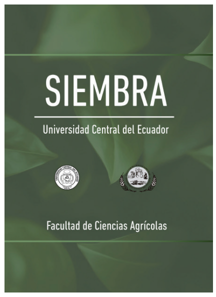
Profitability of crops in rotation under two soil tillage systems in the Tumbaco Valley, Ecuador



Rentabilidad de cultivos en rotación bajo dos sistemas de labranza de suelo en el valle de Tumbaco, Ecuador

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Abstract

Small producers in Ecuador, who are grouped within the typology of peasant family agriculture (PFA), represent 62% of the rural population and contribute to food security by producing basic foodstuffs for the family food basket. Typically, their production system is based on family labor. Their main crops are beans and corn, using the conventional tillage system (CT). Soil erosion is the most serious environmental problem in Ecuador, affecting approximately 50% of the cultivated area. An effective agronomic practice against erosion is no-tillage (NT) complemented with crop rotation (CR). Investments in soil conservation are generally high and not profitable in the short term, so it is a challenge to generate techniques that improve yields, reduce costs and produce benefits from their implementation, in order to motivate their adoption. The objective of this study was to evaluate the bean-corn rotation, comparing NT with CT, at an early stage of its implementation through the benefit/cost ratio (B/C ratio) in the Experimental Field "La Tola" (CADET), in Tumbaco-Ecuador. The results show that the B/C ratio averages for beans were similar in both NT and CT systems; on the other hand, for corn, NT outperformed CT by an average of more than 50%, thus rejecting the hypothesis that NT would generate losses. In conclusion, NT is a profitable soil conservation alternative under the soil-climatic conditions studied.

Keywords: erosion, bean-corn rotation, no-tillage, benefit/cost ratio, profitability

Resumen

Los pequeños productores del Ecuador, quienes se agrupan dentro de la tipología de agricultura familiar campesina (AFC), representan el 62 % de la población rural, contribuyen a la seguridad alimentaria y producen para la canasta familiar los alimentos básicos. Típicamente, su sistema productivo se basa en el trabajo familiar. Sus principales cultivos son el fréjol y maíz, utilizando el sistema de labranza convencional (LC). Por otro lado, la erosión de los suelos es el problema ambiental más serio del Ecuador que afecta, aproximadamente, al 50 % del área cultivada. Una práctica agronómica efectiva contra la erosión es la siembra directa (SD) complementada con la rotación de cultivos (RC). Las inversiones en conservación de suelos, por lo general, son altas y no rentables a corto plazo, por lo que es un reto generar técnicas que mejoren el rendimiento, reduzcan costos y produzcan beneficios desde su implementación, para que motiven su adopción. El objetivo de este estudio fue evaluar la rotación fréjol-maíz, comparando SD con LC, en una etapa temprana de su implementación a través de la relación beneficio/costo (R B/C) en el Campo Experimental "La Tola" (CADET), en Tumbaco-Ecuador. Los resultados muestran que los promedios de la R B/C para fréjol fueron similares en los dos sistemas; en cambio, para maíz, SD superó a LC, en un promedio mayor al 50 %, por lo que se rechaza la hipótesis de que la SD generaría pérdidas. En conclusión, la SD es una alternativa de conservación de suelos rentable bajo las condiciones edafo-climáticas estudiadas.

Palabras clave: erosión, rotación fréjol-maíz, siembra directa, relación beneficio/costo, rentabilidad

1. Introduction

Small producers contribute to Ecuador's food security as they are responsible for the production of basic foodstuffs for the family food basket. They keep their productive rationality associated with the use of family labor force. They produce not only for their own consumption, but they also generate surpluses that cover the needs of the domestic market, preserve agrodiversity and represent 62 % of the economically active rural population (the majority of this population generates its own employment) (Berry & North, 2011; Carrión & Herrera, 2012). As a whole they make up what is known as the Peasant Family Agriculture [PFA] group, a vital engine to fight poverty for the Ecuadorian economy, and which constitutes a support for a more equitable society (Boada & Espinosa, 2016). Beans and corn are among the main crops produced by the PFA.

Bean cultivation, in Ecuador, is carried out by small farmers, orienting production toward self-consumption and domestic market supply. In Ecuador the average cultivated area in the latest cycles was 22,186 ha year^{-1}, of these 3,410 ha were bush beans (determinate growth habit), the average yield of dry beans was 350 kg ha^{-1}. and 1,340 kg ha^{-1} of green pods (Orellana, 2022).

Soft corn is essential for the economy of farmers in the Andean region of Ecuador. The production areas of this type of maize are located between 2,000 and 3,000 m a.s.l., in soils with certain deficiencies, mainly of nitrogen [N] and phosphorus [P], exposed to erosion, the physical process of loss of the arable layer resulting from the dragging of particles by the action of rain and wind on exposed soils (Boada & Espinosa, 2016).

Erosion is intensified by topographic conditions of high slope, soil type and lack of vegetation cover, in addition to certain inadequate practices carried out by farmers (Winters et al., 1998). The United Nations Food and Agriculture Organization [FAO] and Intergovernmental Technical Panel on Soils [ITPS] (2015) highlight that soil degradation increased worldwide, as a consequence of the practice of monoculture, the over-application of chemical pesticides, inappropriate soil management; also, they argue that the damage is not only expressed in increased erosion, but also in compaction, sealing and waterlogging, acidification and salinization, contamination, nutrient imbalance -by excess or deficiency-, loss of soil organic carbon [SOC], which is associated with the production of greenhouse gases and, finally, loss of biodiversity.

Erosion in Ecuador is one of the main environmental degradation problems, affecting approximately 50 % of the cultivated soil. About 15 % of degraded lands are located in the inter-Andean alley, and on the slopes bordering it (Espinosa et al., 2022). Soil loss due to water erosion in agricultural lands reaches 80 ton ha^{-1} year^{-1} (FAO & ITPS, 2015): also, erosion caused by tillage with disc plowing increases. As an example, in the province of Carchi, on a black soil with 30 % slope, erosion was estimated at 40 ton ha^{-1} for each tillage performed (Córdova & Valverde, 2002).

The pressure on land due to the growth of the Ecuadorian population (9.29 million in 1986 to 16.8 million in 2017) has forced farmers in the Andean region to use marginal lands, with steep slopes for production. This trend was accelerated by the successive division of agricultural properties, creating a network of smallholdings with scarce productive resources. Erosion, however, not only occurs in smallholdings, but also in large properties due to the lack of tidiness in cultivating them (Espinosa et al., 2022).

In eroded soils the development of plants is precarious, they are weak, do not cover the soil, and leave little residue on the surface. In addition, the constant movement causes the loss of soil organic matter [SOM] and fertility (Derpsch et al., 2010; Espinosa et al., 2022). The main consequence of this process is the reduction of the production capacity of farms, causing a negative impact on the economy of farmers. Nonetheless, there are also indirect consequences on the inhabitants of urban areas, since the accumulation of sediments in infrastructure works puts hydroelectric power plants, roads and houses at risk (Espinosa et al., 2022).

One of the most effective agronomic practices for erosion prevention and control is conservation tillage, known as no-tillage [NT], complemented by crop rotation (Crovetto, 2006). NT is the preparation of the soil for planting in which soil tillage to place the seeds is minimal, as these are placed in a narrow planting bed; generally, NT depends on the use of herbicides for weed control (Dabalá, 2009). Crop rotation [CR] consists of the alternate sowing of different species on the same soil (the most appropriate is to alternate legumes and cereals), and is applied to mitigate the presence of weeds and improve pest control, as with this practice the biological cycles of weeds are broken, and the balance of nutrients in the soil is promoted (Derpsch et al., 2010; Fan et al., 2020; Kazula et al., 2017).

Espinosa et al. (2022) and Crovetto (2006), among other authors, assure that farmers who adequately manage NT obtain satisfactory yields at lower costs, as it allows to reduce the use of agricultural machinery and fuel; in addition, once the system is consolidated, in the medium and long term, yields stabilize or improve.

Production costs are the monetary value of the factors used in the exercise of an economic activity aimed at the production of a good or service, since every productive process involves the consumption, or wear and tear of one, or more production factors. Payments for the factors of production are considered: payments for labor, i.e. payments of wages, salaries, and benefits to day laborers and employees; payments for inputs used in the production process (seed, fertilizers, compost, pesticides, etc.); as well as payments for the use of capital used in the production process, consisting of the remuneration to the farmer, or agricultural entrepreneur (for the money invested, use of capital goods, interest, profits, etc.). It is the relationship between the investment required to implement a production process and the profit it generates. It is expressed as the B/C ratio and measures the efficiency achieved for each monetary unit invested (Herrera et al., 1994).

In general, investments to implement soil conservation technologies have considerable costs for their establishment, and produce profits only a few years later; so, for these technologies to be successfully adopted, it is necessary to combine them with processes that improve yields, or reduce costs, and produce economic benefits to farmers from the moment of their implementation (Winters et al., 1998). As NT is a successful agronomic practice for surface runoff control that is achieved by planting without soil removal, maintaining cover and implementing RC this article aims to evaluate the yields and production costs of bean and corn crops, in rotation, comparing SD and LC during the first five cycles of their implementation. Additionally, it aims to determine the profitability of each tillage systems. It is hypothesized that the conservation tillage system, implemented in the Academic Teaching and Experimental Field “La Tola” [CADET], in its transition stage, will produce lower yields and higher costs compared to CT, and that, therefore, it would generate losses in income.

2. Materials and Methods

2.1. Study area

The experiment was conducted at CADET, located in the Quito canton of the Pichincha province, at an altitude of 2,465 m a.s.l., 78°21’18’’ west longitude and 00°13’49’’ south latitude. According to the National Institute of Meteorology and Hydrology [INAMHI], the site has an average temperature of 15 °C, average annual rainfall of 927 mm, and relative humidity of 76 %. The lots under study correspond to a mollisol. The CADET has permanent irrigation water and a sprinkler irrigation system. Three factors are evaluated in the research: tillage systems, nitrogen fertilization levels, and crop rotations. Each subplot of the bean-corn rotation has an area of 84 m^2 (12 m x 7 m). Two tillage systems and four nitrogen fertilization levels are evaluated, with three replications. The net area of the experiment covers 2,016 m^2 (84 x 24); additionally, there are 544 m^2 between borders and roads, so the experimental area of this report covers 2,560 m^2.

2.2. Varieties used

We used the INIAP 484-Centenario bean variety, which has resistance to multiple diseases, type 1 growth habit (without guide), pink flower, the color of the bean is red mottled with cream, the bean size is large, its shape is kidney-shaped, with a vegetative period of 110 to 120 days, it develops well between 1,400 to 2,400 m a.s.l., yields “average” 2,150 kg ha^{-1} with a fertilization of 11 kg ha^{-1} nitrogen and 11 kg ha^{-1} phosphorus (P_2O_5), yields “average” yields of 2,150 kg ha^{-1} with a fertilization of 11 kg ha^{-1} of nitrogen and 52 kg ha^{-1} of phosphorus ((P_2O_5), its dry grain contains 26.77 % protein (Murillo et al., 2012).

The corn variety used was INIAP 122-Chaucho Mejorado, which is characterized by its earliness, low plant size, resistance to lodging, tolerance to ear rot, and good grain quality, soft type and yellow color, develops well at an altitude of 2,200 to 2,800 m a.s.l., with "average" dry grain yields of 3,850 kg ha^{-1} for which it needs a fertilization of 80 kg ha^{-1} of N and 40 kg ha^{-1} of P ((P_2O_5). This variety is appropriate for consumption as corn, roasted, mote, humitas, in flour, etc. (Yánez et al., 2013).

2.3. Products, by-products and prices

To determine the price of the products, and by-products that are the object of this study, we conducted a survey in the La Ofelia market (for corn and beans in dry grain) in Quito, and in the El Arenal market in Tumbaco (for corn in corncob). In the case of beans, the production and commercialization of dry beans was evaluated, and the price was set at USD 1.44 kg^{-1} of dry beans.

For maize, the analysis was carried out for the three uses specified by the PFA families: (a) the dry grain that is harvested when the plant reaches the end of its physiological state, that farmers in the sector grow in small extensions for self-feeding and seed. Its price was determined at USD 0.80 kg^{-1} of dry grain; b) tender corn, known as corn, which is a popular dish, and is very popular among the sector's population, which had an average price of USD 0.13 kg^{-1}; c) "the stalk and its leaves", an important by-product for the economy of this stratum of farmers which are used as fodder for feeding farm animals, such as cattle, sheep, rabbits, guinea pigs, etc. Its price is very variable, since it depends on the period of the year: in the dry season its value reaches up to USD 0.10 per unit (stem and leaf), while when it rains, its value decreases, reaching up to USD 0.01 per unit. The price set for this work was USD 0.03 per unit (stem and leaf). Additionally, we considered that, in the case of the CT tillage system, farmers sell this by-product in its entirety, whereas, when NT is implemented, they would sell only 50 % of this by-product, as the rest would be left on the land for decomposition and contribution of SOM.

Labor in the area was valued at USD 20 Jornal^{-1}.

2.4. Economic analysis

The economic analysis was carried out using the B/C ratio method, described by Herrera et al. (1994), for which all the activities carried out when implementing each of the crops in the tillage systems were recorded, from land preparation to harvest and post-harvest; then, these values were costed and added up. On the other hand, the quantity produced of each of the products, and by-products was recorded and multiplied by its price, thus obtaining the gross income, then the equation [1] was applied.

$$B/C\ ratio = {\sum I}/{\sum E} \quad [1]$$

where:

- *∑I: sum of income or monetary benefits from the crop.*
- *∑E: sum of all expenses incurred to implement the crop.*

The result measures the financial efficiency of each dollar invested in each of the crops implemented, for each crop cycle and tillage system.

3. Results and Discussion

3.1. Yields (kg ha^{-1})

Table 1 shows that, yields during the first and third cycles of bean cultivation, the yields in NT were higher than in CT, while in the fifth cycle, which corresponds to the second half of 2021, the results are reversed, i.e., the best yields were obtained in CT, due to the climatic conditions of that year, in which torrential downpours affected, to a greater extent, the NT plot.

Table 1. Yield, production costs, income, and B/C ratio of the bean crop for dry grain crop during three cycles and their averages. CADET, Tumbaco, Ecuador. 2023.

Cycle	Yield (kg ha^{-1})		Production Costs (USD ha^{-1})		Income (USD ha^{-1})		B/C ratio (Return on USD^{-1} Invested)	
	NT	CT	NT	CT	NT	CT	NT	CT
First	2,957.00	1,847.00	2,115.11	2,185.63	4,258.08	2,659.68	2.01	1.22
Third	1,523.38	1,257.82	1,874.33	1,938.87	2,193.67	1,811.26	1.17	0.93
Fifth	1,264.17	2,683.59	2.067.19	2,136.05	1,820.41	3,864.37	0.88	1.81
Average	1,914.85	1,929.47	2.018.88	2,086.85	2,757.38	2,778.44	1.35	1.32

The Higher bean yields under NT in the first (60.10 %) (Montesdeoca et al., 2020) and third cycles (21.11 %), compared to CT, agree with the trend reported by researchers such as Valdivia Lorente and Valle Trujillo (2017), who found that NT reached a yield of 1,924 kg ha-1 higher than CT, which reached 1,710 kg ha^{-1}.

In contrast, the yields corresponding to the fifth cycle (third bean cycle), which show a better performance of CT (higher by 112.28 %), could be explained by the heavy rainfall that occurred during the period in which the crop was in development (September-December, 2021), since in these months the amount of water from rainfall was almost double the amount produced in similar months in the three immediately preceding years (Figure 1). This higher soil moisture, together with the large amount of stubble that was decomposing on the soil surface, especially in NT, caused a saturated environment conducive to a higher incidence of diseases, and weeds that affected the good development of the crop and its yield. Some scientists believe that there is an unfavorable trend in global climate that is harming crop yields (Wonnacott & Wonnacott, 1992), as observed, changes in the atmosphere, the oceans and the biosphere provide unequivocal evidence of a warming world and the consequences show that rainfall is increasing in certain areas, while it is scarce in others, causing major floods in the former, and severe droughts in the latter; therefore, farming methods resilient to these climate factors are needed (Castro, 2021).

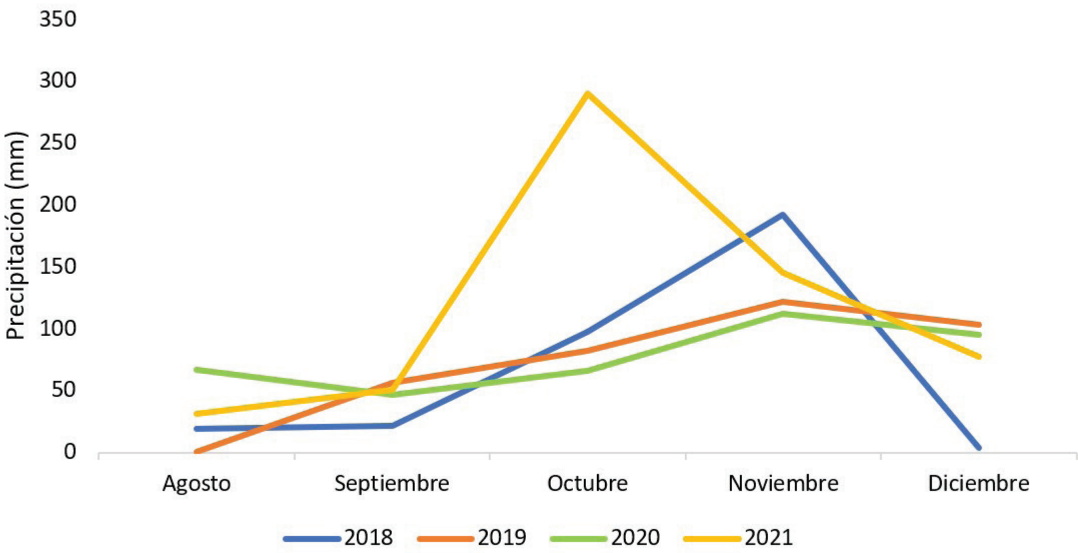

Figure 1. *Comparative data of precipitation recorded in 2018, 2019, 2020, and 2021, "La Tola" Meteorological Station, Tumbaco, Ecuador.*

On the other hand, it is recommended that for subsequent bean cycles, the production and commercialization of the tender grain, which is a fairly common consumption modality in the area, should also be evaluated.

When analyzing the yields of corn for corn (Table 2), in the two cycles evaluated, a better performance is observed in NT compared to CT, since, on average, NT yields 62.73 % more than NT. Corn yields for dry grain (Table 3) also follow the same trend, since, on average, NT is 20.68 % higher than CT.

Table 2. Yield, production costs, income, and B/C ratio of sweet corn on ear, during two cycles and their averages. CADET, Tumbaco, Ecuador. 2023.

Cycle	Yield (kg ha^{-1})		| Production Costs (USD ha^{-1})		Income (USD ha^{-1})		B/C ratio (Return on USD^{-1} Invested)	
	NT	CT	NT	CT	NT	CT	NT	CT
Second	36,712.50	21,772.35	1,748.72	1,931.96	4,772.63	2,830.41	2.73	1.47
Fourth	39,740.86	25,209.79	1,851.19	2,107.80	5,702.02	4,348.69	3.08	2.06
Average	38,226.68	23,491.07	1,799.96	2,019.88	5,237.32	3,589.55	2.90	1.76

Forján y Manso (2013) and Aparicio et al. (2002) observed that NT gives a better yield compared to CT under corn cultivation, because a greater accumulation of residues on the soil is achieved, which provides a dense cover, contributing significant amounts of SOM, and also, by complementing the use of legumes in the crop rotation, the bacteriologically fixed N is incorporated; therefore, there is greater net mineralization of N, and an increase in its residual content in the soil, which affects higher corn yields.

Recent experiments conducted in Ecuador report better yields of NT compared to CT, in different crops (Alvarado Ochoa et al., 2011; Gallager et al., 2017; Quichimbo et al., 2012). In this sense, Alvarado Ochoa et al. (2011) emphasize that proper management of corn residues under conservation tillage doubles the N and potassium [K] content in the soil, which has a positive impact on yields.

Table 3. Yield, production costs, income and B/C ratio of the dry maize crop, during two cycles and their averages. CADET, Tumbaco, Ecuador. 2023.

Cycle	YIeld (kg ha^{-1})		| Production Costs (USD ha^{-1})		Income (USD ha^{-1})		B/C ratio (Return on USD^{-1} Invested)	
	NT	CT	NT	CT	NT	CT	NT	CT
Second	4,505.94	4,305.33	1,778.72	1,986.96	3,604.75	3,444.26	2.03	1.73
Fourth	3,042.88	1,950.01	1,971.19	2,233.80	2,434.30	1,560.01	1.23	0.70
Average	3,774.41	3,127.67	1,874.96	2,110.38	3,019.53	2,502.14	1.63	1.22

The NT is an effective alternative for soil conservation; however, it alone does not completely improve soil and crop performance. For this soil tillage system to work properly, it needs to be complemented with an adequate CR scheme. Crop yield results under NT and the consequent environmental impact depend on the crop sequence because adequate rotations improve nutrient balance, increase SOM content, water utilization, and also have an inhibitory effect on various pathogens (pests and diseases). Rotations and a dense surface cover of plant residues make and regulate water and nutrient cycles (Bell et al., 2003; Castilla, 2013). The use of CR with high capacity to produce root biomass is recommended to prevent the formation of compact strata and improve soil physical quality (Munkholm et al., 2013). In addition, CR improves biomass production in lower layers of the soil profile (zones where the legume root reaches), it improves the quantity and quality of root exudates, increases the microbial population and increases soil aggregates that allow protection of the organic carbon [OC] and N present (Cates et al., 2016; Drinkwater et al., 2007; Plaza-Bonilla et al., 2016).

3.2. Production costs

Regarding production costs, in the three bean cycles there are higher costs associated with CT compared to NT, which represents an average difference of 3.37 %. In the case of corn, the differences are also evident, since on average the production costs for corn in CT exceed those of NT by 12.22 %, and the average production costs for corn for dry grain in CT exceed those of NT by 12.56 %; this is mainly explained by the greater amount of labor that had to be used in CT (USD 20 per day^{-1}), mainly for weed removal (USD 20 per day^{-1}).

3.3. Benefit/cost ratio (B/C ratio)

Dividing the income obtained for the costs incurred, the B/C ratio was obtained, that is, the monetary value that comes in for each dollar invested, which demonstrates the financial efficiency of each of the crops.

For the case of beans, the results of the B/C ratio are not consistent during the evaluated cycles, since in the first and third cycles in NT they were positive with 2.01 and 1.17 compared to CT values that presented B/C ratio of 1.22 and 0.93, respectively; however, for the fifth cycle the response is inverted, with an B/C ratio of 0.88 in NT, while for CT it was 1.81; nevertheless, the average of the three cycles of this financial parameter is presented quite similar (NT: 1.35 vs. CT: 1.32) (Table 1), which allows inferring that bean crop yields were equivalent in the two tillage systems used, and that productivity was rather dependent on the climatic conditions of the site and the growing season.

On the other hand, from the results presented for corn, it can be inferred that the average B/C ratio of the two cycles evaluated (second and fourth) in NT was 64.77 % higher than the average presented by CT (2.90 vs. 1.76); likewise, for dry bean NT was 33.61 % higher than the average presented by CT (1.63 vs. 1.22).

With the results presented, it can be inferred that, consistently, the corn crop adapted better to the changes in crop management that migrating from CT to NT represents: in addition, its yield and profitability are less dependent on the climatic conditions of the place and time of cultivation.

The difference obtained when corn is marketed in corncob, compared to the commercialization of dry grain, is striking, since- in the first case-, a higher profitability is obtained, although the crop remains less time in the field; therefore, there is less exposure to weather conditions and field pests, thus, there is lower risk and, a higher profitability.

4. Conclusions

Yields in the bean crop were higher in NT for the first two cycles compared to CT, while in the last cycle, the yield in the conservation tillage system was lower due to the high rainfall that occurred in the cultivation stage, that affected the bean crop more intensely in this system, because the higher humidity caused the severe presence of diseases caused by soil fungi. Consistently, yields in the maize crop were higher in NT in the two cycles evaluated, both for corn and dry grain, which allows concluding that, under CADET conditions, this species was better adapted to the management of the conservation tillage system.

Regarding production costs for the two crops, they are lower in NT, both for the three bean cycles and for the two corn cycles; a result that is explained by the savings produced by implementing this soil tillage system due to the fact that less labor and agricultural machinery is used (including less fuel use), which makes it cheaper.

It is concluded that bean profitability is not consistent in the cycles analyzed, since its yield and productivity depend on the climate. In the first two cycles evaluated there is a higher profitability in NT, while in the third cycle the results are reversed, since CT was more profitable, due to the fact that bean yields declined ostensibly for the reasons identified above. In addition, when comparing the averages of the three cycles of the parameters analyzed, between the two tillage systems, it is found that they are very similar, to such an extent that the B/C ratio of the two tillage systems are practically equivalent.

Regarding the analysis of the profitability of corn, it is concluded that in the two cycles evaluated, NT was more profitable compared to CT, and this behavior is explained because this plant species was the one that best adapted to the conservation tillage system in which less labor and agricultural machinery is used (including less use of fuel). It is also concluded that it is more profitable for farmers to sell their production in corn rather than in dry corn; also considering that, for the plant to fully mature until it obtains dry grain, it spends more time (60-70 days) in the plots, which extends the risk period of the crop to environmental factors and pests in the field (especially birds and rats). It is also explained by the fact that corn is a daily product on the table of Ecuadorians and its demand is permanent; in addition, in this physiological state of the plant, the farmer uses and/or markets part of the plant (stems and leaves) that in the PFA are used to feed the farm animals, such as cattle, rabbits, guinea pigs, etc.

With the above, the hypothesis that, in the first transition cycles, the conservation tillage system implemented in the CADET would produce lower yields and higher costs compared to CT is rejected; and, therefore, the system implemented would generate losses in income. Overall, NT produced higher yields, lower costs and better profitability. However, with the results shown, it is corroborated that the agricultural activity is exposed to climatic risks such as high rainfall or prolonged droughts, more common in these times of global warming, which can increase the uncertainty of yields and affect profitability.

Contributor Roles

- Fabián Homero Salomón Montesdeoca Montesdeoca: conceptualization, funding acquisition, methodology, project administration, writing – original draft.
- Janeth Alexandra Quishpe Sacancela: investigation.
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- Segundo Samuel Miranda Yupanqui: investigation.
- Lizbeth Leonela Arcos Saravia: investigation (support).
- Ariel Benjamín Armendáriz Serrano: investigation (support).
- Jeffry Stalin Flores Acosta: investigation (support).
- Soraya Patricia Alvarado Ochoa: writing – review & editing.

Ethical Issues

Ethics approval Not applicable.

Conflict of interest

The authors declare that they have no affiliation with any organization with a direct or indirect financial interest that could have appeared to influence the work reported.

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