

## Importance of human capital in the agricultural development of Durango

### Importancia del capital humano en el desarrollo agrícola de Durango

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#### Abstract

Studies carried out in the agricultural field of Durango must assess the sociodemographic factors that this sector presents, such as academic training, age and experience. These factors determine the capacities and competencies of the people who make up the Family Production Unit (FPU) (Unidad de Producción Familiar - UPF) to deal with their daily tasks and to resolve eventualities. The human capital index was calculated through the Portela index, since this formula allows us to analyze the experience acquired over the years along with the level of studies that the people subject to the analysis have. The findings reflect the relatively low rate that occurs in the academic training of FPU owners which has a negative impact on their results. The core of the agricultural sector's backwardness is the lack of academic training and the loss of experience due to generational replacement being limited. This study shows the determination of the human capital of the people who form and are in charge of the family production units, analyzing the differences presented in each agricultural District, having as its main contribution an index of comparison between the producers of the different agricultural Districts.

#### Human capital, the agricultural sector and marginalization

#### Resumen

Los estudios efectuados en el campo agrícola de Durango deben valorar los factores sociodemográficos que presenta este sector, como son formación académica, edad y experiencia. Estos factores determinan las capacidades y competencias de las personas que forman la Unidad de Producción Familiar (UPF) para enfrentar su quehacer diario y la manera de resolver las eventualidades. Se calculó el índice de capital humano a través del índice de Portela ya que esta fórmula permite analizar la experiencia adquirida a través de los años con el nivel de estudios que sustentan las personas sujetas de análisis. Los hallazgos reflejan el índice relativamente bajo que se presenta en la formación académica de los propietarios de las UPF lo que repercute de manera negativa en sus resultados. Como punto medular del rezago del sector agrícola se manifiesta la falta de formación académica y la pérdida de experiencia al estar limitado el reemplazo generacional. El presente estudio pone de manifiesto la determinación del capital humano de las personas que forman y están a cargo de las unidades de producción familiar, analizando las diferencias presentadas en cada Distrito agrícola, teniendo como principal aportación un índice de comparación entre los productores de los diferentes Distritos agrícolas.

#### Capital humano, sector agropecuario y marginación

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## Introduction

Academic training and experience allow comprehensive progress in the development of any economic activity, the agricultural sector, as it operates both in the production and in the exchange of goods and services, requires skills in the technical, administrative and financial fields. The analysis of the sociodemographic factors that agricultural producers possess allows us to establish the real panorama of its evolution in the development of the activity and to lay the foundations to establish the supports to whom the efforts should be directed for the benefit of the sector. Human capital is evaluated in companies in order to determine the ability to anticipate any problems that may arise. In the agricultural sector, greater importance is given to determining the results obtained from the government support provided to the field., however, it is important to determine the root of the problem that is established with the lack of academic training to face not only the issues, but the series of diverse situations that the field faces in agricultural activities. Within the Agricultural Innovation System (Sistema de Innovación Agrícola SIA) one of the essential functions is the mobilization of resources to carry out agricultural activities, where in addition to financial and capital resources, human resources play an indispensable role in the construction, maintenance and transformation of the productive and innovation sector (Torres-Ávila, Aguilar-Ávila, Santoyo-Cortés, & Martínez-González, 2021).

This article is divided into six sections, in the first one, the importance of the agricultural sector as an economic activity in the state of Durango is highlighted, the second reflects on the concept of marginalization, its classification, causes and consequences related to the agricultural sector, in the next section, human capital is conceptualized and the form of evaluation is exposed through the Portela human capital index, subsequently, the results obtained when determining the human capital index in the family production units of the agricultural sector of the state of Durango are explained, highlighting the same indicator for agricultural Districts I, III and VI, presenting their corresponding conclusions. The results obtained allow us to visualize the environmental conditions that have prevailed in these regions., the working capital and demographic characteristics of the producers in each District.

## The Agricultural sector in Durango

Throughout its history, in the state of Durango, the agricultural sector has played an important role at an economic and social level, as a generator of jobs and at a productive level it contributes to the development and growth of the state. Agricultural activity generates around 9.7 million tons of various products and an average of 661,000 hectares of cyclical crops and 50,000 of perennial crops are sown. Most of the state's agriculture is seasonal, mainly in the spring-summer sowing cycle, the most harvested products are beans, green alfalfa, grain corn, fodder oats, fodder corn, barley, chili, forage sorghum, red tomato, bone cotton, pastures and sorghum. Regarding perennial crops, the cultivation of walnuts, asparagus, alfalfa, and blueberries, among others, stand out. (SIAP, 2018-2019). Fruits such as melons, apples, peron apples, quince, apricots and peaches are also grown in the valley region. The GDP (Gross Domestic Product) of the primary activities in Durango, in 2019, amounted to \$607,457.39 pesos, (as of the last quarter of 2019), which represents 3.82% of the total value and contributes 3.4% to the national primary GDP; this includes agriculture, animal husbandry and exploitation, forestry, fishing and hunting (INEGI, 2020).

The employed population in the primary sector represents 13.4% of the total employment of the state with 103,265 people (INEGI, 2019). Of the population employed in the primary sector, 80.7% corresponds to agricultural activities, 18.1% to livestock activities, and the remaining 1.2% to fishing activities (SIAP, 2019).

The value of agricultural and fishing production was \$34,579,830.84 pesos (at current prices) (SIAP, 2019). 72% corresponds to livestock activities, 28% to agricultural activities and 0.10% to fishing activities. The value of the agricultural production was \$9,793,165.90 pesos.

The 39 municipalities in the state of Durango carry out some agricultural activity. According to data from the Food and Agriculture Information Service (Servicio de Información Agroalimentaria y Pesquera - SIAP), as of 2018, the total area sown in the state was of 670,638.4 hectares (ha), which includes the three cycles of agricultural production that have been registered:

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1) autumn-winter cycle (AW), which is sown in the months of October-December and harvested in April-August, 2) the spring-summer cycle (SS) which is sown between March and August and harvested in September-February, and finally the 3) perennial crops (P) that are harvested in January-December.

The SS production cycle is the one that covers the largest area sown in Durango with 87.1% of the total, which means 84,015.39 ha. The P cycle is next with 8.7% and finally, with 4.2% of the total cultivated, the AW cycle. According to SIAP data, of the total area sown in the state, the agricultural modality of irrigation represents 27.8% and the temporary 72.3% (SIAP, 2018).

Around 72 agricultural species are cultivated in the state of Durango, from which, beans and green alfalfa with \$1,183,771.12 and \$1,769,514.48 pesos, respectively, stand out due to their contribution to the total value of production.

Durango is within the states where agricultural activity is concentrated in small regions and the rest of the area is without any economic activity. The percentage of the surface with agricultural and livestock activity is 14% and 17% respectively. 67% of the surface of the state is compromised of land without any economic activity (INEGI, 2017b).

The municipalities with the largest planted areas are Cuencamé (District III) with 62,473.46 ha which represents 9.3% of the sown area in the entire state. Next are Guadalupe Victoria (District III) with 59,192.66 ha (8.8%), Durango (District I) with 58,246 ha (8.7%), Gómez Palacio (District VI) with 41,567.33 ha (6.2%), Canatlán (District I) with 39,626.54 ha (5.9%), Nuevo Ideal (District I) with 35,296 ha (5.3%) and Santiago Papasquiaro (District V) with 34,912 ha (5.2%). The municipality with the smallest area sown is San Luis del Cordero (District VI) with 1% of the agricultural production, which translates into 790 ha (SIAP, 2018).

The state of Durango has irregular rainfall. The municipalities with the highest rainfall, for the year 2020, are those corresponding to District II, where Pueblo Nuevo and San Dimas stand out, ranging in between 761.6 to 1610 mm. The municipalities of District I have an average rainfall of 453.85 mm., among which are Durango, Mezquital, Vicente Guerrero, Súchil, Nombre de Dios, Poanas, Nuevo Ideal and Canatlán. The municipalities with the lowest rainfall in 2020 were those of District VI, Tlahualilo, San Pedro del Gallo, Mapimí, Nazas and San Luis del Cordero.

Average rainfall for the year 2018 was 623.8mm, in 2019 it was 364.3 mm, and for 2020 it was 364.2mm. Compared to 2018, it rained 41.62% less in 2020; in relation to 2019, precipitation was slightly lower with 0.0003%, which conditions the proper development of the crops grown in Durango (CONAGUA, 2019, 2020).

Durango is the fourth state in area size, being 6.3% of the national territory, which causes specific characteristics in its regions, presenting diverse environmental, technological, productive, social and access to markets conditions, the above causes the need for support programs that impact the agricultural Family Production Units (FPU) (Unidades de Producción Familiar - UPF) for the improvement of their conditions and processes. The composition of its soil and its orography make it impossible to technify all its processes, in addition to the scarce rains, there are regions that present a quarter of rainfall (semi desert region) in relation to those with the highest uptake (Quebradas region) in addition to the irregularity in the beginning and end of the rainy season, limiting the proper development of crops and pastures, affecting the agricultural and livestock production of the state (González, Galván, Soto, Rivas, & Pérez, 2018).

The most vulnerable segments require longitudinal and transversal government support that include support in kind, specialized technical advice and business management, in order to cause the integration of a cluster for regional specialization seeking competitive advantages and economies of scale in the main products (Ídem).

## Marginalization

The National Population Council (Consejo Nacional de Población CONAPO) (2016: page) defines marginalization as: “A structural process in relation to the socioeconomic development achieved by the country, that hinders the spread of progress to all social groups, which affects the production structure and is expressed in territorial inequality”. Marginalized communities have high levels of vulnerability, that can hardly be diminished with individual actions, considering that the causes are generated by a model that offers unequal opportunities, favoring disadvantages of increasing marginalization and unfavorable scenarios (Téllez Vázquez, Almejo Hernández, Hernández Álvarez, & Romo Viramontes, 2015).

Marginalization is considered a structural phenomenon whose causes and effects are independent of individual decisions, therefore, in order to reduce marginalization, the intervention of the state in regulatory measures, support for productive activities, is essential, as well as to increase the capacities of producers and planning with a socio-territorial approach to a sustainable development (Ídem).

Durango, although it has a medium marginalization index and occupies the thirteenth place in the national context, stands out in two dimensions of marginalization “population in towns with less than 5,000 inhabitants” with 36.2% of its population dispersed in small rural localities and “employed population with incomes of up to two minimum wages” with 39.2% of the population, generating regions with high degrees of marginalization such as the municipality of Mezquital (District I) which is the second most marginalized municipality nationwide and 23% of the municipalities of Durango with Very High and High degrees of marginalization (National Population Council - Consejo Nacional de Población CONAPO) (2016).

The population is in poverty if it has at least one social deprivation and an income below the value of the poverty line, which means that the value of the income is less than that necessary to purchase the food basket and the non-food basket per month.

Poverty is categorized as *extreme poverty* when the population has three or more social deprivations and *moderate poverty* when it does not fall into *extreme poverty*. It is also considered when the population has *vulnerabilities* due to *social deprivation* when it is above the income level, but presents some social deprivation and *vulnerability due to income* is present when the population does not have social deprivations but the income is equal to or less than the welfare line or income poverty line (CONEVAL, 2020).

In 2018, 74.4% of the population of Durango presented a situation of poverty or vulnerability due to social deprivation at the income level, around 40,400 people, representing 2.2% of the total population, in *extreme poverty* and 35% in *moderate poverty*.

The 2018 Social Development Policy Evaluation (Evaluación de Política de Desarrollo Social) determined that the income of the poorest population consists of government support and remittances, not having a constant source of income generates vulnerability to eventualities, and its proposed that programs should be generated and implemented to increase productivity and provide long-term monitoring of productive projects, in order to increase the income of this population segment,. (Ídem).

## Human capital and its measurement

Organizations as well as companies are founded by the knowledge possessed by the people who comprise them, It is a strategic asset located in the human capital made up of the members that operate it, whom conceive the environment, qualities and relationships of things using their experience and education. Knowledge is a factor that must be generated within the organization, being an intangible resource because it is difficult to perceive (Cabello, Díaz, & Bravo, 2018).

Human capital is the people who make up the organization and who maintain a reciprocal relationship by constituting a means of survival and individual and collective growth. This capital is formed by the intellectual competencies and skills that people possess producing wealth and value, integrated activities should be based on coordinated work (Delgado Cruz, Vargas Martínez, Rodríguez Torres, & Montes Hincapié, 2018).

In agricultural organizations, this knowledge is acquired through experience and is transmitted from generation to generation, however, schooling allows to acquire greater skill in resource management, so it is important to consider it.

By integrating these two concepts, human capital (people who make up the organization) and the knowledge (that these people possess to start the activities) intellectual capital is formed, however, for this to exist within the organization, it must be made up of people, the labor relations that are established through its structure and the relations that are maintained with the outside world.

For an organization to survive over time and achieve success it needs to manage its resources and generate differences that distinguish them from their competition. Such advantages should sustain their development and strengthen the resources and activities (Cabello et al., 2018).

Human capital is feasible to be measured through the Portela multidimensional index cited by Arrazola and De Hevia (2005), this index relates school training and work experience by homogenizing them through a multiplicative relationship, therefore, a measure of the deviation from the population mean is used. The calculation of the Portela Multidimensional Index (CHP) is carried out through the equation (1), this methodology allows us to equate the experience acquired over the years with the level of studies that the people subject to analysis have, it is important to consider the educational level of the people involved in agricultural activities, because this will allow them to have a comprehensive vision of their business unit, interact with suppliers and customers and take advantage of new technologies of vegetative material, fertilization and harvest and post-harvest work. Enabling them to raise the quality of their products, to be able to face the changing context, both environmental and market based, in a better way.

$$CHPi = MEDU \times \left( 0.5 + \frac{\frac{(EDU_i - MEDU)}{e^{(DTEDU)}}}{1 + e^{\frac{(EDU_i - MEDU)}{DTEDU}}} \right) \times \left( 0.5 + \frac{\frac{(EXPE_i - MEXPE)}{e^{(DTEXPE)}}}{1 + e^{\frac{(EXPE_i - MEXPE)}{DTEXPE}}} \right) \quad (1)$$

Where:

$MEDU$  = Average educational level of the agricultural population

$EDU_i$  = Educational level of the i-th individual

$DTEDU$  = Standard deviation of said educational level

$EXPE_i$  = Work experience of the i-th individual

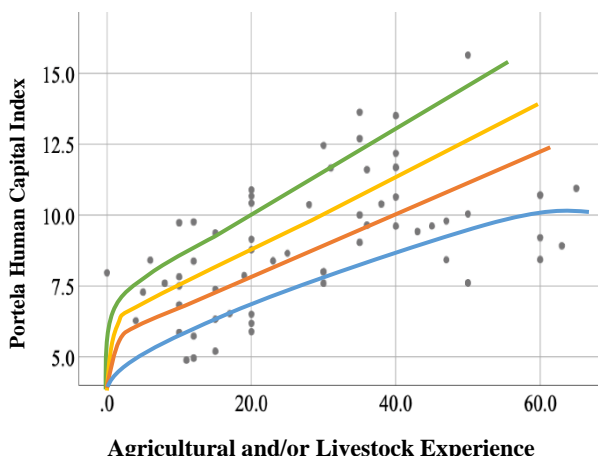
$MEXPE$  = Average experience of the agricultural population

$DTEXPE$  = Standard deviation of said work experience

## Results

When analyzing the statistics of the agricultural sector through the *CHP*, which considers, as already mentioned above, the years of schooling and experience of the interviewed producers, as well as the mean of the population of these variables according to equation 1, it can be seen in graph 1, where the lines represent those producers who completed some level of education whether primary (blue curve), secondary (red curve), high school (yellow curve) or bachelor's degree (green curve). In this sector, a large number of producers who have truncated studies are identified, mainly at the primary level, this results in, having a wide standard deviation around the arithmetic mean of the years of schooling, the sectors' *CHP* significantly decreases having 20.6% of the producers with truncated primary, 19.1% with completed primary, 4.4% with truncated secondary and 16.2% with completed secondary, that is, 60.3% of the studied population is below the arithmetic mean corresponding to 9.23 years of schooling, this causes the dispersion measured with the standard deviation to be wide (5.12), which causes the *CHP* measurement of the sector to be very low. In addition to the other element that intervenes, which are the years of work experience which present a mean of 28.5, with a wide standard deviation of 16.7 (see table 1). This phenomenon can also be observed in the same graph (1), by not forming the curves of educational levels, since around 38% of producers have a truncated education, having more relevance the unfinished primary level, only 10% completed bachelor's degree and 6% postgraduate studies, generating an average *CHP* of 9.

Compared with other studies conducted on the manufacturing industry in the state of Durango, focused on the warehouse manager, an average educational level of 12.67 years of schooling was determined, a deviation of 3.05 years and an experience of 10.4 years with a deviation of 8.15, showing a CHP of 12.43 with a standard deviation of 3.44 (González Lazalde, Galván, Ismael, Pérez, Canales, & Olivera Armando, 2018). Statistics from the agricultural sector show that academic preparation, although it does not seem to be that low, is affected by the large number of producers that are below the arithmetic mean and also with truncated studies, however, the high years of experience impact the index negatively by showing a wide standard deviation, so the overall CHP for the agricultural sector in Durango is low, which limits a solid or integral development of the productive units, although some agriculturists are very productive, most of the Family Production Units (Unidades de Producción Familiar (UPF) are affected by a low human capital index.



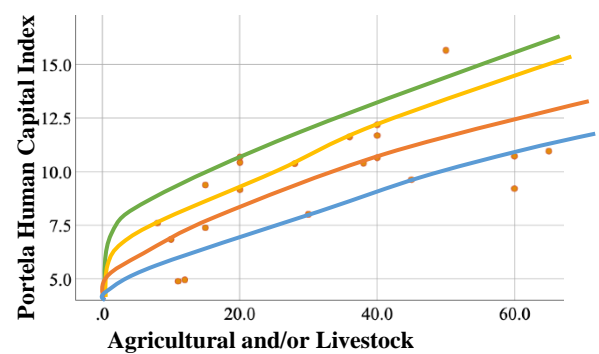
**Graphic 1** Portela Human Capital Index all Districts  
Source own elaboration with SPSS V. 25

	Statistics	Portela Human Capital Index	Years of schooling	Years of experience	Hectares of the UPF
Total	Mean	9.00	9.23	28.50	26.92
	Median	8.84	9.00	26.50	18.00
	Deviation	2.21	5.12	16.70	25.74
District I	Mean	9.55	9.50	31.50	25.45
	Median	9.99	9.00	30.00	14.50
	Deviation	2.43	4.55	17.35	25.04
District III	Mean	7.87	8.17	22.88	47.58
	Median	7.82	7.00	19.00	50.00
	Deviation	1.58	4.63	16.62	29.93
District VI	Mean	9.24	9.65	29.51	15.93
	Median	8.77	9.00	30.00	10.00
	Deviation	2.18	5.84	16.03	14.75

**Table 1** Comparative of statistical agricultural areas of Durango  
Source own elaboration

District I is located in the central region of the state known as the Valleys region, It encompasses the capital of the state being the main urban locality of the entity. The representative sample presented 51% of UPFs headed by men and 49% represented by women, 36% of the producers are in an age range of 51 to 60 years (table 2).

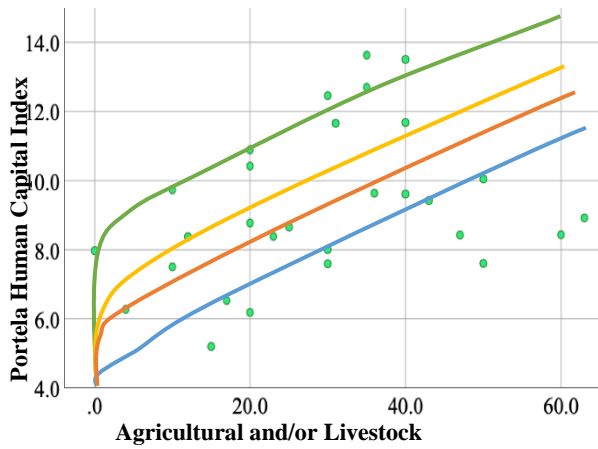
Graphic 2 shows Portela curves generated from the determination of CHP of the producers belonging to District I, which presents a higher arithmetic mean with 9.55, however, it is also the one with the highest standard deviation. This District is characterized by having the highest level of agricultural or livestock experience with 31.5 years on average (table 1) presenting a standard deviation similar to that of the other two Districts analyzed. It can be seen in graph 2 that also shows 36.4% with primary or less, that is, more than a third of the producers with less than six years of schooling and at the other extreme with higher high school studies 13.6%, on average their UPFs have 25.45 hectares.



**Graphic 2** Portela Human Capital Index District I  
Source own elaboration with SPSS V. 25

District III is located in the region known as Los Llanos, where agriculture stands out as the main economic activity, 65% of producers are men and 35% women, the main age group in this District is under 40 years old with 35.3% see table 2. Table 1 shows that the number of hectares of the UPFs is doubled compared to those owned by the producers of District I and for District VI it is more than triple, However, most of the crops are seasonal, which causes difficulties due to the climatic changes that have occurred in recent cycles. It is also a District that presents the lowest level of education with 8.17 years on average and the lowest level of experience with 22.8 years.

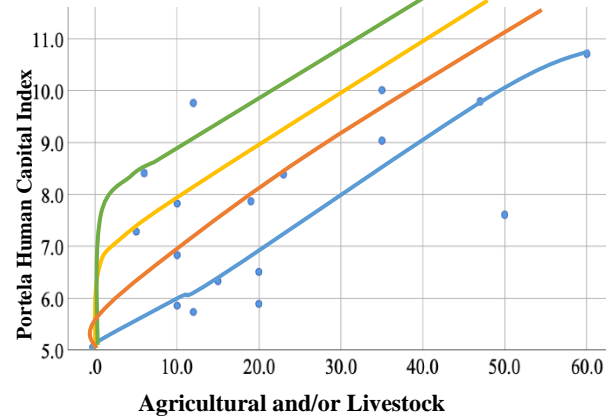
In this District, 47% have primary education or less and only 12% present levels of study higher than high school, counting an average level of schooling of 8.17 years (truncated secondary) causing it to be the District that presents the lowest CHP with a mean of 7.87 and a standard deviation of 1.58 as shown in table 1. It can be seen in graph 3 that about half of the observations are below the blue curve corresponding to the primary level.



**Graphic 3** Portela Human Capital Index District III  
Source own elaboration with SPSS V. 25

District VI is located in the region known as Laguna in the semi-desert area, where the urban towns are located., in second and third place, with the largest number of inhabitants of the entity. It is a region characterized by having irrigated agriculture since the two main dams of the entity flow into this region, it has a wide infrastructure of irrigation channels, the average of hectares of the UPF is 15.93 ha. (It is the lowest of the three analyzed Districts). 62% of UPFs are led by men and 28% by women. The age groups are more balanced than the other regions, standing out with 24% from 51 to 60 years and from 62 to 70 years, another 24% (table 2). This District has a schooling level of 9.65 years on average, being the highest of the three Districts, however, 38% of producers have primary school education or less, although, 31% of the producers have more than thirteen years of study, that is, finished high school or higher, as seen in graph 4 the high school level is identified with the yellow curve and the green curve marks the upper level (bachelor’s degree), meaning a third of the observations lie between these two curves, therefore by also having a high level of observations below the blue curve (primary education level), it has the highest deviation of the three Districts, decreasing the mean CHP of that District by 9.24 below District I and above District III.

The experience of the producers is similar to that of District I with 29.51 years on average and a standard deviation similar to the other two Districts studied with 16.03 years.



**Graph 4** Portela Human Capital Index District VI  
Source own elaboration with SPSS V. 25

	District I	District III	District VI
Under 40 years	18.2%	35.3%	17.2%
41 to 50 years	18.2%	17.6%	20.7%
51 to 60 years	36.4%	17.6%	24.1%
61 to 70 years	18.2%	11.8%	24.1%
Over 70 years	9.1%	17.6%	13.8%

**Table 2** Age groups of producers by agricultural district in Durang  
Source own elaboration

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**Conclusions**

The rural population that mainly makes up agricultural economic activities presents a series of multidimensional lags evident in its level of marginalization, among these lags, the level of the human capital index stands out. Durango has a third of the population dedicated to this sector with more than 61 years of age, that is, it exceeds or is very close to the retirement age. However, the high rates of marginalization in this sector force them to remain in charge of the UPFs. Having a relatively low CHP limits UPFs technological implementations or innovations that can help to improve their production and administrative processes, causing low levels of profitability and productivity.



The CHP of the agricultural sector of Durango is a reflection of the wide dispersion that exists both in the levels of education and in the years of experience, which causes a low index for the sector, that is, although there are many years of experience in agricultural work, the use of this practice is limited by not having an academic training that allows to apply improvements in the administrative and financial management of the productive unit to better face the changes that occur in the markets, environmental contingencies for the survival and growth of its UPFs. It requires comprehensive public policies that involve increasing levels of formal education (education at all levels and certifications) and informal education (training courses) related to their productive and business activity. The involvement of companies, government and academia is necessary with actions focused on this sector to break the social deficiencies that limit this segment of the population and be able to reduce vulnerability to eventualities.

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