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Agricultural organizations and Spending Money on Chemical Fertilizer and Natural Soil Amendments

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Abstract

In this paper, we build a dynamic model to demonstrate that agricultural organizations membership affects the spending money in chemical fertilizer and natural soil amendments by smallholder farmers. This theory utilizes the management choices made by heterogeneous producers over an extended period of time, with the choice to enter the agricultural organizations being considered to be organic. The effect of organizations membership on spending money in chemical and natural fertilizer is estimated using farm-level data from apple growers in three India regions. The research investigation makes use of a recursive binomial model generated, which takes into consideration the possibility of endogeneity in the cooperative membership, as well as selection bias. According to the findings of the empirical research, participation in organizations has a beneficial and important influence on the possibility of making an investment in natural soil amendments. The result also show that the chance of a farmers joining a organization and the possibility of spending money in soil health measurement are both positively and substantially influenced by farm size, tenure security, human capital, and asses to financing. We analyze the conditions under which agricultural organizations contribute to reduced costs as well as increased expenditures on chemical and natural soil amendments.

Keywords: Agricultural organizations, farmers, chemical fertilizers, organic soil amendments, membership.

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1. Introduction

Agricultural organizations are a key tool for boosting the productivity of smallholder farmers in many developing nations, especially via services that facilitate the adoption of cutting-edge farming techniques, environmentally friendly farming methods, and output marketing. Studies have shown that joining organizations has beneficial and substantial effects on outcomes including production pricing agriculture earnings and profitability and output market involvement [1]. The most crucial economic and ecological concerns facing farmers in developing nations is land degradation caused by soil erosion and loss of soil health; however, the part of agricultural organization in investing facilitation in eco-friendly Land administration practices has been underappreciated [2]. Crop production costs are ultimately raised as a consequence of soil degradation, which does not just lead to lower crop yields. So, from the standpoint of organic agriculture, small- scale farmers who are having issues with land degradation must spend on initiatives that improve the soil [3]. Agricultural production may be increased by investing in soil-improving techniques, according to empirical research employing mini-level information.

Fertilizers are utilized to promote soil fertility, but since they are so widely utilized in agriculture, they have a confrontational effect on the atmosphere and cause a number of health issues. Hence, a new agriculture method known as organic agriculture has emerged in the modern world to reduce and eventually eliminate the negative impacts of artificial fertilizers on human health and the environment [4]. Compared to chemical fertilizers, Natural soil amendments are often more affordable and readily accessible. The fertility of the soil is based on organic matter. Bacteria-based fertilizers are uniquely cost effective, and eco-friendly and non bulky, they play a crucial role in nourishment for plants. In contrast, chemical fertilizers are renowned for being expensive and, when used improperly, have a harmful impact on the environment. Due to soil erosion and nitrogen imbalance, all of these result in lower agricultural yields. Moreover, chemical fertilizer differs from natural soil amendments in that it is made up of known-composition simple chemical molecules [5]. As a result of this problem, farmers blend natural and chemical fertilizers for their crops. Many elements, such as temperature, location, environmental circumstances, and soil variety, influence the selection of an appropriate fertilizer in terms of its appropriateness for crop production. A good amount of primary nutrients like phosphorus, potassium and nitrogen and as well as secondary and micronutrients like magnesium, boron and calcium is found in green vegetables, fruits, and cereal crops.

The experiment [6] planned in such a way that it would offer an equal quantity of nutrients but a flexible quantity of carbon via the use of several exogenous organic resources (ORs). The study [7] utilized a comprehensive agricultural Families survey from Guangxi, a significant agricultural area in China, to recognize the effect of farmers' beliefs and risk preferences on their investing in organic fertilizer. The study [8] utilized survey data from Chinese farm households to evaluate the effect of off-farm labor on fertilizers and insecticide spending money. The purpose of the investigation was to investigate the impact that applying liquid organic fertilizers made from sugarcane leaves, waste molasses and distillery slop, had on the development of Green Cos Lettuce [9].

The research [10] investigated whether or not the health of the land exchange influences the amount of biologically based manure that is used by industrial farmers. The article [11] aimed to discover variables impacting the usage of organic fertilizer use among small-scale farmers. The research [12] investigates the impact that women's decision-making roles have on the use of chemical fertilizers in economies that are either emerging or transitioning. The article [13] examined the Actions' core ideas and assesses their viability from the angles of policy development, regional customs, technical assistance, and accomplishments. The research on farmer organization is now quickly forming and expanding in the domains of effectiveness, ownership and management, banking, and Participant Attitudes [14]. The research [15] utilized the twofold Using choice and inclination scoring, they analyze the social effects of organic fertilizer usage.

In this paper, we determine the circumstances under which Agricultural organization contributes to cost savings and increased spending money on chemical and natural soil amendments.

2. Materials and methods

The methods discussed in this part examine the relationship between the choice to meet an open-membership agricultural organization and the decision to spend money on chemical and organic fertilizers. We believe that producers are varied and that the decision to meet organization is endogenous, which is in accordance with prior research.

Ξ stands the result of the choice to meet an organization or not, Here, ξ equal to 1 denotes the farmer entering, and ξ=0not entering. We examine the decision-making challenge faced by a single farmer in a dynamic environment provided that recent investment decisions frequently have an impact on the development of soil quality over time. Household and farm-level factors are typically believed to be unique to every farmer in the empirical literature and frequently include elements like "age, education, household size, farm size, asset ownership, and soil types".We assume that household and farm-level variables, that serve as the foundation of an index, designated by h, are specific to each farmer in accordance with the notion of the so-called position or address designs.A distinguishing feature of an agricultural product is its quality, which also affects the price P producers can charge for their goods. Yet, producing high quality is more expensive because it necessitates using more inputs and adhering to a more exacting production routine.We only take high and low qualities into account as product features in order to concentrate on the essential traits of the driving factors.Using the H and L to represent the high-quality and low-quality products, respectively, and the corresponding pricingP^Hand P^L, respectively. Hence, the value of zero represents the zeroth derivatives of the cross function relative to these parameters. The function indicates the cost production for non-members.The similar quantity of yield may be provided with fewer organic soil additions if the productivity index is greater. The net-returns index and production costs are therefore assumed to be negatively correlated. Figure 1 shows the evolution of costs and returns as a function of h for both high- and low-quality providing nonmembers.The cost function offered by equation (1) serves as the foundation for our graphics study.

$$D^i = (\chi^i - \beta^i\theta)\big(P(s) + N(s)\big) With\ \chi, \beta > 0 and\ x^j - \beta^i\theta > 0^5 \quad (1)$$

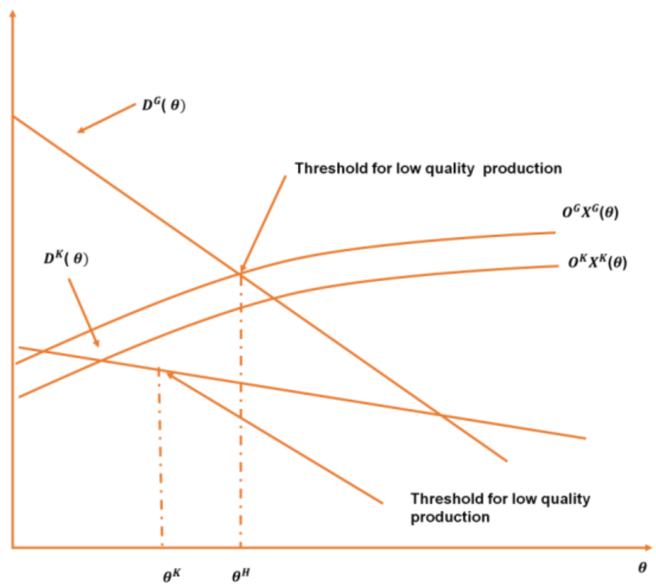

Figure 1: spending money yields and expenses for non-members

The description demonstrates the linearity of the cost utilities in $P(u)$and $N(u)$, so that $D_P^i$and D_N^i based on θ. Figure 1 depicts the minimum requirements for a nonmember household and farm to break even. The same is true for figure 1, which demonstrates that high-quality providing nonmembers can only be profitable if each of their distinct qualities is at least as high. Research has shown that agricultural organizations, in particular, are essential for supplying markets with high-quality goods. Without sacrificing generality, we only take into account organization gains attributable to cost reductions rather than premium sale prices. It is crucial to verify that an alternative theoretical model formulation would not change the research' findings because the farmer's decision to participate in the organization is determined by the size of the organization advantages, not their origin. As was already said, joining an organization entails both benefits and a variety of duties.Farmers make up a diverse population, and their household and farm-level traits, h, are distributed according to a certain function.Below this limit number, we estimate that the farmer's net return potential is so great that joining a coordination doesn't result in any reduction in the production expenses. The total return function for low and high efficient output for members and non-members, depending on the proposed nomenclature, is provided by

$$O^i Z^i(.;\ \theta) - \xi DP^i(.;\theta) - (1-\xi)D^i(.;\theta) \quad (2)$$

Figure 2 shows how rates of return and cost functions evolved through time, which is an expansion of the analysis presented in Figure 1, $Q^i Z^i(.;\ \theta), D^i(.;\ \theta)$ and $DP^G(.;\theta)$as a function of θ. We concentrate our research on the creation of high-quality items without sacrificing generality.The assessment of the cases of organization members who produce low-health goods of qualities that fall between low and high is the same as the evaluation of the high-quality case that has been explained.

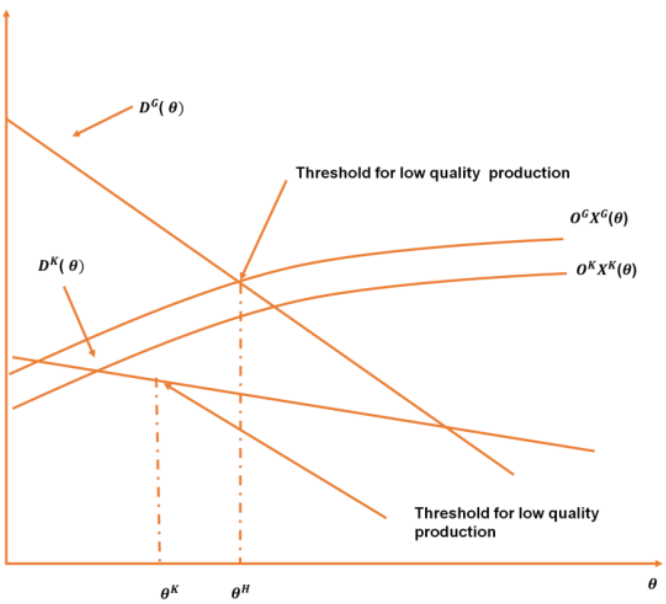

Figure 2: Costs and benefits for both members and non-members

We start with the question of whether or not to enter an existing group, and then examine how joining an organization impacts spending on both synthetic and natural forms of fertilizer.For this reason, it's important to include that the continual use of natural soil amendments enhances the soil health, but the use of chemical fertilizer, which is thought of as a static input, indirectly affects soil quality by removing nutrients during crop harvest.Hence, the change in soil health over time can be depicted by equation (3).

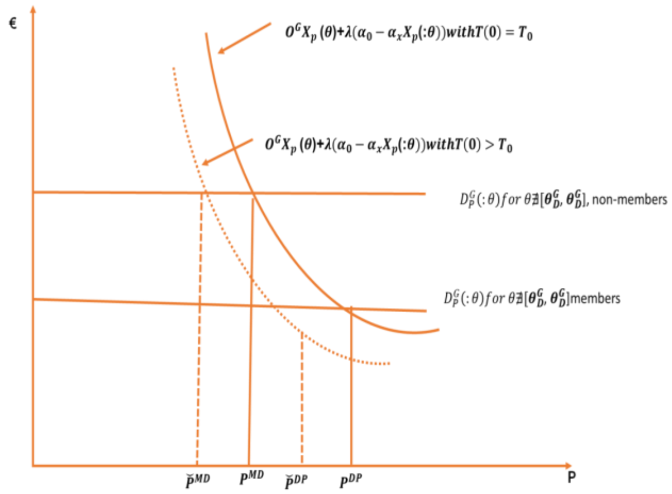

Figure 3: The optimum rate at which farmers should use organic soil amendments

$$T{=}x_o P(s) - w_z Z(P(s), N(s),$$
$$T(s);\ \theta), with\ \ T(0) = T_{0,} \quad (3)$$

We presume that the initial soil health is the same for all farmers in order to avoid making any extra notes. The metric Z indicates the low in soil health proportional to harvested production brought on by soil deterioration in the lack of any spending of money in natural soil additives.According to our presumption, farmers will increase their farm net returns over the planning horizon S, and the current value of soil health at that time will be provided by $T(S;\ \theta)e^{-\delta(S)}$here, δ denotes the value of the intertemporal discount rate. Following that, the farmer's decision-making issue with features g is provided by:

$$I^* = \max_{P,N,\xi} \int_P^S \left\{ \begin{matrix} O^G Z(P(s), N(s),\ T(s);\ \theta) - \xi DP^G(P(s),\ \ N(s);\theta) \\ -(1-\xi)D^G(P(s),\ N(s);\theta) + \xi\mu_0 - \xi\mu_1 \end{matrix} \right. = f^{-\delta s}\, cs + T(S;\theta) f^{-\delta s} \quad (4)$$

$P, N > 0, \xi\ \epsilon[0,1]$ and T=$\alpha_p P - \alpha_Y Y(.;\ \theta)$,With $T(0,\theta) = T_{0,}$ (5)

Here, the Lagrange multipliers μ_0 and μ_1are connected to the ranges within which the choice parameter can be setξ, while α_O and α_Y are described. Since it's not absolutely needed for an unambiguous notation.According to equation (4), farmers should attempt to increase discounted farm net returns throughout the planning horizon.The description of the farmer's decision issue's current value Hamiltonian, H, produces:

$$G{=}O^G Z(P,N,T;\theta) - \xi DP^G(P,N;\theta) - (1 - \xi)D^G(P,N;\theta) + \xi\mu_{o\_}\xi\mu_1 + \lambda\left(\alpha_p P - \alpha_z Z(P,N,T;\ \ \theta)\right) \quad (6)$$

The following statements provide the 1st-order settings for an innerresult with respect to P, N, and an interior and boundary result with respect to n:

$$G_P = O^G Z_P - \xi CO_O^H - (1-\xi)\, D_P^G + \lambda(\alpha_P - \alpha_Z Z_P = 0) \quad (7)$$

$$G_N = O^G Z_N - \xi DP_N^G - (1-\xi) D_N^G - \lambda \alpha_Z Z_N = 0 \quad (8)$$

$$G_\xi = -DP^G + D^G + \mu_0 - \mu_1 = 0 \quad (9)$$

The supplemental online appendix contains the first-order conditions connected to the soil dynamics and their analyses. The Hamiltonian is linear, therefore the best variable is supplied at the domain border, despite the fact that the parameter n is described as a continuous parameter in the range [0, 1].So, joining an organization or choosing not to join one is a potential solution.

Organizations help their associates to execute cost-cutting methods, which allows them to rises pending’s in natural soil amendments and chemical fertilizer, which is an economic explanation for the variation in behaviors between membership and non - members. Researchers found that changes in family and farm characteristics could magnify, dampen, or even reverse the boost in production intensity brought on by the network's connectivity. The specific outcomes are determined by the nature and extent of variations in marginal productivity and marginal costs in relation to the benefits enjoyed by the organization.

Considering the uncertainty over the magnitudes of Z_(Jθ)andD_Jθ, and the indication ofZ_Jθ, the The extra online appendix's research identifies three circumstances that influence the farmer's behaviour in terms of production intensity and links them to the co - operative membership effects. Yet, given a particular population of farmers situated in a given location, it is only possible to empirically measure the relative significant of every of these 3 scenarios, which is crucial for policy research.

2.1 Evaluative Description

We illustrated in the conceptual framework how farmers' traits impact their decision to join organization, and how these decisions typically influence their investment decisions in chemical and organic fertilizers. Yet, because it is an opinion, expected farm net returns cannot be observed. The farmer's investment decision and organization membership status are noted in the information. Since the major objective of the empirical study is to investigate how household and farm-level features θ_ j how to persuade a farmer to join an organization ξ_j, represent the farmer's spending decision as a latent parameter function in order to both express it and assess the effects of the features and organization partnership on the investment decision:

$$Q_{jl}^* = \omega\xi_j + \gamma\theta_j + \mu_{jl}, \;\; Q_{jl} = 1 \; if \; Q_{jl}^* > 0 \quad (10)$$

Here, R_{ik} is a binary indicator values that is equal to 1 if the household decides to spend money on chemical fertilizer and organic soil additives. If farm net returns are as anticipated (Q_{jl}^*) from investments is profitable, otherwise it's 0; ξ_j is a dummy variable for the decision to join an organization; ω and γ are variables to be assessed; and $\mu_{jl}$is afault term considered to be usually spreader.

According to our method, a household decides to join coordination if the expected farm net returns associated with membership are higher than those associated with non-membership. The assumption is made that households will decide to meet organizations if the variation in farm net returns is favorable. However, the respective latent variable function can express as a function of the observed components despite the fact that it cannot be directly observed. Furthermore, $\xi_j$cannot be seen directly, but can be represented as a utility of components that can be seen in the below latent variable function:

$$\xi_j^* = \beta Y_j + \varepsilon_j, \xi_j = 1 \text{ If } \xi_j^* > 0 \quad (11)$$

Here, ξ_j=1, if a family belongs to an organization, and 0 otherwise; $Y_j$is a vector of variables that affect a farmer's choice to join an organization; b is a vector of variables that need to be evaluated; and ε_j is the fault period considered to have a normal distribution. The variance of the error term in the two specifications will correlate if the same unobservable factors have an impact on both the fault term $\varepsilon_i$in the equation for deciding which organisation to join and the error term in the investment equation. Selection bias describes this situation. As a result, the endo geneity of the participation variable must be included in any in-depth analysis of the impact of participation on the spending strategies of farmers.

This study uses the existence of a farmer's local organization as a distinguishing factor. The dearth of agricultural organizations in many communities is one of the main reasons behind India’s low organization membership rate. Consequently, the occurrence of an organization in a village influences the decision to join one, but it shouldn't have an impact on the farmer's decision to spend money on soil analyses. Understanding the causal links between organization membership and propensity to purchase chemical and organic fertilizers is essential, we additionally calculate the average treatment impacts on the treated (ATT) utilizing the methodology suggested. The ATT is measured utilizing the equation (12):

$$TT = \frac{1}{M\xi} \sum_{j=1}^{M\xi} \{ Pr\left(Z_{jl} = 1\right) \mid \xi_j = 1 - Pr\left(Z_{jl} = 0 | \xi_j = 1\right)\} \quad (12)$$

Here, M_ξ stands the average sample for the treatment; $Pr\left(Z_{jl} = 1\right)|\xi_j = 1$ denotes the organization members' anticipated investment likelihood in the observable circumstances,$\Pr\left(Y_{jl} = 1\right)|\left(\xi_j = 1\right)$indicates the likelihood that an organization farmer will not make an investment.

2.2 Statistical analysis and information

The analysis's data came from an apple farmers' household survey that was carried out in India’s “Assam, Arunachala Pradesh, and Punjab provinces between September and December 2013”.In particular, Arunachala Pradesh (28.92%), Punjab (12.53%), and Assam (12.72%) each have over 50% of the nation's apple orchards. In the locations investigated, the livelihoods of smallholder farmers are significantly influenced by the production of apples. Since we are interested in examining how membership in organizations affects apple growers' investment choices, we have focused our investigation on organizations that are specifically focused on apple production and marketing. These organizations serve members in various provinces, regardless of where they are located—in the villages where the farmers live, other towns, or county. The national law on Farmers' Professional Organizations governs how organizations conduct themselves. In order to increase members' participation in output markets, they also give members marketing information (such as prices and channels). Two key indicators of human capital are age and education. Human capital enhances each person's ability to see, understand, and respond to new occurrences, as was already stated. Age and education influence farmers' choice to connect cooperation in a favorable way, according to earlier research.

We evaluate any potential nonlinearity between these variables and investment choices by including “age and age squared terms, as well as education and education squared terms, in the specifications”. In this research, we substitute ownership of livestock, rotary cultivators, and manual sprayers for ownership of physical assets, and we anticipate that these variables will have a favorable effect on the choice to meet an organization.To account for soil conditions and the possibility that farmers will place bigger investments on more productive soils, we add soil quality samples in the research. Many studies have demonstrated that farmers' decisions to invest in soil-developing methods are influenced by the security of their land tenure. Table 1 show that 43% of farmers were members of an organization. Nearly 48.63 years is the average age of the household head, and 7.6 years is the average amount of time spent in school. Compared to those who are not part of the group, members are more likely to purchase natural soil amendments but low likely to purchase chemical fertilizer, the research shows. Associates enjoy greater net farm returns than non-members. As a result, a systematic analysis of the effect of membership in an organization has on investment in chemical and organic soil amendments must take into account the possibility of selection bias that may result from factors that were not mentioned when membership in the organization was not assigned randomly to farmers.

3. Results and Discussions

To justify the use of the RBP methodology, we first introduce estimation from a “seemingly unrelated bivariate probit (SUBP) structure” and the goodness-of-fit test, followed by the results for the “recursive bivariate probit (RBP) methods”.

3.1 Outcomes for the Better-Fit evaluation and SUBP Estimates

The primary goal of assessing the SUBP models is to determine if the decision to select organization partnership has an unobserved heterogeneity-based correlation with the outcome measures and if these two choices are mutually exclusive or complementary. The organization membership variable must be removed from the investment equation in order to estimate the SUBP model. The supplemental online appendix contains the estimates for the two model specifications. These results indicate that unnoticed impacts included in the error terms. The decision to buy chemical fertilizer and organic soil amendments may influence a farmer's decision to join a organization. Be aware that in the RBP framework, increasing the joint density of the studied reliant values does not imply a best fit. The online supplemental appendix includes the outcomes. The three model specifications' P-values are all not statistically varied from 0 at the ten percent stage, showing that the RBP method is valid and the null hypothesis of normality cannot be neglected.

3.2 Outcomes for RBP Estimates

Table 2 provides estimates from the RBP models of the factors influencing organization membership and their effects on chemical and organic fertilizers. As previously mentioned, the FIML technique jointly estimates the two soil spending equations.The findings in table 2's lower section demonstrate that all calculated correlation coefficients in designs one to two are considerably varies from zero, pointing to the existence of choice bias resulting from factors that are not visible.In other words, farmers decide together whether to meetaorganization, invest in chemical and organic fertilizer, and invest in organic soil amendments. The tenure residual coefficients ofvariables are not statistically important in any of the conditions, proving that the tenure secure variable's coefficients have been accurately determined.

3.3 Factors Influencing Participation in and Investment in Institutions

Farmers with more than nine years of schooling are less likely to choose membership, which is likely a result of their higher abilities, which allow them to diversify their resources of income from farming to non-farm sources. The findings are displayed in table 2's lower section. According to our research, joining an organization greatly raises the likelihood of investing in natural soil amendments by fifty one percent. Yet, there was no evidence of a statistically important effect of organization partnership on investments in chemical fertilizer. The RBP approach demonstrates some variations in the magnitude of the average treatment impacts of organization involvement and the marginal impacts, but both exhibit very positive and statistically significant findings. The marginal impact represents how the chance of spending in a specific soil evaluation of quality varies when the organization membership variable goes from 0 to 1, whereas the ATT quantifies the normal effects of organization participation on the possibility of spending in soil health evaluation.

Table 1: Summary analysis and the definition of variables

Variable	Mean (SD)	Definition
Dependent variables		
Farmyard manure	0.29(0.46)	1 if farmer applies farmyard manure, 0 otherwise
Organic fertilizer	0.85(0.38)	1 if farmer applies organic fertilizer, 0 otherwise
Chemical fertilizer	0.94(0.27)	1 if farmer applies chemical fertilizer, 0 otherwise
Membership	0.44(0.50)	1 if farmer is a cooperative member, 0 otherwise
Organic soil amendments	0.88(0.35)	1 if farmer applies organic fertilizer and/or farmyard manure, 0 otherwise
Age	49.64(11.26)	Age of farmer (years)
Education	8.61(3.88)	Years of formal education of farmer
Household size	4.34(1.45)	Total number of household members
Farm size	5.08(3.25)	Total farm size of apple orchard (mu)
Manual sprayer	0.73(0.46)	1 farmer owns manual sprayer, 0 otherwise

Table 2: The RBP Model Calculates the Effect of organization Membership on spending money on Chemical and Natural soil amendments

	Model 2		Model 1	
	Membership	Chemical fertilizer	Membership	Organic soil amendments
Membership		0.515(0.459)		1.673(0.329)
Age	0.046(0.051)	0.057(0.057)	0.048(0.049)	-0.042(0.047)
Education	0.190(0.086)	-0.229(0.097)	0.167(0.080)**	-0.004(0.007)
Household size	0.126(0.053)	-0.001(0.080)	0.118(0.050)**	-0.158(0.061)
Farm size	0.092(0.028)***	0.089(0.048)	0.097(0.028)***	-0.041(0.030)
Manual sprayer	0.769(0.165)	-0.330(0.219)	0.731(0.162)***	-0.304(0.202)
Sandy soil	1.740 (0.407)***	0.210(0.492)	1.450(0.358)***	-0.104(0.473)
Loam soil	0.467(0.192)	0.308 (0.321)	0.421(0.189)**	0.385(0.290)
Livestock	0.123(0.196)	-0.606(0.224)***	-0.012(0.217)	0.009(0.250)
Access to credit	0.129(0.129)	0.412(0.170)**	0.162(0.132)	-0.015(0.187)
Irrigation	0.262(0.145)*	0.417(0.219)*	0.234(0.145)	0.423(0.209)***

Table 3: Impact of the RBP Model's Marginal Estimate on the Likelihood of Spending money on Natural Soil Amendments and Synthetic Fertilizers (in Percent)

Variables	Chemical Fertilizer	Organic Soil Amendments
Membership	0.060	0.308
Education squared	0.003	0.002
Rotary cultivator	0.007	0.078
Farm size	0.012	-0.009
Manual sprayer	-0.037	-0.057
Sandy soil	0.025	-0.022
Punjab	-0.054	-0.049
Road condition	0.022	-0.012
Tenure security	0.083	0.183
Assam	0.063	-0.031

4. Conclusions

This article investigated that investment in chemical and natural soil amendments were affected by Agricultural organization membership. We specifically created a flexible model to demonstrate that participation in organization, and individual and farm level traits affect farmer's choices to spend money on chemical and organic fertilizers. We examined production intensity and the choices made by diverse producers regarding membership in agricultural cooperatives using the model. We looked at review information from apple production households in the India provinces to determine the effect of agricultural organization membership and household and farm level individuality on spending money in chemical and natural fertilizer.

Theoretical investigation revealed that farmers regard joining a cooperative to be the best option for a certain set of household and farm level features. Research also recognized two circumstances when farmers with agricultural organization membership are more inclined to spend in chemical fertilizers and natural soil amendments than those without membership. Our research revealed that organization membership generally had a beneficial impact on investments in chemical and natural soil amendments, while the encouraging impact on chemical fertilizers was not statistically important. The studies also demonstrated that cooperative participation did not have any arguably significant influence on spending money on chemical fertilizer and natural soil amendments. According to our results, agricultural organization has a crucial part in encouraging smallholder farmers to adopt soil health measures that improve agricultural output and environmental sustainability. There are still some issues with the study that could be taken into account in related studies in the future. Even though we discovered that agricultural organization increase the likelihood that members will invest in natural soil amendments, little is known information on the costs and profits effectiveness of organization members compare to non-members in the implementation of technological advances in agriculture.

References

[1] G.E. Mushi, G. Di Marzo Serugendo, and P.Y.Burgi, (2022). Digital technology and services for sustainable agriculture in Tanzania: a literature review. Sustainability, 14(4): p.2415.

[2] A. Hossain, T.J. Krupnik, J. Timsina, M.G. Mahboob, A.K. Chaki, M. Farooq, R. Bhatt, S. Fahad, and M. Hasanuzzaman, (2020). Agricultural land degradation: processes and problems undermining future food security. In Environment, climate, plant and vegetation growth (pp. 17-61). Cham: Springer International Publishing.

[3] F.A.L. Pacheco, L.F.S. Fernandes, R.F.V. Junior, C.A. Valera, and T.C.T. Pissarra, (2018). Land degradation: Multiple environmental consequences and routes to neutrality. Current Opinion in Environmental Science & Health, 5: pp.79-86.

[4] L. Ye, X. Zhao, E. Bao, J. Li, Z. Zou, and K. Cao, (2020). Bio-organic fertilizer with reduced rates of chemical fertilization improves soil fertility and enhances tomato yield and quality. Scientific reports, 10(1): pp.1-11.

[5] X. Wang, J. Fan, Y. Xing, G. Xu, H. Wang, J. Deng, Y. Wang, F. Zhang, P. Li, and Z. Li, (20190. The effects of mulch and nitrogen fertilizer on the soil environment of crop plants. Advances in agronomy, 153: pp.121-173.

[6] H. Luan, W. Gao, S. Huang, J. Tang, M. Li, H. Zhang, and X. Chen, (2019). Partial substitution of chemical fertilizer with organic amendments affects soil organic carbon composition and stability in a greenhouse vegetable production system. Soil and Tillage Research, 191: pp.185-196.

[7] X. Chen, D. Zeng, Y. Xu, and X. Fan, (2018). Perceptions, risk attitude and organic fertilizer investment: Evidence from rice and banana farmers in Guangxi, China. Sustainability, 10(10): p.3715.

[8] Y.Zhang, H.Long, Y.Li, D. Ge, and S. Tu, (2020). How does off-farm work affect chemical fertilizer application? Evidence from China's mountainous and plain areas. Land Use Policy, 99: p.104848.

[9] T. Phibunwatthanawong, and N. Riddech, (2019). Liquid organic fertilizer production for growing vegetables under hydroponic condition. International Journal of Recycling of Organic Waste in Agriculture, 8: pp.369-380.

[10] B. Li, and Y. Shen, (2021). Effects of land transfer quality on the application of organic fertilizer by large-scale farmers in China. Land Use Policy, 100: p.105124.

[11] Abebe, and S. Debebe, (2019). Factors affecting use of organic fertilizer among smallholder farmers in Sekela district of Amhara region, Northwestern Ethiopia. Cogent Food & Agriculture, 5(1): p.1669398.

[12] F. Yuan, K. Tang, Q. Shi, W. Qiu, and M. Wang, (2022). Rural women and chemical fertiliser use in rural China. Journal of Cleaner Production, 344: p.130959.

[13] J. Jjagwe, K. Chelimo, J. Karungi, A.J. Komakech, and J. Lederer, (2020). Comparative performance of organic fertilizers in maize (Zea mays L.) growth, yield, and economic results. agronomy, 10(1): p.69.

[14] J. Grashuis, and Y. Su, (2019). A review of the empirical literature on farmer cooperatives: Performance, ownership and governance, finance, and member attitude. Annals of Public and Cooperative Economics, 90(1): pp.77-102.

[15] E. Martey, (2018). Welfare effect of organic fertilizer use in Ghana. Heliyon, 4(10): p.e00844.