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LEVEL OF ADOPTION AND FACTORS THAT AFFECT THE USE OF TECHNOLOGIES IN HARD CORN

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Abstract

The level of productivity of the hard yellow corn crop, cultivated mainly in the coastal region of Ecuador, registers increases due to technological advances. The technology for the production of corn allows to improve its productivity if it is used correctly; however, various agro-socio-economic factors limit its adoption. In this work, the level of adoption and the factors that affect the use of new technologies for the cultivation of hard corn are established through a semi-structured questionnaire applied to 150 farmers with a scale of variables with three intervals and the calculation of the index of adoption. In Ecuador, the level of technology adoption is high for seed, disease management, and weed control, while soil analysis, crop rotation, nutrition, and direct seeding present a low degree of adoption since producers, based on their experience, modify doses and frequencies in order to reduce costs. The agro-socioeconomic factors that present significant differences in adopting technology are the cost of production followed by the offer of technological packages, training and credit. In addition, farmers demand new technologies from institutions such as irrigation infrastructure, organic waste management and precision agriculture.

Keywords: Accaeptnce, technology, hard yellow corn, factors

Introduction

Currently, developed countries have specialized in providing technology at the international level. In contrast, the technologically dependent industrialization of developing countries means that they persist with unfavorable terms of trade (due to the concentrated nature of the technological supply at the international level), which affects their chances of development (Dulcich, 2018).

A region's comparative advantage in crop production is not only given by its good endowment of natural resources such as land or climate, but it also depends on adopting agricultural technologies (Khonje *et al*., 2015). According to Galindo (2004), it is a mental process in which peasants, after having information about an innovation for the first time, decide to accept or reject it under the influence of certain conditioning factors.

According to Munguía-Aldama *et al*. (2015), corn has social, cultural and food importance, whereas agriculture is traditional, without denying the existence of some modern practices. This species faces climatic changes and the uncertainty that affects production due to cultivation practices and local environmental conditions.

According to the MAG-Agricultural Public Information System (MAG-SIPA, 2022), 259,084 ha of hard corn were harvested in Ecuador in 2020, with a production of 1,430,608 tons, which represents a decrease of 20.6% compared to the previous year. The productivity of hard corn in that same year was 5.52 tons per hectare, compared to the 6.6 tons per hectare harvested in 2019. The total production of 1,430,608 tons is distributed at the provincial level in Los Ríos (41.11%), Manabí (26.55%), Loja (15.33%), Guayas (14.85%) and Santa Elena (1.63%).

The Central Bank of Ecuador reports that the main problems that affected the planting of hard corn (winter season) were: lack of communication routes (24%), unfavorable weather (21%), lack of technical assistance (19%), labor shortage (18%), high cost of labor (11%), lack of financing (6%) and high-interest rates (1%). Additionally, the interviewees mentioned other inconveniences such as the drop in price, the presence of pests in the crop due to excess water, the pandemic had affected the shortage of labor, which has increased, and the lack of access roads to the enclosures, making it difficult to mobilize agrochemical products, which, due to scarcity, their costs are high (BCE, 2021).

The technology to produce corn allows production units to improve their productivity if used properly. However, several factors limit and condition its adoption. The adoption of improved seeds by producers is favored when there are contract sales and financing and irrigation infrastructure for the development of the activity. At the same time, innovations such as soil analysis, balanced fractional fertilization and controlling pests and diseases are also associated with adopting improved corn seeds (Luna et al., 2016).

Knowing the effects of technologies on society is essential to motivate research development since it provides inputs to decision makers and policy generators that allow projecting the impact of future investments (Sánchez and Zambrano, 2019).

Additionally, the technological adaptations to which farmers were forced during the year 2020 in which the pandemic occurred must be considered, since the productivity of hard corn per hectare of land harvested in the country was 6.29 t ha^{-1}, which represents a decrease of 4.2%, compared to the year 2019. This negative behavior is due to several factors, among which are the decrease in labor for phytosanitary control tasks and harvesting that coincided with the critical time of the pandemic (Zambrano & Arias, 2021).

Forero & Rojas (2013) point out that, to reduce technological gaps, governments within the framework of agricultural research seek to generate, adapt, and implement agricultural technologies that support sustainable rural development. However, rural poverty can increase significantly without adopting technologies that lead to productive and economic progress. That is why the research objective was to establish the level of adoption and the factors that affect the use of new technologies in hard corn in representative cantons of the provinces of Los Ríos and Guayas.

Methodology

To obtain information for the study, a survey was applied to 100 farmers in the province of Los Ríos and 50 farmers in the province of Guayas during the agricultural cycle of the second semester of the year 2021. The questionnaire was validated by two technical researchers and two farmers that identified the following technological innovations to measure the level of adoption: soil analysis, seed, nutrition, pest control, disease management, crop rotation, weed control and direct seeding, which are described below.

Soil analysis. The variable of taking and sending soil samples to the laboratory was included.

Seed. Simple and triple hybrids of a hard corn that farmers sow were considered.

Nutrition. The types of chemical fertilizers (nitrogen, phosphorus, potassium) and organic fertilizers (Bocashi) were considered.

Pest control. This index mainly included the use of traps and pheromones

Disease management. Using fungicides applied to the seed, plant and soil was considered.

Rotation. Planting different crops on the same land area was measured by the soybean, peanut, bean, and sunflower options.

Weed control. Pre- and post-emergence herbicide application variables and manual weeding were included.

Direct sowing. This index included the non-removal of the soil and the land cover with residues from the previous harvest.

Variables or traditional factors that affect the use of new technologies were included in the questionnaire, such as cost, technical assistance, training, hectares dedicated to planting corn, ownership of the land, and additionally, the possibility was provided for them to place other factors that were off the list.

The selection of the corn growers to be surveyed was made for convenience, considering the difficulty of accessing the properties due to the restrictions on the mobility of goods and people caused by COVID-19. To quantify and compare the level of adoption, a scale of variables with three intervals was carried out.

Table 1. Assessment of adoption variables.

ASSESSMENT	TECHNOLOGICAL ADOPTION LEVEL
1	Low
2	Medium
3	High

With the information obtained in the intervals, the technology adoption index (TAI) was calculated based on the equation suggested by Vélez *et al*. (2013).:

$$\text{TAI} = \sum_{i=1}^{k=8} * Vi$$

Where:

TAI = Technology adoption index
K = Number of technological components evaluated
Vi= Maximum value obtained using technological components whose value ranges from 0 to 100

The study hypothesizes that there is a high adoption rate of the technologies generated for the management of the hard corn crop.

Results and Discussion

Adoption of technologies in hard corn

Figure 1 shows that the adoption level of soil analysis technology is low and among the main factors that explain this behavior is the high cost of analysis, the great distance from the production units to the laboratories, the lack of technical assistance, and poor training to take soil samples. This behavior has been maintained for several decades, as reported by Chicaiza (2010), in the case of management practices for the cultivation of hard corn in the province of Los Ríos and Guayas.

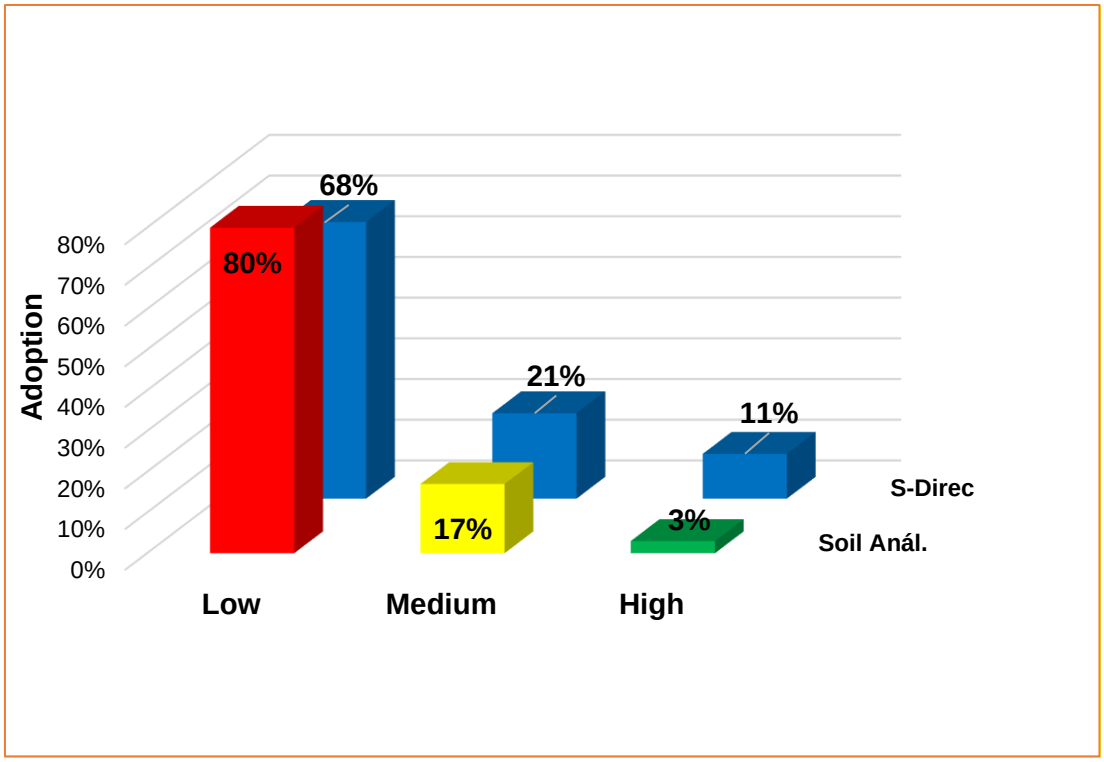

Figure 1. Soil analysis and direct sowing.

Concerning the recommended practice of direct seeding, it also registers a low level of adoption (68%) explained by ignorance of the technology and those who do know it state that it excessively increases weeds and pests. In this sense, Triana and Moreno (2021) affirm that producers do not have mechanisms to protect themselves from adverse economic impacts. Therefore, they must be cautious to have a low risk of losses in adopting novel techniques.

The technology for rotation of the hard corn crop after the harvest registers 48% adoption, although certain inappropriate practices continue to be maintained, such as burning residues that have been compacting the soil.

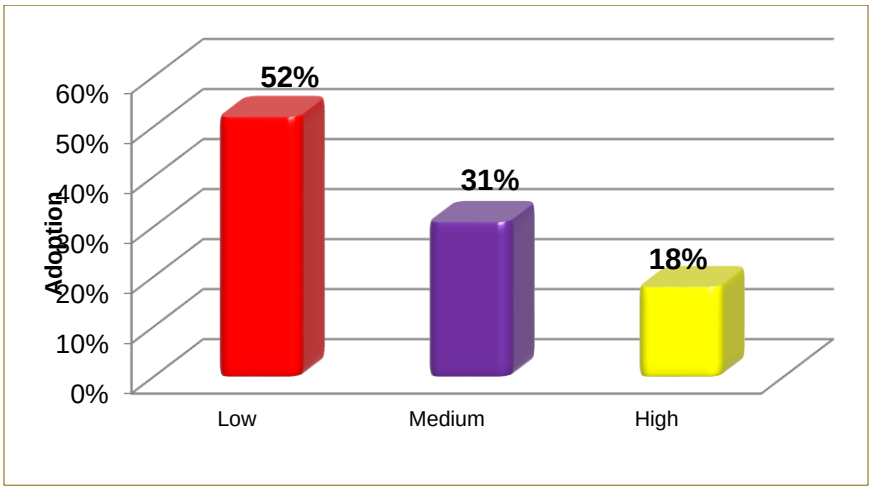

Figure 2. Crop rotation.

Farmers mentioned for not carrying out crop rotation are custom, low availability of land, fallow land after harvest, and the fact that they do not have a profitable substitute crop.

The genetic material or the seed offered by the INIAP and the agrochemical companies register the highest level of adoption with 82% (Figure 3). This level of adoption is consistent with the results of Sánchez and Fernández (2020) since the adoption of hybrid corn seed positively influenced productivity per hectare, regardless of whether it was adopted on its own or through a technological package. However, the effect was undoubtedly more significant for the producers who adopted the technological package.

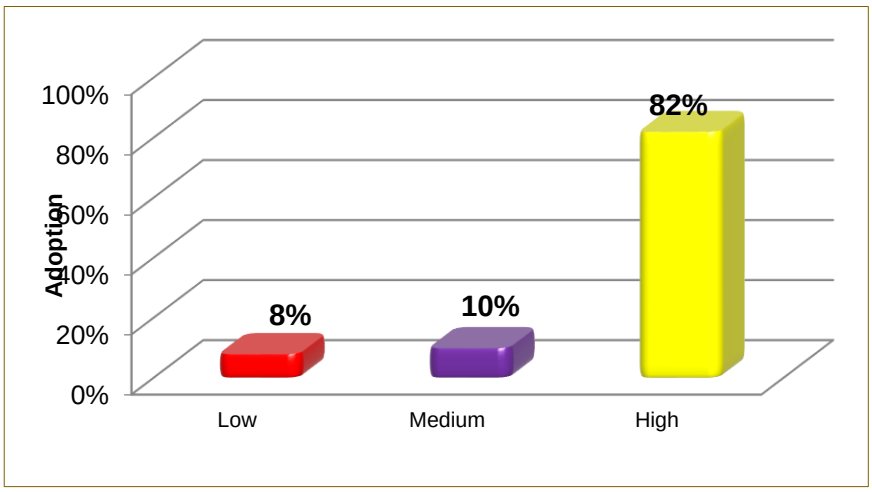

Figure 3. Certified seed.

Although several producers were dissatisfied with the high prices of the seed, the majority acquire it because it increases the production of hard corn, decreases the cost of other inputs, commercial houses and even the government offer it in a technological package or kit and additionally because several agrochemical companies grant them credit even to be paid with the product of the harvest. It should be borne in mind that the innovation proposals are imposed by technologies based on genetically modified varieties in the laboratory and widely distributed in commercial establishments throughout the country, such as agrovets, which are agents that provide technical assistance (Pereira, 2018).

Nutrition consists of the fertilization carried out during sowing and the development of the plantation, generally with Urea, an easily absorbed nitrogenous fertilizer bought by farmers at an average price of 35 dollars per quintal and according to the needs. Soil nutrients also use the fertilizers muriate potassium and aluminum phosphate.

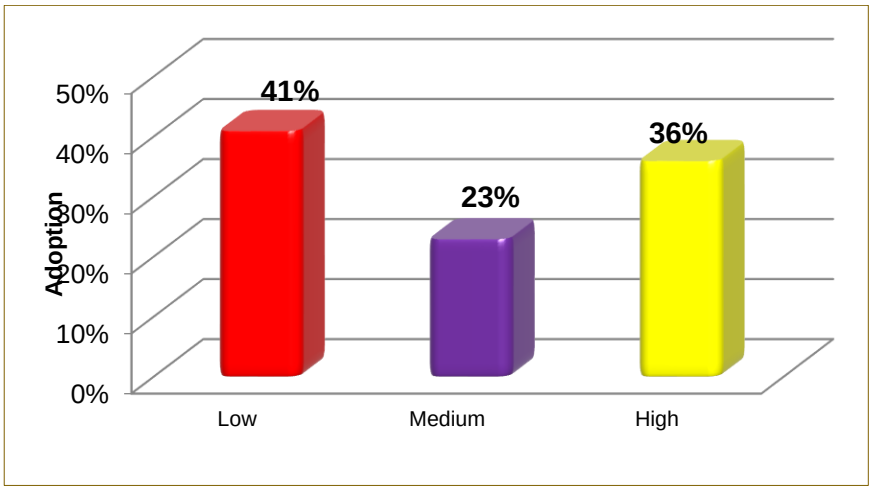

Figure 4. Crop nutrition.

The level of adoption was around 59% between medium and high, which usually follows an application pattern based on the suggestions of the agrochemical companies that offer credit and that, out of habit, say they know the need for the nutrition of the corn plant (Figure 4).

The attack of the different pests registers a medium (51%) and high (29%) adoption level; the most predatory is the *Spodoptera frugiperda*, which is a worm that attacks the bud of the plant in the first days of the crop, that is why two controls carry this out with broad-spectrum insecticides such as *Chlorpyrifos*, *Lufenuron*, and *Thiodicarp*.

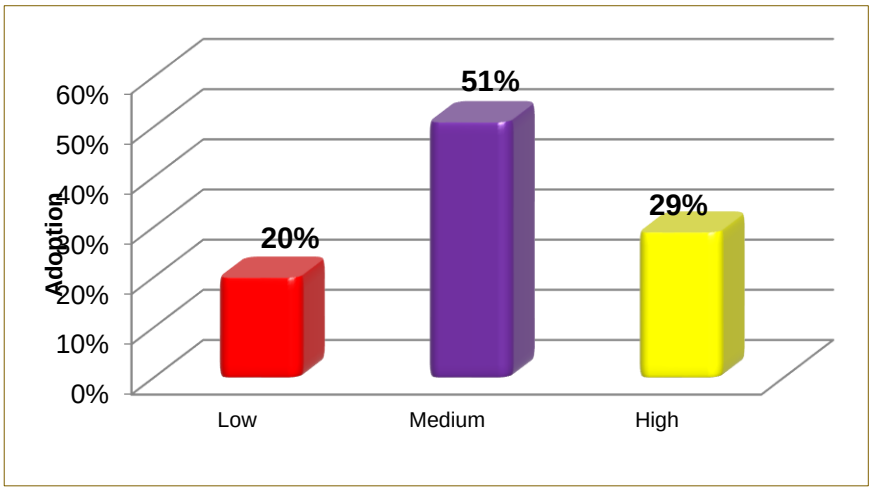

Figure 5. Pest control.

According to corn growers, the presence of pests is highly variable and chemical companies offer a variety of products for their control and even in specific years, the presence of pests drastically decreases.

The technologies generated for disease management and weed control register a similar adoption percentage. The diseases that most attack the crop are ear rot, leaf blight and red ribbon, controlled with copper sulfate pentahydrate, which is why they register a medium (31%) and high (56%) percentage.

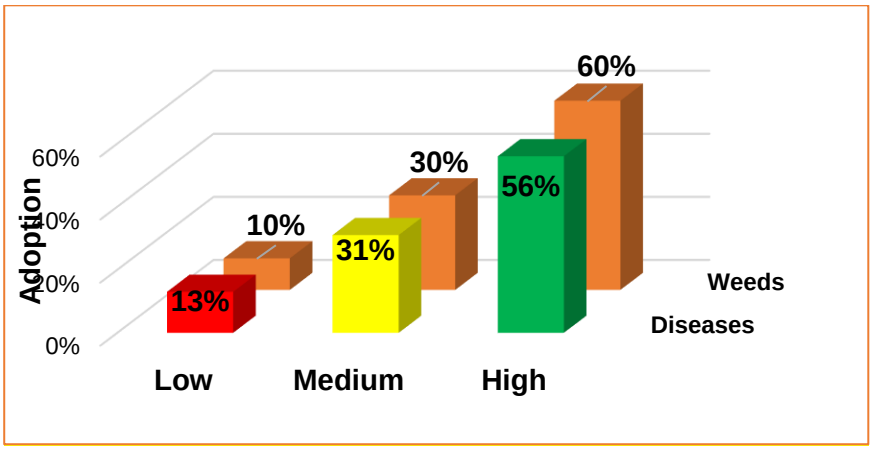

Figure 6. Disease management and weed control.

The adoption of technologies to control weeds is between a medium level (30%) and a high level (60%), which comprises pre-emergent weed control with chemicals 2-4D Amine, Glyphosate, Gramoxone and Nicosulfaron (Figure 6). In addition, after sowing, they apply Atrazine to control broadleaf weeds and pendimethalin, which eliminates seeds of other grasses, and as a complementary task, they carry out manual weeding.

The high level of disease management and weed control adoption indicated to the producers mainly because they are trained in these tasks. What has been stated agrees with Pérez and Larios (2018). They affirm that if the producers are constantly trained in various agricultural topics, they can apply and adopt the practices and technologies learned in the training processes and, in addition, they can pass on that knowledge to family members and other producers in the community.

Technology adoption rate of hard corn

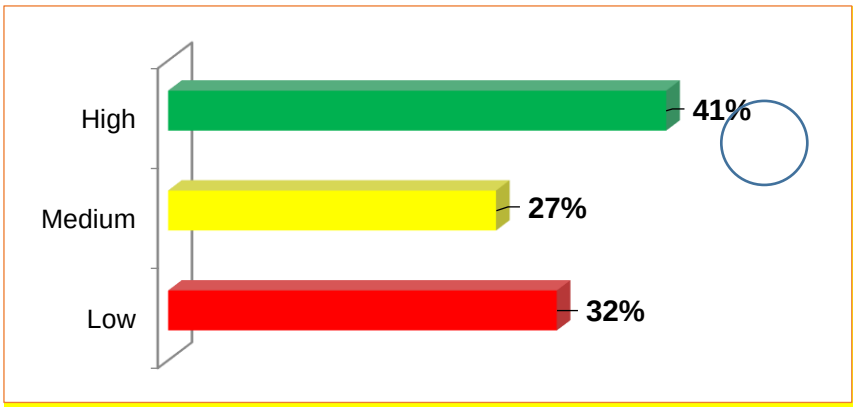

Figure 7. Technology adoption rate.

Figure 7 shows the percentages of adoption of technologies for the cultivation of hard corn in self-governing cantons of the provinces of Los Ríos and Guayas. On average, 41% shows a high level of adoption, which, together with the average level, has a total adoption of

68%, in which the high use of certified seed stands out. However, the use of improved varieties and chemical inputs does not guarantee an increase in agricultural productivity, but also that the one-dimensional approach of increasing production per planted hectare has consequences on the biodiversity, land concentration, associativity, and role of women (Bonilla & Singaña, 2019). Therefore, in order to increase or at least maintain the levels of technological adoption, public policies are necessary to control the prices of seeds and fertilizers and also intensify training events and credit accessibility programs, according to what is suggested by Rodrigues *et al*. (2020), for hard corn, programs to expand technical assistance and rural extension services are required with a greater frequency of visits, awareness meetings and training to stimulate the adoption of sustainable agricultural practices.

Conclusions

In the two provinces studied, the level of technological adoption in hard corn is high for seed, disease management and weed control, while the technologies of soil analysis, crop rotation, nutrition, and direct seeding present low adoption because producers, based on their experience, modify doses and frequencies to reduce production costs.

The agro-socioeconomic factors that present significant differences in adopting technology are the cost of production followed by the offer of technological packages, training, and credit. The results show the seed as the most widely adopted, which affects obtaining a high average adoption rate.

The investments made in hard corn make it possible to generate technologies that contribute significantly to its productivity, which is why the adoption of public policies to control the prices of seeds and fertilizers is suggested, as well as intensifying training events and credit accessibility programs.

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