Article

Diagnosis of lentil cultivation in family production units in Michoacán

J. Trinidad Sáenz-Reyes[1]
Hipólito Jesús Muñoz-Flores[1]
Magali Ruíz-Rivas[1]
Agustín Rueda-Sánchez[2]
David Castillo-Quiroz[3]
Francisco Castillo-Reyes[3§]

[1]Uruapan Experimental Field-INIFAP. Av. Latinoamericana num. 1110, col. Revolution, Uruapan, Michoacán, Mexico. CP. 60150. Tel. 800 0882222, ext. 84215. (saenz.j.trinidad@inifap.gob.mx; munoz.hipolitojesus@inifap.gob.mx; ruiz.magali@inifap.gob.mx). [2]Experimental Center Altos de Jalisco-INIFAP. Free highway Tepatitlán-Lagos de Moreno km 8, Tepatitlán, Jalisco, Mexico. CP. 47600. Tel. 800 0882222, ext. 84504. (rueda.agustin@inifap.gob.mx). [3]Saltillo Experimental Field-INIFAP. Saltillo-Zacatecas highway km 342+119, num. 9515, col. Hacienda de Buenavista, Saltillo, Coahuila, Mexico. CP. 25315. Tel. 800 0882222, ext. 83515. (castillo.david@inifap.gob.mx).

[§]Corresponding author: reyes.francisco@inifap.gob.mx.

Abstract

Lentil (*Lens culinaris* Medik) represents a crop with a high nutritional value; in Mexico, it is sown in approximately 8 550 ha with a total yield of 8 931 t and Michoacán is the main producer with 93% of the national production. The integration of lentil family production units under the territorial development program justifies a technical-operational analysis. The objective was to carry out the technical-productive diagnosis of lentil cultivation in the family production units of PRODETER-Lenteja in the state of Michoacán. Twenty three percent of the members were surveyed in the municipalities of Coeneo, Huaniqueo and Jiménez. The results indicated that the area dedicated to the crop is small and indicates a problem of micro-parceling, use of landrace seed from the previous harvest without prior selection, lack of prevention or control of diseases such as powdery mildew and excessive use of chemical products for aphid control, which implies environmental damage and health risk for producers and consumers, low average crop yield (0.95 t ha^{-1}), a deficient or no market study, which results in the non-sale of the product or payment at low prices by intermediaries ($4.00 to 10.50 kg^{-1}), high average costs in the preparation of the land ($4 000.00 ha^{-1}) and the harvest ($5 800.00 ha^{-1}), which results in a low profitability (B/C R= 0.69-1.56). Only 15% of producers have technical assistance to solve phytosanitary or crop management problems.

Keywords: *Lens culinaris*, prodeter, productivity, profitability.

Reception date: February 2022
Acceptance date: May 2022

Introduction

Lens culinaris Medik. (lentil) is a crop intended for grain production because it contains high nutritional value, in addition, it has the characteristic of being resistant to drought; it can grow in a wide range of soils, from light to the heaviest, with pH between 5.5 to 9 and without tolerance to salts. Its cultivation in fertile soils and with high humidity can cause an excess of foliage production that results in a decrease in grain production (Cárdenas *et al*., 2014). Its harvest is mainly used in human food, as it contains about 25% of protein and a high content of iron, fiber, vitamins and minerals; however, the whole plant or grain is also used as fodder for livestock feed (Peñaloza *et al*., 2007; Erskine *et al*., 2009; Basantes, 2015; Zagoruyko *et al*., 2020).

Its production is concentrated in Asia, North Africa, Western Europe and part of Latin America. In recent years, a tendency to increase its consumption has been observed, although it is still considered a grain of low consumption (Cárdenas *et al*., 2014). The main producing countries are India, Canada and Turkey and the crop ranks sixth in the global ranking of dry grain production (Erskine *et al*., 2009). In Mexico, it is sown on an area of approximately 8 550 ha with a total yield of 8 931 t.

The state of Michoacán ranks first with about 7 373 ha with a production of 7 689 t and an average yield of 1 t ha^{-1} (SEDRUA, 2018). Usually, lentil is grown in land with slopes of less than 3%, in soils of the type Vertisol, Histosol, Planosol, Leptosol and Cambisol, under irrigation or rainfed conditions (INEGI, 2009a, 2009b, 2009c; INAFED, 2019a, 2019b, 2019c). Through the Secretariat of Agriculture and Rural Development (SADER, for its acronym in Spanish) with its rural development program, it encourages associated producers in a rural territory through the so-called territorial development projects (PRODETER, for its acronym in Spanish), which are made up of a group of family production units (FPUs).

With the aim of improving primary production and creating or strengthening a set of rural enterprises within a specific territory; the foregoing in order that they can profitably assume the economic functions of the production chains in which they participate and the reduction of costs of production, generation and retention of added value, improvement of the prices of their products or services, as well as the increase of their income and the productive conditions, profitability and sustainability of the FPUs.

PRODETER-Lenteja in the state of Michoacán was formed to integrate the production chain of this crop, however, prior to this, it was necessary to make a diagnosis on the production and commercialization of lentil that shows the current situation of the crop. In accordance with the above, the objective of this study was to carry out the technical-productive diagnosis of lentil cultivation in the family production units of PRODETER-Lenteja in the state of Michoacán.

Materials and methods

The study was carried out from December 2019 to April 2020 in the municipalities of Coeneo, Huaniqueo and Jiménez of the state of Michoacán, where PRODETER-Lenteja was implemented, this area has the following boundaries: to the north with the municipalities of Panindícuaro, Puruándiro and Morelos, to the south with Quiroga and Erongarícuaro, to the east with Chucándiro and Morelia and to the west with Zacapu (Figure 1).

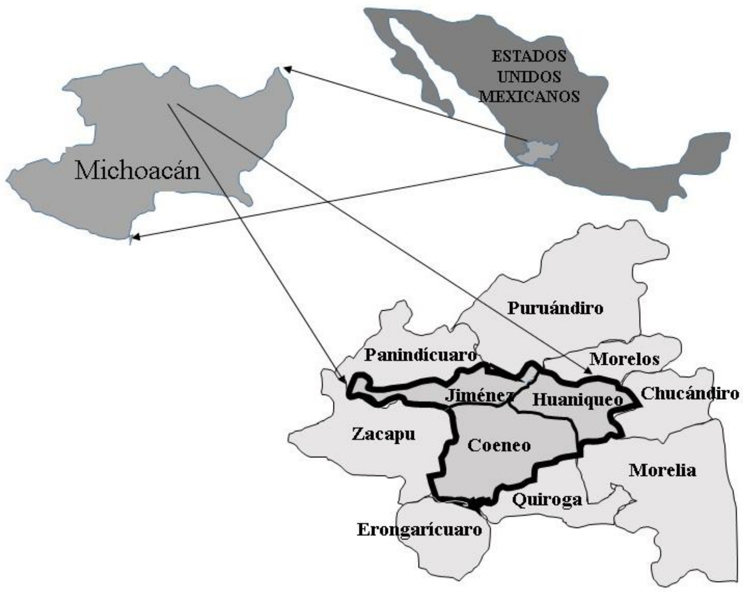

Figure 1. Location and boundaries of PRODETER-Lenteja in the state of Michoacán.

Geographically, the municipalities are located at 19° 48' north latitude and 101° 35' west longitude for Coeneo, at 19° 54' north latitude and 101° 30' west longitude for Huaniqueo and 55' north latitude and at 101° 45' west longitude for Jiménez. Regarding the relief, the first ones have an altitude of 2 040 m and the last one at 2 020 m, all with a temperate climate and rains in summer, with an average annual temperature of 8 to 25 °C and a rainfall of 816, 850 and 760-900 mm, respectively (INEGI, 2009a, 2009b, 2009c; INAFED, 2019a, 2019b, 2019c).

The information was obtained through the application of surveys to producers responsible or in charge of the management of the FPU. The survey was developed and validated considering the proposed variables and was divided into two components: the first on productive aspects of the crop and the second on the commercialization of the product. In total, 40 variables were evaluated, which were systematized and defined the diagnosis of lentil cultivation in FPUs. The sample size was represented by 23% of the total population under study, applying a total of 40 surveys (85% men and 15% women) based on a total of 171 producers of the FPUs of PRODETER-Lenteja.

The application of surveys to the FPUs was carried out *in situ* through a series of questions to carry out the diagnosis of this production system. The selection of the producers was through a random sampling and for the collection of field information, a mobile application compatible with the Android operating system and designed by the Agricultural Information System (SIAP, for its acronym in Spanish) was used; in addition, an additional printed survey with open-ended questions was developed to supplement the information. Descriptive statistics tools were used, with the support of the SAS software ver 9.2 (Statistical Analysis System, 1992), for the processing of the information of the variables that imply the establishment and technological management of the crop, as well as production costs, income, profitability, commercialization and its problems.

Results and discussion

Cultivation area

The total area of land by FPU is small, it was found that 10% of respondents have areas of less than 1 ha of land, 52.5% between 1-2 ha, 30% from 2.1 to 5 ha and 7.5% greater than 5 ha. In general, FPUs are made up of an average area under ‘entarquinamiento’ (spate irrigation) of 1.5 ha and under rainfed conditions of 2 ha, both for lentils such as corn and chickpea (Table 1).

Table 1. Area of the family production units of PRODETER-Lenteja in Michoacán, 2020.

Area	Average	Minimum	Maximum	Standard deviation
Area under spate irrigation	1.5	0.5	5	1.6
Rainfed area	2	0.5	10	2.1

In the FPUs under PRODETER-Lenteja in Michoacán, the two main agricultural production systems are lentil and corn, where 100% of respondents are engaged in lentil cultivation and 90% of them also grow corn. The size of the FPU employed locally is 1.5 to 3 ha, which contrasts with the area allocated in other countries such as Canada, where the area for lentil production is large, mechanized, with intensive use of inputs and reduced use of labor (De la Tejera and Santos, 2001). This area dimension of each FPU could be one of the main problems associated with low productivity due to micro-parceling.

Sowing

The sowing is carried out both mechanically and manually, with the use of machinery (tractors) classified as own, payment of maquila and community use, which was in different state conditions. The economic resource invested for each and every one of the activities during the cultivation cycle comes from the economic resources of those responsible for the FPUs, from family loans, remittances and credits (Figure 2).

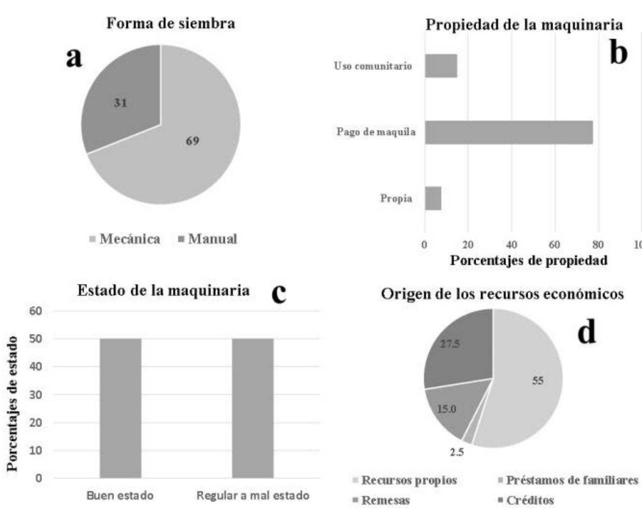

Figure 2. Aspects of sowing lentils. a) form of sowing; b) ownership of machinery; c) state of machinery; and d) origin of economic resources.

Landrace seed is used in the sowing of the crop, on average 100 kg ha^{-1} [standard deviation (SD)= 24.3], in a range between 65 and 150 kg ha^{-1}. This number of seed used is higher compared to that used in Ecuador, which ranges from 70 to 90 kg ha^{-1} (Basantes, 2015) or in Chile, which varies between 70 and 80 kg ha^{-1} with the Calpún-INIA variety (Peñaloza *et al*., 2007).

Cultural work

This legume is sown in the autumn-winter agricultural cycle under the system known as 'entarquinamiento' or 'enlagunado' (spate irrigation), which consists of flooding the fallowed lands, prior to sowing. The preparation of the land for sowing is diverse and begins with a fallow in August and September. Prior to the spate irrigation, brush clearing with a machete, harrowing, sowing and harrowing are carried out, however, not all the producers necessarily carry out all the activities, nor in the order mentioned. From the date on which the water is discharged from the flooded lands, they are in optimal conditions for seed germination and crop development and there is a period of 30 days to sow, which occurs between October and November.

Producers who sow under rainfed conditions (6%) apply a furrow irrigation in the production cycle. In the study area, no chemical or biological fertilization (*Rhizobium leguminosarum* bv *viciae*) is carried out during the production cycle, both of which are of utmost importance for increasing yield. It has been proven that the association of this bacterium with the plant improves growth, nodulation and yield (Cárdenas *et al*., 2014), although by itself, the lentil reduces dependence on inorganic nitrogen fertilizers and improves soil health because it fixes nitrogen at an average rate of 80 kg N ha^{-1} $year^{-1}$ (Ghanem *et al*., 2017).

Some formulations used as fertilization, for example, in Argentina, the fertilization is carried out with nine to 10 units of phosphorus and 12 to 14 of sulfur, usually with the fertilizer source called simple superphosphate (Prieto and Antonelli, 2008) or with the dose 36-92-50, although it is recommended that the ideal is to do so based on the previous soil analysis. For a harvest of 2 t ha^{-1}, about 95-100 kg ha^{-1} of nitrogen is required and approximately 75% is given by the symbiotic fixation of *Rhizobium* (Basantes, 2015).

The control of weeds in the cultivation of lentils is of great importance since these emerge when the land is flooded, which makes manual weeding necessary, which results in an increase in production costs, this practice is carried out from July to October and it is important to carry out their control since they compete for nutrients, water and space, causing low yields in production. Among the main weeds that appear are *Eichhornia crassipes* (Mart.) Solms (common water hyacinth) and *Polygonum* sp. (dotted smartweed).

As an important pest is *Aphis craccivora* Koch (aphid), regionally known as "mielecilla", which is observed when the crop is approximately 25 cm tall and for its control, the chemical insecticide Foley® is applied at an average dose of 1 L ha^{-1} (SD= 0.51) in a range of 0.5 to 2 L ha^{-1} in 200 L of water, since if its control is not carried out, the harvest is lost almost entirely, mainly if the pest appears at the early stage of the crop.

In high infestations, the insect can be found from the base of the stem to the maximum height of the plant, causing the fall of leaves and flowers, so its damage (not quantified) can seriously affect the yield of the crop. In other countries (Ecuador), Lorsban® is used at doses of 400 cc in 200 L of water for the control of aphids (*Macrosiphum* sp.), although it is recommended to apply insecticides only when the economic threshold of the pest population may cause damage to the crop (Basantes, 2015). Among the diseases is *Erysiphe polygoni* DC. (powdery mildew), widely distributed, but no control action is carried out and its impact on production is unknown.

In some regions of the world, diseases that affect seed yield or quality are reported, such as wilt caused by *Fusarium* sp. In the region of Faisalabad, Pakistan, where this pathogen is devastating and the solution to the problem was the development of resistant varieties with high yield (Akhtar *et al*., 2016), in Chile, rust is caused by *Uromyces fabae* Pers. and is one of the main limitations in the production of lentil, so cultivars resistant to this pathogen were introduced (Peñaloza *et al*., 2007) and in Ecuador, it is recommended to use Oxicarboxin® (*Plantvax*) in doses of 200 g ha^{-1} in 200 L of water (Basantes, 2015).

Harvest

It is carried out when the foliage has a yellowish color and the pods are lemon-green, the plants are pulled up and small mounds known as 'gavillas' are formed, all manually, which are left to dry in the open field for an average time of 13 days (SD= 2.89), in a range of eight to 21 days, to later group them and take them to the place where the mechanical threshing will be carried out for the extraction of the grain, which is carried out with private threshers that are in regular conditions.

The harvest is 100% manual, which implies the payment of up to 20 daily wages ($4 000.00), which strongly impacts production costs, this form of harvest is due to the lack of specialized machinery; Cardenas *et al.* (2014) point out that, to use mechanized harvesting, plants must have homogenized height, in addition to the position of the first pod, since this variable is important for mechanized harvesting.

Yield

The average yield for the 2020 cycle was 0.95 t ha^{-1} (SD= 2.27) in a range of 0.5 to 1.5 t ha^{-1}, where 95% of producers achieve a maximum of 1 t and only 5% produce more than this amount. This low yield can reflect the type of seed used, which in this case is landrace seed, and the availability of moisture during the production period, since only 6% of producers carry out a furrow irrigation in the production cycle when it is not with the spate irrigation system, as well as the lack of fertilization and control of pests and diseases.

The average production determined in this study is 64% lower compared to the Calpún-INIA variety (1.5 t ha^{-1}), in addition, this variety was 17% lower than Araucana-INIA (1.8 t ha^{-1}) in evaluations carried out in an environment without incidence of *Uromyces fabae* Pers. (rust), the yield was between 60 and 95% higher than susceptible cultivars such as Araucana-INIA and Súper Araucana-INIA, respectively (Peñaloza *et al*., 2007), and is also lower compared to that reported in Ecuador of 1.5 to 2 t ha^{-1} (Basantes, 2015). In Nepal, a FPU of 0.26 ha achieved a grain production of 90 kg ha^{-1}, using a local variety, little use of fertilizer and a rainfall of 253 mm during the growing season (Paudel *et al*., 2020), in addition, it is pointed out that the variability in rainfall during the production period is responsible for up to 41% in production (Erskine and El Ashkar, 1993).

Commercialization

Ninety percent of the producers sell the grain to the national market and the rest to the local market. However, they comment on the need to have direct commercialization channels to the consumer or direct contracting with the industry, the installation of a supply center or commercialization with their own brand, through an excellent presentation, effective and massive diffusion of the product. In addition, they consider that economic integration companies would bring them greater income and the creation of collection centers, a machinery center and a warehouse for the supply of inputs.

In general, there are associated problems, which indicates that the commercialization system of lentil grain still shows deficiencies that could be linked to the fragility of the organization to negotiate with buyers, despite being formed in an organization, most of the respondents state that they sold the product to intermediaries due to the long distances to foreign markets and the unpunctual payment for their product. These weaknesses could be due, on the one hand, to the absence of an adequate organization to face the ups and downs of the market and, on the other hand, to the ownership of a small area by FPU, which shows a problem of micro-parceling. Table 2 shows the production volumes and destination of lentils.

Table 2. Production and destination of lentil crop in the family production units of PRODETER-Lenteja in the state of Michoacán, 2020.

Production and destination	Average	Minimum	Maximum	Standard deviation
FPU production (t)	1.7	0.5	4	1
Yield (t ha^{-1})	0.95	0.5	1.5	0.2
Sale (t)	1.6	0.3	4	0.8
Self-consumption (t)	0.3	0.02	1.5	0.5
Livestock feed (t)	0.5	0.5	0.5	0

Production indicators

The average production costs per ha are \$11 000.00 (SD= 1 995.26) in a range of \$8 800.00 to \$14 900.00. The preparation of the land and the cutting of the plant for its drying in the harvesting process are the activities with the highest cost (71%) of the production process (Table 3).

Table 3. Production costs (\$) of lentil cultivation in the family production units of PRODETER-Lenteja in the state of Michoacán, 2020.

Value	Activity costs						Production costs (\$/ha)
	Sowing*	Pest control	Cutting	Threshing	Transport home	Transport to warehouse	
Average	4 000	460	3 850	600	1 290	800	11 000
Minimum	1 400	290	1 750	360	600	600	8 800
Maximum	7 000	600	5 000	964	2 000	1 000	14 900
SD	1 600	103	940	160	443	163	1 995

*= it includes the cost of preparing the land; SD= standard deviation.

The income from the sale of lentil in the FPUs varies according to its commercialization, for example, in the 2018 harvest, it was sold to the government of the state of Michoacán through the Integral Development of the Family (DIF, for its acronym in Spanish) at a price of \$18.00 kg^{-1}, on the other hand, from the 2019 harvest, most of the producers did not obtain sales due to the low price offered by intermediaries; however, some did sell at a price of \$8.00 kg^{-1}, these factors determine the profitability of the crop, in addition to the production costs and the productivity of the crop.

Those who sold to DIF in 2018 obtained a benefit/cost ratio greater than 1 (B/C R= 1.56), which indicates that they reached profits and those who marketed with intermediaries in 2019 did not recover the investment (B/C R= 0.69). Paudel *et al.* (2020), Medina, 2018, mention that, in Nepal, the profit margin was 53.5 dollars per hectare for grain produced in highlands and 22.2 dollars per hectare for grain produced in lowlands, with production costs of 295 and 237 dollars per hectare, respectively.

For 2020, the profitability was determined including the income from straw, which are destined for livestock feed, determining that, when selling to intermediaries, they did not obtain profits (B/C R= 1.05) and only when a production of around 1.5 t ha^{-1} is reached, which few producers achieve, and in the hypothetical case that they sold at a price of \$18.00 kg^{-1}, similar to the price of DIF in 2018, an B/C R= 1.94 would be obtained, which indicates that the cultivation of lentil would be profitable (Table 4).

Table 4. Income (\$) and profitability (B/C R) of lentil cultivation in the family production units of PRODETER-Lenteja in the state of Michoacán, 2020.

Value	Income per lentil grain (\$ ha)		Benefit/cost ratio		Income from straw (\$ ha^{-1})	Total income (\$ ha)		Benefit/cost ratio	
	DIF	Intermediary	DIF	Intermediary		DIF	Intermediary	DIF	Intermediary
Average	17 100	7 600	1.56	0.69	4 000	21 100	11 600	1.94	1.05
Minimum	9 000	4 000	0.82	0.36		13 000	8 000	1.18	0.73
Maximum	27 000	12 000	2.45	1.09		31 000	16 000	2.81	1.45
SD	4 089	1 647	0.47	0.19		4 089	1 647	0.50	0.22

SD= standard deviation.

Problems

The problems detected were the following: deficient or no market study, which results in the non-sale of the product or payment at low prices by intermediaries (\$4.00 to 10.50 kg^{-1}). High costs in the preparation of the land (up to \$7 000.00 ha^{-1}), in the cutting of the plant in the harvest stage (up to \$5 000.00 ha^{-1}) and low crop yields (0.8 to 1 t ha^{-1}), as long as the 'cabañuelas' are not present, presence of late frosts, poor preparation of the land and lack of fertilization.

Low profitability (B/C R= 1.05) due to low productivity and low purchase prices of lentils by intermediaries. Lack of prevention or control of diseases, such as powdery mildew, and excessive use of chemicals for aphid control (unquantified impacts), which results in environmental damage and health risk for producers and consumers. Use of landrace seed from the previous harvest, without prior selection. Only fifteen percent of producers have technical assistance and 85% do not have it and to solve a phytosanitary problem of the crop, they seek advised from other producers (65%) or in establishments that sell agrochemicals (35%).

Conclusions

The cultivation of lentil in the area of influence has a low productivity due to high production costs and low sale price offered by intermediaries, which results in low profitability; coupled with the lack of commercialization channels that determine a fair price, the need of producers to have a machinery center that reduces the high costs of preparing the land and cutting the plant in the harvesting process.

Cited literature

Akhtar, S.; Ahsan, M.; Jawad, A. M.; Pervaiz, A. J. y Abbas, G. 2016. Respuesta de diferentes poblaciones de lenteja al estrés biótico (marchitez por *Fusarium*). Agrociencia. 50(3):367-373.

Basantes, M. E. R. 2015. Manejo de cultivos andinos del Ecuador. Publicaciones científicas. Universidad de las Fuerzas Armadas ESPE. Sangolquí, Ecuador. 33-37 pp.

Cárdenas, T. R. M.; Ortiz, P. R. H.; Rodríguez, M. O.; de la Fe, M. C. F. y Lamz, P. A. 2014. Comportamiento agronómico de la lenteja (*Lens culinaris* Medik.) en la localidad de Tapaste, Cuba. Cultivos Tropicales. 35(4):92-99.

De la Tejera, H. B. G. y Santos, O. A. 2001. Impactos de la política agrícola en los mercados y en el desarrollo: el caso de la lenteja en México y Canadá. Economía y Sociedad. 6(9):95-114.

Erskine, W. and Ashkar, F. E. 1993. Rainfall and temperature effects on lentil (*Lens culinaris*) seed yield in Mediterranean environments. J. Agric. Sci. 121(3):347-354.

Erskine, W.; Muehlbauer, F. J.; Sarker, A. and Sharma, B. 2009. The Lentil: botany, production and uses. Cabi. Preston, London, UK. 1-3 pp.

Ghanem, M. E.; Kibbou, F. E. and Guiguitant, J. X. 2017. Opportunities to improve the seasonal dynamics of water use in lentil (*Lens culinaris* Medik.) to enhance yield increase in water-limited environments. Chem. Biol. Technol. Agric. 4(22):1-6.

INAFED. 2019a. Instituto Nacional para el Federalismo y el Desarrollo Municipal. Enciclopedia de los municipios y delegaciones de México. Estado de Michoacán de Ocampo. H. Ayuntamiento de Coeneo.

INAFED. 2019b. Instituto Nacional para el Federalismo y el Desarrollo Municipal. Enciclopedia de los Municipios y Delegaciones de México. Estado de Michoacán de Ocampo. H. Ayuntamiento de Huaniqueo.

INAFED. 2019c. Instituto Nacional para el Federalismo y el Desarrollo Municipal. Enciclopedia de los Municipios y Delegaciones de México. Estado de Michoacán de Ocampo. H. Ayuntamiento de Jiménez.

INEGI. 2009a. Instituto Nacional de Estadística, Geografía e Informática. Prontuario de información geográfica municipal de los Estados Unidos Mexicanos Coeneo, Michoacán de Ocampo clave geoestadística 16016 2009.

INEGI. 2009b. Instituto Nacional de Estadística, Geografía e Informática. Prontuario de información geográfica municipal de los Estados Unidos Mexicanos Huaniqueo, Michoacán de Ocampo clave geoestadística 16037 2009.

INEGI. 2009c. Instituto Nacional de Estadística, Geografía e Informática. Prontuario de información geográfica municipal de los Estados Unidos Mexicanos Jiménez, Michoacán de Ocampo clave geoestadística 16044 2009.

Medina, M. J.; Alejo, S. G.; Soto, R. J. M. y Hernández, P. M. 2018. Rendimiento de maíz grano con y sin fertilización en el estado de Campeche. Rev. Mex. Cienc. Agríc. 9(21):4306-4316.

Paudel, G. P.; Devkota, M.; Keil, A. and McDonald, A. J. 2020. Climate and landscape mediate patterns of low lentil productivity in Nepal. PLoS One. 15(4):1-19.

Peñaloza, E.; Tay, U. J. y France, I. A. 2007. Calpún-INIA, cultivar de lenteja (*Lens culinaris* Medik.) de grano grande y resistente a roya. Agric. Téc. Chile. 67(1):68-71.

Prieto, G. y Antonelli, M. 2008. Fertilización en lenteja-soja de 2º. Fuentes de fertilizantes y efecto residual en soja de 2º. Informaciones agronómicas de Hispanoamérica (LACS). 40:11-12.

SAS. 1992. Statistical Analysis System. SAS/STAT User Guide. SAS Institute, Inc. Relase 6.03 (Ed.). Cary, NC. USA 1028p.

SEDRUA. 2018. Secretaría de Desarrollo Rural y Agroalimentario. Anuario agroalimentario 2018. Michoacán. SEDRUA-SIAP-INEGI-SADER. Morelia, Michoacán, México. 72 p.

Zagoruyko, M. G.; Chaplygin, M. Y. and Davydova, S. A. 2020. Diversification of lentil production. E3S web of conferences. 193(01022):1-7.