Evaluation of agricultural production efficiency of China as determined by using Data Envelope Analysis (DEA)

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Wang Yuanyuan
PhD, Scholar
Institution: College of Economics and Management, Huazhong Agricultural University, Wuhan, Address: Hubei P.C. 430070, China
E-mail: **wyy271157363@163.com**

Shoaib Ahmed Wagan
Institution: College of Economics and Management, South China Agricultural University
Address: 483 Wushan Road, Tianhe, Guangzhou, 510642, P.R. China.
Institution: Management School, Hainan University, Haikou, China.
Department of Rural Sociology, Sindh Agriculture University Tandojam
Department of Management Science, ISRA University Hyderabad, Sindh, Pakistan
E-mail: **waganshoaib@yahoo.com**

Qurat Ul Ain Memon
Department of Rural Sociology
Institution: Sindh Agriculture University Tandojam, Pakistan
E-mail: **anymemon15@yahoo.com**

Ghulam Hussain Wagan
Department of Agricultural Economics
Institution: Sindh Agriculture University Tandojam, Pakistan
E-mail: **gulwagan79@gmail.com**

He Yucheng*
Professor, College of Economics and Management
Institution: College of Economics and Management, Huazhong Agricultural University, Wuhan, Address: Hubei P.C. 430070, China
E-mail: **hychhzau@163.com**
(*Corresponding author)

Abstract

Agriculture is an important source of economy and livelihood of farming communities in all over the world. It is a fundamental factor of development which support by providing source of food and fiber to the high populated countries of the world such as China. China is feeding world largest portion of population by advancement in agricultural output. The aims to analyse the agricultural production efficiency of China by using Data Envelopment Analysis (DEA). To analyse the agricultural production efficiency the output factors were used agricultural production million tons acquired by using the combination of inputs such as agricultural land million hectares, agricultural labor million workers, agricultural tractors millions and agricultural fertilizer million tons and the data were used during the period of 1978 to 2018. The empirical result represents that during 1978 to 2018 production efficiency levels as economic efficiency, pure achieved by 10 efficient years, similarly, pure technical efficiency achieved by 16 years of efficient level during 1978 to 2018. However, the scale efficiency gained the level of efficiency of 1 by 11 years during period of 1978 to 2018. The study shows the overall agricultural production efficiency of China is considerable at high level due to its' strongly depends on technological use and strict policies of development. The study concluded that for more efficient agricultural production of China occurs with application of new agricultural technology.

Keywords: Agriculture. China. Data Envelopment Analysis. Production efficiency. Technology.

1. Introduction

Agriculture is an important source of economy and livelihood of farming communities in all over the world. It is a fundamental factor of development which support by providing source of food and fiber to the high populated countries of the world. The growth of agriculture sector is the key factor for income growth, poverty alleviation, eradication of hunger (Wagan, et al. 2019; Li. X, Zhang. Y, Liang. L, 2017). The rapid industrialization and urbanization transform agricultural labor to industrial sectors across the world, this transformation adopted earlier in developed countries, however developing countries also emerging in this ongoing transformation, on one hand industrial development support per capita income and on another hand agricultural productivity comes under danger of low production and consequently, low agricultural production created a challenging situation of food insecurity (Lobley, M.; Potter, C. 2004; Bañski, J.; Stola, W. 2002). The economic reform and industrial revolution in China started from 1978 which leads fast movement of labor from agricultural and rural sector to urban and industrial sector. This transformation changes the structure of countries economy from agricultural economy to industrial economy as agricultural land rapidly changing to industrial sector. On the other hand, situation of climate change has affected the agricultural productivity and lost the cultivated land which results disturbance in food productivity, population food demand and consumption of food (Guerra, C.A.; Metzger, M.J.; Maes, J.; Pinto-Correia, T. 2016). This condition demand advanced agricultural and efficient food productivity, to response this situation China has adopted advance technologies and policies to support crucial demand of agricultural and food (Chen T, Rizwan M, Abbas A. 2022). The agricultural productivity has increased with the green revolution technology, per capita production considerably increased by use of high yielding improved seed technology, the irrigation system has developed with canal and water channel system, application of pesticide, chemical fertilizers and new mechanized agricultural practices supported agricultural production (Hazell, 2009; Rosegrant and Hazell 2000). Agriculture sector played a central role to eradicate poverty and cut huger of China. It has been considered as the fundamental factor of China's economy for decades and remains vital for sustainable food security. Figure 01 shows area and production of major crop (grain crops, cotton and sugarcane crop) in China. The agriculture production of China increases with various periods from 1978 with the adoption of advance policies of agricultural development such as subsidy on seed, fertilizers, low taxes or tax reduction policy, agricultural technology and mechanized agriculture with subsidies on purchasing of machinery and marketing policies with suitable price of agricultural output (Thirtle, C, Piesse. J, 2007; Heady, 2011; Yang *et al*. 2008; Yu and Jensen 2010; Wagan *et al.* 2018).

The agriculture development of China has started from 1978 with economic reform of China; the per capita agricultural output growth improved a lot and food demand has fulfilled by domestic production, beside challenge of agricultural and arable land conversion to urban and industrialization purpose high population of the world serious issue in world food demand. The fast growth of urban territories and industrial sector has presents great challenges for agricultural output but the advance technological development i. e. mechanized agricultural system, improvement in plant biotechnology and plant breeding and genetics provide high yielding seed which support remarkable growth in agriculture output.

This per acre yield improvement helps in providing food to 22% of the world population with available 9% of the arable land (Sheng Y, Tian X, Qiao W, Peng C. 2020; Yu J. and Wu J. 2018). The policy of household responsibility system contributed in achievements of agriculture output growth, same way the agricultural marketing system started operations through state and local government, the agricultural output growth was achieved by 5.3% per year in the period of 1978 to 2017 which is two times higher from previous period of 1952 to 1977 (Huang and Rozelle 2018). The food grains production has increased by 7.7 percent which is recorded as from 304.8 million tons to 407.3 million tons from 1979 to 1984, this progress has been possible with improvement in production technology and technical efficiency which enable China to meet about 95 percent of domestic food demand by its domestic cultivation (Wagan et al 2018; Sheng, Y., Tian, X., Qiao, W., & Peng, C. 2020). However, the productivity of agricultural output was lowers down as from 512.3 million tons to 430.7 million tons during 1998 to 2003 because of the environmental changes and the high cost of production, considering these issues Chinese government has given subsidies such as grain subsidy, necessary input purchase subsidy, subsidy on high yielding advance quality seed, machinery purchase subsidy and reduction in taxes which enhanced agricultural production by 601.9 million tons (Liu *et al* 2015; Sheng, Y., Tian, X., Qiao, W., & Peng, C. 2020).

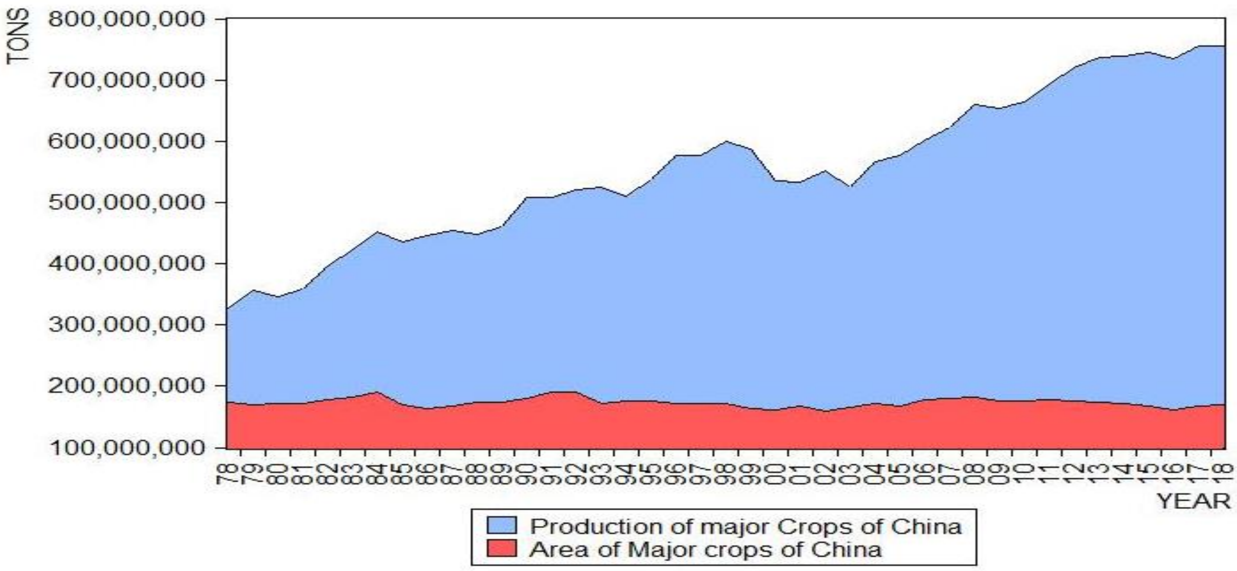

Figure 01: represents the agricultural output of major crops including Grain crops, Cotton, and Sugarcane area of China from 1978 to 2018

Source: Data were obtained from, China statistical year book various and Food and Agriculture Organization

Currently China is producing 18 percent of the world's grain production and about 29 percent to world's meat production and about 50 percent of world vegetable production. The high improvement in the agricultural output supported China as a world's largest agricultural producer country. In terms of grain production China has ranks in the of world as a largest wheat and rice producer country, it also ranks the first position in the world's highest tea and cotton production. In Fish production the China has ranks the highest position in world. In fact, the production of agricultural sector is two times higher then the agricultural output growth of United States of America. This progress becomes possible with advance technological use and mechanized agricultural system (Wagan et. al., 2019; Carter, C.A. 2011)

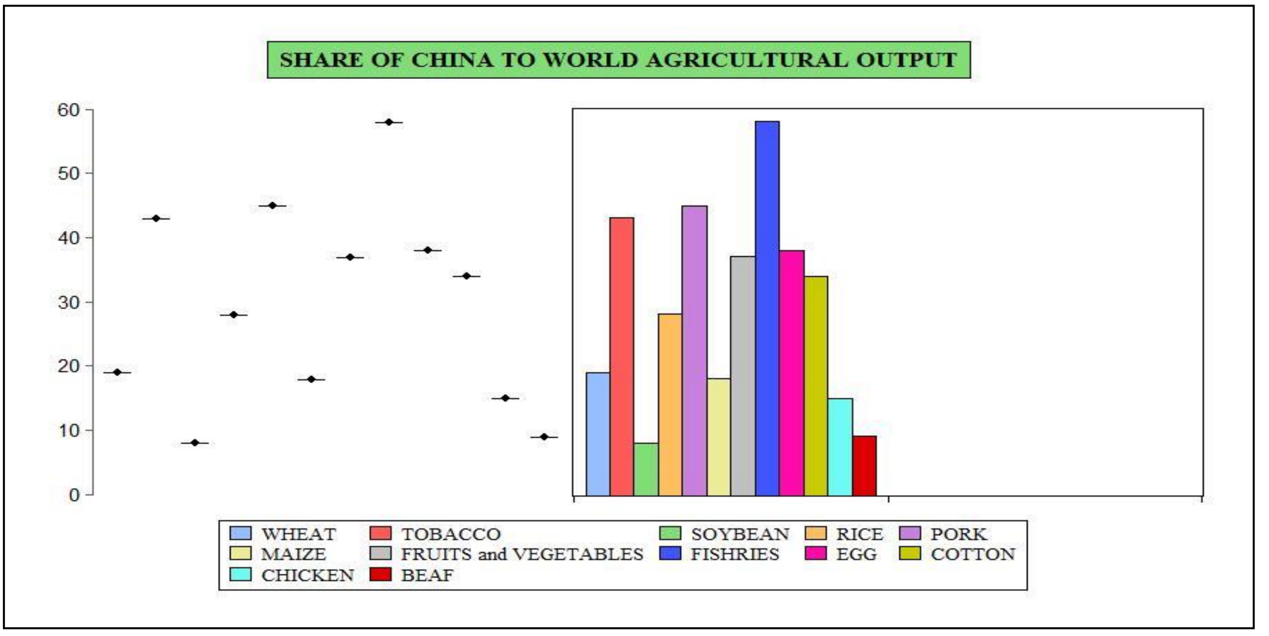

Figure 02: represents the share of agricultural outputs in world agricultural production
Source: Data were obtained from Food and Agriculture Organization (FAO)

Stable agricultural output growth of China has mainly driven by increasing inputs and technology innovations; due to which agricultural production has improved to cut hunger and reduce the poverty (Li, 2013). Although limited land shifts of agricultural labor to non-agricultural sector, the agricultural production continuously increased (Madhur. B, 2015).

Stable growth in agriculture and grain production is not an aim of China to fulfill domestic demand of food but also playing important role in world grain market due to which China has achieved the healthy development (Piessse and Thirtle 2009; Heady 2011; Li. X, Zhang. Y, Liang. L, 2017) The most populous countries of World China trying to improve the agricultural productivity to reduce poverty and remove hunger by achieve standard of living, agricultural growth rate of China is continuously moving at very high level, the production of food crops grow faster than the population growth rate (Madhur, 2015). The present study aims to analyse the agricultural production efficiency of China, with focus find-out results of scale efficiency, economic efficiency and overall efficiency. The present research has contribution in available literature to understand trends of agricultural productivity change and production efficiency of China and effective policies supports production efficiency of China. The rest of the paper is organized as follows. In the subsequent section description of literature review about production efficiency. Section three briefly description of study area. Section four presents methodology and empirical model proposed. Section five presents the results of agricultural production efficiency of China. Section six is main conclusion.

2. Literature Review

McMillan et al. (1989) analyzed the impact of China's economic reforms on agricultural productivity growth. They found that efficiency improvement at the farm household level immediately after the household responsibility system and reform accounted for approximately 40 percent of agricultural output growth between 1979 and 1984. Fuglie and Rada (2018) used the Food and Agriculture Organization (FAO) data to measure the TFP of China's agriculture, forestry and fishery sector as a whole and showed that aggregate TFP in China grew at a rate of 2.7 per cent a year during 1978–2013, accounting for 61.4 per cent of its total agricultural output growth since 1978. They attributed this productivity growth to ongoing technological progress and increased public R&D investment.

Umetsu *et al* (2003) examined the regional difference in total factor productivity, technology and efficiency change in rice sector of Philippine for the post-green era. Results show the gain of production growth was due to introduction of modern seed verities rice seed however decline in growth was due to growing modern rice verities in lowland agricultural system. Investment in infrastructure development, education, increasing the adoption of tractors and favorable ago-climatic environmental condition are the main concerned the production growth.

Chavas (2005) investigated the farm household efficiency: evidence from the Gambia. Efficiency analysis conducted at farm level and household level. Econometric analysis indicates technical efficiency is fairly high due to access on technology of most the farm households, modest results of scale efficiency was found and allocative inefficiency by contrast is found to be important for most of the farm households. Allocative inefficiency caused by limitation in markets for financial capital and nonfarm employment. Armagan *et al.* (2010) estimated efficiency and total factor productivity of crop production at NUTS1 level in Turkey: Malmquist index approach. NUTS (The Nomenclature of Territorial units for Statistics) regions in Turkey were selected as decision making units; to estimate the efficiency and total factor productivity changes during 1994 to 2003 the Data Envelopment Analysis (DEA) and Malmquist productivity index were used. Results reveals there has been decrease in technical efficiency and total factor productivity in regions excludes Western Marmara, the Aegean, the Mediterranean and the East Black Sea Region. The decrease in agricultural production efficiency caused by real price level remained same and the real price of inputs increased regardless the decreasing population economically active in agricultural sector, and the difficulty experienced in integration of the latest technology to the agricultural sector. Lotfi et al (2012) declared the patterns of agricultural development must be optimize constantly and the cash crops efficiency must grow high, particularly the comprehensive growth by the food centered to food and cash crops. Tan and Floros (2012) stated that the high production in traditional agricultural system gain by the use modern technology. Chang *et al* (2014) argued that for high yield of crops the technology is very important factor, adoption of new quality seed and use modern methods of agricultural activity promotes production level. King *et al* (2016) proposed factors of agricultural production system. For enhancement of agricultural production, systematical use of soil, fertilizer, plant nutrition and improved agricultural technology are distinct factors.

Khan. F, Salim. R, Bloch. H. (2014) Nonparametric estimates productivity and efficiency change in Australian Broadacre Agriculture. The empirical results show there is slower growth of total factor productivity due to slower growth in technological progress which is main driver of declining trend of productivity growth. Liu *et at* (2015) analysis the productivity and efficiency change in China`s rice production during new farm subsidy years. Study explores the rice production growth of China, little contributed by technical efficiency changes technical. Farm subsidy on rice farms efficiency has not significant. Improved and upgraded technology may help rice farmers for better rice production. Li. X, Zhang. Y, Liang. L. (2017) analysis the agricultural production input/output efficiency and special disparity in China. Study results indicate the agricultural production inputs has technical efficiency but there is lack of scale efficiency and there has large disparity in east, center and western regions.

Wang, S.L., Tuan, F., Gale, F., Somwaru, A. and Hansen, J. (2013) evaluates the agricultural total factor productivity growth in 1985 to 2007. Their study showed that agricultural production efficiency and total factor productivity growing continuously during economic reform period due the change in agricultural technological progress, agricultural development policies and public intervention in Research and Development support funds and investment in infrastructure development. Ullah, A, Khan. D, Zheng. S. (2017) examine the technical efficiency of peach growers: evidence from Khyber Pathunkhwa, Pakistan. Study results suggested that technical efficiency of peach farmers can be improved by appreciate use of inputs and proper management to avoid production process errors and problem.

Huang, J. and Rozelle, S. (2018). assess the China's 40 years of agricultural development and reform and agricultural production efficiency. They argue that the institutional reforms, market integration, and technological progress, have played an essential role in contributing to the rapid productivity growth in China. The rapid growth in agricultural production is possible with institutional reforms, market integration, technological progress and increase investment of public in Research and Development programs. The improvement in network of roads and railway system promotion of technological diffusion and agricultural and rural marketing system improvement and rural land reform also support a remarkable growth in agricultural output. Guo, X., Lung, P., Sui, J., Zhang, R. and Wang, C. (2021). Evaluated the Agricultural support policies and China's cyclical evolutionary path of agricultural economic growth. They used the nonlinear MS(M)-AR(p) model to distinguish China's agricultural economic cycle into three growth regimes rapid, medium, and low and analyze the probability of shifts and maintenance among the different regimes. They further calculated the average duration of each regime. Moreover, they calculated the growth regime transfers for specific times. In this study, they find that China's agricultural economy has maintained a relatively consistent growth trend with the support of China's proactive agricultural policies. However, China's agricultural economy tends to maintain a low growth status in the long term.

Ma L, Long H, Tang L, Tu S, Zhang Y, Qu Y. (2021) Analysis the spatial variations of determinants of agricultural production efficiency in China. The paper constructs an evaluation index system of China's Agricultural Production Efficiency from the perspective of input–output. The spatial auto-correlation model and econometric model are used to calculate the spatio-temporal evolution characteristics and influencing factors of China's APE in 1990 and 2017. The results show that China's APE level is relatively low, and there are significant spatial differences. The extremely high efficiency regions are distributed in the eastern plains of China; the regions with extremely low efficiency are mainly distributed in the southwest and the western regions of China. The results of the spatial correlation effect show that the H-H agglomeration regions of APE are usually distributed in the eastern coastal areas and northeastern areas, while the L-L agglomeration regions are mainly distributed in the central mountainous areas and the border areas of western Yunnan. From 1990 to 2017, the influencing factors of APE have gradually changed, and showing a more complex trend, mainly including farmland management scale, multiple crop index, rural per capita net income, population density, and precipitation per unit area. Finally, the corresponding policy and suggestions are provided.

Hsu, S.Y., Yang, C.Y., Chen, Y.L. and Lu, C.C. (2023). Analysis the agricultural efficiency in different regions of China. They used the dynamic slacks-based measure (DSBM) and the total-factor agricultural efficiency (TFAE). the efficiency was explored by

30 administrative regions and the eastern, central, and western regions of China from 2012 to 2016. The variable was used as the agricultural land area as the carry-over variable and uses agricultural labor, total agricultural machinery power, rural electricity consumption, agricultural fertilizer use, and agricultural GDP to find-out the efficiency of agricultural production in different regions. Their empirical results show that from 2012 to 2016, the best administrative region in terms of overall agricultural production efficiency in China was the east. In terms of the overall analysis of the region, the east had the highest overall agricultural production efficiency, while the central region had the lowest. The input variable that needed the most improvement was rural electricity consumption, with the largest adjustment in rural electricity consumption being observed in Hebei and Liaoning provinces of the eastern region. Furthermore, from 2012 to 2016, both overall agricultural production efficiency and agricultural GDP showed upward trends. However, adjustments are still needed for other relevant agricultural input variables to effectively allocate resources and improve the overall agricultural production efficiency

3. Study Area

The present study aims to evaluate agricultural production efficiency of China since technological progress and economic reform. China is a great producer and contributor in world food demand and feed world’s largest population by producing different agricultural production from different ago-ecological zones.

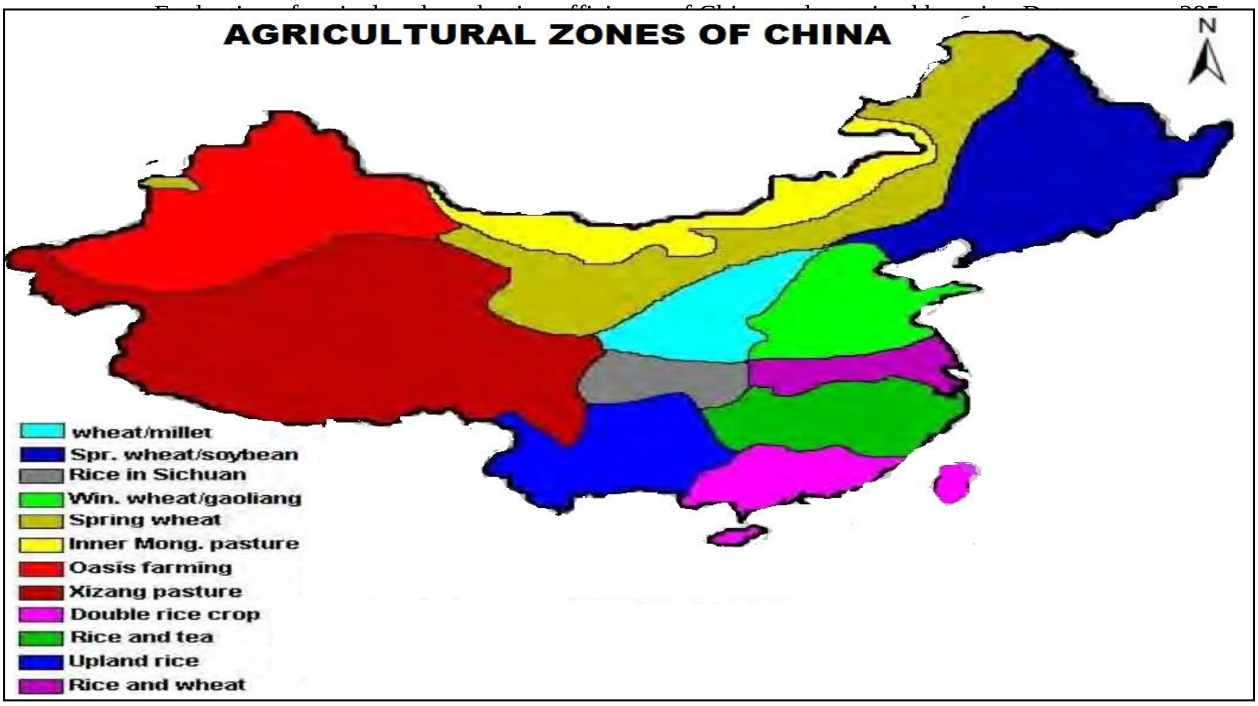

Figure 03: represents Agro-ecological zones of China

China is the world's largest country in term of geography and different climatic conditions. The agro-ecology and cropping regions are divided into wheat and millet producing zone of south, semi-arid zone centeral China. Spring wheat and soybean producing northern zone, Winter wheat/gaoliang producing zone of south eastern zone, double rice cropping zone of eastern China, Rice and tea producing zone of eastern China upland rice producing zone of eastern China, rice and wheat belt of south eastern China, pasture zone of inner Mangolia and pasture zone of semi-humid zone and humid zone. It has tropical monsoon climate and consist whole year rounds cropping as wheat, rice, maize however rice is the main dominant crops on other grain crops (Figure 03).

4. Methodology and empirical model proposed

4.1. Data Envelopment Analysis (DEA) Model

The model of Data envelopment analysis (DEA) was given by Charnes, Cooper and Rhodes during 1978 and the main assumptions are the constant return to scale (CRS), and the assumption of CRS is suitable for decision making units (DMUs) which operates at an optimal scale. In the year of 1984 the Bankler, Charnes and Cooper had introduced the extension of CRS DEA for interpretation of Variable Return to Scale (VRS); DEA model are both either the input oriented or the output-oriented model. Earlier explained as to reduce input at greatest level expended efficiency in the condition of output remains constant, nevertheless, latter-on the evaluation is to increasing output efficiency in the condition where the input resource remains constant (Coelli 1996). In the present study the agricultural production efficiency of China is planned to evaluation; for agricultural production efficiency inputs are easier control. Thus, we used Variable Return to Scale (VRS) input-oriented DEA in paper to analyses the agricultural production efficiency.

There are n DMUs for a given time period, and Xi and Yr are the input and output vectors for the given DMU with m inputs and s output respectively.

Xj = (X1j, X2j,…, Xmj)T, Yj = (Yij, Y2j, …, Ymj)T j = 1, 2, 3, …, n (1)

While Xij (i=1,2,3,…,m) is the ith input variable of jth DMU; Yrj (j=1,2,3,…s) is rth variable output of jth DMU. The VRS input oriented DEA is given as fallows (Wang, et al, 2012**)**

$$\begin{cases} \min \theta = VD_2 \\ s.t \sum_{j=1}^{n} X_j Y_j \leq \theta X_D \\ \sum_{j=1}^{n} Y_j \lambda_j \geq 1 \\ \sum_{j=1}^{n} \lambda_1 = 1 \\ \lambda_j \geq 0, i = 1,2,3,\ldots,n \end{cases} \quad (2)$$

In equation number 2, the value of efficiency of each DMU represented by θ and the $0 \leq \theta \leq 1$, i.e $\theta = 1$ indicates the technical efficiency of DMU and $\theta < 1$showing technically inefficient of the DMU.

4.2. Data

In this study we used data from various issues of China statistical year book for the period of 1978 to 2018. The ouputof modal is used as agricultural production in million tons and the combination of set of inputs used as agricultural land million hectares, agricultural labor used million persons, number tractors used for agriculture in millions and fertilizer million used tons for the period of 1978 to 2018. The descriptive statistics were used to the variable used for analyzes of the agricultural production efficiency of China. In the results variables the variability across all sample, subsequently all the variables of China have high standard deviation in relation to its mean.

Table 01: Descriptive statistics

Output Variable	**Units**	**Min.**	**Max.**	**Mean**	**Median**	**Std. Dev.**
Agricultural Production	Million Tons	328	755	554	537	122
Input variables	**Units**	**Min.**	**Max.**	**Mean**	**Median**	**Std. Dev.**
Agricultural Land	Million Hectares	160	191	173	172	729
Agricultural Labor	Million Workers	215	391	320	319	461
Agricultural Tractors	Millions	193	238	126	119	731
Agricultural fertilizer	Million Tons	884	612	376	408	167

Authors own calculations by using EViews

The results of descriptive statistics show the average agricultural output of major crops is 554 million tons maximum level of output is 755 and minimum was 328 million tons during 1987 to 2018. The recorded inputs used such as agricultural land was an average 173 million hectares, minimum land 160 and maximum was 191 million hectare, the average agricultural labor were recorded as 320 millions in which the maximum level were 391 and minimum were 215 million, The average number of agricultural tractors were 126 million, the minimum number were 193 and maximum tractors were recorded as 238 million; the average fertilizer used for agricultural production were recorded as 3764 million tons, the maximum number were 884 million tons and 612 million tons were recorded as minimum level of fertilizer used in China during 1978 to 2018 (Table 01).

5. Results

5.1. Results of Agricultural Production efficiency of China

The results of Data Envelopment Analysis (DEA) show the different efficiency level of agriculture of China as presented in table 02. The results show that during study period from 1978 to 2018 the agricultural production efficiency of China was efficient in 1978 and 1979 the agricultural production relatively efficient; economic efficiency, pure efficiency and scale efficiency all values were 1. Likewise, the efficiency of agriculture production was efficient in 1983, 1984, 1985, 1986, 1996, 2015, 2016 and 2018 the value of economic efficiency, pure technical efficiency and scale efficiency were recorded as one during these years. Overall, the results show economic efficiency, pure technical efficiency and scale efficiency; from 1978 to 2018 the agricultural production in such 10 years is comparatively favorable in term of production without insufficient input dissolution and misuse of inputs. Agricultural production efficiency of remaining years is comparatively inefficient representing the agricultural production not reached at best point of production while optimization level of agricultural production inputs could be applied. However, the results of pure efficiency highlights that during period of 1978, 1979, 1983, 1984, 1985, 1986, 1987, 1990, 1996, 1998, 1999, 2002, 2013, 2015, 2016 and 2018 the value pure technical efficiency were comes as one which enlightens that in these years the agricultural production affective optimum; the progress of agricultural production strongly depend on agricultural technology which sustained the agricultural production, however the except these years the remaining years results shows the pure technical efficiency of agricultural production is less than 1 which presents the weaker dependency of agricultural production on technology but mostly depends on natural resource inputs. Likewise, the results of scale efficiency represented from table 02 shows that during 1978, 1979, 1982, 1983, 1984, 1985, 1986, 1996, 2015, 2016, and 2018 the scale efficiency appears as 1 which means unchanged return to scale of such period; the agricultural production inputs of such years achieving the best combination and the years of 1980, 1981, 1988, 1989, 1993, 1994, 1995, 1997, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2006, 2007, 2009, 2010 and 2017 reveals increasing return to scale; the agricultural production gains at optimum level is increasing greater than the input used, therefore increasing of agricultural output continuously acquiring by increasing agricultural production inputs. Results also shows that during 1987, 1990, 1991, 1992, 1998, 2008, 2011, 2012, 2013 and 2014 the scale efficiency of is less than 1 showing decreasing return to scale explained as the output agricultural is increasing less than its input used. Thus, the increasing use of agricultural inputs result not optimized production of output so that to acquire more return to scale, it is important to increase the production technical efficiency of agriculture. For analysis of inputs dimensions, we used input orientated DEA, it mainly concerns to combination inputs used to analyses efficiency of output. Theoretically the combination of inputs increases the output production in China results shown in table 02

Table 02: Analysis of input-oriented DEA for agricultural production efficiency of China

Year	Economic Efficiency	Pure technical Efficiency	Scale Efficiency	Output Results
1978	1.00	1.00	1.00	Crs

1979	1.00	1.00	1.00	Crs
1980	0.94	0.99	0.95	Irs
1981	0.94	0.98	0.96	Irs
1982	0.99	0.99	1.00	Crs
1983	1.00	1.00	1.00	Crs
1984	1.00	1.00	1.00	Crs
1985	1.00	1.00	1.00	Crs
1986	1.00	1.00	1.00	Crs
1987	0.99	1.00	0.99	Drs
1988	0.94	0.94	0.99	Irs
1989	0.93	0.94	0.99	Irs
1990	0.97	1.00	0.97	Drs
1991	0.92	0.94	0.98	Drs
1992	0.92	0.95	0.97	Drs
1993	0.98	0.98	0.99	Irs
1994	0.92	0.94	0.98	Irs
1995	0.94	0.96	0.98	Irs
1996	1.00	1.00	1.00	Crs
1997	0.98	0.98	0.99	Irs
1998	0.99	1.00	0.99	Drs
1999	0.99	1.00	0.99	Irs
2000	0.91	0.99	0.91	Irs
2001	0.87	0.96	0.91	Irs
2002	0.92	1.00	0.92	Irs
2003	0.85	0.97	0.87	Irs
2004	0.87	0.93	0.93	Irs
2005	0.88	0.95	0.93	Irs
2006	0.88	0.91	0.97	Irs
2007	0.88	0.90	0.99	Irs
2008	0.92	0.93	0.99	Irs
2009	0.91	0.92	0.98	Irs
2010	0.91	0.92	0.98	Irs
2011	0.93	0.92	0.99	Drs
2012	0.96	0.97	0.99	Drs
2013	0.98	1.00	0.98	Drs
2014	0.98	0.99	0.99	Drs
2015	1.00	1.00	1.00	Crs
2016	1.00	1.00	1.00	Crs
2017	0.91	0.92	0.98	Irs
2018	1.00	1.00	1.00	Crs

Authors own calculation by using DEAP 2.1

5.2 Analysis input redundancy on the basis of input indicators

Study used Input oriented DEA to apply and analyse input redundancy on the basis of input indicators of China. The study findings shows that during 1980, 1981, 1982, 1988, 1989, 1992, 1993, 1994, 1995, 1997, 2000, 2001, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013 and 2014 appears different value of input redundancy, but years of 2012, 2013 and 2014 are at the stage of increasing return to scale which reveals such year could not develop potential of return to scale possibly because of small input scale or further enhancement of technical efficiency, while the production redundancy appears in remaining years because of large production input scale in China table 03.

Table 03: Input redundancy analysis on the basis of input indicators of China

Year	Land	Labor	Tractor	Fertilizer
1978	0.00	0.00	0.00	0.00
1979	0.00	0.00	0.00	0.00
1980	0.00	0.00	0.00	1015975.13
1981		1391505.08		1010528.77
1982	37479.45	4414569.10	0.00	775154.29
1983	0.00	0.00	0.00	0.00
1984	0.00	0.00	0.00	0.00
1985	0.00	0.00	0.00	0.00
1986	0.00	0.00	0.00	0.00
1987	0.00	0.00	0.00	0.00
1988	0.00	0.00	568929.98	0.00
1989	0.00	0.00	400034.79	0.00
1990	0.00	0.00	0.00	0.00
1991	0.00	0.00	0.00	0.00
1992	131216.46	48757635.98	0.00	0.00
1993	0.00	36567426.36	0.00	.00
1994	0.00	12040453.81	0.00	2032835.72
1995	0.00	1362628.56	0.00	1626888.16
1996	0.00	0.00	0.00	122864.00
1997	0.00	0.00	0.00	400706.71
1998	0.00	0.00	0.00	0.00
1999	0.00	0.00	0.00	0.00
2000	0.00	0.00	0.00	16832.59
2001	0.00	0.00	0.00	483611.96
2002	0.00	0.00	0.00	0.00
2003	0.00	0.00	32779.04	0.00
2004	0.00	0.00	0.00	0.00
2005	0.00	0.00	56223.51	0.00

2006	0.00	0.00	0.00	420572.39
2007	0.00	0.00	0.00	378747.60
2008	0.00	18832011.80	750420.90	0.00
2009	0.00	8721279.01	879768.60	0.00
2010	0.00	3279157.41	943580.24	0.00
2011	0.00	13276997.43	919586.85	0.00
2012	1541940.18	3212607.74	625620.30	0.00
2013	3416041.67	5218617.90	21404.43	0.00
2014	0.00	0.00	0.00	0.00
2015	0.00	0.00	0.00	0.00
2016	0.00	0.00	0.00	0.00
2017	0.00	12040453.81	0.00	0.00
2018	0.00	0.00	0.00	0.00

Authors Own calculation by using DEAP 2.1

5.3. Overview of Agricultural production efficiency of China

The agricultural productivity growth and efficiency of output gains has critically achieved by agricultural innovations and advancement of technological development in all over the world; the policy implication for agricultural development supports the agricultural production efficiency and upgrade the farmers to ensure the strongly growth of agriculture, economic development and social welfare (Stads and Rahija, 2012; Huang and Rozelle, 2010; Li. X, Zhang. Y, Liang. L, 2017).

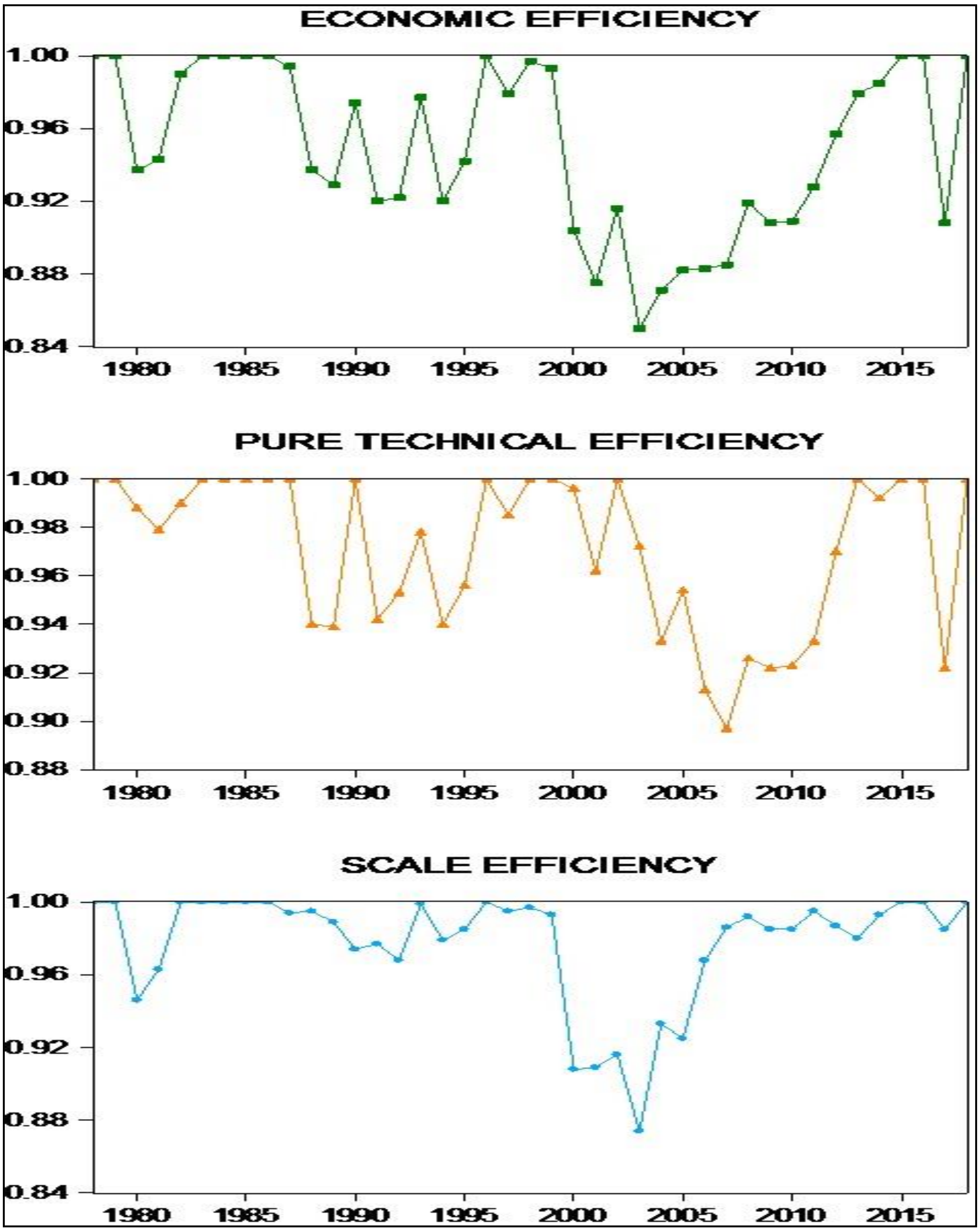

Figure 04: represents comparative efficiency change of agricultural production in China

Authors own work by using EViews

The figure 04 highlights the three stages agricultural production efficiency change of China; The study findings show that during 1978 to 2018 the agricultural productivity and efficiency level varies from 0.84 to 1 level, the highest value of economics efficiency of agricultural production gains by 10 times during these 10 ten years the agricultural productivity of China achieved efficient level of output. Similarly, pure technical efficiency achieved the efficient level of agricultural output by 15 years and Scale efficiency achieved by 11 times value of 1 and represents the efficient level of output (Figure 04). Overall, study result shows that in China the agricultural production efficient due to use of advance technology and modern growing practices and supportive agricultural development policies of China.

6. Conclusion

The present study investigated the agricultural production efficiency of China during period of 1978 to 2018. The three levels of agricultural production efficiency such as economic efficiency, pure technical efficiency and scale efficiency were analyzed by used DEAP 2.1. the study findings indicates that during 1978 to 2018 Chinese agricultural production efficiency score gains 10 times the value of 1 which represents in such years the agricultural output achieved at efficient level; similarly, the results of pure technical efficiency uncover the facts as about 15 years value appears 1 which clarifies such years the agricultural production affective and optimized, the growth of agricultural production strongly depends on agricultural technology due to which continuously agricultural production level achieved at optimized level and the findings of scale efficiency enlightens during study period of 1978 to 2018 about 11 years value appears as 1 which means in such years the agricultural production inputs achieving the best combination of gaining optimum level of output. Comparatively China has considerable agricultural production efficiency level with used of advance technology and strict development policies. Therefore, the present study concludes that achieving considerable agricultural production efficiency level due to its strong dependence on technology; so for more improvement of agricultural production achieved by strong policies implications.

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