Agricultural productivity in Bahía de Banderas, Nayarit, Mexico: Analysis of corn production among medium- and large-scale farmers

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ABSTRACT

Objective: To determine the average productivity per hectare of commercial white corn among medium- and large-scale farming units in Bahía de Banderas, Nayarit, Mexico.

Design/methodology/approach: A quantitative approach was employed using a non-experimental, descriptive research design.

Results: The average productivity per hectare of commercial white corn during the 2022-2023 cycle was 1.291497419.

Limitations on study/implications: Access to farmers' plots for questionnaire data collection was challenging, as some were located far from the main access roads.

Findings/conclusions: Producers in Bahía de Banderas, Nayarit, Mexico, reported an average productivity of 1.29 tons per hectare of commercial white corn. However, some producers experienced negative returns during the study period due to high production costs and low corn prices. Additionally, there was considerable heterogeneity in production costs and income among the 81 farmers who participated in the study.

Keywords: productivity, farmers, corn.

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INTRODUCTION

In Mexico, the National Institute of Statistics and Geography (INEGI, 2022), classifies the primary sector into the following categories: agriculture; livestock breeding and production; forestry; fishing; and hunting. The Economic Commission for Latin America and the Caribbean (2022) estimated a 4.4% growth in Mexico's agricultural GDP for that year.

Reinforcing the above, Food and Agriculture Organization of the United Nations Mexico (2020) states that agriculture is more than a key productive sector for the country's economic development, particularly in rural areas, where 41.9% of the population depends on the primary sector as their main livelihood. In total, 24.6 million hectares in Mexico are allocated to primary sector activities.

Nayarit is one of the 31 states that, together with Mexico City (formerly the Federal District), constitute Mexico's 32 federal entities. Bahía de Banderas is one of the fastest-growing municipalities in the state. With respect to the agricultural sector, the grain crops with the highest planting demand in this municipality are beans, sorghum, sugarcane, mango, and grain corn (SIAP, 2023). Notably, corn was the leading export product of Bahía de Banderas in 2022, with sales valued at US$1.34 million, primarily destined for France (Data México, 2023).

According to Caamal y Pat (2018), the primary sector faces problems related to low crop productivity; limited access to and availability of resources; unstable irrigation systems; and the absence of adequate social protection mechanisms for agricultural workers.
Similarly, Hernández (2020) identifies low productivity as one of the most significant challenges in agriculture, attributing it to the limited adoption of technologies and innovations; the scarcity and obsolescence of agricultural machinery; reduced water availability; and the inefficient use of productive resources.

Based on the above, the objective of this study was to determine the average productivity per hectare of commercial white corn among medium- and large-scale farming units in Bahía de Banderas, Nayarit, Mexico.

MATERIALS AND METHODS

The study adopted a quantitative, non-experimental, descriptive research design. To determine productivity in agricultural units, the formula established by the Agri-Food and Fisheries Information Service (SIAP, 2022) in its Technical Standards for the Generation of Basic Agricultural Statistics (NTGEBA) was applied. According to these standards, productivity is measured as yield and expressed per hectare (unit of measurement per hectare; tons/ha).

For this study, the target population consisted of medium- and large-scale producers cultivating more than five hectares of corn, listed in the database of the Valle de Banderas Irrigation Unit Users Association, A.C., Bahía de Banderas delegation, for the 2022-2023 autumn-winter agricultural cycle. The total population comprised 81 producers. It is important to note that no sampling procedure was applied; instead, a census of all 81 observational units was conducted.

During the fieldwork phase, a survey was administered to collect data for subsequent analysis. The instrument was designed based on previously validated tools, such as the National Agricultural Survey (ENA, 2020).

Once the survey instrument was designed, construct validity was assessed through expert review. The field instrument consisted of a 33-item questionnaire. The validation process was conducted during in-person meetings held at the agricultural production units and at the offices of the irrigation association. After the instrument had been validated, it was administered to the agricultural units. In addition to the questionnaire, field observation techniques were employed. The data collected were processed using Microsoft Excel and IBM SPSS Statistics through descriptive statistical analysis, encompassing data collection, organization, presentation, analysis, and reporting of the observed results.

RESULTS AND DISCUSSION

In the primary sector, productivity is determined through the variable yield per unit of measurement, which in this study was expressed as tons per hectare (tons/ha). To obtain the results for this variable during fieldwork, the final output (tons of corn per harvested hectare) was considered.

In addition, the economic value of the resources used to achieve this level of production was calculated. It is important to emphasize that the findings reflect the average productivity per hectare of commercial white corn among the 81 farmers included in the study.

Figure 1 illustrates the method used to determine productivity, as well as the production factors involved, such as land, labor, materials and inputs, financial and miscellaneous costs, and machinery and equipment, applied to obtain the final output.

The average yield of farmers in Bahía de Banderas was 8.2901 tons of corn per hectare. An important factor is the sale price, which during the 2022-2023 production cycle was below market expectations; as a result, some producers were unable to recover their investment costs. The average price was $6,343.20 Mexican pesos per ton.

Regarding land, the average rental price per hectare was $5,680.25.

In terms of labor, an average of one permanent field worker (employed throughout the entire production cycle) and two temporary workers (hired for specific stages of the cycle) were contracted per farmer. With respect to gender composition, 95% of the labor force was male and 5% female.

The stages of the production process with the highest labor demand were fertilization and pest control, as well as harvesting, selection, and packaging.

The average daily wage paid to field workers was $401.54 Mexican pesos. During the production cycle, permanent labor worked a total of 45.87 days, while temporary workers were employed for 43.09 days. After the harvest, temporary workers were dismissed, generally receiving only the legally mandated benefits.

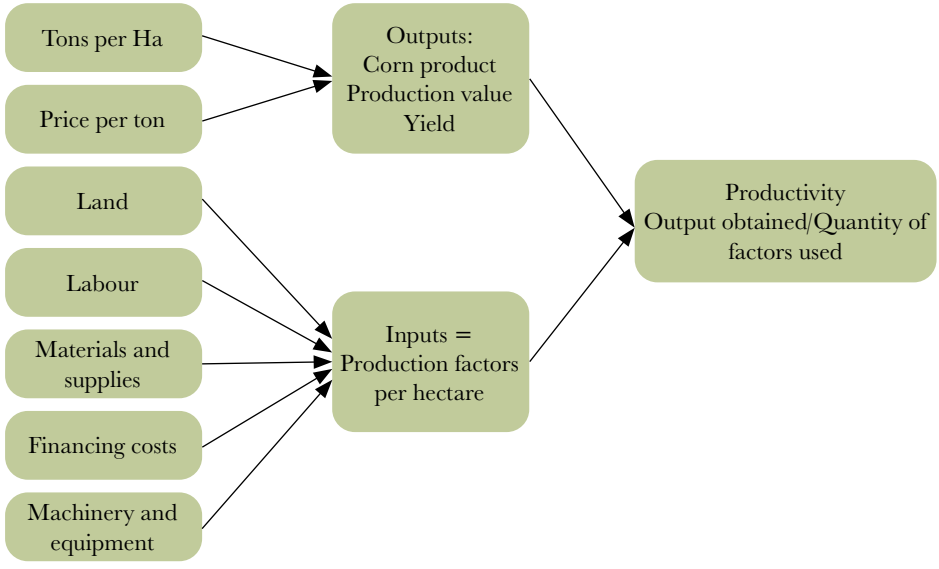

Figure 1. Elements to calculate productivity.

The producer actively participates in corn cultivation throughout the entire production process. Responsibilities include operational tasks, supervision, and administrative activities, which are performed based on accumulated experience and practical knowledge. On average, producers work 8 h and 40 min per day, with a maximum of up to 14 h daily, seven days a week, including holidays.

Most farmers do not receive a fixed salary; instead, their compensation depends on the net returns obtained at the end of the production cycle, after covering production costs and outstanding debts.

In addition, the inputs and materials used in the production of one hectare of commercial white corn included seeds, fertilizers, herbicides, insecticides, and pest control products, among others, with an average cost of $22,163.27. Farmers in Bahía de Banderas purchase these inputs from local and regional suppliers.

Another production factor was financing cost. In this regard, 88% of the farmers did not obtain third-party loans for the production cycle, including credit from financial intermediaries or government programs, primarily because they considered that they did not meet the eligibility requirements and that interest rates were too high. Only 12% applied for and received a loan. The average financing cost was $136.09 per hectare, while professional service fees averaged $93.21.

Water use was one of the most critical resources in the production process. All surveyed farmers cultivated irrigated land. Irrigation services were provided by the Asociación de Usuarios de la Unidad de Riego Valle de Banderas AC. Water was delivered through canal systems and tanker trucks. For the 2022-2023 cycle, the irrigation cost was $1,317.00 per hectare for all farmers.

Similarly, the cost of insurance, marketing, and technical assistance services averaged $109.75 per hectare.

Machinery and equipment used by farmers represent a challenge to overcome, due to the high costs involved in acquiring, renting, and maintaining them. In the production cycle analyzed in this research, 53% of respondents reported renting machinery for this cycle, while 47% indicated that it was owned. Furthermore, this production factor was used for activities such as harrowing, subsoiling, plowing, sowing, spraying, cultivation, and threshing.

The total cost invested in the machinery and equipment production factor per hectare averaged $7,179.47. Regarding the application of technology, drones were the only technology used by these farmers for the different irrigation stages of their land.

The procedure applied to obtain the average total production cost of one hectare of corn consisted of calculating the amount of production costs for each farmer separately (summing all the previously mentioned productive resources). Subsequently, the data from the 81 farmers who participated in the sample were added together and finally divided by the same number. The formula used is presented below.

Procedure for calculating the production cost for the 81 farmers

$$Production\ cost = r + L + ps + i + w + me + fc + mc$$

where: r=rent; L=labor; ps=profesional services; i=inputs and materials; w=water; me=machinery and equipment rental; fc=financing costs; mc=miscellaneous cost.

Finally, the average total production cost of one hectare of commercial white corn for the 2022-2023 cycle among the 81 medium- and large-scale farmers in the Bahía de Banderas region, Nayarit, was $42,507.15.

Another important aspect is the average income per hectare of corn for the 2022-2023 cycle, which amounted to $52,685.80, with an average profit of $10,178.65.

Likewise, the study variable productivity per hectare was calculated according to the following procedure: first, yield per hectare was obtained using the formula tons/ha; it was then multiplied by the final sale price to obtain total income. Subsequently, this amount was divided by the total production cost of the same hectare in order to determine the productivity of each farmer.

$$Productivity = \frac{(ton\ /\ ha)(final\ price\ per\ ton)}{Total\ cost\ of\ the\ factors\ of\ production}$$

where: (ton/ha)=tons per hectare; $final\ price$=Final market price per ton.

The average productivity per hectare of commercial white corn in the 2022-2023 cycle was 1.291497419. This result was obtained by dividing the productivity of all farmers by the same number of participants (Table 1).

Likewise, the previous table shows negative productivity for 14 (17%) farmers; that is, they incurred losses during this production cycle, as their input costs were higher than their income.

These results contrast with the technological package proposed by Trust Funds for Rural Development (FIRA, by its acronym in Spanish) (2023), which indicates that producing one hectare of white corn in Nayarit requires $33,913.00 Mexican pesos. However, the findings of this study show an amount of $42,507.15 for that same hectare in the same area, resulting in lower profit margins. Specifically, the results of this research estimate an average profit of $10,178.65, compared to $11,447 according to FIRA. Therefore, farmers receive lower income from their harvest.

In addition, Funds for Rural Development (FIRA) establishes a wage of 300 per workday for labor, whereas the results of this study show an average of $401.54 per workday. In light of these data, the findings do not align with this institution, and farmers appear to be the least favored in terms of access to credit under the technological package developed by FIRA.

As noted by Sandoval (2023), Hernández (2021), Velásquez (2023), Gutiérrez (2023), National Agricultural Survey (ENA, 2020) y Ávila (2017), the main problem faced by agricultural production units is production costs. The results of this study confirm this situation and additionally highlight low sale prices, as pointed out by Gutiérrez (2023). These problems arise because farmers do not have guaranteed final prices for their products and must instead accept the prices offered by buyers.

Table 1. Productivity per hectare.

Number of farmers	Productivity	Number of farmers	Productivity	Number of farmers	Productivity
1	1.272322101	28	0.968532574	55	1.342786282
2	1.397750073	29	1.159012356	56	1.569867578
3	0.994425777	30	1.168687522	57	1.85437601
4	1.206109205	31	1.454394349	58	1.100110011
5	2.289377289	32	1.788672724	59	2.040446178
6	1.06379386	33	1.073701971	60	1.405337882
7	1.094376987	34	1.173468111	61	2.231376588
8	1.168017755	35	2.028992715	62	2.43405176
9	0.871444384	36	1.754550866	63	0.973885442
10	0.718670791	37	1.635343548	64	0.868827703
11	1.192543098	38	1.31755644	65	0.774316517
12	1.186805515	39	1.328211472	66	1.400239105
13	0.915720967	40	0.730394685	67	1.540770952
14	1.315648043	41	1.14093559	68	1.012526398
15	1.299625584	42	1.545479473	69	1.45075493
16	1.157814212	43	1.155046052	70	0.830361036
17	1.525179072	44	0.748732523	71	1.590544965
18	1.204197488	45	2.044692737	72	1.096304237
19	0.992171657	46	1.358261425	72	1.52025743
20	1.180873083	47	0.825140863	74	1.15166959
21	1.194479666	48	1.019619471	75	1.337579618
22	1.162018592	49	1.684800681	76	1.187267165
23	1.264498733	50	1.17172115	77	1.175529243
24	1.773039372	51	1.180615591	78	1.329014038
25	1.029090174	52	1.144574004	79	1.638334851
26	1.0074525	53	1.330613306	80	1.161574579
27	0.851072042	54	1.110489568	81	1.229799039
				average productivity	1.291497419

Another factor influencing price formation is the lack of government support to regulate pricing policy, leaving producers to negotiate the final price of corn on their own. This situation reduces the value of production and directly affects the productivity of the economic units studied. Indeed, 17% of farmers reported low productivity, meaning that their costs exceeded their income. On the other hand, resources were not used efficiently or effectively.

Adding to the cost-related information, the findings also confirm what Ortiz and Castillo (2020) state: all agricultural processes generate both direct and implicit costs, which are important to estimate and analyze.

In the surveyed production units, those in charge do not keep formal records of their production costs, nor do they quantify them. Likewise, they do not consider the wages of

themselves or their family members who contribute to the work, which makes it difficult to calculate their actual profits accurately.

These results are similar to those established by Delgadillo and Leos (2016) who argue that financial costs are generally quantified for tax purposes and include all fixed and variable costs, but exclude those associated with business management and the wages of the producer or family members. Likewise, farmers keep informal accounting records, and few hire professional accounting services.

Another factor influencing the productivity of the surveyed producers is machinery and equipment used in operational processes. This production factor represents a challenge for farmers due to the high costs associated with acquisition, rental, and maintenance. In addition, a major problem lies in delays and the poor condition of rented machinery, as well as the lack of maintenance, adjustment, or repair, which causes interruptions in activities and results in additional costs. These are the same problems described by Hernández (2020).

Regarding technology adoption, its implementation is low; only a few producers use drones for irrigation in their production processes. On the other hand, the results of this research are consistent with Ramírez *et al.* (2022) and ENA (2020), in that lack of supervision, limited training, negligence, absence of a procurement and input planning strategy, slow and complex administrative procedures, and employee idleness contribute to problems in the overall operation of agricultural enterprises.

In the area where the surveyed farmers are located, the corn market is in constant fluctuation, influenced by macroeconomic variables such as inflation and climatic conditions, thereby generating difficulties for producers. In this regard, the findings are consistent with those of the FAO (2019), which explains that limited market access and the lack of organizational structure among farmers hinder the commercialization of their products.

With these results, productivity theory is confirmed, as it measures the efficiency of the resources used to obtain goods and services and their optimal management. In this sense, the findings are consistent with Muñoz (2012), who states that the fewer resources invested in producing the same quantity of goods, the greater the efficiency of the enterprise.

On the other hand, although farmers make extensive use of their available resources, they do not implement adequate controls to maximize their profits, leading to higher input costs, which directly affects low productivity.

CONCLUSIONS

In conclusion, producers reported an average productivity of 1.29 per hectare of commercial white corn. Some of them registered negative productivity during this period due to high production costs and low prices.

Another aspect to consider is the lack of homogeneity in production costs and income among the 81 farmers who participated in the study. Each of them applies their own methods for cost allocation and quantification, and in some cases, they do not maintain formal records, which makes the rapid and accurate collection of information difficult.

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