpower, seeds, bullock labour, working capital, farm implements and machinery and crop protection measures ect. The farm income is determined by the efficiency with which farmers are able to utilize the resources at their command. If the farmers are efficient in the use of scare resources then farmers can increase their household income. In Indian agriculture, the availability of resources is not the same all over the country.

In this context, the present paper surveyed and reviewed the major research works on resource use efficiency in agriculture and tries to identify the important research gap for scope for further research in the discipline of resource use efficiency in agriculture. The major works of the resource use efficiency are listed below.

Author(s) Objective Efficiency

Measured Resources Methodology Major Findings

Heady. et.al. (1954) To study the Resource returns and productive co-efficient. Land, Labour and Capital Agricultural households selected from Alabama, Northern Iowa, Southern Iowa and Montana in USA by Random sample method. The marginal productivity of labour on crop and livestock were significant in Iowa and Alabama. Capital returns were significantly greater than the cost of capital for crops in Montana and Southern Iowa.

Desai (1963) To study the increasing income and production on Indian agriculture. Resource use including agricultural techniques 40 agricultural households selected from Ahamed Nagar and Nasik districts in Maharastra State by Random sample method. The study concludes that the intensity of resource use which was not relevant to its resource endowment of the farmers.

Khusro (1964) To study the return to scale in Indian agriculture. Owned labour The data obtained from Indian Studies of Economics of Farm Management data from 1954-55 to 1956-57. The main finding of the study was that efficiency of owned labour does not decrease by farm size.

Raj Krishna

(1964) To analyse the allocative efficiency in Indian agriculture. Land, labour, bullock labour, seeds, manure and fertilizer. The data obtained from Indian Studies of Economics of Farm Management data from 1954-55 to 1956-57. The study observed that the bullock labour input was highly correlated with land and manual labour. The mean labour input seems to have been excessive in first two years.

Schultz (1964) To examine the allocative efficiency of traditional agriculture in India. Land, labour, bullock labour, seeds, manure and fertilizer. To test the hypothesis "the poor countries are relatively inefficient in disposal of resources". By using Indian Farm Management Data. This study pointed out that the traditionally the Indian farmers are rational to distribute factors of production.

Author(s) Objective Efficiency

Measured Resources Methodology Major Findings

Acharya (1965) To study the resource productivity and optimum allocation Land, labour, plant and machinery Census method was followed and Queensland sugarcane farmers are surveyed This study concludes that the marginal productivity of plant, labour and machinery decreases and the marginal productivity of fertilizer increases.

Hopper (1965) To analyse the allocative efficiency of traditional agriculture in India. Various input factors and their different uses The data obtained from Indian Studies of Economics of Farm Management data from 1954-55 to 1956-57. Major finding of the study that the decision on allocation is determined by production response, input prices and expected returns of the current agricultural year.

Kuber Ram et.al. (1965) To estimate the relationship between farm management factors and farm income. Various input factors 60 agricultural households surveyed in Kanjhwala block, Delhi by adopting random sampling method. This study concludes that the farm earnings could be increased by increasing labour and capital efficiency and input-output ratio.

Sahota Gian (1968) To study the efficiency of Indian farmers in allocation resources available to them among different production alternative. Human labour, bullock labour, fixed capital, land, seeds, fertilizers and manure and irrigation Secondary

data collected from Indian Farm Management Survey. The study observed that the multidimensional analysis of resource allocation indicates comparatively few significant inefficiencies of resource allocation in Indian agriculture.

Saini (1969) To explore the resource-use efficiency in different category of farmers in the states of UP and Punjab. Human labour, bullock labour, fixed capital, land, seeds, fertilizers and manure and irrigation Secondary data obtained from Farm Management Studies of UP and Punjab States. The allocation of various input factors depend upon the expected return on the particular crop. Thus, it concludes that the farmers are very rational in the use of their resources.

Author(s) Objective Use-Efficiency

Measured Resources Methodology Major Findings

Sankhyan et.al (1971) To study the resource efficiency in seed potato farms and maize in Himachel Pradesh. Human labour, bullock labour, fixed capital, land, seeds, fertilizers and manure In Mahasu district of Himachel Pradesh 30 farmers were selected by adopting random sampling method. This study concludes that the constant return to scale observed in seed potato and diminishing return observed in Maize. The farm resources within each crop were optimally allocated in the case of seed potato.

Desai (1973) To examine the resource-use in farmers of central Gujarat. Hire labour, fertilizers and manure The farm management data of Baroda district (1968-69) was used

for analysis. This study found that the optimum use of hired labour and sub-optimum use of fertilizer and manure in the region.

Rathore et.al. (1973) To study resource-use efficiency and return from some commercial crops of Himachel Pradesh. Human labour and other inputs 25 farmers from each commercial crop such as potato, ginger, tomato, been and chilli by using random sampling method (1973-74) The study revealed that human labour use alone accounts for more than one third of the total cost in all crops and suggest increasing the bullock labour for reducing the overall cost.

Singh Uma Shankar et.al (1973) To study resource-use efficiency in relation to resource endowments. Various input factors Sample of low income and high income farmers were selected in rural Delhi during 1967-1968. The average farm situation indicated that the high income farm group was more efficient as compared to low income group farmers.

Singh (1975) To analyse the resource-use, farm size and return to scale. Human labour, bullock labour, fixed capital, land, seeds, fertilizers and manure By the random sampling method 150 households were survey ford from 15 villages from Deoria district of UP. The efficiency of bullock labour was greater for small farmers as compared to large farmers. At the same time, the efficiency in fertilizer and manure are greater for the large farmers as compared to small farmers.

Objective Efficiency

Measured Resources Methodology Major Findings

Sampath (1979) To study the nature and measurement of economic efficiency in Indian agriculture. Total economic efficiency in resource-use Secondary data obtained from the farm management survey for Deoria district of UP. The level of economic efficiency in resource-use is greater for the large farmers as compared to small farmers.

Bhardwaj et.al (1980) To compare the resource-use efficiency in Wheat and Maize. Human labour, bullock labour, seeds, fertilizer and manure A total of 84 agricultural households randomly selected in two villages from Ghmrwin District of Himachel Pradesh. The study observed that there was an excess use of bullock labour for wheat and maize in the study area and negative marginal value productivity.

Muraleedharan

(1987) To find out the rsource-use efficiency in Kole lands. Various input factors 142 Kole land holders were surveyed form Trichur district of Keral State. The study indicated that the farmers are inefficient to allocate their inputs. There is considerable scope for augmenting profit from Kole.

Thakur et.al. (1990) To analyse the resource-use, farm size and return to scale on tribal farms. Various factors of production for agriculture Census method was adopted and data

collected from representative tribal village of Himachal Pradesh. This study concluded that the factors of production were not efficiently used. Farm size was important factor to influence the productivity of inputs at farm level cannot be supported.

Bhise et.al (1992) To examine the input use efficiency in energized farms. Various input factors for paddy and sugarcane 120 agricultural households covered from paddy (60) and sugarcane (60) through the random sampling method in Nizambad district of AP. The analysis revealed that the marginal value productivity to opportunity cost ratios for the entire input variable in both crops indicated a high degree of resource-use efficiency.

Author(s) Objective Efficiency

Measured Resources Methodology Major Findings

Chandra Dinesh (1992) To analyse the resource-use efficiency in different irrigated systems. Human labour, bullock labour, seeds, fertilizer and manure and tractor power 100 farmers were surveyed by multi-stage random sampling

in Ghaziabad district of UP. The study observed that human labour, bullock labour and tractor power were used in excess on all the irrigation system.

Raja (1992) To examine the farm size, resource use pattern and productivity in Indian agriculture. Various input factors for paddy cultivation 160 farmers were surveyed by random sampling method from two main blocks of Periyar district, Tamil Nadu.

The results of the study showed that the output elasticity of paddy trends to declined when the farm become larger in size.

Shete et.al (1992) To identify the resource use and input-output relationship of mixed and arable farming. Various input factors The sampling design adopted for the study was two-stage stratified random sampling method. There were 120 households selected in 12 villages of Ahmednagar district of Maharashtra. The study found that the use of all resources was higher on mixed farmers compared to arable farmers in both the irrigated and un-irrigated regions.

Singh et.al. (1992) To explore the input use efficiency in wheat crop.

Various input factors for wheat cultivation 200 sample agricultural households (small, medium and large) selected from the data set of cost of cultivation survey, Haryana State 1980-82. The study identified that there was more use of human labour on small farms. On medium and large farmers, more use of machine labour and less use of human labour has resulted in higher marginal value productivity of human labour.

Author(s)

Objective Efficiency

Measured Resources Methodology Major Findings

Chhotan Singh et.al.

(1994) To explore the resource allocative efficiency on various size of farms. Various input factors for paddy cultivation The data set of "Economics of Farm Mechanization and Agricultural Inputs in Salem District, Tamil Nadu" project used for analysis. The study revealed that expenditure on fertilizer, irrigation and bullock labour significantly increased the farm return on all size of farms.

Krishna Rao

et.al. (1994) To study the resource use efficiency in paddy. Various input for paddy cultivation 240 agricultural households selected from watershed and non-watershed areas in Rangareddy district of AP. The study found that the utilization of human labour, cattle labour and fertilizers were not at optimum level in the case of adopters.

Chandrashekhar et.al. (1996) To examine the resource-use efficiency in groundnut. Land, farm yard manure and seed 100 groundnut farmers were selected from Challakere Taluk of Karnataka state during 1991 agricultural year. The production function analysis revealed that land, farm yard manure and seed in the case of small farmers contributed significantly to the production.

Panda (1996) To explore the relationship between various input use and various tenurial categories. Human labour, bullock labour, fixed capital, land, seeds, fertilizers and

manure and irrigation 165 various categories of tenurial households surveyed from Puri district of Orissa. The study indicates that the land ownership has a limited impact on use and crop productivity.

Raja (1996) To analyse the resource efficiency in the context of technology change. Various input for tobacco cultivation 150 tobacco farmers surveyed from four villages in Edapadi panchaya of Salem distict. The excessive or indiscriminate use of pesticides in turn leads to a decline in productivity of tobacco in most of the farmers.

Author(s) Objective Efficiency

Measured Resources Methodology Major Findings

Venketaraman

et.al. (1996) To examine the resource efficiency in tomato cultivation. Various input for tomato cultivation 150 tomato farmers surveyed from Kolar district of Karnataka State. The study pointed out that the large farmers are underutilized the fertilizers, human labour and animal labour

Koppad et.al.

(1997) To analyse the resource efficiency in maize cultivation. Various input for maize cultivation 120 farmers surveyed from head, mid and tail reach of the

Malaprabha Command Area of Karnataka. The study concludes that the land, manures and fertilizers were over utilized in head reach and underutilized in mid and tail reach.

Velavan et.al. (2000) To examine the resource-use efficiency in groundnut. Various input for groundnut cultivation 120 farmers selected from irrigated and un-irrigated regions in Salem district of Tamil Nadu. The study indentified that there is large scope for adding more farm inputs in both irrigated and un-irrigated groundnut cultivation.

Rama Rao et.al. (2003) To examine the technical efficiency of crop production. Technical efficiency of various farm inputs From the Anhdra Pradesh farm management survey three representative districts were chosen for study. The study found that the technical efficiency of production is determined by farmer's education. Therefore, it suggests that motivation of formal and informal education for farmers.

Senthil Kumar et.al (2005) To explore the resource use efficiency in paddy cultivation. Various input factors for paddy cultivation 90 farmers surveyed from head, mid and tail reach of the Lower Bhavani Basin Project (LBP) Command Area of Tamil Nadu. The study suggests that there is scope for further use of various input factors for enhancing the productivity.

Koshta et.al (2005) To analyse the economic efficiency of paddy production. Various input factors for paddy cultivation 202 farm households selected from

irrigated and rainfed regions of Chattisgarh. The cost of cultivation is much higher in irrigated area as compared to rainfed region.

Author(s) Objective Efficiency

Measured Resources Methodology Major Findings

Rangappa et.al. (2005) To examine the resource use efficiency between canal and tank irrigation in paddy cultivation. Various input factors for paddy cultivation The data were collected 48 respondents each from canal irrigated and tank irrigated in Shimoga district of Karnataka. Low productivity of inputs was found with respect to human labour and fertilizer in tank irrigated paddy which might be due to the problems related to water management.

Shanmugam et.al. (2006) To explore the technical efficiency in agriculture production in India. Technical efficiency of various farm inputs Secondary data used from Indian Agricultural Institute during the period of 1990-91. The technical efficiency greatly depends on agro-climatic zones, technological factors and crop mix.

Bhende et. al. (2007) To analyse the technical efficiency of major food and cash crops in Karnataka. Technical efficiency of various farm inputs Secondary data used from University of Agricultural Sciences during the period of 1993-94. Educational achievements of the farm household determine technical efficiency in both food and cash

crops in Karnataka. In addition to that the farm size and technical efficiency are inverse relationship.

Fernandez1 and Peter (2009) To identify the sources of input use inefficiency in sugar cane production. Technical efficiency of various farm inputs A total of 140 respondents were interviewed in Negros Island by using random sampling method. The overall technical efficiency of sugar cane farmers in Central Negros is positively related to farmers' age and experience, access to credit, nitrogen fertilizer application, and soil type and farm size.

Rai et.al. (2011) To measure water use efficiency in Godavari river basin in India. Godavari Water The Chinna Ghanapur and Machavaram important river basin villages were selected for the study and Census method was adopted.Due to the frequent availability and free of cost farmers are inefficiently use the irrigation water for paddy cultivation.

Taiwo et.al. (2011) To study the resource use efficiency in hybrid and traditional maize. Various input factors for maize cultivation 100 farmers in Giwa Local Government Area of Kaduna state was surveyed by random sampling method. There is large scope for increase the resource use in both hybrid and traditional maize cultivation.

Author(s)	Objective	Efficiency Measured Resources	Methodology	Major Findings
Heady. et.al. (1954)	To study the Resource returns and productive co-efficient.	Land, Labour and Capital	Agricultural households selected from Alabama, Northern Iowa, Southern Iowa and Montana in USA by Random sample method.	The marginal productivity of labour on crop and livestock were significant in Iowa and Alabama. Capital returns were significantly greater than the cost of capital for crops in Montana and Southern Iowa.
Desai (1963)	To study the increasing income and production on Indian agriculture.	Resource use including agricultural techniques	40 agricultural households selected from Ahamed Nagar and Nasik districts in Maharastra State by Random sample method.	The study concludes that the intensity of resource use which was not relevant to its resource endowment of the farmers.
Khusro (1964)	To study the return to scale in Indian agriculture.	Owned labour	The data obtained from Indian Studies of Economics of Farm Management data from 1954-55 to 1956-57.	The main finding of the study was that efficiency of owned labour does not decrease by farm size.
Raj Krishna (1964)	To analyse the allocative efficiency in Indian agriculture.	Land, labour, bullock labour, seeds, manure and fertilizer.	The data obtained from Indian Studies of Economics of Farm Management data from 1954-55 to 1956-57.	The study observed that the bullock labour input was highly correlated with land and manual labour. The mean labour input seems to have been excessive in first two years.
Schultz (1964)	To examine the allocative efficiency of traditional agriculture in India.	Land, labour, bullock labour, seeds, manure and fertilizer.	To test the hypothesis "the poor countries are relatively inefficient in disposal of resources". By using Indian Farm Management Data.	This study pointed out that the traditionally the Indian farmers are rational to distribute factors of production.

Author(s)	Objective	Efficiency Measured Resources	Methodology	Major Findings
Acharya (1965)	To study the resource productivity and optimum allocation	Land, labour, plant and machinery	Census method was followed and Queensland sugarcane farmers are surveyed	This study concludes that the marginal productivity of plant, labour and machinery decreases and the marginal productivity of fertilizer increases.
Hopper (1965)	To analyse the allocative efficiency of traditional agriculture in India.	Various input factors and their different uses	The data obtained from Indian Studies of Economics of Farm Management data from 1954-55 to 1956-57.	Major finding of the study that the decision on allocation is determined by production response, input prices and expected returns of the current agricultural year.
Kuber Ram et.al. (1965)	To estimate the relationship between farm management factors and farm income.	Various input factors	60 agricultural households surveyed in Kanjhwala block, Delhi by adopting random sampling method.	This study concludes that the farm earnings could be increased by increasing labour and capital efficiency and input-output ratio.
Sahota Gian (1968)	To study the efficiency of Indian farmers in allocation resources available to them among different production alternative.	Human labour, bullock labour, fixed capital, land, seeds, fertilizers and manure and irrigation	Secondary data collected from Indian Farm Management Survey.	The study observed that the multidimensional analysis of resource allocation indicates comparatively few significant inefficiencies of resource allocation in Indian agriculture.
Saini (1969)	To explore the resource-use efficiency in different category of farmers in the states of	Human labour, bullock labour, fixed capital, land, seeds, fertilizers and manure and	Secondary data obtained from Farm Management Studies of UP and Punjab States.	The allocation of various input factors depend upon the expected return on the particular crop. Thus, it concludes that the farmers are very rational in

	UP and Punjab.	irrigation		the use of their resources.
Author(s)	**Objective**	**Use-Efficiency Measured Resources**	**Methodology**	**Major Findings**
Sankhyan et.al (1971)	To study the resource efficiency in seed potato farms and maize in Himachel Pradesh.	Human labour, bullock labour, fixed capital, land, seeds, fertilizers and manure	In Mahasu district of Himachel Pradesh 30 farmers were selected by adopting random sampling method.	This study concludes that the constant return to scale observed in seed potato and diminishing return observed in Maize. The farm resources within each crop were optimally allocated in the case of seed potato.
Desai (1973)	To examine the resource-use in farmers of central Gujarat.	Hire labour, fertilizers and manure	The farm management data of Baroda district (1968-69) was used for analysis.	This study found that the optimum use of hired labour and sub-optimum use of fertilizer and manure in the region.
Rathore et.al. (1973)	To study resource-use efficiency and return from some commercial crops of Himachel Pradesh.	Human labour and other inputs	25 farmers from each commercial crop such as potato, ginger, tomato, been and chilli by using random sampling method (1973-74)	The study revealed that human labour use alone accounts for more than one third of the total cost in all crops and suggest increasing the bullock labour for reducing the overall cost.
Singh Uma Shankar et.al (1973)	To study resource-use efficiency in relation to resource endowments.	Various input factors	Sample of low income and high income farmers were selected in rural Delhi during 1967-1968.	The average farm situation indicated that the high income farm group was more efficient as compared to low income group farmers.
Singh (1975)	To analyse the resource-use, farm size and return to scale.	Human labour, bullock labour, fixed capital, land, seeds, fertilizers	By the random sampling method 150 households were survey ford from 15 villages	The efficiency of bullock labour was greater for small farmers as compared to large farmers. At the same time, the

		and manure	from Deoria district of UP.	efficiency in fertilizer and manure are greater for the large farmers as compared to small farmers.
Author(s)	**Objective**	**Efficiency Measured Resources**	**Methodology**	**Major Findings**
Sampath (1979)	To study the nature and measurement of economic efficiency in Indian agriculture.	Total economic efficiency in resource-use	Secondary data obtained from the farm management survey for Deoria district of UP.	The level of economic efficiency in resource-use is greater for the large farmers as compared to small farmers.
Bhardwaj et.al (1980)	To compare the resource-use efficiency in Wheat and Maize.	Human labour, bullock labour, seeds, fertilizer and manure	A total of 84 agricultural households randomly selected in two villages from Ghmrwin District of Himachel Pradesh.	The study observed that there was an excess use of bullock labour for wheat and maize in the study area and negative marginal value productivity.
Muraleedharan (1987)	To find out the rsource-use efficiency in Kole lands.	Various input factors	142 Kole land holders were surveyed form Trichur district of Keral State.	The study indicated that the farmers are inefficient to allocate their inputs. There is considerable scope for augmenting profit from Kole.
Thakur et.al. (1990)	To analyse the resource-use, farm size and return to scale on tribal farms.	Various factors of production for agriculture	Census method was adopted and data collected from representative tribal village of Himachal Pradesh.	This study concluded that the factors of production were not efficiently used. Farm size was important factor to influence the productivity of inputs at farm level cannot be supported.
Bhise et.al (1992)	To examine the input use efficiency in energized farms.	Various input factors for paddy and sugarcane	120 agricultural households covered from paddy (60) and sugarcane (60) through the	The analysis revealed that the marginal value productivity to opportunity cost ratios for the entire

			random sampling method in Nizambad district of AP.	input variable in both crops indicated a high degree of resource-use efficiency.

Author(s)	Objective	Efficiency Measured Resources	Methodology	Major Findings
Chandra Dinesh (1992)	To analyse the resource-use efficiency in different irrigated systems.	Human labour, bullock labour, seeds, fertilizer and manure and tractor power	100 farmers were surveyed by multi-stage random sampling in Ghaziabad district of UP.	The study observed that human labour, bullock labour and tractor power were used in excess on all the irrigation system.
Raja (1992)	To examine the farm size, resource use pattern and productivity in Indian agriculture.	Various input factors for paddy cultivation	160 farmers were surveyed by random sampling method from two main blocks of Periyar district, Tamil Nadu.	The results of the study showed that the output elasticity of paddy trends to declined when the farm become larger in size.
Shete et.al (1992)	To identify the resource use and input-output relationship of mixed and arable farming.	Various input factors	The sampling design adopted for the study was two-stage stratified random sampling method. There were 120 households selected in 12 villages of Ahmednagar district of Maharashtra.	The study found that the use of all resources was higher on mixed farmers compared to arable farmers in both the irrigated and un-irrigated regions.
Singh et.al. (1992)	To explore the input use efficiency in wheat crop.	Various input factors for wheat cultivation	200 sample agricultural households (small, medium and large) selected from the data set of cost of cultivation	The study identified that there was more use of human labour on small farms. On medium and large farmers, more use of machine labour and less

			survey, Haryana State 1980-82.	use of human labour has resulted in higher marginal value productivity of human labour.

Author(s)	Objective	Efficiency Measured Resources	Methodology	Major Findings
Chhotan Singh et.al. (1994)	To explore the resource allocative efficiency on various size of farms.	Various input factors for paddy cultivation	The data set of "Economics of Farm Mechanization and Agricultural Inputs in Salem District, Tamil Nadu" project used for analysis.	The study revealed that expenditure on fertilizer, irrigation and bullock labour significantly increased the farm return on all size of farms.
Krishna Rao et.al. (1994)	To study the resource use efficiency in paddy.	Various input for paddy cultivation	240 agricultural households selected from watershed and non-watershed areas in Rangareddy district of AP.	The study found that the utilization of human labour, cattle labour and fertilizers were not at optimum level in the case of adopters.
Chandrashekhar et.al. (1996)	To examine the resource-use efficiency in groundnut.	Land, farm yard manure and seed	100 groundnut farmers were selected from Challakere Taluk of Karnataka state during 1991 agricultural year.	The production function analysis revealed that land, farm yard manure and seed in the case of small farmers contributed significantly to the production.
Panda (1996)	To explore the relationship between various input use and various tenurial categories.	Human labour, bullock labour, fixed capital, land, seeds, fertilizers and manure and irrigation	165 various categories of tenurial households surveyed from Puri district of Orissa.	The study indicates that the land ownership has a limited impact on use and crop productivity.
Raja (1996)	To analyse the resource efficiency in the context of technology change.	Various input for tobacco cultivation	150 tobacco farmers surveyed from four villages in Edapadi panchaya of Salem distict.	The excessive or indiscriminate use of pesticides in turn leads to a decline in productivity of tobacco in most of the farmers.

Author(s)	Objective	Efficiency Measured Resources	Methodology	Major Findings
Venketaraman et.al. (1996)	To examine the resource efficiency in tomato cultivation.	Various input for tomato cultivation	150 tomato farmers surveyed from Kolar district of Karnataka State.	The study pointed out that the large farmers are underutilized the fertilizers, human labour and animal labour
Koppad et.al. (1997)	To analyse the resource efficiency in maize cultivation.	Various input for maize cultivation	120 farmers surveyed from head, mid and tail reach of the Malaprabha Command Area of Karnataka.	The study concludes that the land, manures and fertilizers were over utilized in head reach and underutilized in mid and tail reach.
Velavan et.al. (2000)	To examine the resource-use efficiency in groundnut.	Various input for groundnut cultivation	120 farmers selected from irrigated and un-irrigated regions in Salem district of Tamil Nadu.	The study indentified that there is large scope for adding more farm inputs in both irrigated and un-irrigated groundnut cultivation.
Rama Rao et.al. (2003)	To examine the technical efficiency of crop production.	Technical efficiency of various farm inputs	From the Anhdra Pradesh farm management survey three representative districts were chosen for study.	The study found that the technical efficiency of production is determined by farmer's education. Therefore, it suggests that motivation of formal and informal education for farmers.
Senthil Kumar et.al (2005)	To explore the resource use efficiency in paddy cultivation.	Various input factors for paddy cultivation	90 farmers surveyed from head, mid and tail reach of the Lower Bhavani Basin Project (LBP) Command Area of Tamil Nadu.	The study suggests that there is scope for further use of various input factors for enhancing the productivity.
Koshta et.al (2005)	To analyse the economic efficiency of	Various input factors for paddy cultivation	202 farm households selected from irrigated and rainfed	The cost of cultivation is much higher in irrigated area as compared to

	paddy production.		regions of Chattisgarh.	rainfed region.

Author(s)	Objective	Efficiency Measured Resources	Methodology	Major Findings
Rangappa et.al. (2005)	To examine the resource use efficiency between canal and tank irrigation in paddy cultivation.	Various input factors for paddy cultivation	The data were collected 48 respondents each from canal irrigated and tank irrigated in Shimoga district of Karnataka.	Low productivity of inputs was found with respect to human labour and fertilizer in tank irrigated paddy which might be due to the problems related to water management.
Shanmugam et.al. (2006)	To explore the technical efficiency in agriculture production in India.	Technical efficiency of various farm inputs	Secondary data used from Indian Agricultural Institute during the period of 1990-91.	The technical efficiency greatly depends on agro-climatic zones, technological factors and crop mix.
Bhende et. al. (2007)	To analyse the technical efficiency of major food and cash crops in Karnataka.	Technical efficiency of various farm inputs	Secondary data used from University of Agricultural Sciences during the period of 1993-94.	Educational achievements of the farm household determine technical efficiency in both food and cash crops in Karnataka. In addition to that the farm size and technical efficiency are inverse relationship.
Fernandez1 and Peter (2009)	To identify the sources of input use inefficiency in sugar cane production.	Technical efficiency of various farm inputs	A total of 140 respondents were interviewed in Negros Island by using random sampling method.	The overall technical efficiency of sugar cane farmers in Central Negros is positively related to farmers' age and experience, access to credit, nitrogen fertilizer application, and soil type and farm size.
Rai et.al. (2011)	To measure water use efficiency in Godavari river basin in India.	Godavari Water	The Chinna Ghanapur and Machavaram important river basin villages were selected for the study and Census method was adopted.	Due to the frequent availability and free of cost farmers are inefficiently use the irrigation water for paddy cultivation.
Taiwo et.al. (2011)	To study the resource use efficiency in hybrid and traditional maize.	Various input factors for maize cultivation	100 farmers in Giwa Local Government Area of Kaduna state was surveyed by random sampling method.	There is large scope for increase the resource use in both hybrid and traditional maize cultivation.

Critical Review of the Literature

The studies on resource use efficiency in agriculture emerged from the 1950's. In beginning period, the studies concentrating on resource return, production and return to scale (Heady et.al. 1954; Khusro, 1964; Desai, 1963). Later, the focuses of the study moved towards the allocative efficiency and income generation in agriculture (Raj Krishna, 1964; Schultz; 1964; Acharya, 1965; Hopper, 1965). Further, the studies reach its peak to study the resource use efficiency in agriculture.

In the case of resource use efficiency, few of the studies analyse the efficiency of farm resources such as human labour, bullock labour, fixed capital, land, seeds, fertilizers and manure. The major crops are potato, maize, wheat and important classifications are tenure and farm size. They conclude that the scope for maximizing the efficiency of farm inputs and explained the role of tenure, farm size and other factors to enhance the recourse use efficiency in agriculture (Saini, 1969; Sankhyan et.al. 1971; Singh, 1975; Bhardwaj et.al; 1980; Chandra Dinesh, 1992; Panda, 1996).

On the other hand, some the scholars studies the resource use efficiency of various farm input of wheat, paddy, groundnut, maize, tomato and tobacco cultivation. These studies explore the role of farmer's education for achieving resource use efficiency in agriculture. Further, they suggests that the implementation of formal and informal farm education in the surveyed agricultural regions. In addition, the gave a suggestions to improve the resource efficiency in various crops (Kuber Ram et.al. 1965; Singh Uma Shankar et.al. 1973; Muraleedharan, 1987; Thakur et.al. 1990; Bhise et.al. 1992; Shete

et.al . 1992; Raja, 1992; Singh et.al. 1992; Chhotan Singh et.al.1994; Krishna Rao et.al.1994; Venketaraman et.al. 1996; Raja, 1996; Koppad et.al. 1997; Velavan et.al. 2000; Koshta et.al. 2005; Senthil Kumar et.al. 2005; Rangappa et.al. 2005; Taiwo et.al. 2011).

The scholars like Desai, (1973), Rathore et.al. (1973), Chandrasekhar et.al. (1996) and Sampath (1979) studied the total economic efficiency of recourses like human labour, fertilizers and manure and other farm inputs. They explain the role of farm size and farmer's economic background for enhancing the resource use efficiency. They concludes that the small farmers and economically well off farmers achieved greater efficiency in various farm inputs in the surveyed regions.

In addition to that some the studies on resource use efficiency specifically analyse the technical efficiency of various farm inputs (Rama Rao et.al. 2003; Shanmugam et.al. 2006; Bhende et. al. 2007; Fernandez1 and Peter, 2009). These studies explore that the role of farmer's education, environmental factors and agro-climatic factor for the attainment of technical efficiency in farm inputs. Only few studies analyse the resource use efficiency in terms of various segments of the surface irrigation such as head, mid and tail reach.

Conclusion

In the critical review of the literature on resource use efficiency in agriculture, majority of the studies analyse the resource use efficiency in maize, paddy, groundnut, wheat, tomato, potato, tobacco and other crops. They analysed the resource use efficiency and total economic efficiency and technical efficiency in various crops and various

agricultural regions. The studies covered major farm inputs such as human labour, bullock labour, fixed capital, land, seeds, fertilizers and manure and irrigation. Though, the studies fail to incorporate the ideologies of resource use efficiency in the context of head, mid and tail reaches of the cannel irrigation. This research gap opens the new avenue of research to conduct the study on economics of resource use efficiency in head, mid and tail reaches.

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