

Review Article

Effect of Land Fragmentation on Technical Inefficiency of Malt Barely Production in Ethiopia: Meta-analysis

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Abstract

The review of literature on the impact of land fragmentation on malt barley production technical inefficiency in Ethiopia. Farmers produce farm products at low technical efficiency. Low technical efficiency occurs due to the increase in the number of plots. Different findings on the impact of land fragmentation on malt barley production technical inefficiency by farmers resulted in contrary findings (negative and positive). In the current study in the direction of effect estimation, in this research work, meta-analysis has been done for finding the result on 4 studies selected based on PRISMA criteria. Based on the random effect model, the result indicated that land fragmentation puts the technical inefficiency of malt barely farmers at a disadvantage, but if the effect is not strong enough, it affects their technical efficiency. Furthermore, the subgroup analysis also found the differential effects of land fragmentation on different farmers. The influence of first two study are strong, whereas that of remain two study are weak. So, fewer fragments ought to be provided to all farmers, mainly to the first two study farmers, to increase productivity and the status of food security among farmers.

Keywords

Land Fragmentation, Technical Inefficiency, Malt Barley Production, Ethiopia

1. Introduction

Agriculture is an important sector of any economy that sustains growth and provides job opportunities [14]. It contributes 4% of the whole global economic output. Furthermore, it is the one that provides jobs to one billion people worldwide, raw material source for industries and performs a very essential function in controlling the world environmental situation [13]. In sub-Saharan African countries, it is predominantly controlled by smallholder producers who possess minimal or no modern agricultural practices and related technology [7]. Besides, agriculture is a significant foreign exchange earner and accounts for about 15 percent of the African GDP [11].

Ethiopia, being the origin of many cereal crops, is also thought to be the center of origin of barley, and due to this, there are many local barley cultivars which are well adapted to environmental conditions of the country [3]. Malt barley production is a sub-sector in Ethiopia that has been one of the most developed sub-sectors in recent years due to the commitment of multinational breweries to address their malt requirement by providing it from local production [1]. However, among the factors contributing to low malt barley production in Ethiopia are lack of improved variety, reduced inputs, land fragmentation and reduced research findings on the production practices [4].

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Where there is land fragmentation, farmers will spend additional money to travel from farm to farm, plow fragmented plots, manage work in the different plots and haul farming equipment [6]. The research indicates a negative impact of land fragmentation on agricultural productivity [5]. Land fragmentation is shown to hinder productivity in several aspects. Disconnection of ownership of land can potentially increase transport costs at a very fast rate, and management, monitoring and security of fragmented land could be more time-consuming, complicated and costly [10]. Small disconnection farms could also make cultivation of some crops more difficult and restrict farmers from venturing into very high-margin crops; thus, if farmers possess small plots of land, they could be forced to plant less profitable crops [2].

In Ethiopia most of the results on the effect of land fragmentation on technical inefficient of malt barely production were mixed results (positive or negative). Therefore, the paper is prepared to discover the direction of the effect of land fragmentation on the technical inefficient of malt barely production by integrating the existing findings of different research studies conducted in Ethiopia. To accomplish the study purpose Meta-analysis is used. This approach was adopted because it removes the problem of subjectivity and produces statistically abstract results. The result of this paper will be to offer important information for policymakers, land fragmentation experts and agricultural officers who are con-

cerned with enhancing the progress of the farmers in the country. Moreover, up to date in Ethiopia except for narrative research studies, no empirical statistical study has been conducted that evaluates the effect of land fragmentation on technical inefficiency of malt barely production. The outcome of this study is, therefore, significant to redirect the line of land fragmentation system and examine the current performance of the land fragmentation in the country. Policy makers may use this finding as an input for developing future agricultural policy within the country.

2. Methods

In this review, PRISMA (Referred Reporting Items for Systematic Review and Meta-Analyses) was used in selecting articles to include in Meta-analysis. PRISMA statement includes 27 items Checklist [8] and a four-phase flow Figure 1 below. The relevance of the studies reviewed was confirmed based on their topic, abstracts, objectives, and methodology. In accordance with this, some of the articles were eliminated as they were not pertinent to current study objectives. For others, all the content of the articles was selected based on the independent (Land Fragmentation) and dependent variables (Technical inefficient of Malt barely production) under investigation.

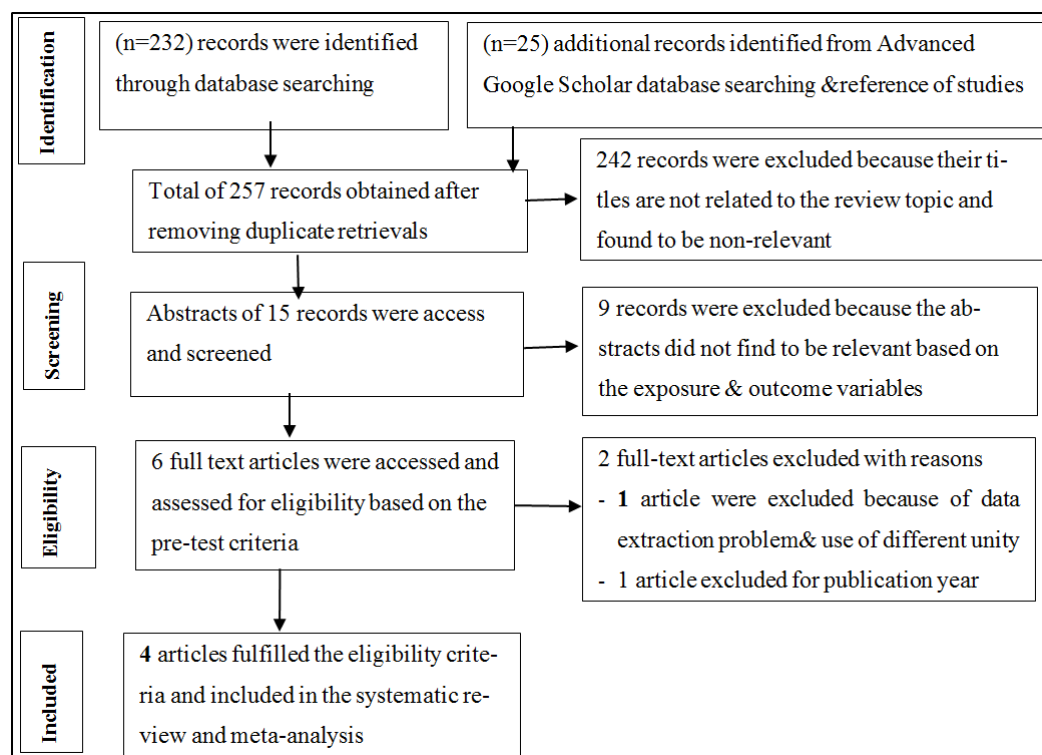


Figure 1. PRISMA flow diagram to select studies for the systematic review & meta-analysis in Ethiopia.

Evidence for this meta-analysis was gathered through electronic web-based searching. The major databases that

were searched were Advanced Google Scholar, Science direct and AGRIS databases to retrieve articles dealing with the

issue in question. These databases were searched since they index a huge majority of the peer reviewed literature, which is a quality control measure. The following combinations of words were used during literature searching: "agricultural land fragmentation" OR "Land fragmentation" AND "technical efficiency of malt barely production" OR "relationship of land fragmentation and technical efficiency" AND "impact of fragmentation on crop production" AND "Ethiopia".

Since there was a policy change in agriculture in the district after 2018, only cross-sectional data and observational studies, all such papers published after 2018 were chosen. only English language articles were chosen. Using exclusion criteria, i.e., review articles, duplication of studies, studies conducted outside of Country, studies with incomplete data and measurement of the variable (Land Fragmentation) and were not included in the analysis process to ensure methodological consistency across each study.

The pertinent data was extracted from each original study by using the format prepared in STATA version 17 software for meta-analysis. For the data extraction criteria, the type of product, statistical analysis used by the researcher, type of

variable, unit of analysis, study period, and study design were used. Heterogeneity among the original studies was checked by using the I^2 test statistics and Galbraith plot. The overall effect was expressed in terms of beta coefficient. Publication bias was tested using funnel plot asymmetry and statistical significance test by Egger linear correlation under random effects model. The random effect model was used for this study since there is heterogeneity in the provision of land fragmentation for technical inefficient of malt barely produce. The random effect model is expressed as:

$$\ln Y_i = \alpha + \ln \beta X_i + \varepsilon_i \text{ and } \varepsilon_i = v_i - u_i$$

Where, Y_i = Technical inefficient of malt barely production for each study i

α = Constant term showing individual effect

X_i = land fragmentation for each study i

ε_i = Error term

v_i = The symmetric component

U_i = asymmetric error component

Table 1. List of four studies to be included in Meta analysis on effect land fragmentation on technical inefficiency of malt barely production, Ethiopia.

S/n	Authors name	Publication year	Study design	Model used	Outcome
1	Mersha <i>et al.</i> , 2017	2017	Cross-sectional study	Cobb-Douglas production function	Technical inefficient of malt barely production
2	Edao <i>et al.</i> , 2021	2021	Cross-sectional study	//	//
3	Wollie <i>et al.</i> , 2018	2018	Cross-sectional study	//	//
4	Paul <i>et al.</i> , 2017	2017	Cross-sectional study	//	//

3. Result of Review

3.1. Identification of Articles

As shown in Figure 1 above, 257 records of the review topic were identified in the initial step out of which 242 were rejected in the initial screening because their titles have no bearing on the review topic and found to be irrelevant. The remaining 15 records and abstracts were retrieved and screened. But 9 were excluded since the abstracts were not relevant according to the exposure and outcome variables. Because the abstracts were not found to be relevant according to the exposure and outcome variables. Therefore, 6 full text articles were retrieved and evaluated for eligibility. At this level 2 article were also excluded. Articles were not considered based on data extraction issues and different cases of unity and year of publication. Total four Articles were in-

cluded for meta-analysis. All four included and available articles were from a representative of Ethiopia.

3.2. The Effect of Land Fragmentation on Technical Inefficient of Malt Barely Production

The overall result indicated that farmers with more land plots were technologically inefficient in malt, barely production by 0.57, compared to farmers with few land plots. The output of the model indicated the values of I^2 of 31.58%, $p = 0.28$. This indicated that there was low-level observed heterogeneity among studies. This heterogeneity is due to variation within study, as different types of producers are being encompassed in the study. The weight for every study included in this study was allocated based on individual study effect size. In this, the allocated weight for [9, 3, 15] and [12] were 42.38%, 34.10%, 5.90% and 17.62% respectively. Therefore, the research that

has high weight (42.38% and 34.10%) has high effect size (Figure 2 below).

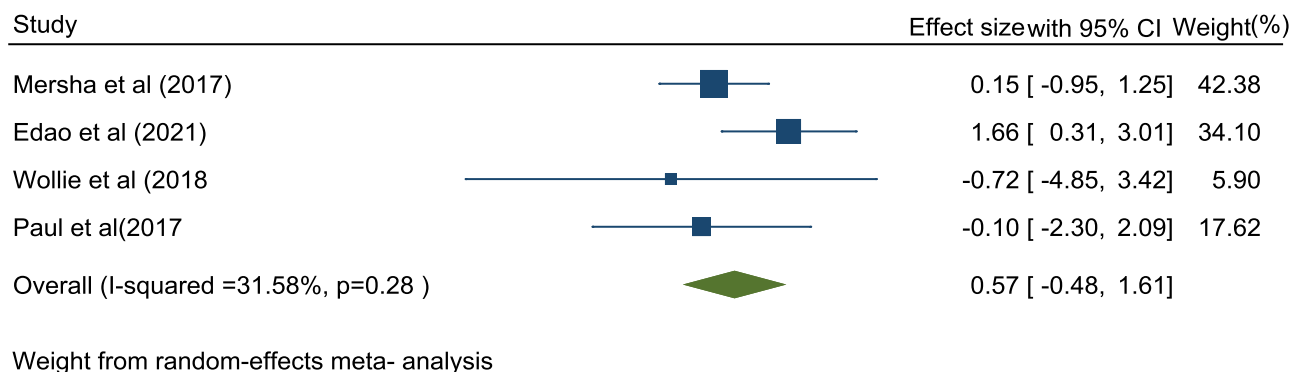


Figure 2. Forest plot and random effect model using Coefficient as effect size measurement.

As shown on Figure 3 below, the additional test of I^2 is Galbraith plot, it was used to observe heterogeneity among studies. The result of Galbraith plot also shows us low-level

observed heterogeneity, because all studies lied within the confidence bounds.

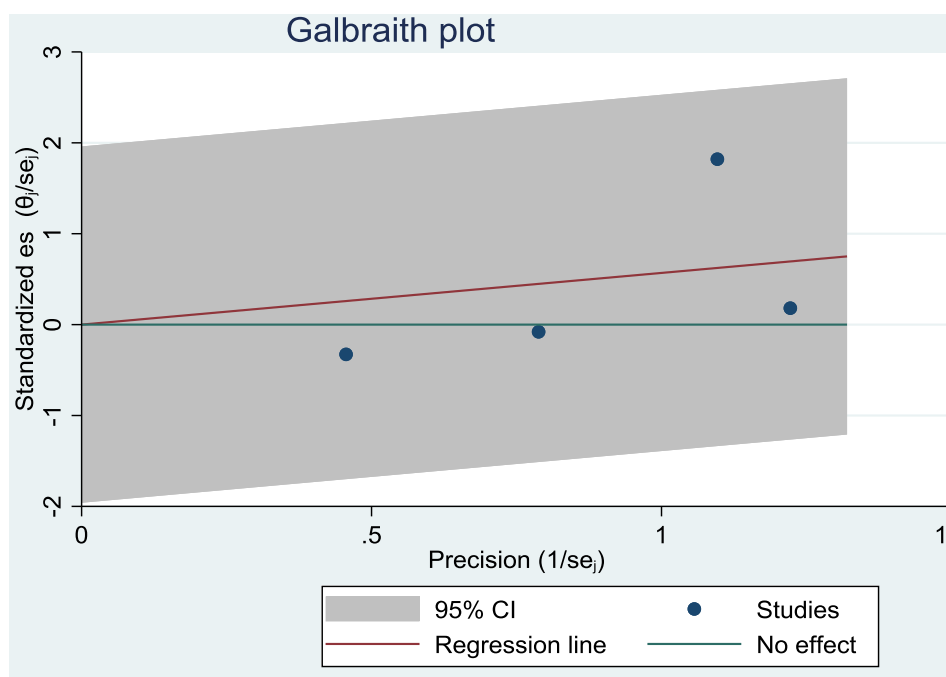


Figure 3. Galbraith plot for heterogeneity of the included studies.

3.3. Publication Bias Diagnostic Test

Figure 4 publication bias, represented was confirmed using asymmetry of funnel plot observation to confirm this in consideration of the funnel plot, left side three studies and right side one studies of the funnel plot; therefore, the plot is asymmetry, it indicates publication bias. The finding of funnel

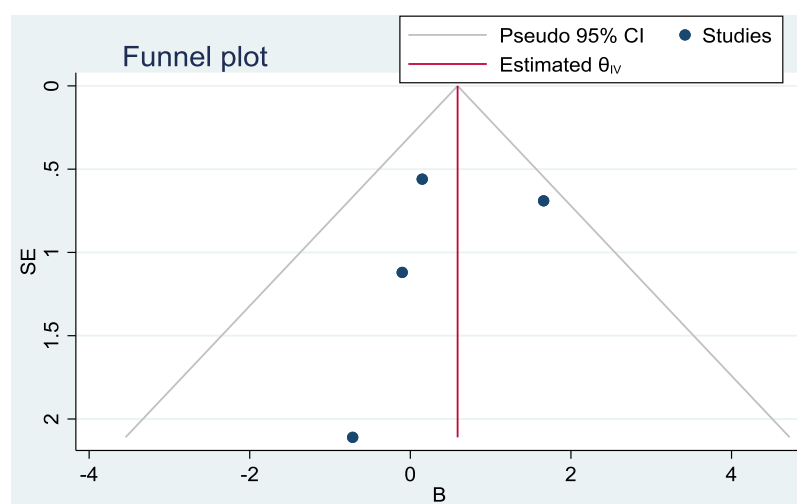
plot reporting publication bias among the studies.

Table 2 below showed the Egger test result, it also showed publication bias. The test result showed negative insignificant bias with coefficient = -0.73, $p=0.699$. Small-study effects, small sample sizes, model assumptions which is a form of publication bias is an occurrence in which small studies sometimes report larger treatment effects than larger effects.

Table 2. Egger test for small study effect.

Regress standard normal deviate of intervention effect estimate against its standard error Number of studies = 4 Root MSE = 1.3132						
Std_eff	Coefficient	Std. errs.	t	P>t	[95% conf. interval]	
Slop	1.121296	1.302255	0.86	0.48	-4.481854	6.724446
bias	-0.730062	1.63574	-0.45	0.699	-7.768085	6.30796

Test of H_0 : no small-study effects, $p = 0.699$.

**Figure 4.** Publication bias funnel plot for studies.

4. Discussions

Ethiopia has the highest potential malt barely cropping yield. This potential crop incorporation of land fragmentation, it made malt barely producers a recently new. The meta-analysis result indicates that those farmers have higher numbers of plots raise the technical inefficient of malt barely production by 0.57, as compared to the farmers who have a smaller number of plots. This finding is in line with the results of [15, 12], in which their finding implies that there is potential production of malt barely in the country, therefore, if attention is given to the land fragmentation and efficiency of malt barley production, it will improve productivity and efficiency of farmers.

In the analysis, a low level of heterogeneity ($I^2 = 31.58$) among the studies was identified. Therefore, the fixed effects model was used to estimate the pooled effect. And the result presence of publication bias. These may have been underestimating the real effect of land fragmentation on technical inefficient of malt barely production. Therefore, the findings of this meta-analysis would be best explained in the context of both original research and the current analysis.

5. Conclusion and Recommendations

The result of Meta-analysis was realized when the combined effect on technical inefficient of malt barely production brought about by land fragmentation intervention is 0.57. However, in Ethiopia, land fragmentation effect on improving malt barely production is not strong. And the result of heterogeneity ($I^2 = 31.58$) suggest low among the studies were realized. The increased number of plots positively affect technical inefficiency of malt barley production. Therefore, this should exist of number of plots to increase technical inefficiency. Hence, the land policy that favors consolidated land holding increases the efficiency and productivity of farmers.

Abbreviations

AGRIIS	International System for Agricultural Science and Technology
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses

Author Contributions

Adane Edao: Formal Analysis, Methodology, Software, Writing - original draft

Alihasen Yacob: Methodology, Software, Writing - review & editing

Conflicts of Interest

The authors declare no conflicts of interest.

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