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The nexus between credit access and agricultural productivity in Sub-Saharan Africa: A Systematic Review and Meta-analysis

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Abstract: Many Sub-Saharan African economies heavily rely on agriculture, which has been under several shocks and consequently has resulted in low productivity that has caused food insecurity. In particular, the nexus between credit access and agricultural productivity, however, is still poorly understood. This paper carried out Preferred Reporting Items for Systematic Reviews and Meta-Analyses on 26 carefully chosen published items and estimated the overall effects of credit access on agricultural productivity in sub-Saharan Africa. The use of PRISMA 2020 criteria is where our study breaks. The search strategy to identify relevant articles for the review was done on online scholarly databases Google Scholar, Science Direct, Africa wide Knowledge, and the AGRIS open database, through the use of keywords like “Credit access AND Agricultural Production” OR “Agricultural productivity” OR “Agricultural product*” AND “Sub-Saharan Africa”. The random effect model and meta regression analysis were applied to show the effect of credit access on agricultural productivity. The model output showed that access to credit increases agricultural productivity adoption by 0.96 unit, as compared to farmers who have no access to credit. The meta-analysis suggests that agriculture is more exposed to credit constraints than other (non-agricultural) sectors, ceteris paribus, with an overall pooled association effect size for credit access and agricultural productivity of 0.96 (95% CI, 0.84–1.09; P = 0.00) and significant heterogeneity between studies (I^2 = 83%, P < 0.000).Future reviews and meta-analyses increasingly focusing on methodological details are recommended to provide insights on credit access effects on sub-Saharan African agricultural productivity, which is mainly responsible for food security in the region. Policy implications and prolonged credit effects on agricultural productivity in sub-Saharan Africa are then contemplated.

Keywords: Credit access, Agricultural productivity, Meta-analysis, Systematic review, and Sub-Saharan Africa.

1. Introduction

Many economies in Africa heavily rely on agriculture, but agriculture has suffered several shocks that resulted in lower production and raised concerns about food insecurity. In Africa as a whole 239 million people (17.8% of the total) experienced chronic hunger in 2019, and 399 million extra (29.5%) had extreme food insecurity (FAO., 2022). Although Sub-Saharan Africa (SSA) currently has an average yield from agriculture that is roughly 50% lower than that of other nations with middle or low incomes globally, major increases in farm productivity are expected to combat hunger as well as poverty, and less than 20% of their biological potential is realized in average yields (www.yieldgap.org) (Stevenson et al., 2019).

More than half of rural people in Sub-Saharan Africa rely on agriculture for their farm incomes, food, and informal employment, which accounts for a sizeable portion of their GDP (Dorward & Chirwa, 2010). According to (Chirwa & Dorward, 2013), there is a belief that rural populations can achieve higher incomes and reduce hunger by enhancing the production potential per land unit, providing access to credit, and ready markets. Nevertheless, this calls for greater funding for R&D as well as the application of innovative, farmer-friendly agricultural technologies, all of which boost output, guarantee food security, and yield higher returns on investment(Adamu, 2022).

Using technology innovations, implementing targeted investments, and maintaining continuous production with higher efficiency are all necessary for output from agriculture, as account for one of the basics of growth in the economy (Terin et al., 2014). For agricultural producers to purchase farm inputs among other things, formal agricultural credit is important (Rehman et al., 2019). There can occasionally be a delay between the money farmers spend on raising livestock and/or growing crops and the money they get from marketing their produce. For farmers, having access to agricultural credit is especially crucial during this transitional period (Taremwa et al., 2021).

Lack of official agricultural credit may force many agricultural operations to become unprofitable due to excessively high-interest rates and unfavorable terms when borrowing from unofficial sources like moneylenders, friends, and family (Seidu & Tanko, 2022). Like other firms, agriculture needs cash for both operations on the farm and the purchase of contemporary agricultural machinery. When cash is made available on time, modern technologies, and seeds are adopted, increasing farm efficiency and output, which in turn accelerates growth (Kassie et al., 2013; Mazvimavi & Twomlow, 2009). Credit is one of the main obstacles preventing small-scale farmers from implementing agricultural technologies and becoming productive (Flory, 2012). The uptake of technology by agriculturalists and their overall potential for output are limited in the absence of formal credit options for marginal and smallholder farmers. The provision of credit services allows the majority of farmers in Sub-Saharan Africa, who are impoverished and among the most destitute of the poor, to escape poverty and maintain their standard of living.(Abdallah et al., 2019).

However, there exist conflicting results for studies conducted in the sub-Saharan region of Africa that demonstrate the adverse effects of credit on smallholder producers in agriculture (Mboulou, 2020; Siyoum et al., 2012). The present investigation was intended to resolve issues among several divergent researchers and improve the accuracy of findings in light of those inconsistent results. Therefore, this paper responded to the following main question: i) what is the overall effect of credit access on the agricultural productivity of smallholder farmers in Sub-Saharan Africa? To respond to the question and come up with policy relevant information, quantitative analysis (meta-analysis) was conducted. Moreover, the theory suggests that smallholder farmers' agricultural credit access decisions depend on complex interactions among a large set of factors including demographics, wealth, agroecology, markets, information, social networks, risk, and uncertainty(Pannell & Claassen, 2020). The inability of empirical results to converge on the main factors influencing agricultural productivity is partially attributable to this complexity. The majority of individual studies typically present peculiar findings that are unique to a certain farmer group, productivity, technology, or geographic area (de Oca Munguia & Llewellyn, 2020; Prokopy et al., 2019).

Review and synthesis papers have increased as a result of the growing demand in this field for evidence-based policymaking(de Oca Munguia & Llewellyn, 2020; Ruzzante et al., 2021). Thus, this study summarizes findings from about 23 years of published work regarding the nexus between agricultural productivity in Sub-Saharan Africa and credit access. With the help of these guiding principles of agricultural efficacy, policymakers, researchers, and lenders will be able to focus on enhancing the quality of financing for smallholders in Sub-Saharan Africa.

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2. Methods and Materials

2.1 Study Protocol

A database of applied economics for agriculture publications concerning access to credit in sub-Saharan Africa was developed by drawing on the work of (Rosenstock et al., 2015). In this investigation, methods for locating research on the relationship between credit and productivity in agriculture have been developed using similar search terms. Using the selection criteria, articles that meet the study's goal were found. The desired outcome was established before the beginning of article identification. Consequently, studies on sub-Saharan Africa's productivity in agriculture and credit services were carefully chosen for this investigation. All of the following had been necessary for inclusion: English-language manuscripts; published articles; dissertations; studies that focused on sub-Saharan Africa; studies looking at the relationship between credit access and agricultural productivity or credit availability and farming; cross-sectional studies; and studies done between 2000 and 2023. However, book chapters, reviews, research published before 2000, studies performed elsewhere than sub-Saharan Africa, studies involving both time series and panels of data, abstract-only papers, dummy credit variables, and replicate articles were excluded. Following the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines for systematic evaluation procedures guaranteed the methodology and design of this study.

2.2 Data Search Strategies

The article search strategy was leveraged by the overall objective, namely to summarize the currently documented access to credit nexus on the agricultural productivity in sub-Saharan Africa. The search to identify relevant articles for the review was done on online scholarly databases (Google Scholar, Science Direct, Africa wide Knowledge (multidisciplinary index to research and publications by Africans and about Africa), and the FAO's AGRIS (International System for Agricultural Science and Technology) open database, through the use of keywords and search terms. To increase the chances of hitting, more articles were included through thorough referencing and joining together search terms logically returns good results. Therefore, data searching was done systematically using Google Scholar, Science Direct, Africa Wide Knowledge, and FAO's AGRIS Open database by using key terms. Furthermore, additional data were also procured through referencing and author sharing. Key terms like "Credit access AND Agricultural Production" OR "Agricultural productivity" OR "Agricultural product*" AND "Sub-Saharan Africa" were used to get pertinent articles that could respond to the review questions. The database search was conducted from June 02, 2023, to October 05, 2023.

2.3 Data extraction method

To ensure data accuracy and consistency, pertinent study data was extracted using the standardized extraction form. Finding pertinent articles for the study is the main focus of the data extraction method. The use of the EndNote library allowed us to remove all duplicate articles from the title and the summary, the first reading phase allowed us to remove some selected articles. Then after a full reading of the articles, studies that met the inclusion/exclusion criteria were selected. Studies were extracted based on; study design, study area, year of publication, research target, and outcome. The data were extracted for all agricultural productivities such as crop-related productivities, livestock productivities, and other agricultural productivities, which were solely done in different regions of Sub-Saharan Africa. After the data were extracted, they were reported in an aggregated form as a case. From reviewed articles data were created in Excel and organized to see the average effect size of credit access on agricultural productivity in Sub-Saharan Africa. The studies were also grouped by regions into SSA sub-regions (West Africa, East Africa, Southern Africa, and Central Africa) based on the United Nations (UN) scheme classification and by year of publication. However, no study from central Africa met the inclusion/exclusion criteria for this specific study.

2.4 Quality Assessment

When researchers use the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist and its extensions, it guarantees that they generate thorough, superior research reviews. It also facilitates a more seamless professional evaluation process(Page et al., 2021). PRISMA guidelines were therefore used to evaluate the quality of the articles that were being reviewed. All of the selected research studies belonged to the same category, and each analysis complied with the rigorous standards established by PRISMA, 2020.

2.5 Statistical analysis

Data analysis was done using STATA version 16 software. In this study, both qualitative and quantitative data analyses were undertaken. Frequency and percentage measures were applied to analyze qualitative data. In this study, credit access was used as an intervention variable, whereas agricultural productivity was used as a response (outcome) variable. In this study, credit access continuous mean effect values were and used as two group comparisons (i.e the overall mean effect value on credit accessed(treated) and not accessed(controlled) See forest plot of STATA 16 output below) of mean values and agricultural productivity was used as the continuous outcome variable thus dummy measures for these variables were not considered in this study to keep methodological similarity. The random effect, fixed effect, and combined effect models are the three models that can be used in a meta-analysis. Using the heterogeneity between the selected studies as a basis, the model is chosen. (Higgins & Leturque, 2010).

In a meta-analysis, heterogeneity can arise from variations in the impact of the intervention variable on the outcome variable, which may be attributed to variations in product type, target group, geography, or other factors. I^2 was used to measure heterogeneity (I^2 = 0, no heterogeneity; I^2 = 0–50%, low; I^2 = 50%–75%, medium; and I^2 = > 75%, high heterogeneity). When there is a considerable amount of heterogeneity, a random effect model is used; when there is little heterogeneity, a fixed effect or combined effect model is used(Fletschner et al., 2010). In this study random effect model was applied since there is strong heterogeneity (I^2 = 83%) between the studies. Hedges's g was used as the indicator of the effect size of the pooled 26 observations. Moreover, meta-regression analysis was conducted using the Meta effect size as the dependent variable with some modifications in moderators. A publication bias test was also performed using the regression-based Egger test. If $p < 0.05$ for the biased coefficient, it showed the presence of publication bias and the insignificant test result denoted the absence of publication bias (Dong et al., 2012).

3. Results and Discussions

3.1 Articles identification

We identified a total of 18,268 original articles in four databases, referencing studies and sharing from authors. By using EndNote 20, after the deletion of the 8,804 duplicates, 9,464 articles were retained. A title-based selection resulted in the exclusion of 3,975 articles that did not meet the specific criteria. Abstracts of the remaining 5,489 articles were read and reviewed, excluding 5,457 more articles. After reading the full text of the remaining 32 articles, 6 more articles were excluded. Thus, only 26 articles meeting the inclusion criteria were selected. The representative schema of the research and the number of eligible studies are shown in Figure 1 by applying the PRISMA ,2020 criteria (Page et al., 2021). The PRISMA Report consists of a 27-item specification and a four-phase flow diagram (Agbodji & Johnson, 2021; Girma & Kuma, 2022). Moreover, the final list of studies used for doing a meta-analysis is shown in Table 1.

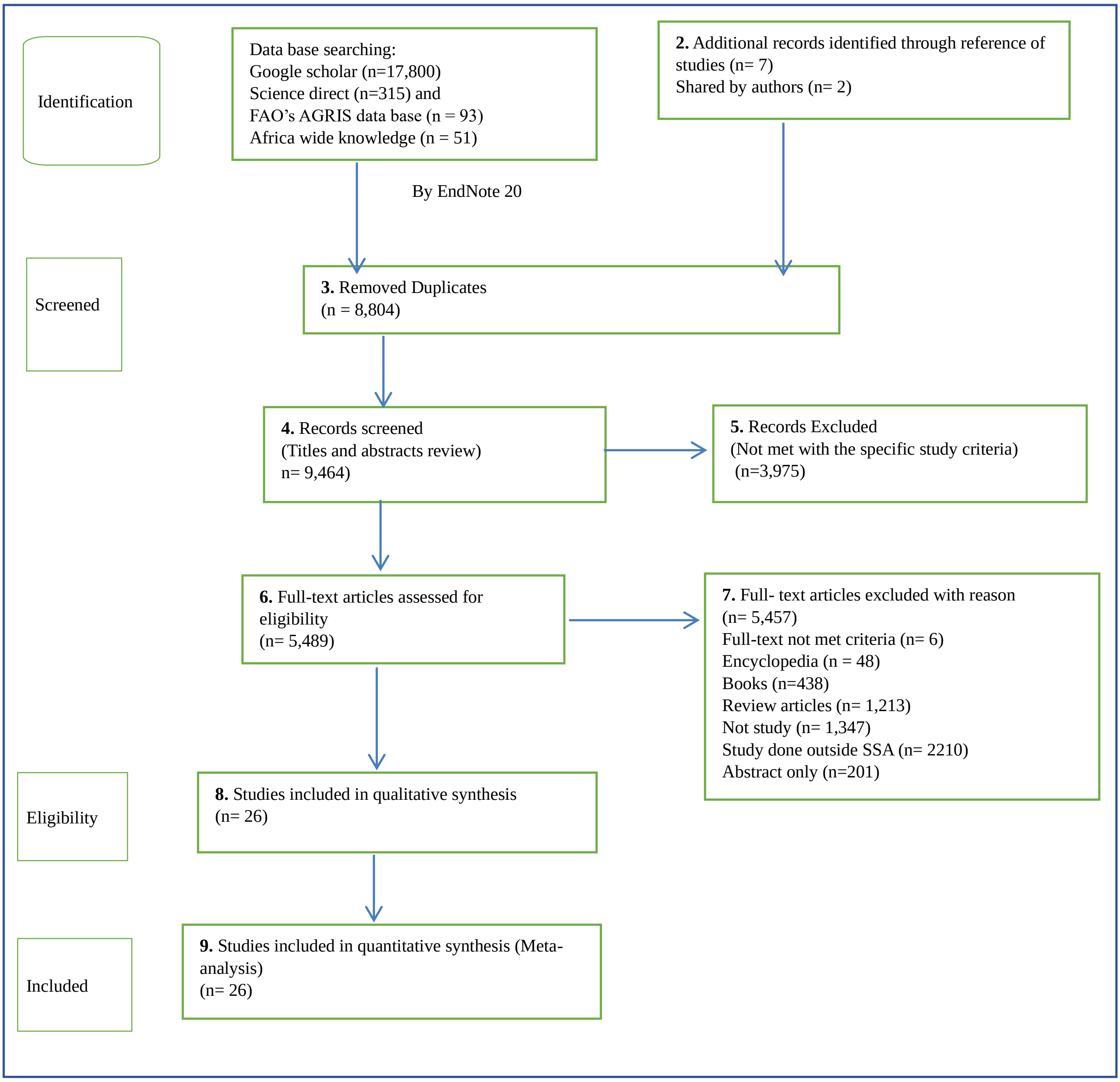

Fig. 1. Flowchart for the selection of studies based on the PRISMA 2020 guidelines.

Table 1: The final identified studies for doing a meta-analysis

No.	Author	Publication year	Study area (Place)	Research target	Sample Size	Research Design
1	Gebeyehu et al.	2020	Ethiopia	credit access & farm productivity	260	cross-sectional
2	Geleta et al.	2018	Ethiopia	credit impact on HH income	188	cross-sectional
3	Berhanu et al.	2021	Ethiopia	credit impact on HH food insecurity	360	cross-sectional
4	Adamu	2022	Ethiopia	credit access & farm productivity	376	cross-sectional
5	Mengistu	2019	Ethiopia	Institutional credit & crop productivity	853	cross-sectional
6	Geta & Hamiso	2017	Ethiopia	microfinance credit & crop productivity	194	cross-sectional
7	Awe	2020	Nigeria	credit access & farm output	94	cross-sectional
8	Ponguane	2016	Mozambique	credit subsidy on crop productivity	107	cross-sectional
9	VUKEY	2019	Ghana	savings & agricultural productivity	222	cross-sectional
10	Taremwa et al	2021	RWANDA	credit access & agricultural productivity	422	cross-sectional
11	Kehinde	2021	Nigeria	Agricultural credit on productivity	300	cross-sectional
12	Nosiru	2010	Nigeria	Microcredit & agricultural productivity	90	cross-sectional
13	Olagunju & Babatunde	2011	Nigeria	credit& poultry productivity	280	cross-sectional
14	Seidu & Tanko	2022	Ghana	credit program & Maize productivity	130	cross-sectional
15	Bakare et al.	2023	Nigeria	Microcredit & rice productivity	320	cross-sectional
16	Awotide	2015	Nigeria	credit & agricultural productivity	856	cross-sectional
17	Alfa & Abdulfatah	2019	Nigeria	credit & rice productivity	389	cross-sectional
18	Ojo	2019	Nigeria	credit & rice productivity	360	cross-sectional
19	Spio	2006	South Africa	credit and agricultural productivity	153	cross-sectional
20	Njogu et al.	2018	Kenya	Bank credit and agricultural production	316	cross-sectional
21	Assouto & Houngbeme	2023	Benin	credit & agricultural productivity	356	cross-sectional
22	Motsoari	2012	Lesotho	credit & agricultural productivity	100	cross-sectional
23	Agboklou & Ozkan	2023	Togo	credit & rice farm productivity	102	cross-sectional
24	Girabi & Mwakaje	2013	Tanzania	microfinance credit & farm productivity	98	cross-sectional
25	Ibrahim & Bauer	2013	Sudan	credit & farmers' profitability	200	cross-sectional
26	Ogundeji et al.	2018	Lesotho	credit & farm income	100	cross-sectional

3.2 Results from the Meta-Analysis

This subsection portrays the results of the descriptive statistics and Meta-analysis, framed around the economic effects of credit access on agricultural productivity in Sub-Saharan Africa. Recall that 26 articles retained for the systematic review (100%) qualified for the Meta-analysis. Almost all of the retained articles here are empirical, country-specific articles, probably because they contained same-scale data on agricultural sectors, which was a prerequisite for the meta-analysis (Gerstner et al., 2017).

3.3.1 Credit Access and Agricultural Productivity Studies by Regions in Sub-Saharan Africa

The horizontal bar graph in Fig. 2 below portrays the percentage of studies done on the Connection between credit availability and agricultural productivity in each region of SSA except central Africa, where no study meets the specific criteria of this study. Fig. 2 below also, shows that about 46.1% of studies were done in the western African region, 38.5% of studies in the eastern African region, and 15.4% of studies in southern Africa. This suggests that there aren't enough studies on how credit availability and agricultural productivity are related, especially in the southern and central regions of SSA. Therefore, to improve agricultural output across the region and make the best use of the resources that are available for credit access, it is necessary to carry out concrete investigations. This is consistent with the outcomes of a systematic review and meta-analysis in Ethiopia (Girma, 2022), credit access can help smooth out supply constraints for agricultural inputs. Therefore, studies must take due consideration on the relationship between agricultural productivity and credit in SSA.

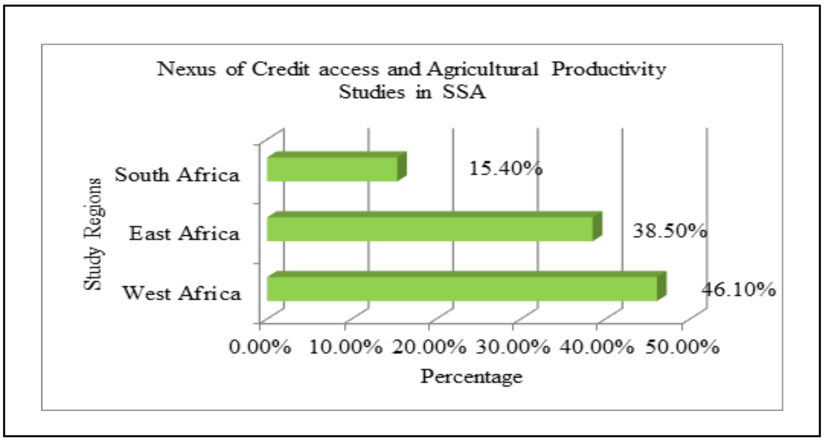

Fig. 2 Credit access and agricultural productivity studies by region in Sub-Saharan Africa.

3.3.2 The effect of Access to Credit on Agricultural productivity in Sub-Saharan Africa

The findings of the random effect model's meta-analysis regarding the effects of credit availability on agricultural productivity in Sub-Saharan Africa are shown in Fig. 3 below. Hedge's g statistics were used to illustrate the average effect size.

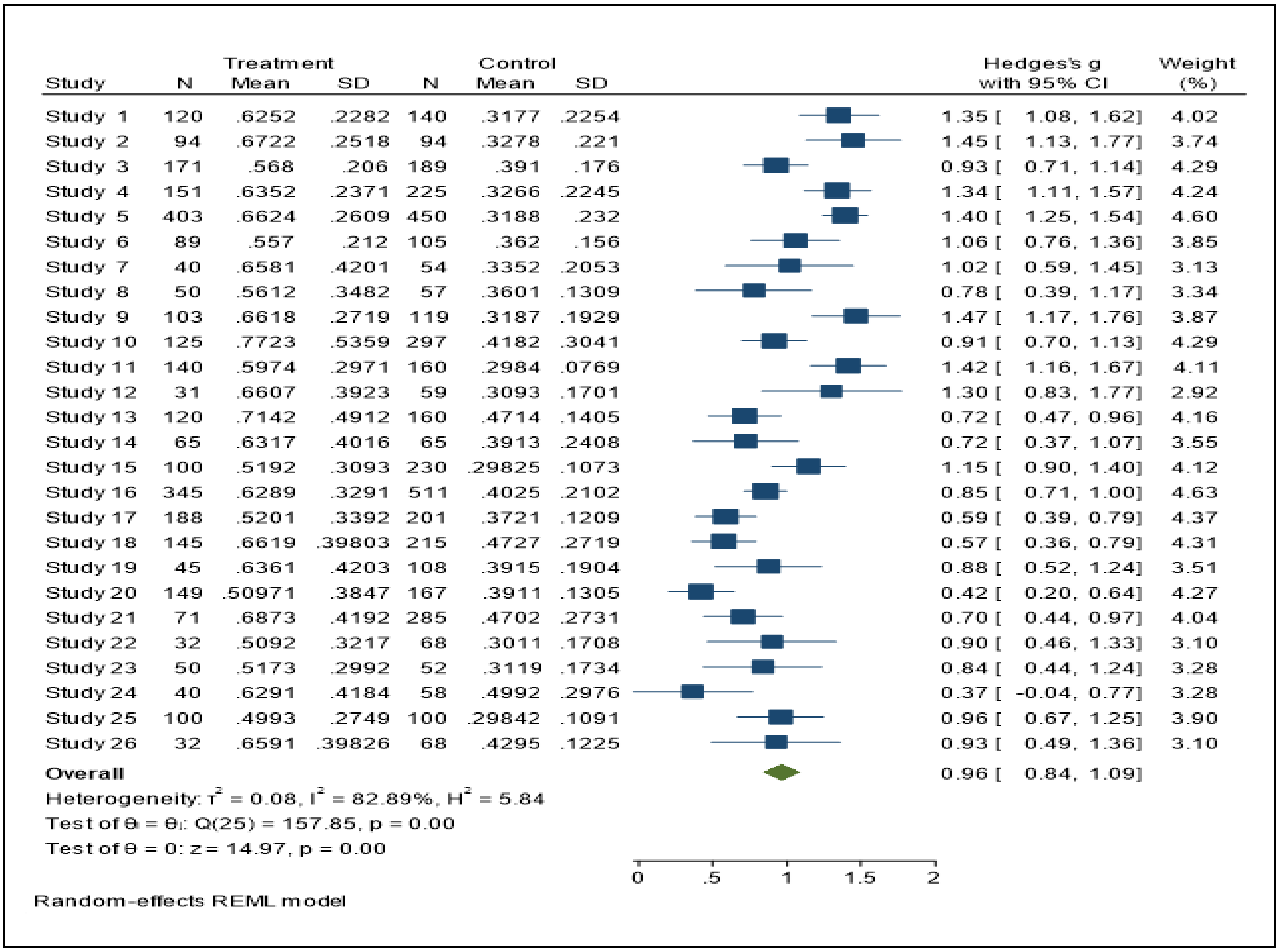

Fig. 3 Random effect model output

According to the model's output, which is based on the above figure, producers who have access to credit are 0.96 units more productive overall than those who do not. The argument was that in the SSA, gaining access to credit increases farmers' economic and agricultural productivity and enables them to supply, buy, and use contemporary farm inputs. This result is consistent with the research (Adamu, 2022; Nordjo & Adjasi, 2020; Taremwa et al., 2021; Zewdie, 2015), that demonstrated how having access to credit enhances farmers' ability to supply and buy modern farm inputs and technology, which increases both the amount and the quality of production. Furthermore, an I2 value of 83% with $p < 0.000$ was found in the model output, falling within the range of significant heterogeneity. This suggested that the impact of credit availability on farmers' overall agricultural productivity in Sub-Saharan Africa varies (heterogeneously). This result is consistent with (Thompson, 2001).

3.4 Meta-Regression Analysis

A statistical method for estimating the mean and variance of actual demographic effects from a group of empirical analyses purporting to address the same topic of study is called a meta-analysis. Additionally, as (Egger et al., 1997), the slope is derived from a weighted regression of the effect size (Meta es), on its standard error (Meta se), with the option to adjust for moderators. The result from Table 2 showed a tau square value of 8.5e-07 and a smaller I-squared residual value of 0.00% which implied that all covariates have explained almost all of the variation between the studies. The joint test for all of the covariates gives a p-value of 0.0000 indicating some evidence for an association of at least one of the covariates with the treatment effect. Furthermore, the regression analysis showed an adjusted R-square value of 100% which implied the between-study variance explained by all covariates for these case-eligible studies. The impact of credit access on overall agricultural productivity is as expected showing positive coefficients in the treated group (credit-accessed households) and negative coefficients in the controlled group (not credit-accessed households). This is in line with the findings of (Bakare et al., 2023; Geleta et al., 2018; Gershon et al., 2020).

Table 2: Meta-Regression Analysis Output.

```
Random-effects meta-regression                    Number of obs  =        26
Method: REML                                      Residual heterogeneity:
                                                              tau2 = 8.5e-07
                                                            I2 (%) =    0.00
                                                                H2 =    1.00
                                                     R-squared (%) =  100.00
                                                  Wald chi2(4)   =    157.83
                                                  Prob > chi2    =    0.0000

--------------------------------------------------------------------------------
         _meta_es |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------------------------------------------------------------------------
         _meta_es |          1     .08642   11.57   0.000     .8306198     1.16938
         _meta_se |  -5.20e-16   1.256683   -0.00   1.000    -2.463053    2.463053
     EventTreated |   1.81e-19   .0005923    0.00   1.000    -.0011608    .0011608
   Eventcotrolled |  -2.91e-19   .0004484   -0.00   1.000    -.0008788    .0008788
            _cons |   1.11e-16    .227787    0.00   1.000    -.4464543    .4464543
--------------------------------------------------------------------------------
Test of residual homogeneity: Q_res = chi2(21) =  0.00   Prob > Q_res = 1.0000
```

3.5 Publication Bias Diagnostic Test

The funnel plot, a widely used diagnostic visualization in meta-analyses, is particularly advantageous to evaluate small-study effects and bias in publications(Light & Pillemer, 1984). It is a case study of a scatter diagram used to compare results from studies, which shows the proximity of the estimated intervention effect size to the true impact measurement. Graphical evaluation of funnel maps can be subjective when detecting imbalances, but it is still valuable for data exploration (Peters et al., 2006). It is desirable to evaluate funnel-plot asymmetry more formally. Thus, Statistical methods were developed to identify the asymmetry in a funnel diagram(Sterne et al., 2011). To quantify funnel graphs, Egger's regression statistical test for small study effect was employed. This test offers weighted regression analyses of the magnitude of the effect forecasts on their precision measures (standard errors). In addition, Egger's regression statistical test is recommended for grouped or ungrouped continuous data in comparison to Begg, Peters, and Harbord tests. Bias in publication can be caused by chance, valid differences, reporting bias, and poor methodological quality (Egger et al., 1997). The intercept line is the relevant metric in this case. A statistically significant intercept, or one having $p < 0.05$, indicates biased publication. As indicated in Table 3, the test statistics for this study's results indicated bias in publication was not present.

Table 3: shows the regression-based Egger test for small study effects

```
Regression-based Egger test for small-study effects
Random-effects model
Method: REML

H0: beta1 = 0; no small-study effects
            beta1 =     -0.15
      SE of beta1 =     1.036
                z =     -0.15
       Prob > |z| =    0.8828
```

Test of H_0: no small-study effects P = 0.8828.

The Egger's test result in Table 3 showed a bias coefficient of – 0.15 and a standard error of 1.036, giving a p-value of 0.8828. This test thus suggests little evidence for the presence of small-study effects. Therefore, smaller studies (those with larger standard errors) have no larger Hedge’s g statistics effects, which did not suggest publication bias. Therefore, the study result from the test statistics showed the absence of publication bias.

4. Conclusions

Agriculture is constantly subject to a variety of unpredictable factors, including changes in the climate, financial constraints, and man-made and natural hazards. Credit access is crucial for enhancing agrarians' ability to smooth out input supply constraints and sparking demand for heightened output in farming. The results of the random effect model show that if sub-Saharan African farmers have access to credit, they can raise agricultural productivity by 0.96 (95% CI, 0.84–1.09; P = 0.00) units. Agricultural chemicals, livestock, high-producing plants, and other productive inputs could be purchased by farmers with easier access to credit. Based on the results of this systematic review and meta-analysis, Productivity in agriculture is significantly enhanced by the availability of credit in Sub-Saharan Africa. Thus, governments at various levels and non-governmental organizations supporting farmers in SSA countries should give due attention in enabling farmers to access credit to boost agricultural productivity. They should give top priority to establishing rural financial institutions that operate jointly with the private sector to provide credit and savings services to the farming community. This can be possible through investing in rural infrastructure, agricultural input supplies, technologies, and the establishment of centers that educate and train farmers, all of which are crucial in raising farmers' awareness and enhancing their use of credit. This credit service should be provided at low-interest rate to make it available to all farmers.

Conflicts of Interest

"The authors declare no conflicts of interest."

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