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Environmental and Socioeconomic Drivers Influencing Agriculture Development among Smallholder Farmers in Ecuador

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Understanding smallholder farmers' perceptions of climate change, technology, association involvement, and government policy, including its indicators, impacts, and impediments, is critical for promoting sustainable agriculture. Thus, this study aimed to evaluate the most significant social and environmental factors restricting the agricultural development of small farmers in terms of credit facilities and government subsidies. The agriculture area of Colon (Ecuador) was selected for a stakeholder analysis to identify and assess the priority, needs, goals and requirements of key people regarding agriculture and environmental management. Besides, a logistic regression model was applied to estimate the effect of social and environmental independent variables on credit facilities and government benefits. According to results, smallholder farmers face many challenges, but targeted policy development, supporting the perception of climate change, and enhancing access to markets can help them overcome these obstacles.

Keywords: agricultural policy, environmental management, sustainable agriculture, climate change, farmer perception.

Introduction

The agriculture sector employs a vast number of individuals and contributes significantly to the nation's gross domestic product (ERS, 2023; OECD, 2016). However, agriculture is frequently dismissed as a low-status occupation, which reduces the number of agricultural jobs available (Roser, 2023). In this sense, agricultural policies tend to ensure safeguards for farmer's income, a stable supply of food, and protection of the environment (Kaplan, 2019). Government policies support the development of small farmers. For example, many countries provide financial support to farmers with low income through crop insurance programs (Mahul and Stutley, 2010). This allows farmers to purchase seeds, fertilizers, and other necessary supplies for their farms. Nonetheless, in some countries, agricultural policies seem to misrepresent commodity prices, inflate rural land prices, and defend inefficient producers from changes in the markets to which they sell (Gawith and Hodge, 2019). Furthermore, most efforts are directed toward increasing agricultural yield and profit, with little regard for smallholder producers (Antonelli, 2023). Changing agricultural policies is therefore critical to increasing rural job opportunities, fair trade, climate change adaptation, and nature conservation.

Climate change and water scarcity have a global impact on agriculture: on reduced productivity, crop damage, reduced livestock production, and loss of property (FAO, 2019), because feed supply has encouraged intensive agriculture, including deforestation and the use of agrochemicals, thereby increasing greenhouse emissions and aggravating climate change (Musafiri et al., 2022). For instance, climate change is expected to cause tropical areas to lose up to 200 suitable plant growing days per year by 2100 (Cinner et al., 2022). In circumstances like these, farmers have no choice but to find a way to adapt to these changes; otherwise, they risk experiencing reduced yields and higher costs (Malhi et al., 2021). In addition, while it is essential to comprehend the magnitude of losses that climate change is anticipated to cause in important food production sectors, it is the social dimensions of vulnerability that define the extent to which societies are likely to be impacted by these changes (Cinner et al., 2022). As a response to the effects of climate change, initiatives like Conservation Agriculture (CA) are beginning to develop. CA is based on minimal soil disturbance, permanent soil cover with crop residues, and diverse crop rotation (Ramírez-Orellana et al., 2021; Su et al., 2021; Ngaiwi et al., 2023). Additionally, the measure with the highest potential for nature protection and climate change mitigation is the regrowth of natural vegetation on abandoned cropland (Gvein et al., 2023).

Ecuador is a developing country located in South America with a population of around 16 million people. The country has made great strides in socioeconomic development over the past few decades, but there are still some challenges. Smallholder farmers make up a large proportion of the population and are particularly vulnerable to these challenges (Córdova et al., 2018). Ecuador faces significant environmental challenges, such as deforestation and pollution (Van der Hoek, 2017). These problems threaten both the environment and the livelihoods of those who depend on it, including smallholder farmers.

Increased productivity can be accomplished by having access to credit and government subsidies, as well as by participating in the formulation of agricultural policies (Awotide et al., 2019; Gawith and Hodge, 2019). Different socioeconomic statuses and crop land ownership have an effect on the way individuals perceive government policies, loans, chemicals, and benefits (Ngaiwi et al., 2023). Thus, this study hypothesizes that socio-economic causes, climate change measures, and government support affect agriculture development. Consequently, the purpose of this study is to evaluate the most significant social and environmental factors restricting the agricultural development of small farmers in terms of credit facilities and government subsidies.

Methods

Study area description

The study was conducted in the area of Colon, a district of Manabi at 46 meters above sea level (m.a.s.l.) in Ecuador (South America) according to *Fig. 1*. Crop farming, and livestock keeping are the primary agricultural activities in Colon. The primary food crops in the study area include peanut, banana, manioc, watermelon, melon, cocoa, maize, sugarcane, and rice. The main livestock reared in the study area includes cattle, poultry, horses,

Fig. 1. *Study area in the area of Colon, Ecuador*

and donkeys. Colon has a tropical savannah climate, and it is hot every month. The average annual temperature is 30°C and the average annual rainfall is 511 mm. It does not rain for almost 154 days per year; the average humidity is 76% and the ultraviolet (UV) index is 6.

Stakeholder analysis

Stakeholder analysis is used to identify and assess the priority, needs, goals and requirements of key people (actors) that significantly influence the success of agriculture. It was used as a tool for assessing different interest groups around a policy issue or intervention, and their ability to influence the final outcome (Grimble and Wellard, 1997; Sah et al., 2014; Yang et al., 2015; Ogunniyi et al., 2021).

The study was conducted with stakeholders in order to evaluate their perception about issues, influences, and priorities in agriculture demand in Colon, Ecuador. A sample of farm owners (35), researchers (15), government functionaries (6), specialists (10), and agriculture dealers (15) was included in the study. Scientist from Technical University of Manabí and National Institute of Agriculture Research were selected. Dealers from Agribusiness agencies participated as stakeholders as well. Collected data from checklists were subjected to descriptive statistics.

Logistic regression analysis

A logistic regression model was applied to estimate the effect of social and environmental independent variables on credit facilities and government benefits (Branca and Perelli, 2020; Mwaura et al., 2021). This statistical model uses the logistic function, or logit function, which maps a sigmoid function according to:

$$f(x) = \frac{1}{+ e^{-x}} \qquad (1)$$

The sigmoid function can be calculated using the following equation since linear relationships between the various independent variables are believed to exist in logistic regression.

$$y = f\,(\boldsymbol{\beta}_0 + \boldsymbol{\beta}_1 \boldsymbol{x}_1 + \boldsymbol{\beta}_2 \boldsymbol{x}_2 + \ldots \boldsymbol{\beta}_1 \boldsymbol{x}_1) \qquad (2)$$

This study hypothesized that the several independent variables influencing the farmers' perception included age, gender, education, cultivated cropland area, number of livestock, access to chemicals, access to hire external labor, group participation in associations, access to technical assistance, and climate change perception are related to perceiving benefits from government (*Table 1*). The independent variables were selected based on the stakeholder analysis.

Table 1. *Independent and dependent variables: names, descriptions, and measurement units*

Variable name	Variable description and measurement units
Farm owner, Age	Continuous variable (Years)
Farm owner, Gender	Dummy variable (1 male, 0 female)
Farm owner, Education level	Dummy variable (0 primary school, 1 high school, 2 B.Sc., 3 M.Sc.)
Land cultivated	Continuous variable (Cropland area in hectares)
Livestock	Continuous variable (Livestock owned, e.g., cattle)
Chemicals	Dummy variable (1 if using chemicals, 0 if not using chemicals)
Government benefits	Dummy variable (1 if perceiving government benefits or subsidies, 0 otherwise)
External labour	Continuous variable (Number of people involved in external labour)
Group participation	Dummy variable (1 if member of farmer's association, 0 otherwise)
Technical assistance	Dummy variable (1 if receiving government tech assistance, 0 otherwise)
Climate change perception	Dummy variable (1 if perceiving climate change, 0 otherwise)
Credit facilities	Dummy variable (1 if perceiving credit from government, 0 otherwise)

B.Sc. – Bachelor of Sciences, M.Sc. – Master of Sciences

Results and Discussion

Stakeholders' perceptions

Table 2 shows the outcomes of an issues analysis conducted with farmers, academics, bureaucrats, experts, and retailers in the agricultural sector. More than 80% of farmers stated that the government's lack of agricultural support for smallholders, academic institutions' limited participation in advising small farmers, and agroindustry's lack of involvement were the biggest issues. More than 90% of researchers agreed that biodiversity conservation, ecosystem services, climate change, and water quality issues were not well perceived by farm owners in general. More than 90% of agro dealers noted the lack of policies favourable to agribusiness, commercial exporters, and large landowners over small farmers. According to this research and references, many smallholder farmers struggle to meet the expenses of basic inputs such as seeds and fertilizers, let alone the more expensive investments required to embrace new technologies or implement conservation practices (Anang and Zakariah, 2022). In addition, environmental protection policies in agriculture must be considered within this framework.

Table 3 summarizes the principal influences of stakeholders. Farmers had less of an impact on the development of agricultural policies, access to agricultural inputs and funding, and the promotion of cooperative associations and businesses, according to the results. According to more than 80% of researchers, the most significant influences exerted by this group of stakeholders were activities taken to mitigate the negative effects of climate change on agriculture and the use of digital technology to assist small farmers. Another challenge for smallholder farmers in connecting with buyers for their products was noted by functionaries (100%), specialists (60%), and dealers as a major influence in cooperative associations and businesses. Without any group participation, many small farmers are compelled to sell their goods through intermediaries, who frequently exploit them by offering unfairly low prices or exorbitant commissions (Anang and Zakariah, 2022). Moreover, smallholder farmers frequently lack access to technologically advanced farming practices, which can create barriers for them to compete with large size farms.

All stakeholders agreed as the main priority the improvement of the effects of agricultural policies in order to enhance access to markets (*Table 4*). The adoption of the agricultural policy that emphasizes the production of surpluses for export has resulted in programs that tend to favor large farms that can maximize yields by taking advantage of economies of scale and Green

Table 2. *Stakeholders' perceptions of major issues*

Major issues	Stakeholders' perception				
	Farmers n = 35	Researchers n = 15	Functionaries n = 6	Specialists n = 10	Dealers n = 15
Small farmers' lack of government agricultural support	26 (74%)	11 (73%)	3 (50%)	4 (40%)	12 (80%)
Policies favour agribusiness, commercial exporters, and large landowners over small farmers	14 (40%)	12 (80%)	1 (17%)	7 (70%)	14 (93%)
Inefficient distribution of subsidies, loans, and other forms of financial assistance to small farmers	21 (60%)	13 (87%)	2 (33%)	7 (70%)	10 (67%)
Lack of technical assistance provided to small farmers	21 (60%)	7 (47%)	5 (83%)	8 (80%)	3 (20%)
Limited participation of academic institutions to assist small farmers	30 (86%)	6 (40%)	5 (83%)	9 (90%)	14 (93%)
Poor participation of small farmers in associations (group participation)	12 (34%)	14 (93%)	5 (83%)	10 (100%)	11 (73%)
Lack of agroindustry's involvement	29 (83%)	12 (80%)	4 (67%)	8 (80%)	12 (80%)
Lack of assistance about the impacts of climate change on agriculture	29 (91%)	12 (93%)	4 (83%)	8 (90%)	12 (93%)

Table 3. *Major influences of stakeholders on issues*

Major influences	Stakeholders' perception				
	Farmers n = 35	Researchers n = 15	Functionaries n = 6	Specialists n = 10	Dealers n = 15
Participation in the process of agricultural policies	5 (14%)	6 (40%)	6 (100%)	3 (30%)	3 (20%)
Promoting cooperative associations and businesses	6 (17%)	10 (67%)	6 (100%)	6 (60%)	13 (87%)
Participation with the goal of improving access to agricultural inputs and funding for farmers	5 (14%)	4 (27%)	4 (67%)	4 (40%)	13 (87%)
Digital technologies support for small farmers	3 (8%)	12 (80%)	3 (50%)	5 (50%)	2 (13%)
Climate change actions to reduce impacts on agriculture	3 (9%)	13 (87%)	2 (33%)	2 (20%)	1 (7%)

NA – not available

Table 4. *Major agricultural development priorities as perceived by stakeholders*

Major priorities	Stakeholders' perception				
	Farmers n = 35	Researchers n = 15	Functionaries n = 6	Specialists n = 10	Dealers n = 15
Improving the effects of agricultural policies	32 (97%)	12 (80%)	6 (100%)	9 (90%)	12 (80%)
Analysing government policies to sustainably boost agricultural productivity	27 (77%)	8 (53%)	4 (67%)	8 (80%)	12 (80%)
Access to finance and agricultural inputs	25 (71%)	5 (33%)	3 (50%)	8 (80%)	9 (60%)
Market solutions, higher-value products	32 (91%)	10 (67%)	4 (67%)	4 (40%)	12 (80%)
Degradation of agricultural land	35 (100%)	14 (93%)	2 (33%)	7 (70%)	12 (80%)

Revolution technologies (Gawith and Hodge, 2019; Kaplan, 2019). Smallholder farmers often have difficulty accessing markets due to their remote location or lack of transportation infrastructure. Smallholder farmers will be able to sell their products more readily and at a fair price through improving their access to marketplaces. Many smallholders lack the necessary marketing skills and networks needed to sell their products at fair prices on the open market. On the other hand, there is concern about the deterioration of agricultural land. In smallholder farms, a lack of implementation of land management policies contributes to a reduction in soil fertility (Ebanyat et al., 2010).

The average responses from *Tables 2*, *3*, and *4* about stakeholders' perceptions of issues, factors, and priorities are summarized in *Fig. 2*. The results show that farm owners are more focused on identifying significant priorities linked to agricultural land degradation, market solutions, financial accessibility, policy analysis, and enhancing the effectiveness of agricultural policies. Farm owners highlighted issues and priorities in agricultural development goals before other stakeholders. In terms of information and market leadership, dealears and researchers, however, had a greater impact on the growth of agriculture. The information gathered for this document indicates that smallholder farmers frequently do not have secure land tenure, which makes it challenging for them to apply for loans or make long-term investments in their farms. Smallholder farmers frequently lack the funding necessary to expand their operations or invest in new technology (Adams et al., 2021; Awotide et al., 2019). Their capacity to boost productivity and compete with large commercial enterprises is thus constrained.

Socioeconomic factors influencing perception on benefits

According to *Table 5*, the majority of the owners who were interviewed were full-time farmers, with 40% of those farms being led by women (average age 48 years old). The age of men who led farms was between the 31 and 73. The interviewed owners had education levels ranging from primary to postgraduate, with 22.8% having only completed their primary schooling; 34.3% had a bachelor's degree; and 14.3% completed a postgraduate education. According to the results, farmers who did not receive technical training or completed a formal education system were at a disadvantage when it came to managing pests, reversing soil erosion, and dealing with the effects of climate change (Ceci et al., 2021).

The average cropland area owned by middle-aged owners, who are between 31 and 39 years old, is 9.87 hectares, with a maximum value of 25 hectares. Up to 78 livestock units were owned by the same middle-aged owners. The owners evidenced the challenge of purchasing chemicals such as fuels, solvents, insecticides, herbicides, fungicides, fertilizers, and veterinary chemicals. At least 51.4% of the property owners who were interviewed reported having trouble getting these chemicals.

The majority of the farm owners hired up to 24 people as external labor force. More than half (51.4%) of owners, 56% of whom were women, were not members of a farmers' association or an agricultural group. Of all farm owners, 25.7% received proper technical assistance such as

Fig. 2. *Identification of stakeholders' perceptions, with the average number of answers from stakeholders represented on the y-axis*

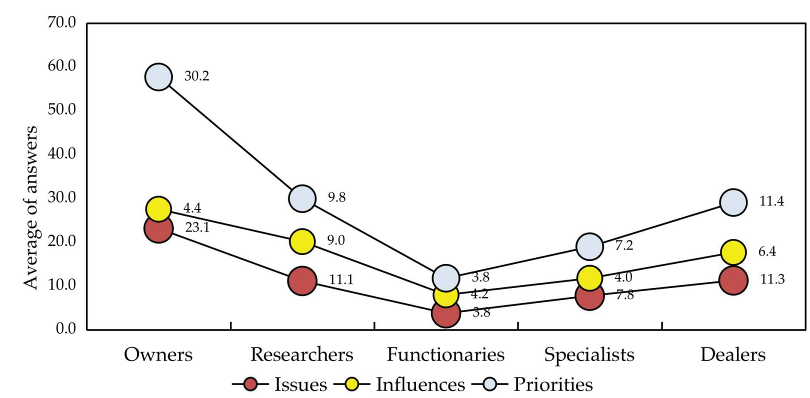


Table 5. *Sociodemographic characteristics of the Colon farmers*

Variable name	Farm owner
Age between 29–39 years old	16 (45.7%)
Age between 42–48 years old	8 (22.8%)
Age between 54–73 years old	11 (31.4%)
Male	21 (60%)
Female	14 (40%)
Primary education	8 (22.8%)
Secondary education	10 (28.6%)
B.Sc. degree	12 (34.3%)
M.Sc. degree	5 (14.3%)
Land cultivated between 0.2–10 ha	25 (71.4%)
Land cultivated between 11–25 ha	9 (25.7%)
Livestock between 1–20 units	26 (74.3%)
Livestock between 20–80 units	9 (25.7%)
Chemicals, have access	17 (48.6%)
Government benefits	16 (45,7%)
External labor from 20 to 30 people	9 (25.7%)
Group participation	17 (48.6%)
Technical assistance	9 (25.7%)
Climate change perception	18 (51.4%)
Credit access	14 (40%)

erosion control, irrigation, drainage, water quality, waste management, among others. Climate change effects on agriculture are clearly perceived by all farmers. However, 51.4% identified that drought and soil degradation as climate change effects were the result of agricultural practices. They understood that poor agricultural management before and during drought could have synergistic effects on soil properties. While creating climate change adaptation initiatives, policymakers and climate change leaders should take smallholder farmers' socioeconomic aspects into account (Mthethwa et al., 2022).

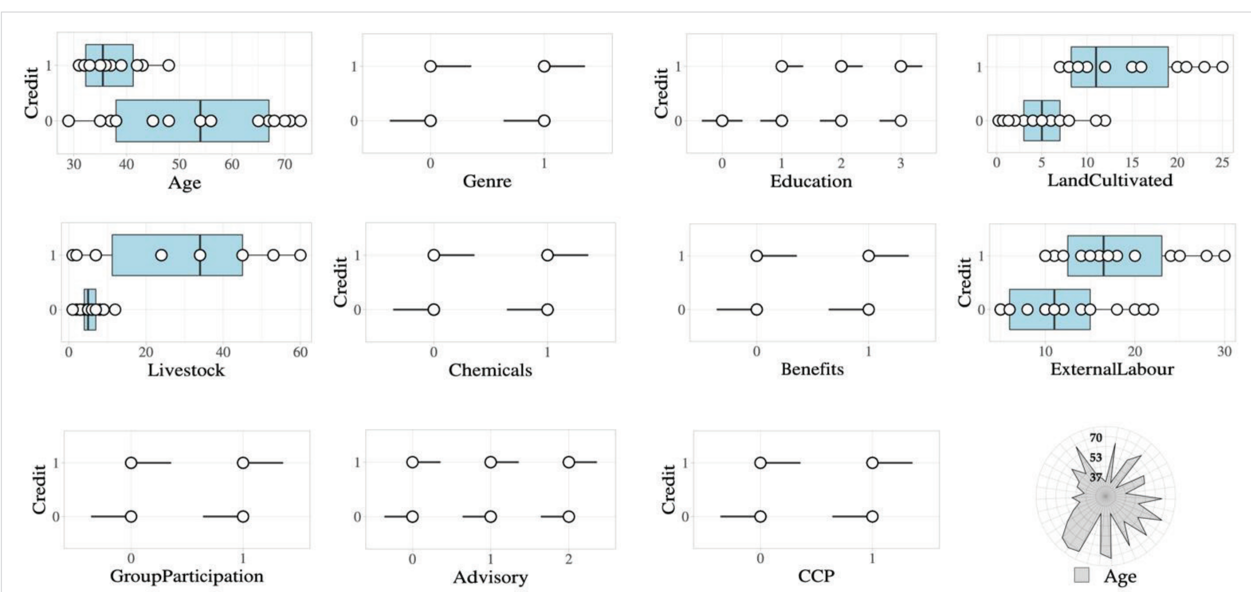
Table 6 and *Fig. 3* show that six variables significantly influenced smallholder farmers' access to credit facilities, according to the logistic regression analysis ($P < 0.05$). The identified sociodemographic constraints to credit access were farm owners' age, level of education, the size of cultivated land, the number of people hired as external labor, the amount of advisory received, and the number of livestock units owned. As determined by the logistic regression model, the age of the farm owner had a negative impact on obtaining credit facilities. The perception of the financing facilities was positively impacted by the farmer's

Table 6. *Sociodemographic factors influencing credit facilities and government benefits*

Variables	Credit facilities			Government Benefits		
	Coefficients	St. Error	P-value	Coefficients	St. Error	P-value
Age	–0.124	0.048	0.010	–0.025	0.024	0.309
Education	1.843	0.625	0.003	0.539	0.366	0.141
Cultivated land	0.563	0.216	0.009	–0.036	0.056	0.515
External labor	0.351	0.115	0.002	–0.031	0.051	0.537
Livestock	0.052	0.024	0.029	0.006	0.016	0.730
Advisory	1.051	0.533	0.049	0.115	0.462	0.803
Chemicals	1.073	0.716	0.134	0.357	0.682	0.601
Group participation	–0.383	0.695	0.581	0.829	0.695	0.233
Gender	–0.179	0.474	0.706	0.288	0.693	0.678
CCP	0.383	0.695	0.581	–1.327	0.719	0.065

CCP – Climate change perception

Fig. 3. *Socioeconomic factors influencing farmers' perceptions of benefits from government*



gender. According to results, farms owned by women mainly had effective financing options. Nevertheless, a better understanding of farmers' attitudes and perceptions, as well as socioeconomic factors influencing access to credit and government benefits, is deemed important for agricultural development and climate change action (Kebede et al., 2019; Khoza et al., 2022; Mugumaarhahama et al., 2021; Musafiri et al., 2022).

Acording to *Table 6*, all variables had no effect on government benefits (provision of seeds, subsidized fertilizers, irrigation facilities, price control, etc.). However, a smallholders' capacity to take advantage of possibilities is hampered not only by the scarcity of resources, but also by the difficulty and length of the application procedure for government and international organization funding.

Conclusions

Policy for smallholders must be adapted to the situation. Smallholder development has the potential to promote or sustain growth in some circumstances and for some small farms, as well as to provide development that is at least somewhat equal. In other situations, governments must consider whether there are social justifications for assisting small farms. Families with little or no formal agricultural expertise run a large number of small farms in the study region of Ecuador. As a result, individuals might lack the skills or background needed to benefit from emerging technologies or management techniques that could boost their output and profits. All societal members would profit from the implementation of these policies, which would result in a more inclusive and sustainable growth. It is crucial to have access to experienced individuals, including engineers, agronomists, and other experts, in order to plan and implement productive initiatives. The mapping of stakeholder perceptions revealed that climate change and agriculture policy pose the greatest threat to the world's agricultural ecosystems and economies. Reduced harvests and higher prices for food imports from less severely affected regions will result from a failure to adapt. Exploring strategies to use agriculture development to the benefit of smallholder farmers would be made possible by fair governance for agricultural and rural development, which would make any intervention and credit as transparent as possible. This study makes an innovative contribution through its comprehensive approach to smallholder development, which covers everything from contextual adaptation and knowledge transfer to inclusive growth and sustainable practises.

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