Research Journal of Agriculture and Forestry Sciences ISSN 2320– 6063
Vol. 8(3), 41-47, July (2020) Res. J. Agriculture and Forestry Sci.

A meta-analysis of economic efficiency in crop production in Ethiopia

Mustefa Bati
Agricultural Economics Department, Haramaya University, Ethiopia
mustefabi1@gmail.com

Available online at: www.isca.in, www.isca.me
Received 29th April 2020, revised 30th May 2020, accepted 3trd July 2020

Abstract

Though enormous researcher were conducted their study on economic efficiency in crop production, they found significant differences in mean economic efficiency scores and sign of important explanatory variables. Thus, this study aimed at determining the sources of differences in the overall mean economic efficiency estimates among crop production studies in Ethiopia using a meta-regression analysis based on 19 studies published from 2005-2019. The result of descriptive statistics revealed a significant inefficiency in crop production in the country. Accordingly, the overall average technical, allocative and economic efficiencies of reviewed empirical studies were 76%, 61% and 47% percent, respectively, indicating available prospects in enhancing economic efficiency in crop production in Ethiopia. Consequently, it also implies that output can be increased by 24 percent or cost can be reduced by 53 percent given the existing level of technology and resources. The econometrics results of meta-analysis also pointed out that out of twelve independent variables incorporated in the Tobit model method of efficiency estimation, number of independent variables, mean technical efficiency score, mean allocative efficiency score, type of model, method of efficiency estimation and dummy 2015 were found to affect mean economic efficiency of empirical studies positively and significantly where as type of crops, functional form and number of inputs were found to affect it negatively and significantly. Thus, there were a room to decrease variation among mean economic efficiency estimates if researches and academicians set out strategies directed towards the above mentioned causes of variations. Besides, this paper determines the causes of variations for economic efficiency in crop production only. Thus, it further call up other researchers and academicians to made further analysis on economic efficiency of agricultural production as a whole covering large number of studies and wide geographic areas.

Keywords: Meta-regression analysis, Tobit, Translog, Random effect.

Introduction

Agriculture is the corner-stone of Ethiopian economy that accounts for 36.3% of GDP, employees 73% of labour force and over 70% of exports earning[1]. However, its performance has been unsatisfactory and unable to meet the ever increasing demand of the increasing population[2]. Thus, in order to enhance production and productivity a number of scholars have conducted their studies on economic efficiency of agricultural production in general and crop production in particular. However, based on economic efficiency scores, they reached with different conclusions. Thus, some have revealed high scores[3-8] while others have revealed low scores[9-12,2]. These differences are accounted due to variations in the types of crops, study area, sample size and number of explanatory variables[13], type of data used, region where the studies were undertaken and type of methodology[14,15].

In Ethiopia there were few studies that were conducted on efficiency using meta-analysis. However, their scope is limited to the analysis of technical efficiency. Consequently, it was only the work of Hassen and VPS Arora[13] that was conducted their study on meta analysis of agricultural production. Thus, no similar statistical study has been conducted on the stated topic. So, the aim of this paper is, to determine the causes of variations in Economic efficiency estimates among Ethiopian crop production studies using meta-analysis. Furthermore, the main research questions of the study were: i. What are the main causes for variations in Economic efficiency estimates among crop production studies in Ethiopia? ii. What are the magnitude of influence of study's characteristics on overall mean economic efficiency in the country?

Efficiency Methodologies and Meta-analysis review: The concept of economic efficiency, was initially proposed by Farrell[16]. According to him, technical efficiency (TE) is the firm's ability to produce maximum output from a set of inputs, allocative efficiency (AE) is the measures of firm's ability in selecting the optimal input combinations and economic efficiency as a product of the two.

Economists have developed and used various methodologies of efficiency measurements. Among those measurements' it is basically undertaken by using stochastic production fronteir[17]. Stochastic production frontier can be parametric, which can determined using econometric methods or non-parametric, which use linear programming method to construct a non-parametric 'piece-wise' surface over the data[18].

Meta-analysis is a method of combining the finding of various studies, investigate variations and synthesize outlines[15].

It is used to examine the causes of variations in the finding among studies than to develop an overall estimate[19]. Initially, Meta-analysis studies was conducted on agricultural technical efficiency for the first time by Thiam *et al*[20]. Later on, Bravo *et al.*[21] and Ogundari and Brummer[22] also conducted their study on technical efficiency of developed and developing country farming and Nigerian agriculture, respectively. In Ethiopia, it were the finding of Tesfaye and Tadele[15] and Geffersa *et al.*[23] that were conducted their study technical efficiency using meta-regression analysis. Besides, it was only study by Hassen and VPS Arora[13] that conducted their study on meta-analysis of economic efficiency in agricultural production. Almost all of them were undertaken their study using meta-regression techniques, which is used to investigate the consequences of study-specific characteristics on published empirical findings[24].

Methodology

Methods of Data Extraction and Data: Methodology employed in this paper follows similar method of meta-analysis with that of Bravo *et al.*[21], Tesfaye and Tadele[15] and Hassen and VPS Arora[13]. The studies used for this analysis were assembled from a number of sources. The primary studies used for this meta-analysis were compiled from various sources. Among them, a Google scholar, portal of Science-hub, Z-Libraries and Haramaya University's Library services web were the major ones. To boost reliability of the paper, thesis and dissertation work were excluded from the data. Accordingly, a total of 19 published empirical studies on economic efficiency of crop production that were published from the year 2005 to 2019 were extracted for analysis.

Variables and their Descriptions: After a thorough review of previous studies on meta-analysis of efficiencies, the following variables were hypothesized to affect the overall mean of economic efficiency.

Economic efficiency Score (EE): It was represented by the average economic efficiency reported and was the dependent variable for this particular meta-analysis.

Crop type (CT): It was a discrete variable and considered as one if article was conducted on food crops and zero, otherwise.

Study region (SR): It was also a discrete variable and considered as one if article was conducted in Oromia region and zero, otherwise.

Sample Size (SS): It refers to the number of observation in primary study.

Method of Efficiency estimation (MEE): It was a discrete variable and took the value of 1 if article used Stochastic production frontier (parametric) and 0 if Data Envelopment analysis (non-parametric).

Number of explanatory variables (NEV): It was a continuous variable and refers to the amount of independent variables in primary study.

Technical efficiency (TE): It was the average technical efficiency reported.

Allocative efficiency (AE): It refers to the average allocative efficiency reported.

Functional form (FF): It was a discrete variable and took the value of one if the studies were applied Cobb-Douglas production function and zero if it was undertaken by using Translog functional form.

Type of model (TM): It was also a discrete variable and given number one if article were applied Tobit and zero if it was used ordinary least square (OLS).

Number of inputs (NI): It refers to the total number of inputs in primary study.

Dummy 2015 (D2015): It was a discrete variable and provided a value of one if article conducted in the year 2015 and zero, otherwise.

Dummy 2005 (D2005): It was also a discrete variable and taken as 1 if article conducted in the year 2005 and 0, otherwise.

Method of Data Analysis: This paper employed descriptive statistics and econometrics model to analyze the data that were extracted from different studies. Accordingly, in descriptive part mean, standard deviation, percentage and t-test were used to test for overall mean difference. In econometric analysis, given the range of efficiency score between zero and one, two-limit Tobit model were used. Hence, for this empirical investigation, the following model is estimated:

$$\mathrm{EEEE} = (\mathrm{CT, SR, SS, MEE, NEV, TE, AE, FF, TM, NI, D2015, D2005}) \qquad (1)$$

Where: EE represents mean economic efficiency, CT is crop type, SR is study region, SS is sample size, MEE is method of Efficiency estimation, NEV is number of explanatory variables, TE is the mean technical efficiency, AE is the mean allocative efficiency, FF is functional form, TM is the type of model, NI is the number of inputs, D2015 and D2005 are dummy 2015 and 2005, respectively.

With this specified explanatory variables, the two-limit Tobit model is specified as:

$$EE_i^* = \beta_0 + \sum \beta_i X_i + \mu_i \qquad (2)$$

$$EE_i = \begin{cases} 1, if\ EE_i^* \geq 1 \\ EE_i^*, if\ 0 < EE_i^* < 1 \\ 0, if\ EE_i^* \leq 0 \end{cases}$$

Where: X_i and β_i represents explanatory variables and parameters estimated and μ_i is the disturbance term.

Results and discussion

Descriptive Statistics Results: The summary of study specific characteristics on economic efficiency of crop production were described using the following Table-2.

The mean economic, technical and allocative efficiency scores were 0.47, 0.76 and 0.61, with standard deviation of 0.14, 0.07 and 0.20, respectively (Table-2). Thus, the higher value of standard deviation for allocative efficiency revealed that there was relatively high variation in mean allocative efficiency than technical and economic efficiency. Consequently, the value of t test for technical efficiency is higher than economic and allocative efficiency (Table-2).

Thus, farmers in the country obtained higher technical efficiency level than economic and allocative efficiency. Similarly, the average number of sample size, independent variables and number of inputs included in the model were 188, 7.40 and 5.52 with a standard deviation of 125.44, 2.48 and 1.26, respectively. It also revealed that out of 19 total empirical studies reviewed 89.5% of them were used stochastic production frontier (parametric model) whereas the remaining 10.5% were used DEA (non-parametric model). Consequently, the value of t test also confirmed the variation of mean economic efficiency due to variations in efficiency estimation method used. Besides, as a functional form, majority (84.2%) of them were used Cobb-Douglas production functional form. Consequently, as indicated by the value of t test, mean Economic efficiency also varied due to the variation in the type of functional form. Moreover, of the total studies reviewed, 89.5% of them were used Tobit model while only 10.5% were used OLS. Similarly, the value of t test again revealed that variations in the type of model used led to variability in mean Economic efficiency.

Table-1: Overview of empirical studies taken for the analysis.

First author	Crop type	Year	Study area	Sample Size	TE (%)	AE (%)	EE (%)
Hika Wana	Sesame	2018	Oromia	124	75.16	72.95	53.95
Berhan Tegegne	Onion	2015	Amhara	200	79.7	59.91	47.745
Mustefa Bati	Maize	2017	Oromia	240	81.78	37.45	30.62
Getachew Wollie	Barley	2018	Amhara	123	70.9	68.6	48.8
Kifle Degefa	Maize	2017	Oromia	124	82.93	66.03	54
Gosa Alemu	Sorghum	2016	Amhara	130	74	44	32
Musa Hassen	Maize	2015	Oromia	138	84.87	37.47	31.62
Mustefa Bati	Coffee	2017	Oromia	200	71.71	14.13	10.12
Desale Gebretsadik	Sesame	2017	Tigray	126	71	90	64
Sisay Debebe	Maize	2015	Oromia	385	62.3	51.7	39
Musa Hasen	Maize	2018	Oromia	480	82.24	37.07	28.97
Ermiyas Mekonnen	Sesame	2015	SNNPR	120	67.1	67.25	45.14
Beneberu Teferra	Wheat, faba bean and lentil	2018	Amhara	480	77	69	53
Tolesa Tesema	Maize	2019	Oromia	154	71.65	70.06	49.89
Milkessa ASFAW	Wheat	2019	Oromia	152	78	80	63
Tsegaye Melese	Rice	2019	SNNPR	148	78.5	80.56	63.18
Jema Haji	Vegetable	2006	Oromia	150	91	60	56
Arega	Traditional maize	2005	Oromia	47	68	83	56
Arega	Hybrid maize	2005	Oromia	51	78	77	61

Table-2: Summary of variables used in meta-analysis.

Variables	Mean	Std. Deviation	% of the mean with Dummy=1	% of the mean with Dummy=0	Min	Max	t-value
Mean economic efficiency	0.47	0.14	-	-	0.10	0.64	14.031
Mean technical efficiency	0.76	0.07	-	-	0.62	0.91	47.545
Mean allocative efficiency	0.61	0.20			0.14	0.90	13.578
Sample Size	188	125.44	-	-	47	480	-
Number of explanatory variables	7.40	2.48	-	-	5	13	-
Number of inputs	5.52	1.26	-	-	4	8	-
Method of Efficiency estimation			89.5	10.5	-	-	12.369
Functional form			84.2	15.8	-	-	9.798
Type of model			89.5	10.5	-	-	12.369
Dummy 2015			21.1	78.9	-	-	2.191
Dummy 2005	-	-	10.5	89.5	-	-	1.455
Crop type	-	-	68.4	31.6	-	-	6.245
Study region	-	-	78.9	21.1	-	-	8.216

Table-2 also further revealed that on average, 21.1 and 10.5 of the studies were conducted in the year 2015 and 2005, respectively. Consequently, the value of t-test also pointed out that the overall mean Economic efficiency of the year 2015-2019 were more efficient than the year 2005-2014. Thus, yearly variation created variations in the mean economic efficiency. Finally, Table-1 also revealed that 68.4% and 78.9% of the studies were conducted on food crops and in Oromia region as opposed to other crops and regions, respectively. Likewise, Oromia region were more economically efficient in crop production than other regions. Thus, crop and regional variability led to variations in mean economic efficiency.

Econometric Results: A test were made for multicollinearity, omitted variable, normality and heteroskedasticity before estimating the model. The test result showed that there were no severe multicollinearity, omitted variable (PV=0.4179) and heteroskedasticity problems (PV=0.7993) in the data set. The analysis was made by using SPSS 20 and STATA 14 statistical Softwares.

The result of marginal effect of Tobit model revealed that of the total 12 variable used in the model, 9 of them were found to be statistically significant in affecting the mean economic efficiency scores (Table-3). Tobit and OLS estimates were compared in Table-3. Accordingly, OLS estimates generate different result to that of Tobit model. This was mainly due to the difference in standard errors. Thus, in methodological point of view, Tobit model is more appropriate than OLS. The discussion of each of significant variable of Tobit model are presented as follows:

Crop type: It is a significant and has a negative impact on average economic efficiency score at 1 percent level of significance. The finding show that studies on food crops generate lower mean economic efficiency estimate than other crops. Thus, majority of the farmers produce crops to maximize their output than maximizing their profit. Similar finding is obtained with that of Bravo *et al.*[21] and Tesfaye and Tadele[15].

Method of Efficiency Estimation: It is a significant and has a positive impact on average economic efficiency score at 5 percent significance level. Thus, parametric models generates higher mean economic efficiency estimates than non-parametric models and become the causes for variability in mean economic efficiency scores.

Number of explanatory variables: It is also statistically significant and has a positive impact on average economic efficiency score at 5 percent significance level. It is in line with the finding of Hassen and VPS Arora[13], which may be because of the fact that both inclusion of irrelevant variables in the model and omission of important variables from the model leads to a series estimation problems.

Mean technical efficiency Score: It is also statistically significant and has a positive impact on average economic efficiency score at 1 percent significance level. However, it contradict with that of Hassen and VPS Arora[13], due to the fact that attaining high technical efficiency have a direct contribution on economic efficiency. Thus, joint intervention is needed to improve the existing level of economic and technical efficiency of crop production.

Mean allocative efficiency Score: It is also positive and statistically significant in affecting average economic efficiency at 1 percent level of significance. Thus, attaining higher allocative efficiency score led to higher economic efficiency and their improvement also required dual intervention.

Functional form: It is a significant and has a negative impact on average economic efficiency score at 5 percent level of significance. Thus, studies that employed Cobb-Douglas functional form generate lower average economic efficiency than that of Translog. Similar finding was obtained with that of Hina and Bushra[25].

Type of model: It is statistically significant and has a positive impact on mean economic efficiency at 1 percent level of significance. Thus, studies that employed Tobit model generate higher mean economic efficiency scores than that of ordinary least square (OLS).

Number of inputs: It is statistically significant and has a negative impact on average economic efficiency at 1 percent significance level. Thus, a rise in the number of inputs by one unit led to a decrease in average economic efficiency by 0.0226 units. However, it s against that of Bravo *et al.*[21], Ogundari and Brummer[22] and Tesfaye and Tadele[15].

Dummy 2015: It is statistically significant and has a positive impact on mean economic efficiency at 1 percent level of significance. Thus, studies published from 2015-2019 years significantly generates higher average economic efficiency than that of 2005-2014, implies that their exist economic efficiency improvements over a years.

Conclusion

This paper aimed at determining the causes of variations in Economic efficiency estimates among crop production studies in Ethiopia. It applied meta-regression analysis on a total of 19 empirical studies that were published from the year 2005-2019.

Table-3: Maximum likelihood estimation results of Tobit and OLS regression.

	Tobit				OLS			
Variables	dy/dx	Std. Err.	Z	P>|z|	Coeff.	Std. Err.	T	P>t
Crop type	-0.0338***	0.0116	-2.9100	0.0040	-0.0229	0.0210	-1.0900	0.3180
Study region	-0.0011	0.0120	-0.0900	0.9280	0.0090	0.0222	0.4100	0.6980
Sample size	0.0000	0.0000	1.1500	0.2500	0.0000	0.0001	-0.0100	0.9900
Method of Efficiency Estimation	0.0870**	0.0430	2.0200	0.0430	0.0317	0.0710	0.4500	0.6710
Number of explanatory variables	0.0051**	0.0025	2.0400	0.0420	0.0046	0.0049	0.9500	0.3810
Mean technical efficiency score	0.7248***	0.1120	6.4700	0.0000	0.5533**	0.1678	3.3000	0.0160
Mean Allocative efficiency score	0.8558***	0.0440	19.4700	0.0000	0.7779***	0.0569	13.6600	0.0000
Functional form	-0.0770**	0.0324	-2.3700	0.0180	-0.0381	0.0551	-0.6900	0.5150
Type of model	0.0657***	0.0238	2.7700	0.0060	0.0410	0.0421	0.9700	0.3680
Number of inputs	-0.0226***	0.0067	-3.3800	0.0010	-0.0170	0.0123	-1.3800	0.2170
Dummy 2015	0.0300***	0.0113	2.6500	0.0080	0.0176	0.0198	0.8900	0.4080
Dummy 2005	-0.0184	0.0182	-1.0100	0.3120	-0.0186	0.0359	-0.5200	0.6220
Cons	-	-	-	-	-0.3982	0.1394	-2.8600	0.0290

Where: *, ** and *** refers to 10%, 5% and 1% significance level, respectively.

The result of descriptive statistics shows that 76%, 61% and 47% were the overall mean levels of technical, allocative and economic efficiency, respectively. In another word, farmers that can produce crop can rise their production on average by 24% when they are technically efficient. In the same manner, they can diminish their expenditure by 53% without any change from optimum level of output. Thus, there exist a chance for an enhancement of efficiencies of crop production in the country.

The econometrics finding of meta-analysis indicate that out of twelve variables included in the Tobit model number of explanatory variables, mean technical efficiency, mean allocative efficiency, type of model, method of efficiency estimation and dummy 2015 were statistically significant and had a positive impact on overall mean economic efficiency while type of crops, functional form and number of inputs were found to affect it negatively and significantly.

The econometric results further revealed that mean economic efficiency varied due to variation in the types of crops. Thus, food crops generate more mean economic efficiency than other crops. Consequently, it also revealed that parametric model generate higher average economic efficiency result than non-parametric ones. Besides, farmers of the country generates higher mean technical efficiency levels than economic and allocative efficiency, confirmed that their primary aim is to enhance their output than maximizing their profit. Furthermore, though a rise in number of explanatory variable rises the mean economic efficiency, a rise in number of inputs led to a decrease in mean economic efficiency. Moreover, studies that employed Tobit model generate higher mean economic efficiency, suggested that the appropriateness of two-limit Tobit model in determining the major determinants.

The result further revealed that, dummy 2015 is more efficient than 2005. Thus, their exist economic efficiency improvement from year to year. This study determine the causes of variations in mean EE for crop production only. Thus, it call up other researchers and academicians to make a further analysis on economic efficiency of agricultural production as a whole covering large number of studies and wide geographic areas.

References

1. UNDP (2018). Ethiopia's progress towards eradicating poverty. Paper to be presented to the inter-agency group meeting on the implementation of the third United Nations decade for the eradication of poverty (2018-2027) Addis Ababa, Ethiopia.

2. Musa Hasen, Aemro Tazeze, Alem Mezgebo and Eden Andualem (2018). Measuring Maize Production Efficiency in the Eastern Ethiopia: Stochastic frontier approach. *African Journal of Science, Technology, Innovation and Development*, 10(7), 779-786. http://dx.10.1080/20421338.2018.1514757.org

3. Arega D. Alene and Rashid M. Hassen (2005). The Efficiency of Traditional and Hybrid Maize Production in Eastern Ethiopia: An Extended Efficiency Decomposition Approach. *Journal of African Economics,* 15, 91-116.

4. Jema Haji (2006). Production Efficiency of Smallholders' Vegetable-dominated Mixed Farming System in Eastern Ethiopia: A Non-Parametric Approach. *Journal of African Economies*, 16(1), 1-27.

5. Kifle Degefa, Moti Jelata and Belaineh Legesse (2017). Economic efficiency of smallholder farmers in maize production in Bako Tibe district, Ethiopia. *Development Country Studies,* 7(2), 80-86.

6. Desale Gebretsadik (2017). Technical, Allocative and Economic Efficiencies and Sources of inefficiencies among Large-scale Sesame Producers in Kafta Humera District, Western Zone of Tigray, Ethiopia: Non-parametric approach. *International Journal of Scientific & Engineering Research,* 8(6), 2041-2061.

7. Milkessa Asfaw, Endrias Geta and Fikadu Mitiku (2019). Economic Efficiency of Smallholder farmers in Wheat Production: The case of Abuna Gindeberet district, Western Ethiopia. *Review of Agricultural and Applied Economics,* 22(1), 65-75.

8. Tsegaye Melese, Mebratu Alemu, Amsalu Mitiku and Nesre Kedir (2019). Economic Efficiency of Smallholder Farmers in Rice Production: The Case of GuraferdaWoreda, Southern Nations Nationalities People's Region, Ethiopia. *International Journal of Agriculture Innovations and Research*, 8(2), 151-167.

9. Sisay Debebe, Jema Haji, Degye Goshu and Edriss A. (2015). Technical, Allocative and Economic Efficiency among Smallholder Maize Farmers in Southwestern Ethiopia: Parametric approach. *Journal of Development and Agricultural Economics*, 7(8), 283-292. http://dx.10.5897/JDAE2015.0652.org

10. Musa H. Ahmed, Lemma Z. and Endrias G. (2015). Measuring Technical, Economic and Allocative Efficiency of Maize Production in Subsistence Farming: Evidence from the Central Rift Valley of Ethiopia. *Applied Studies in Agribusiness and Commerce,* 9(3), 63-74. http://dx.10.19041/APSTRACT/2015/3/9.org

11. Gosa Alemu and Jema Haji (2016). Economic Efficiency of Sorghum Production for Smallholder Farmers in Eastern Ethiopia: The Case of Habro District. *Journal of Economics and Sustainable Development*, 7(15), 44-51.

12. Mustefa Bati, Alemu Ayele, Mulugeta Tilahun and Raja. K. (2017). Studies on Economic Efficiency of Coffee Production in Ilu Abbabor Zone, Oromia Region, Ethiopia. *Journal of Agricultural Economics and Rural Development,* 3(3), 293-306.

13. Hassen Nurhussen and VPS Arora (2019). Meta regression analysis of economic efficiency in farm households in

Ethiopia. *Research Journal of Agriculture and Forestry Science,* 7(4), 1-9.

14. Odeck J. and Bråthen S. (2012). A meta-analysis of DEA and SFA studies of the technical efficiency of seaports : A comparison of fixed and random-effects regression models. *Transportation Research Part A.*, 46(10), 1574-1585.

15. Tesfaye Solomon and Tadele Mamo (2019). A synthesis of Ethiopian agricultural technical efficiency: A meta-analysis. *African journal of agricultural research*, 14(9), 559-570.

16. Farrell M.J. (1957). The measurement of Productive Efficiency. *Journal of Royal Statistical Society*, 120(3), 253-281.

17. Coelli T.J., Rao D.P. and Battese G.E. (1998). An introduction to Efficiency and Productivity Analysis. Kluwer Academic Publishers. Springer Science: New York.

18. Coelli T.J. (2005). An introduction to Efficiency and Productivity Analysis. Kluwer Academic Publishers, Boston.

19. Card N.A. (2012). Applied Meta-Analysis for Social Science Research. Todd D. Little, Ed. New York, London: The Guilford Press.

20. Thiam A., Bravo-ureta B.E. and Rivas T.E. (2001). Technical efficiency in developing country agriculture: a meta-analysis. *Agricultural Economics*, 25, 235-243.

21. Bravo-Ureta B.E., Solís D., Moreira V., Maripani J., Thiam A. and Rivas T. (2007). Technical efficiency in farming: A meta-regression analysis. *Journal of Productivity Analysis*, 27, 57-72.

22. Ogundari K. and Brümmer B. (2011). Technical Efficiency of Nigerian Agriculture A meta-regression analysis. *Outlook on Agriculture*, 40(2), 171-180.

23. Geffersa A., Frank W. and Amir M. (2019). Technical Efficiency in Crop Production across agro-ecological zones in Ethiopia: A meta analysis of frontier studies. *Outlook on Agriculture*, 1–11.

24. Alston J.M., M.C. Marra, P.G. Pardey and T.J. Wyatt (2000). Research Returns Redux: A Meta Analysis of the Returns to Agricultural R & D. *The Australian Journal of Agricultural and Resource Economics*, 44 (2), 185-215.

25. Hina F. and Bushra Y. (2016). Efficiency and Productivity Analysis of Pakistan's Farm Sector: A Meta-analysis. *Pakistan Journal of Agricultural Research*, 29(3), 312-322.