Assessing Livestock Farm Financial Performance and Climate-Smart Agricultural Practices Nexus: Empirical Evidence from Ghana

Martinson Ankrah Twumasi

***Abstract*—** This study assesses the association between climate-smart agricultural practices (CSAP) and livestock farm economic performance. The data used for this study consist of 260 livestock farmers from the Northern part of Ghana. Due to the problem of selection bias, the endogenous treatment regression (ETR) method was applied for the study's analysis. The result also showed that CSAP has a positive and significant association with livestock farm financial performance. Thus, net returns, returns on investment (ROI), and livestock profit margins are more likely to increase as farmers adopt CSAP. Moreover, we observe that women in livestock farming and high-income earners involved in CSAP tend to have higher net returns, ROI, and profit margins compared to their counterparts. The results from this study have shown that CSAP can be a great channel for livestock development in the nation. The results provide clues to national governments and policymakers to initiate strategies and methods to make CSAP attractive for agricultural growth.

***Index Terms*—**Climate-smart agricultural Practices; Financial performance; Ghana,

I. Introduction

Many studies have reported that changes in climate have a more detrimental effect on developing nations than developed countries [1–4]. According to some studies, it is projected that the rate of incidence and magnitude of some severe climatic events and disasters, including extreme weather events, droughts, floods, rising sea levels, and storms, are more likely to increase in developing nations, with Sub-Sahara Africa being the hardest hit [5,6]. When this happens, the agriculture sector suffers the most. Therefore, studies aimed at providing remedies to climate change negative impact on the environment, agricultural sector, and humans have become essential. In this study, we examined the determinants of CSAP and its association with goat farm financial performance (i.e., net returns, ROI and profit margins) in northern Ghana.

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The study emphasizes goat farming in rural Ghana because of their comparative advantages over rearing other farm animals [7,8]. For instance, there is no need to secure huge starting capital for goat farming [8]. Additionally, Adams *et al.*, (2021) showed that goats' disease tolerance is high, and they are marketability in the nation; hence, serving as a good source of income for farmers while playing a vital role in curbing poverty or enhancing the wellbeing of rural livestock farming households [9,10]. In addition, goat farming significantly contributes to Ghana's Gross Domestic Product (GDP) through the livestock industry. For instance, Ghana's livestock sector respectively recorded a 1.3% and 8.4% contribution to Ghana's GDP and the agricultural sector's GDP in 2014 [11]. Despite all the advantages highlighted in goat production, poor climatic conditions have remained a significant challenge for its producers over the past decades. Producers of goat producers are facing poor feeding, high incidences of diseases, and the reduction in goat products such as milk, fibers, and meat stemming from rapid weather changes. Although livestock (goat) farming is widespread in northern Ghana, sustainable livestock production in the region faces difficulties from climatic variations [11,12]. Thus, CSAP adoption becomes essential for these goat farmers.

CSAP is a set action mechanism designed with the aim of increasing the resilience and productivity of land and agriculture products affected by changes in climate conditions. With the adoption of CSAP, many of the core agriculture issues caused by climate change can be curtailed. CSAP may increase farm resource efficiency, contributing to increased productivity and income sustainability while causing a reduction in greenhouse gas emissions [13,14]. There is an increasing interest in CSAP, particularly in developing countries, due to its potential attributes of ensuring food security, climate change resistance, and reducing greenhouse gas emissions [15]. However, its adoption in SSA, particularly in Ghana, is low because of insufficient awareness, funds, and practical information [16,17]. Thus, it is imperative to examine the determinants of CSAP. Also, looking at the significant contribution of CSAP to sustainable farming, it is likely to have a potential positive association with farm financial

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performance; hence, the motivation for this study.

The study contributes to literature in several ways. First, it is among the few studies addressing the role of CSAP on livestock farming, particularly the first in Ghana. Second, the relationship between CSAP and farm financial performances is analyzed heterogeneously based on household income and gender composition. Finally, the econometrics method adopted for the study alleviates the problem of endogeneity likely to cause inconsistency in the analysis.

II. Methods and Material

A. Econometrics model specification

This study assessed how CSAP relates to livestock farm economic performance. Due to the potential endogenous issues associated with CSAP and its binary nature, the ETR method is applied to the study's estimation. Ankrah Twumasi[18] suggested the ETR can provide consistent results when working with dummy variables associated with potential endogeneity issues. With the ETR model, we can estimate the direct relationship between CSAP and the outcome variables [19]. The maximum likelihood estimations of first- and second-stage equations are done separately using the ETR approach.

In the initial stage, we calculated the probability of practicing CSA. Here, it is presumed that the ith farmer probability of practicing CSA will rise if the benefit or the expected utility derived from CSAP has significant value over the utility of not practicing CSA. The utility difference can be expressed by a latent variable as $CSAP_i^* = CSAP_{i1}^* - CSAP_{i0}^* > 0$; where $CASP_{i1}^*$= practicing CSA and $CSAP_{i0}^*$= not practicing CSA. However, $CSAP_i^*$, which is a latent variable, is observable and takes the expression below:

$$CSAP_i^* = \alpha X_i + \beta I_i + \mu_i \;\; CSAP_i = \begin{cases} 1 \; if, \;\; CSAP_i^* > 0 \\ 0 \; if, \;\; otherwise \end{cases} \quad (1)$$

where $CSAP_i^*$ refer to the probability of practicing CSA; i.e., $CSAP_i = 1$ if the farmer is practicing CSA and $CSAP_i = 0$ if otherwise; I_i is the instrumental variable (IV), which needed to be added to the in the first stage estimation. Following [12], the instrument selected for the study is Peer Pressure (i.e., whether the farmer's friend/relative is practicing CSA). X_i is a vector of the explanatory variables (see Table 1), $\alpha \; and \; \beta$ are the explanatory variables' vector of parameters to be estimated and μ_i is a random disturbance term. In addition, the IV is tested to ensure its validity using the Pearson correlation method (see Table A1 in appendix). The IV has a significant correlation with CSAP but no significant correlation with the outcome variables.

In the ETR second stage, we calculated the outcome variables. The model is specified as follows;

$$FFP_i^* = \gamma CSAP_i + \emptyset X_i + \varepsilon_i, \quad (2)$$

where FFP_i^* refers to livestock farm financial performance (i.e., net return, ROI, and profit margin). While $CSAP$ and X_i are defined above, γ, $\emptyset$, and φ are parameters to be estimated. ε_i is an error term.

B. Data Source

The data of this study consists of goat producers from the Upper West region in a district called Lawra in Ghana. This region and the district were purposively chosen due to climatic variations and vegetation, making livestock production a favorable business to pursue. The process of data collection was by multistage sampling techniques. The region and the district were selected in the initial stage. In the next stage, we randomly chose three (3) communities (Mettoh, Kasalgri, and Tabier) from the selected district. Finally, we randomly chose 300 goat producers; however, our analysis was based on 260 respondents due to some inappropriate information delivered by the respondents, according to our knowledge.

The data collection was conducted using interview schedules and structured questionnaires. In this study, farmers' CSAP were collected. It was revealed that out of the 260 goat farmers, 211 practiced CSA, while 49 did not. Diverse information gathered from the questionnaires for the survey includes household socioeconomic and demographic characteristics and other various variables that will help achieve the study's aim. STATA and SPSS softwares are used for the analysis

III. Results and Discussions

A. Descriptive Statistics

The variables used in the study have their descriptions in Table 1. The recorded values of the dependent variables are net returns (GH¢ 2,540 per hectare), ROI (0.57), and profit margins (0.11). The respondents involved in CSAP are 81%. The percentage for male, married, credit constrained, cooperative members and access to market respondents are 73, 78, 43, 36 and 32, respectively. Also, the respondents' average age, education and farming experience are approximately 42, 9, and 15, respectively. About 59% of the sampled farmer have their friends/relatives practicing CSA.

TABLE I VARIABLES DESCRIPTION AND DESCRIPTIVE STATISTICS

Variables	Description	Mean	Std. Dev.
Outcome variables			
Net returns	Total livestock revenue minus investment costs (GH¢1000/hectare)	2.54	1.34
ROI	Return on investment (Ratio of net returns to investment costs)	0.57	1.82
Profit Margins	Ratio of net returns to total revenue	0.11	1.72
Focal variable			
CSAP	Whether the respondent adopted Climate-smart practices (1=Yes, 0=No)	0.81	0.55
Control variables			
Gender	Whether the respondent is a male (1=Yes, 0=No)	0.73	0.52
Age	Respondent age	42.16	9.06
Marital status	Whether the respondent is married (1=Yes, 0=No)	0.78	0.52

Education	Respondent's years of formal education	8.87	5.04
Household size	Respondent's total household size	4.21	2.64
Farm size	Total farmland size (in hectares)	0.49	0.64
Training	Whether the respondent has had any livestock farming training program in the past years (1=Yes, 0=No)	0.31	0.42
Experience	Respondent's years of farming experience	14.74	8.49
Market access	Whether the respondent has access to markets (1=Yes, 0=No)	0.32	0.48
Extension services	Whether the respondent has access to extension services (1=Yes, 0=No)	0.54	0.46
Credit constraint	Whether the respondent was credit constrained in a formal financial institution in the past year (1=Yes, 0=No)	0.43	0.53
Membership	Whether the respondent is a member of a cooperative (1=Yes, 0=No)	0.36	0.41
Peer Pressure (IV)	Whether the farmer's friend/relative is practicing CSA	0.59	0.61

Source: survey results, 2020. Note: 1 USD= GH¢5.2

B. Empirical Results and discussions

Determinants of livestock farm financial performance

The determinants of CSAP are displayed in the second column of Table 2. The table revealed that factors such as education, training, years of farming experience, extension services, membership, and peer pressure (the IV) have significant connections with CSAP adoption. For example, the training variable has a positive and significant coefficient. This shows that farmers engaged in livestock farming training programs are more likely to be involved in CSAP. Also, the positive and significant value for the peer pressure coefficient can be explained by the fact that farmers who have friends or relatives as adopters of CSAP are more likely to adopt CSAP.

Determinants of livestock farm financial performance

As observed from the lower part of Table 2, the coefficients of $\rho_{\mu v}$ are statistically significant and positive. This the absence of potential association between CSAP and the outcome variables, so the null hypothesis can be rejected. Once more, it shows that unobserved attributes affects the CSAP variable, suggesting the existence of a positive selection bias [20].

The factors having a relationship with the farms' financial performance are seen in columns 3 to 5 of Table 2. The observation shows that the main variable (CSAP) has a significant positive connection with all the outcome variables. This indicates that CSAP increases the goat farmer's net returns, ROI, and profit margin. Improvement in farmers efficiency may be achieved through the adoption of CSA, hence, enhancing farm financial performance. The finding aligns with [21] and [22] studies. For example, [22] revealed that climate change adaptation and coping strategies profoundly impact farm efficiency and productivity, an enhancer of financial performance. Other variables significantly affect farm financial performance, including education, training, farming experience, market access, extension services, and membership. For example, the positive coefficient of the education variable shows that farmers are more likely to increase far financial performance should they have more years of schooling. A finding supporting [12] study. Also, credit constraint shows a negative relationship with the outcome variables. Thus, farmers who experience credit constraints are less likely to improve farm financial performance. Ensuring sustainable farming is highly related to financial resources [23]; thus, being credit constrained, a detriment factor of farmers' efficiency, is more likely to affect farm productivity and earnings.

TABLE II DETERMINANTS OF CSAP AND ITS IMPACT ON GOAT FARMERS' NET RETURNS, RO1 AND PROFIT MARGINS (ETR METHOD)

	CSAP Adopter	Net Returns	ROI	Profit Margin
CSAP		0.344 (0.018)***	0.152 (0.053)***	0.122 (0.047)**
Gender	0.021 (0.018)	0.009 (0.016)	0.011 (0.028)	0.028 (0.017)
Age	-0.013 (0.026)	0.042 (0.173)	-0.055 (0.086)	-0.021 (0.011)*
Marital status	0.013 (0.018)	0.232 (0.331)	0.068 (0.051)	0.028 (0.026)
Education	0.062 (0.015)***	0.094 (0.025)***	0.016 (0.006)*	0.004 (0.015)
Household size	0.043 (0.087)	-0.213 (0.154)	-0.089 (0.130)	-0.011 (0.113)
Farm size	0.018 (0.041)	0.061 (0.022)**	-0.051 (0.088)	0.021 (0.019)
Training	0.047 (0.017)**	0.134 (0.041)***	0.053 (0.023)*	0.051 (0.012)***
Experience	0.044 (0.008)***	0.019 (0.050)	0.040 (0.018)*	0.014 (0.005)**
Market access	0.025 (0.078)	0.052 (0.005)***	0.021 (0.009)*	0.023 (0.010)*

Extension services	0.074 (0.032)*	0.041 (0.019)*	0.014 (0.065)	0.028 (0.011)**
Credit constraint	-0.033 (0.095)	-0.073 (0.016)***	-0.068 (0.047)	-0.039 (0.017)*
Membership	0.027 (0.013)*	0.022 (0.009)*	0.044 (0.011)***	0.072 (0.035)*
Peer Pressure (IV)	0.089 (0.013)***			
Constant	1.067 (0.622)***	1.098 (0.152)***	0.151 (1.649)***	1.003 (0.331)***
$\rho_{\mu v}$		0.247 (0.085)***	0.202 (0.065)***	0.344 (0.125)***
Log-likelihood		-1051.166	-1177.526	-1270.149
Wald test X^2		$X^2(1)$= 7.17***	$X^2(1)$= 3.65***	$X^2(1)$= 18.16***
Observations		260	260	260

Survey results, 2020. Note: ***p < 0.01, **p < 0.05, *p < 0.1; Robust standard errors are presented in parentheses

C. Further Analysis

The study carried out a heterogeneous analysis to add to the novelty in Table 3, using different attributes/groups of the respondents or their households. More specifically, gender and the income levels of households are considered for the analysis. Here, high(low)-income households have an average income above(below) the median total household income of the sample group.

The heterogeneous findings reveal that CSAP has a heterogeneous relationship with farm financial performance based on household income and gender. In particular, the results show that males and females are likely to increase farm Net returns, ROI and Profit Margins as they adopt CSAP, but the females' coefficients show greater values than males. Thus, CSAP positive effect on farm financial performance is prominent among the females' farmers. We can attribute these findings to the fact that male household heads are usually seen as breadwinners, i.e., burdened with financial responsibilities, in developing nations, including Ghana. Therefore, these men may participate in non-farming activities or practice credit fungibility. Practicing farm credit fungibility may cause a reduction in the funds required for farming [24], while non-farm activities give the farmers less time to concentrate on their farm activities [22]; thus, farm financial performance is likely to fall. This results support the findings of [25] and [24] studies that indicated that male farmers' level of fungibility on agricultural credit as a result of their financial commitments is high. Also, the analysis indicates that both low- and high-income households adopting CSAP are likely to cause financial performance enhancement. Although Net returns, ROI, and Profit Margins may be affected detrimentally among low-income households due to insufficient financial resources, adopting CSAP may help householders (including low-income households) increase their farm efficiency, thus improving farm financial performance. The study agrees with [13] findings, which showed that CSAP improves farm productivity and efficiency.

TABLE III DISAGGREGATED ANALYSIS BY GENDER AND HOUSEHOLD INCOME LEVEL: ETR MODEL ESTIMATES

Variables	Items	Sample size	Fish net returns	ROI	Profit Margin
CSAP for Male	Yes	153	0.191 (0.025)***	0.098 (0.024)***	0.102 (0.010)***
	No	37	0.081 (0.035)**	0.057 (0.053)	0.039 (0.087)
CSAP for Female	Yes	58	0.266 (0.031)***	0.120 (0.013)***	0.135 (0.029)***
	No	12	0.078 (0.041)*	0.052 (0.015)***	0.045 (0.006)***
CSAP for Low-income HH	Yes	84	0.140 (0.014)***	0.094 (0.012)***	0.051 (0.027)*
	No	37	0.048 (0.017)**	-0.037 (0.012)**	-0.015 (0.047)
CSAP for High-income HH	Yes	127	0.233 (0.018)***	0.129 (0.023)***	0.134 (0.065)*
	No	12	0.098 (0.016)***	0.083 (0.012)***	0.073 (0.031)*

Note: Survey results, 2020. Note: ***p < 0.01, **p < 0.05, *p < 0.1. Standard errors in parentheses. Household income= the sum of farm, off-farm and other income. HH=household

IV. Conclusion and Policy Implications

Based on survey data from northern Ghana, this study assesses the association between climate-smart agricultural practices (CSAP) and livestock farm financial performance. The data used for this study consist of 260 livestock farmers. Due to the problem of selection bias, the endogenous treatment regression (ETR) method was applied for the study's analysis. The result also showed that CSAP is positively and significantly associated with livestock farm financial performance. Thus, net returns, returns on investment (ROI), and livestock profit margins are likely to increase as farmers adopt CSAP. Moreover, we observe that women in livestock farming and high-income earners involved in CSAP tend to have higher net returns, ROI, and profit margins compared to their counterparts.

The results pave the way for valuable policy implications. Based on the findings, it is obvious that designing policies aimed at encouraging CSAP among livestock farmers in the nation by the government and policymakers should be prioritized. Policymakers' measures should be geared toward organizing CSAP programs and training for livestock farmers. This can be done by tasking extension officers to organize CSAP meetings in person or radio programs to empower the farmers.

The sample size limits the study due to financial constraints. Future studies can consider larger sample groups, for instance, the whole nation if data are available.

APPENDIX

Table A1 The selected IV validity test analysis (Pearson correlation)

Variables	Correlation coefficient	*p*-value
CSAP	0.642**	0.029
Net returns	0.255	0.318
ROI	0.401	0.264
Profit Margins	0.016	0.139

Note: Survey results, 2020. Note: **p < 0.05

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REFERENCES

[1] Roessig, J.M.; Woodley, C.M.; Cech, J.J.; Hansen, L.J. Effects of global climate change on marine and estuarine fishes and fisheries. *Rev. Fish Biol. Fish.* 2004. https://doi.org/10.1007/s11160-004-6749-0

[2] Bandara, J.S.; Cai, Y. The impact of climate change on food crop productivity, food prices and food security in South Asia. *Econ. Anal. Policy* **2014**, doi:10.1016/j.eap.2014.09.005. https://doi.org/10.1016/j.eap.2014.09.005

[3] Kahsay, G.A.; Hansen, L.G. The effect of climate change and adaptation policy on agricultural production in Eastern Africa. *Ecol. Econ.* **2016**, doi:10.1016/j.ecolecon.2015.11.016. https://doi.org/10.1016/j.ecolecon.2015.11.016

[4] Wheeler, T.; Von Braun, J. Climate change impacts on global food security. *Science (80-.).* 2013. https://doi.org/10.1126/science.1239402

[5] Field, C.B.; Barros, V.; Stocker, T.F.; Dahe, Q.; Jon Dokken, D.; Ebi, K.L.; Mastrandrea, M.D.; Mach, K.J.; Plattner, G.K.; Allen, S.K.; et al. *Managing the risks of extreme events and disasters to advance climate change adaptation: Special report of the intergovernmental panel on climate change*; 2012; ISBN 9781139177245. https://doi.org/10.1017/CBO9781139177245

[6] World Bank Vulnerability, risk reduction and adaptation to Climate change: Indonesia. *Clim. Risk Adapt. Ctry. Profile* **2011**, doi:10.1111/j.1740-9713.2010.00403.x. https://doi.org/10.1111/j.1740-9713.2010.00403.x

[7] Adams, F.; Ohene-Yankyera, K.; Aidoo, R.; Wongnaa, C.A. Economic benefits of livestock management in Ghana. *Agric. Food Econ.* **2021**, *9*, doi:10.1186/s40100-021-00191-7. https://doi.org/10.1186/s40100-021-00191-7

[8] Devendra, C. Small Ruminants: Imperatives for Productivity Enhancement Improved Livelihoods and Rural Growth - A Review. *Asian-Australasian J. Anim. Sci.* **2001**, *14*, 1483–1496, doi:10.5713/ajas.2001.1483. https://doi.org/10.5713/ajas.2001.1483

[9] Devendra, C.; Chantalakhana, C. Animals, Poor People and Food Insecurity: Opportunities for Improved Livelihoods through Efficient Natural Resource Management: *http://dx.doi.org/10.5367/000000002101294010* **2016**, *31*, 161–175, doi:10.5367/000000002101294010. https://doi.org/10.5367/000000002101294010

[10] Dossa, L.H.; Rischkowsky, B.; Birner, R.; Wollny, C. Socio-economic determinants of keeping goats and sheep by rural people in southern Benin. *Agric. Human Values* **2008**, *25*, 581–592, doi:10.1007/s10460-008-9138-9.

[11] Ministry of Food and Agriculture [MoFA] *Facts and Figures*; 2015;

[12] Ankrah Twumasi, M.; Asante, I.O.; Essilfie, G.; Ntim-Amo, G.; Modzi, S.K.; Jiang, Y. Household income improvement among Ghanaian livestock farmers: Does climate change adaptation strategies matter? *Environ. Dev.* **2022**, *44*, 100737, doi:10.1016/j.envdev.2022.100737. https://doi.org/10.1016/j.envdev.2022.100737

[13] Agbenyo, W.; Jiang, Y.; Jia, X.; Wang, J.; Ntim-Amo, G.; Dunya, R.; Siaw, A.; Asare, I.; Twumasi, M.A. Does the Adoption of Climate-Smart Agricultural Practices Impact Farmers' Income? Evidence from Ghana. *Int. J. Environ. Res. Public Health* **2022**, *19*, 3804, doi:10.3390/ijerph19073804. https://doi.org/10.3390/ijerph19073804

[14] Mizik, T. Climate-Smart Agriculture on Small-Scale Farms: A Systematic Literature Review. *Agronomy* **2021**, *11*, 1096, doi:10.3390/agronomy11061096.

[15] Billore, S.D.; Dupare, B.U.; Sharma, P. *Addressing Climate Change Impact on Soybean through Resilient Technology*; 2018; Vol. 16;.

[16] Portia, A.W.; Reuben, T.L.; Isaac, Y.; Godfred, K.F. Smallholder farmers experiences of climate variability and change on pineapple production in Ghana: Examining adaptation strategies for improved production. *J. Agric. Ext. Rural Dev.* **2018**, *10*, 35–43, doi:10.5897/jaerd2017.0919.

[17] Patnaik, U.; Das, P.K.; Bahinipati, C.S. Development interventions, adaptation decisions and farmers' well-being: evidence from drought-prone households in rural India. *Clim. Dev.* **2019**, *11*, 302–318, doi:10.1080/17565529.2017.1410084.

[18] Ankrah Twumasi, M.; Jiang, Y.; Asante, D.; Addai, B.; Akuamoah-Boateng, S.; Fosu, P. Internet use and farm households food and nutrition security nexus: The case of rural Ghana. *Technol. Soc.* **2021**, *65*, 101592, doi:10.1016/j.techsoc.2021.101592.

[19] Terza, J. V.; Basu, A.; Rathouz, P.J. Two-stage residual inclusion estimation: Addressing endogeneity in health econometric modeling. *J. Health Econ.* **2008**, *27*, 531–543, doi:10.1016/j.jhealeco.2007.09.009.

[20] Ma, W.; Nie, P.; Zhang, P.; Renwick, A. Impact of Internet use on economic well-being of rural households: Evidence from China. *Rev. Dev. Econ.* **2020**, *24*, 503–523, doi:10.1111/rode.12645.

[21] Anugwa, I.Q.; Onwubuya, E.A.; Chah, J.M.; Abonyi, C.C.; Nduka, E.K. Farmers' preferences and willingness to pay for climate-smart agricultural technologies on rice production in Nigeria. *Clim. Policy* **2021**, 1–20, doi:10.1080/14693062.2021.1953435.

[22] Ankrah Twumasi, M.; Jiang, Y. The impact of climate change coping and adaptation strategies on livestock farmers' technical efficiency: the case of rural Ghana. *Environ. Sci. Pollut. Res.* **2021**, *28*, 14386–14400, doi:10.1007/s11356-020-11525-1.

[23] Asante, B.O.; Ennin, S.A.; Osei-Adu, J.; Asumadu, H.; Adegbidi, A.; Saho, M.; Nantoume, H. Performance of integrated crop-small ruminant production systems in West Africa. *Agrofor. Syst.* **2019**, doi:10.1007/s10457-018-0196-8.

[24] Saqib, S. e; Khan, H.; Panezai, S.; Ali, U.; Ali, M. Credit Fungibility and Credit Margin of Investment: The Case of Subsistence Farmers in Khyber Pakhtunkhwa. *Sarhad J. Agric.* **2017**, *33*, 661–667, doi:10.17582/journal.sja/2017/33.4.661.667.

[25] Chandio, A.A.; Jiang, Y.; Rehman, A. Credit margin of investment in the agricultural sector and credit fungibility: the case of smallholders of district Shikarpur, Sindh, Pakistan. *Financ. Innov.* **2018**, *4*, 1–10, doi:10.1186/s40854-018-0109-x.

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