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ECONOMIC VIABILITY OF THE IMPLEMENTATION OF GOOD AGRICULTURAL PRACTICES IN ONION PRODUCTION

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ABSTRACT

The objective of this study was to estimate the gap in the costs of production units that implement good agricultural practices (GAP) in onion production and those that do not, in two of the principal producing states of this vegetable in Mexico, through a cost analysis and the construction of representative production units (RPUs), with the purpose of contributing to the development of strategies to promote the adoption of GAP protocols among small and medium scale onion producers. The results evidence that the RPUs that have GAP certification are larger, have higher yields, incur in fixed unitary costs ($\$.t^{-1}$) up to 40 % higher and variable costs slightly more than 20% lower, compared to the RPUs that do not have GAP certification. These parameters allow certified RPUs to recover up to 2.25 dollars for each dollar they invest, while the RPUs that do not have certification recover 16 cents. The support for GAP certification could help relatively poor farmers to gain access to export markets in a profitable way, thus providing a development strategy for some segments of the rural population.

Keywords: certification, international trade, vegetables, panels, profitability.

INTRODUCTION

International trade of fruits and vegetables is a sector that involves millions of dollars and which has had constant growth in recent decades, representing one of the main areas of exports and currency generation for Mexico (Piñeiro and Díaz-Ríos, 2004). For example, in 2017, Mexico exported to USA a total value of 13.2 billion dollars of fruits and vegetables (SIAVI, 2018). In addition to this growth, international trade of fruits and vegetables has experienced large changes due to the increasing development of sanitary, phytosanitary and quality standards and regulations, some of mandatory nature overseen by public agencies and others of voluntary nature developed by the global food distribution chains or international organizations (Cofre, Riquelme, Engler and Jara-Rojas, 2012). These regulations respond to the preoccupations of consumers about safety and quality of foods, environmental conservation , scientific advances related to the risks associated with foods, and preoccupations about the economic costs associated with the dangers and outbreaks of food-borne disease transmission (Henson, 2008).

In response to the need to reduce the risks of contamination associated with the production and commercialization of fresh fruits and vegetables, and as a mechanism to generate greater market opportunities, great efforts have been made in all the government levels and

of the food industry to develop safe practices for fruit and vegetable management in the entire food chain. These efforts emphasize the application of good agricultural practices (GAP) during the phases of production and harvest, good practices in manufacture or fabrication (GMP/GFP) during the phase of adaptation of a product, and in general during the post-harvest management (Piñeiro and Díaz-Ríos, 2004).

In Mexico, the National Service for Agrifood Health, Safety and Quality (*Servicio Nacional de Sanidad, Inocuidad y Calidad Agroalimentaria*, SENASICA), which depends on the Ministry of Agriculture, Livestock Production, Rural Development, Fishing and Food (*Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación*, SAGARPA), is the agency responsible for guaranteeing the safety of farmland products through the implementation of protocols that help producers and packagers in the reduction of biological, chemical and physical risks that can endanger the safety of the product, and, therefore, the health of the consumers (SENASICA, 1994).

The adoption of these protocols implies expenses associated to the implementation, maintaining and certification of GAP, which are added to the production costs, among which irrecoverable costs related to the re-mechanization of production processes, the establishment of export channels, and the accumulation of information about the market stand out (Roberts and Tybout, 1997; Fafchamps, El hamine and Zeufack, 2008), which affects the profitability of production units (Cofre *et al*., 2012). According to the literature, these implementation costs have a higher impact in small-scale farmers, due to the scale of production and the lack of technical or financial capacity to comply with the implementation and certification of private protocols, even risking being marginalized from the exporting process (Avendaño and Várela, 2010; Henson, 2008). For example, Bovay, Ferrier and Zhen (2018) estimated the costs for producers of fruits and vegetables to comply to the new rules included in the *Food Safety Modernization Act* (FSMA) and found that for large-scale producers the costs are around 0.23% of their sales, while for medium-scale producers it is 4.2% and for small-scale and very small-scale producers it is 6.8%.

There is a scarcity of studies in the agriculture and livestock sector to address the impact in costs for producers and to identify benefits and limitations of the implementation of GAP and GMP, and which in addition take into consideration the different sizes of the production units. The objective of this study was to estimate the gap in costs of the production units that implement GAP in onion production and those that do not, in two of the principal producing states of this vegetable in Mexico through a cost analysis, with the purpose of contributing to the development of strategies of government and related private organizations that seek to promote the adoption of GAP protocols among small and medium scale onion producers.

Onion is one of the main vegetables produced in Mexico; in the year 2016, the amount produced was 1,635,049 t, occupying number twelve at the global level (FAOSTAT, 2018). In the same year, 378,016 t, were exported, of which 93.7% was destined to consumers in the United States of America; the growth rhythm of exports of this vegetable is 6% annually (Trade Map, 2018). At the national level, according to data from SIAP (2017),

the principal producing state in Mexico is Chihuahua with 447,607 t, and Guanajuato occupies the sixth place with 124,583 t, while Morelos the ninth with 69,601 t.

Concerning the Mexican companies that have the certification of GAP implementation, according to data from SENASICA (2016), there are twelve companies that have this type of certification, of which two are found in Guanajuato and another two in Morelos.

METHODOLOGY

This research study was conducted in two of the principal onion producing states in Mexico, particularly in Santa Cruz de Juventino Rosas, Celaya and León, municipalities of Guanajuato, and Ayala, Cuautla and Tepalcingo, municipalities of Morelos. The data were collected in the second semester of the year 2015, and correspond to the costs and profits obtained during the spring-summer cycle of the year 2014 (base year).

Representative Production Units

To analyze the implementation costs of good production practices, representative production units (RPUs) that have GAP certification and those that do not have this type of certification were compared.

A representative production unit or representative farm was defined by Elliott (1928) as a modal farm or production unit in a distribution of frequencies of the farms from the same universe; a farm is representative because it represents a group of farmers that essentially do the same, and naturally, it can be representative of a group in size, organization, methods and practices, property and in many other things.

Although the use of this concept as a tool for decision making presents some limitations (Carter, 1963), it has been adapted to study the economic impacts at the farm level of the federal law of agricultural improvement and reform from 1996 in the United States (Smith *et al*., 1997), and in Mexico to study the productive, economic and financial behavior of pork farms and to project their economic viability (Zavala-Pineda, Salas-González, Leos-Rodríguez and Sagarnaga-Villegas, 2012; Sagarnaga *et al.,* 1999), and to estimate profitability of emblematic crops in the humid tropics (Sagarnaga, Salas and Aguilar, 2014); in addition, in 2008 it was used by SAGARPA as part of a project for the analysis of the public policy of ten agriculture and livestock products (Olmos, 2012).

Obtaining data of income and expenditures of production units has represented a limitation in the studies related with production costs, primarily derived from the lack of trust of farmers to provide this information (Ruiz, Ruiz, Torres and Cach, 2012) and the scarce use of financial logbooks (Aguilar-Gallegos, Muñoz-Rodríguez, Santoyo-Cortés and Aguilar-Ávila, 2013).

To solve these limitations, the technique of expert panels or focus groups are used, and this technique is particularly useful to explore the knowledge and experiences of the people in an environment of interaction that allows examining what the person thinks, how he/she thinks, and why he/she things that way (Hamui-Sutton and Varela-Ruiz, 2013). Thus, six panels were integrated that were made up, each, by six experts, five producers and a technical advisor, for the definition of the characteristics of the representative production

units according to the suggestions from Elliott (1928); that is, they are production units whose size, practices and infrastructure are similar to most of the units there are in the regions analyzed, each of them codified according to what was proposed by Sagarnaga *et al*. (1999) (Table 1).

The data related with production costs, income and technical parameters were obtained through dialogue with the producers, following the methodological proposal by Sagarnaga *et al*. (1999). The data were processed with the support of a spreadsheet.

To classify the production costs (Table 2), both of the RPUs that implemented GAP and those that did not, the proposal by the *Agricultural and Applied Economics Association* (2000) was used. The profitability was estimated through the benefit/cost relation (B/C), the portion which exceeds the unit will indicate the degree of profitability of the RPU (Gittinger, 1983).

RESULTS AND DISCUSSION

Profile of the RPUs

The RPUs of the two states analyzed was found in pieces of land whose property regimen is *ejido*, they have two production cycles per year, and they have irrigation. When it comes to the size of the RPUs (Table 3), experts indicated that the RPUs that have the GAP

Table 1. Characteristics of the representative production units.

Location	Key code
Santa Cruz de Juventino Rosas; Guanajuato	GTCBJR
Ayala, Morelos	MRCBAY
Celaya, Guanajuato	GTCBCE
Cuautla, Morelos	MRCBCU
León, Guanajuato	GTCBLE
Tepalcingo, Morelos	MRCBTE

Source: prepared by authors.

Table 2. Types of costs analyzed.

Types of costs	Concepts
Variable	Seed, fertilizers, insecticides, fungicides, herbicides, surfactants, soil amendments, fuels and lubricants, tools, temporary contract labor.
Fixed	Amortization of spare parts and supplies, depreciation of machinery, vehicles and equipment, payment of electricity, telephone and water, administrative costs (including permanent staff, marketing, promotion).
Opportunity costs	They are equivalent to the income that is not received when withdrawing a limiting input in a productive activity to assign it to another. For example: the cost of land (property of the producer), cost of own capital invested in operating expenses or working capital, in land, buildings, installations, machinery and equipment; the workforce of the producer, his family and the business management.

Source: prepared by authors.

Table 3. Profile of the representative production unit.

URP	Characteristic	Yield (tha^{-1})	Area (ha)	BPA certification
GTCBJR, MRCBAY	Seed: Certified Highly mechanized field and post-harvest production system with controlled use of fertilizers and integrated pest management. Highly trained operators Production destination: 100% export.	36.0 - 42.0	22.0 - 35.0	Yes
GTCBCE, MRCBCU	Seed: Certified The mechanized production system in the field, controlled use of fertilizers and integrated pest management. Destination of the production: 75% national market, 25% is exported.	20.0 - 29.0	13.0 - 15.0	Yes
GTCBLE, MRCBTE	The production system with intensive use of labor both in the field without post-harvest management, with empirical use of fertilizers and agrochemicals, the production is heterogeneous. Destination of the production: 100% national market.	17.0 - 20.0	4.0 - 5.0	No

Source: own elaboration based on information provided in expert panels.

certification are up to 700% larger than those that do not have good practices certification. The results agree with those obtained in other studies that argue that the GAP or clean production systems certification is associated preferably to larger pieces of land, due to the level of investment required (Cofre *et al.*, 2012; Nahuelhual, Engler, Carrillo, Moreira and Castro, 2009).

The yields of the certified RPUs are nearly 150% higher than those of RPUs that are not certified (Table 3), which is because when they implement the GAP protocols they develop the technical capacities of the staff, use improved seeds, improve practices of plant nutrition, and control of pests and diseases; this allows increasing the yields (FAO, 2012) and therefore impacts the profitability of the RPUs. These results contribute empirical evidence to the economic benefits that are obtained when implementing GAP (Hobbs, 2003), such as those identified in oil palm in Colombia (Fontannilla, Mosquera, Ruiz, Beltrán and Guerrero, 2015) and Malaysia (Awang *et al.*, 2016).

Concerning commercialization, the experts pointed out that the largest RPUs which have GAP certification channel most of their production to the exports market, while the RPUs that are not certified trade their production in the national market. Various authors (Cofre *et al.,* 2012; Henson, Masakure and Cranfield, 2011) agree that in the adoption of GAP protocols, whether public or private, allow the exporting companies and/or producers to gain access to larger and better markets. Instead, "non-certified" producers, generally small-scale producers, are excluded from the more demanding markets and have only the possibility of opting for markets of lower requirements (Cofre *et al.*, 2012).

Costs of GAP certification

The implementation of GAP certifications does not only involve costs associated with obtaining the certificate (certification audit), but also those related to the implementation

of management practices and technologies, conservation and management of the GAP registry, which represents a significant investment (Avendaño and Várela, 2010) and a decrease in the operative costs for farmers (Nahuelhual *et al*., 2009).

When analyzing the production costs of the RPUs (Table 4), the unitary fixed costs (t^{-1}) of the RPUs that have a certification are on average 40% higher than those of RPUs without certification. This is explained because the certified RPUs must cover the fixed costs derived from the depreciation of sanitary infrastructure, construction, maintenance of machinery and equipment, permanent workforce, and administration costs; these costs can be excessively high, as in the case of the MRCBCU RPU in reference to the means (liquidity) of small-scale companies, and can force them to exit or to move to less profitable markets (Avendaño and Varela, 2010), as in the case of the GTCBLE and MRCBTE RPUs.

Regarding the variable production costs (Table 4), it was observed that the RPUs that have certification have lower unitary variable costs, and this is because, on the one hand, the certified RPUs implement integrated pest management plans, where although the authorized products are more expensive, they are applied less frequently, which reduces the application of agrichemicals; and, on the other hand, by improving the nutrition and pest control, in addition to the use of improved seeds, their yields are improved, reducing the variable unitary costs. These results agree with those obtained by Srisopaporn, Jourdain, Perret and Shivakoti (2015) in their study with GAP adoption in rice.

The high variable unitary costs in which the non-certified RPUs incur are explained because due to their size they do not generate scale economies, nutrition practices are performed empirically and they do not have technical advice. According to the experts, the costs related with the implementation of GAP range between 7% and 9.6 % of the total unitary costs (Table 4).

The results obtained support the arguments of authors such as Henson (2008) and Cofre *et al*. (2012), who mentioned that the costs associated to certification protocols obstruct the

Table 4. Summary of production costs.

Type of cost	URP					
	GTCBJR	MRCBAY	GTCBCE	MRCBCU	GTCBLE	MRCBTE
BPA certification	Yes	Yes	Yes	Yes	No	No
Variable costs (CV) ($)	3362.31	3321.66	3222.11	3911.65	2092.57	2131.96
Fixed costs (CF) ($)	1502.96	1663.79	1766.58	2063.26	361.69	384.04
Opportunity costs (CO) ($)	1154.99	1315.14	1569.69	1737.30	909.31	910.38
Total cost (CT) ($)	5824.23	6083.65	6327.96	7443.09	4571.96	4383.96
Yield (t/ha)	55	42	36	29	20	17
Unit CV ($/kg)	61.13	79.09	89.50	134.88	104.63	125.41
Unit CF ($/kg)	27.33	39.61	49.07	71.15	18.08	22.59
Unit CT (CTU) ($/t)	105.90	144.85	175.78	256.66	228.60	257.88
BPA cost ($/t)	7.91	10.34	16.92	17.70	–	–
% of BPA with respect to CTU	7.5	7.1	9.6	6.9	–	–

Source: prepared by authors.
$ denotes measurement in US dollars, average exchange rate of the spring-summer cycle 2014, 13.07 MX pesos according to the Diario Oficial de la Federación (DOF).

trade of farmland products; small-scale producers from developing countries who do not have sufficient resources in human capital, technology and infrastructure to ensure quality are affected more, and therefore, due to their size (economy of scale), large exporters and/or producers can amortize the costs of compliance associated to the private protocols for GAP certification. This coincides with the data reported by Bovay, Ferrier and Zhen (2018).

Profitability

Regarding the profitability of the RPUs analyzed (Table 5), results indicate that the RPUs that are certified recover up to $2.25 for each peso they invest, while the RPUs that do not have certification barely recover 16 cents. This difference is explained because, on the one hand, the yields improve when implementing GAP, on the other, the GAP certification eases access to the USA market, through exporting companies that offer better and more stable prices.These results contribute to the empirical evidence generated in other studies that argue about the direct benefits of the certification through the reduction of costs, a higher and more consistent quality, and a greater efficiency of the production processes, as well as effects at the market level that have even lower transaction costs, price primes, market access, growth in the market participation and/or the ability of attracting new clients (Fouayzi, Caswell and Hooker, 2006; Henson *et al.*, 2011). For their part, Avendaño and Várela (2010) argue that the certification communicates its standards to the consumers through seals and certifications, allowing them to add value to the product via the differentiation and the inclusion of the attributes of quality and safety, which ease the access to new and potentially more advantageous markets.

Results indicate that the investments directed at the compliance of GAP are worth it, because they obtain on average positive returns from the investments, result that agrees with those obtained by Kleemann, Abdulai and Buss (2014), in the evaluation that they made about the adoption of GAP in pineapple, where they concluded that the implementation of GAP is consistent with the notion that access to the exports markets through certification can improve agricultural income and reduce poverty.

In this sense, the development of the capacity of exporters to comply with the standards could help the companies to diversify their export markets and to improve the stability

Table 5. Profitability of the RPUs.

Indicator	URP					
	GTCBJR	MRCBAY	GTCBCE	MRCBCU	GTCBLE	MRCBTE
Yield (t/ha)	55.0	42.0	36.0	29.0	20.0	17.0
Sale price ($/t)	344.15	347.97	336.50	321.21	252.38	298.26
Total revenue ($)	18 928.25	14 614.91	12 114.08	9315.00	5047.53	5070.48
Total cost ($)	5824.23	6083.65	6327.96	7443.09	4571.96	4383.96
Profitability (%)	3.25	2.40	1.91	1.25	1.10	1.16

Source: prepared by authors.
$ denotes measurement in US dollars, average exchange rate of the spring-summer cycle 2014, 13.07 MX pesos according to the Diario Oficial de la Federación (DOF).

of their sales given the uncertainty of international markets (Chen, Otsuki and Wilson, 2006).

CONCLUSIONS

Compliance with the safety norms implies a total average cost of an additional 54% for the production units. The gap in the production costs between certified onion farms and non-certified onion farms is due primarily to the fixed costs and the administrative expenditures, influenced by the size of the production unit.

The offer of public goods focused on safety, such as the support for GAP certification, helps relatively poor farmers to gain access to the exports markets in a profitable way, thus providing a development strategy for some segments of the rural population.

The certified farms showed greater advantages in all the areas analyzed, and it will be important to study the factors that limit the production units in the compliance of the safety norms.

This study would be enriched by a prospective analysis of the economic viability of RPUs to study the impact of the public policy as support to the certification of small-scale producers.

Presently, consumers are more aware and pay greater care to the diseases caused by viruses, bacteria and from zoonosis transmission, which is why complying with safety norms will be fundamental for the growth of production units and their access to the markets.

The trend regarding the demand from consumers in terms of safety and quality is increasing, which is why the object of this study is current and relevant.

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