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Economic Evaluation of Two Systems of Production of Tomato (*Lycopersicon esculentum* Mill) in Green-House

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Abstract: In the present investigation was assessed the profitability of two production systems (conventional and organic) of tomato type Saladette, under greenhouse conditions in the community of San Bernardino Tepenene, belonging to the municipality of San Juan Tzicatlacoyan, Puebla-Mexico. It used the indicators of economic evaluation: Net Present Value (VAN), Cost-Benefit ratio (B/C), Net investment-benefit ratio (N/K) and Internal Rate of Return (IRR) to perform the analysis of profitability. The results obtained in the conventional production system for a period of 10 years were: VAN = 759,695.72, B/C = 1.32, N/K = 3.52 and TIR = 18.80; that in comparison with those obtained in the system of organic production for the same period were: VAN = 2,281,659.96, B/C = 2.15, N/K = 12.36 and TIR = 22.90. On the basis of these indicators, it is concluded that the form of production of tomato under an organic management is more viable from the point of view of economic and ecological, instead of conventional production. Demonstrating that the profitability of this investment project is excellent because they have good prospects of marketing in Mexico and USA.

Key words: Organic management, greenhouse, profitability, economic indicators, prospects, excellent

INTRODUCTION

The demand for food and source materials has exceeded the natural capacity of the land for cultivation. Hence, approximately 1,500 million ha of land are used for agriculture and 2,600 million people depend economically on it (Howden *et al*., 2007; Alston and Pardey, 2014). Likewise, a study by the Organization for Economic Cooperation and Development (OECD) and the Organization of the United Nations Food and Agriculture Organization (FAO), mentioned that the world agricultural production of commodities forecasts an average growth of 1.5% per annum, compared with 2.1% in the previous decade (Anonymous, 2013a, b). Ferrato and Mondino (2008) pointed out that the growth in vegetable production step of 324-881 million tons in the period 1980-2005, representing an average annual rate of 4.1%. It is stressed that the horticultural sector is dynamic, due to its orientation toward the market to international competition and natural factors (Anido *et al*., 2010).

One of the most important vegetable\regarding the production is the tomato (*Lycopersicon esculentum* Mill) which is cultivated in all types of soils for family use and commercial (Adekiya and Agbede, 2017) for the year 2013, occupied the first place with a total sown area of 4.734 million ha and a production of 163 million tons (Anonymous, 2013a, b). FAO (2012) indicated that about 80% of the production is found in China, USA, India, Egypt, Turkey, Italy, Iran, Spain, Brazil and Mexico. To date China is the first producer with 50 million tons, followed by India with 18 million tons, United States with 12 million tons and Mexico is located in the tenth position with 3,282 million tons (Anonymous, 2013a, b).

In Mexico, the statistics of the Agricultural Information System reported that in the year 2014 were planted 52.374 thousand ha of tomato with a production of 2,875.164 tons with a value of 15.735 million pesos. In both that system data product, indicated that exports amounted to 20 billion pesos, being the United States and Canada the main buyers where the major producers were Sinaloa with 867,832.04 tons, San Luis Potosi with 196,011.25 tons and Michoacan with 169,768.98 (Anonymous, 2015a, b).

In this perspective, the technological change has claimed more labor for example: in 1991 for the production of tomato is required 122 days of labor per hectare

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(Albarran *et al*., 1994) and for 2010 was 199 days, it is worth mentioning that in this period was reduced the harvested area of tomato to 22.5 thous.ha (Barron, 2013). So, Ruiz (2008) mentions that there is a loss of competitiveness that is associated with the repeated outbreaks that have led to the closure of the border is strongly affecting the producers of tomato. It should be noted that in Mexico, the use of technologies such as the greenhouse and micro tunnel outweighs the negative trends in the cultivation of tomato (Sanchez-Del *et al*., 2009; Galindo, 2015). The production of tomato under green house conditions during the year 2014, represented the 26.2% national with yields averages of 171.82 tons/ha where Puebla ranked fourteenth place with 75219.09 tons of tomato (Anonymous, 2015a, b).

The community of San Bernardino Tepenene belongs to the municipality of San Juan Tzicatlacoyan, Puebla-Mexico, its main economic activities are agriculture and trade, although, the first is severely restricted by conditions edaphoclimatic, since, 90% of its land is not suitable for the practice of agriculture and with an average annual rainfall of 600-800 mm, conditions that limited to a more this activity (Anonymous, 2005).

Due to the difficult conditions of production that families face of San Bernardino Tepenene in the year 2014, Family Production Units (FPU), were favored with the obtaining of greenhouses with dimensions of 40, 120 and 1,000 sm. The cultivation mainly sown in these greenhouses is the tomato in a conventional manner, since, the projects proven The chemicals necessary for the production of this vegetable, however, some (UPF) have opted for a type of organic production which will demand a greater labor but lower production costs, actions that improve the price of marketing of the region.

The aim of the following research was to perform a comparison of profitability between a production of tomato (*L. esculentum* Mill) conventional and organic type (Saladette) in greenhouse conditions in the community of San Bernardino Tepenene in the municipality of San Juan Tzicatlacoyan, Puebla-Mexico. Cost-effectiveness studies between these production systems are null, this is why it is important to demonstrate the advantages and scope of organic production.

MATERIALS AND METHODS

The economic information was obtained from the investment, carried out for both Family Production Units (FPU) in tomato Saladette type in the community of San Bernardino Tepenene, belonging to the municipality of San Juan Tzicatlacoyan, Puebla-Mexico. Subsequently, it was determined the profitability of both systems of production through the indicators of economic assessment of the conventional system and the organic.

Understood by conventional production system to a productive system which uses all kinds of appropriate technologies and available that science has proven as beneficial in terms of increased crop production such is the case of the use of herbicides, fungicides, insecticides, chemical fertilizers, etc. (Galindo *et al*., 2015).

The talk of an organic production system, refers to the process that uses methods that respect the environment from the stages of production up to the handling and processing; in such a way as to consider a system of production as organic, it denotes the fulfillment of specific rules that regulate the production methods, in the case of organic agriculture, the rule that I think is the 04-23-97 Mexican Official Standard NOM-037-FITO-1995 which prohibits the majority of pesticides and synthetic fertilizers, all synthetic condoms, genetically modified organisms, the sewage sludge and irradiation. The following work focuses on the economic profitability of this type of production system by which the description of the productive processes becomes second term.

Some of the activities within this productive process were the use of seedlings certified as organic, the subscriber is made by the application of vermicompost and subsequently the foliar application to basis of earthworm humus to avoid diseases phytopathogenic by fungi are resorted to perform transplantation in high beds of 30 cm of height to prevent excessive moisture in the soil of the bed in addition to applying a bio-fungicide to basis of Trichoderma harzianum, since, it presents various mechanisms of action that allow you to control the most common pathogens while improving the vegetative growth and development of the roots to make more available nutrients to the plant. Likewise, for the control of plagues is used yellow traps and manual clearance (Romero-Arenas *et al*., 2009; Victoria-Arellano *et al*., 2015).

Indicators of economic evaluation: Economic evaluation is one that identifies the intrinsic merits of the project, regardless of how you obtain and pay the financial resources you need and how the distribution of surpluses or utilities that generates. The indicators for the economic evaluation are concepts valued that express the economic performance of the investment and on the basis of these data, we can take the decision to accept or reject the realization of a project or in your case, evaluates its profitability from same (Munante, 2002; Romero-Arenas *et al*., 2009). The indicators most

commonly used are those who consider the time value of money as are: the Net present Value (VAN) the Internal Rate of Return (IRR) the relationship benefit-net investment (N/K) The Benefit-cost ratio (B/C) and the recovery period (P/R).

Net Present Value (VAN): Is to upgrade to the present value of the future cash flows that will generate the project, discounted at a certain interest rate ("the discount rate") and to compare them with the initial amount of investment. As the discount rate is normally used the opportunity cost of capital of the company that makes the investment:

$$VAN = -A+[FC_1/(1+r)^1]+$$
$$[FC_2/(1+r)^2]+...++[FC_n/(1+r)^n]$$

Where:

A = Initial outlay
FC = Cash Flows
n = Number of years (1, 2, ..., n)
r = Type of interest ("the discount rate")
$1/(1r)^n$ = Discount factor for that type of interest and that number of years

To evaluate an investment project from the economic point of view, the criterion of decision of the VAN is that must be: if VAN>0: The project is profitable if VAN = 0: The project is postponed; if they<0: The project is not profitable. In general terms, the VAN represents the gain additional updated that generates the project above the discount rate (Munante, 2000; Romero-Arenas *et al*., 2009).

Internal Rate of Return (IRR): The IRR economic project is the discount rate that makes the updated value of the flow of benefits to equalize the updated value of the flow of costs, i.e., scores are made with different consecutive discount rates until the VAN is close or equal to zero and we obtain a positive NPV and one negative:

$$\sum_{T=1}^{T} B_t(1+r)^{-t} - \sum_{T=1}^{T} C_t(1+r)^{-t_0}$$

Where:

B_t = Benefits in each period the project t
C_t = Costs in each period of the project
$(1r)^{-t}$ = Discount factor
r = Update rate
t = Time in years

To evaluate an investment project from the economic point of view, the criterion of decision of the TIR is that must be: If IRR>discount rate (r): the project is acceptable; if IRR = R: the project is postponed; if IRR<discount rate (r): the project is not acceptable (Munante, 2002; Romero-Arenas *et al*., 2009).

Net investment-benefit ratio (N/K): The relationship benefit/Investment we indicates the net profit generated by the project for each unit of money invested. The data is obtained with the VAN; when you divide the sum of all the benefits between the sum of the costs, i.e., the ratio resulting from dividing the current value of the flow of funds or net incremental benefits in the years after that this stream has become positive (N_t) between the flow of the flow of funds in the first years of the project in that the current is negative (K) to an upgrade fee t previously determined. The formula to obtain the relationship benefit-net investment is:

$$\frac{N}{K} = \sum_{T=1}^{T} N_t(1+r)^{-t} / \sum_{T=1}^{T} C_t(1+r)^{-t}$$

Where:

N_t = Current of the flow of funds in each period, after it has become positive t
C_t = Current of the flow of funds in the initial periods of the project when is negative t
$(1r)^{-t}$ = Discount Factor
r = Update rate
t = Time in years

To evaluate an investment project from the economic point of view, the criterion of decision of N/K is that must be: If N/K>1: the project is acceptable; If N/K = or close to 1: The project is postponed; If N/K<1: The project is not acceptable. The formal criterion of selection, through this indicator is to accept all projects that's N/K are equal to or greater than one to the selected update rate (Munante, 2002; Romero-Arenas *et al*., 2009).

Cost-benefit ratio (B/C): Also, called "index of performance". In a method for the evaluation of projects, which is based on the "present value" and that is to divide the present value of the income between the present value of the expenditure. If this index is >1, it is accepted the project if it is lower than 1, it is not accepted because it means that the profitability of the project is less than the cost of capital. The value of the cost/benefit ratio will change according to the selected update rate or that the higher the rate, the lower the ratio in the resulting index. The formula used is:

$$\frac{B}{C} = \sum_{T=1}^{T} B_t(1+r)^{-t} / \sum_{T=1}^{T} C_t(1+r)^{-t}$$

Where:

B_t = Benefits in each period the project t
C_t = Costs in each period the project t
r = Update rate
t = Time in years
$(1r)^{-t}$ = Discount factor

To evaluate an investment project from the economic point of view, the criterion of decision of the B/C is that must be: if B/C>1; the project is acceptable; if B/C = or close to 1; the project is postponed if B/C<1; the project is not acceptable. In accordance with the formal criterion of selection of investment projects based on this indicator we will accept the project or catalog as profitable if the B/C is greater than one (Munante, 2002; Romero-Arenas *et al*., 2009).

Update rate: For the financial analysis, took a discount rate of 1.28% which represents the real interest rate calculated based on a nominal rate of 5.06% (Cetes) and an inflation of 3.73% per annum (forecast) for 2014 (Anonymous, 2015). Projected income and expenditure for each of the two production systems (conventional and organic) according to the production capacity of each greenhouse of 1,000 m^2. In the conventional system yield obtained was 72,000 kg of tomato saladette during two production cycles (12 months) at a price of $4.96 pesos per kilo and in the organic system yield obtained was 54,000 kg to a sales price of $9.04 pesos per kilo (Anonymous, 2015a, b).

RESULTS AND DISCUSSION

For the case of the production of tomato saladette under greenhouse conditions with system of conventional and organic production, investment costs, fixed, variable and totals are expressed in the following table.

The analysis of the equilibrium point is a method of financial planning which aims at projecting the level of net sales that a company needs to not lose-no win in an economy with price stability to take decisions and achieve objectives (Munante, 2002). The point of balance is calculated mathematically as follows:

$$PE.VV = CFT/[1-(CVT/IT)]$$

Where:

PE.VV = Point of balance in the sales value
PE.VP = Point of balance in the Production Volume
CFT = Sum of Total Fixed Cost
IT = Total Income
UV = Units sold

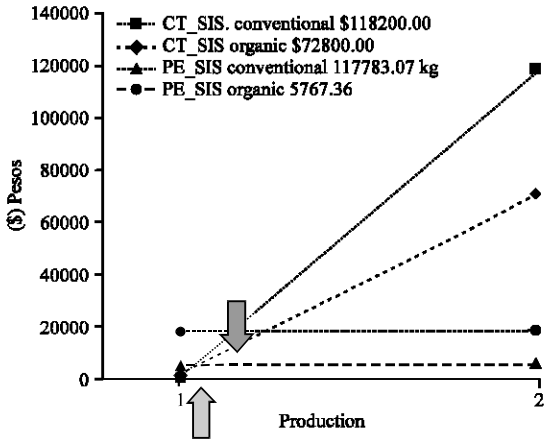

Fig. 1: Point of balance for the conventional production and organic cultivation of tomato under greenhouse conditions in the community of San Bernardino Tepenene, belonging to the municipality of San Juan Tzicatlacoyan, Puebla-Mexico for the year 2015

PE.VV = 88204 pesos, PEVV = 17783.07 kg

The amount of the income needed to achieve the balance point, amounts to $88204.00 pesos obtained by a sale of 17783.07 kg in 1,000 m^2 to a sales price of $4.96 pesos per kg, produced conventionally (Fig. 1):

PE.VV = 51323.07 pesos, PEVV = 5677.36 kg

The amount of the income needed to achieve the balance point, amounts to $51,323.27 pesos obtained by a sale of 5,677.36 kg in 1,000 m^2 to a sales price of $9.04 pesos x kg produced in organic form (Fig. 1).

The investment made by the producers of tomato under greenhouse with a surface area of 1,000 m^2 of both productive systems, conventional and organic of San Bernardino Tepenene was $660,000.00. Production costs were $84,600.00 in the conventional system and $48,800.00 in the organic more administration costs $33,600.00 for the first and $24,000.00 for the second sales revenues, in the conventional were $357,120.00 and $488,160.00 in the organic. For two shekels in a period of 12 months, the projected revenues and expenditures are presented in Table 1. Table 2 projected income and expenditure to 10 years for the conventional and organic production of both systems of tomato under greenhouse conditions in the community of San Bernardino Tepenene belonging to the municipality of San Juan, Puebla-Mexico Tzicatlacoyan,

with a surface area of 1000 m^2 for the year 2015. The method to calculate manually the indicators according to Munante (2002) is the following:

- Multiply the total costs and total revenues by the factor of update (1 0.0128)-T where T is the time in years (Table 3)
- Proceeded to calculate the van and the ratio B/C
- Thereafter, it is estimated the flow of funds which is obtained by subtracting the total benefits total costs year-on-year of the project (Table 4)

Table 1: Costs of production of two systems of tomato under greenhouse of thousand m^2 in San Bernardino Tepenene, Tzicatlacoyan, Puebla-Mexico for the year 2015

	Pesos ($)	
Cost	Conventional management	Organic management
Investment	660000.00	660000.00
Fixed costs	84600.00	48800.00
Variable	33600.00	24000.00
Total	778200.00	732800.00

Table 2: Projected income and expenditure to ten years for the conventional and organic production of both systems of tomato under greenhouse conditions in the community of San Bernardino Tepenene belonging to the municipality of San Juan, Puebla-Mexico Tzicatlacoyan with a surface area of 1000 m^2 for the year 2015

	Produccion			
	Income		Outlays	
Years	Conventional	Organic	Conventional	Organic
1	357120.00	488160.00	660000.00	660000.00
2	357120.00	488160.00	220740.48	171963.92
3	357120.00	488160.00	220740.48	171963.92
4	357120.00	488160.00	220740.48	171963.92
5	357120.00	488160.00	220740.48	171963.92
6	357120.00	488160.00	220740.48	171963.92
7	357120.00	488160.00	220740.48	171963.92
8	357120.00	488160.00	221740.48	172963.92
9	357120.00	488160.00	221740.48	172963.92
10	357120.00	488160.00	221740.48	172963.92

- Once you have obtained the flow of funds, it is updated with the same discount factor (1 0.0128)-T where t is the time in years (Table 4)
- Proceeded to calculate the ratio N/K
- The calculation of the IRR is carried out at the start of the flow of funds to the 4.48% and updated is looking for a rate of upgrade in which the costs are slightly higher than the benefits which must be more than 4.48% proceeded to calculate the flow of funds to 10% (Table 4).

Indicative estimates

Conventional production system:

VAN = 3117110.90-2357415.19 = 759695.72

B/C = 3117110.90/2357415.19 = 1.322

N/K = 1055015.53/299319.81 = 3.52

TIR = 1.28+(10-1.28)

[(759695.72)/(759695.72)-(355710.98)] = 18.80

Organic production system:

VAN = 4260889.50-1979229.54 = 2281659.96

B/C = 4260889.50/1979229.54 = 2.152

N/K = 2071025.02/167550.70 = 12.36

TIR = 1.28+(10-1.28)

[(1903474.31)/(1903474.31)-(1072592.89)] = 22.90

The present research work presents the first study where there is an economic evaluation of production of tomato (*L. esculentum* Mill) variety Saladette in two production systems (conventional and organic) both under greenhouse conditions in the community of San Bernardino Tepenene in accordance with the values

Table 3: Calculation of the van and the ratio B/C for conventional and organic production of both systems of tomato under greenhouse conditions in the community of San Bernardino Tepenene belonging to the municipality of San Juan Tzicatlacoyan, Puebla-Mexico with a surface area of 1,000 m2 for the year 2015

	Total cost ($)					Total cost ($)			
Years	Conventional system	Organic system	Total gross benefits ($) conventional system	Total gross benefits ($) conventional system	Update factor 1.28%	Conventional system	Organic system	Total gorss benefits ($) conventional system	Total gross benefits ($) organic system
1	660000.00	660000.00	357120.00	488160.00	0.98	643525.74	643525.74	348205.93	475975.04
2	220740.48	171963.92	357120.00	488160.00	0.95	209858.21	163486.28	339514.36	464094.23
3	220740.48	171963.92	357120.00	488160.00	0.93	204619.94	159405.50	331039.74	452509.97
4	220740.48	171963.92	357120.00	488160.00	0.90	199512.42	155426.58	322776.66	441214.87
5	220740.48	171963.92	357120.00	488160.00	0.88	194532.39	151546.98	314719.83	430201.71
6	220740.48	171963.92	357120.00	488160.00	0.86	189676.67	147764.21	306864.11	419463.44
7	220740.48	171963.92	357120.00	488160.00	0.84	184942.15	144075.87	299204.48	408993.22
8	221740.48	172963.92	357120.00	488160.00	0.82	181142.72	141296.51	291736.03	398784.34
9	221740.48	172963.92	357120.00	488160.00	0.80	177392.38	138371.14	285696.00	390528.00
10	221740.48	172963.92	357120.00	488160.00	0.78	172212.58	134330.74	277353.76	379124.69
Total						2357415.19	1979229.54	3117110.90	4260889.50

Table 4: Calculation of the relationship N/K and the IRR for both systems of conventional and organic production, under greenhouse conditions in the community of San Bernardino Tepenene belonging to the municipality of San Juan Tzicatlacoyan, Puebla-Mexico with a surface area of 1,000 m^2 for the year 2015

	Flow of funds			Updated flow			Updated flow 10%	
Years	Conventional system	Organic system	Factor 1.28%	Conventional system	Organic system	Factor 10%	Conventional system	Organic system
1	-302880	-171840	0.98	-295319.81	-167550.70	0.91	-268472.56	-152318.82
2	136379.52	267419.52	0.95	129656.15	254236.02	0.83	107153.85	210112.41
3	136379.52	267419.52	0.93	126419.81	247890.03	0.75	94981.07	186243.45
4	136379.52	267419.52	0.90	123264.24	241702.45	0.68	84191.14	165086.03
5	136379.52	267419.52	0.88	120187.44	235669.32	0.62	74626.95	146332.10
6	136379.52	267419.52	0.86	117187.44	229786.78	0.56	66149.26	129708.64
7	136379.52	267419.52	0.84	114262.33	224051.07	0.51	58634.64	114973.62
8	135379.52	266419.52	0.82	110593.31	217641.62	0.47	51978.86	102291.56
9	135379.52	266419.52	0.80	108303.62	213135.62	0.42	45931.31	90390.31
10	135379.52	266419.52	0.78	105141.18	206912.11	0.39	40536.48	79773.58
	Total			759695.71	1903474.31		355710.98	1072592.89

Leal *et al.* (2016)

obtained and applying the indicators of economic evaluation can be interpreted in the following manner.

VAN to the system of conventional production, means that during the life of the project to a discount rate of 1.28% is going to obtain a net profit of $759, 695.72 pesos. In accordance with the formal criterion of selection and evaluation through this indicator, the project is determined as profitable. For the organic production system the VAN means that during the life of the project to a discount rate of 1.28% is going to obtain a net profit of 2.281 659.96 pesos. In accordance with the formal criterion for selection and assessment, through this indicator, the project is determined as very profitable. The fact that the VAN obtained of the produced organically is greater than what has been acquired conventionally is due to a better positioning in terms of purchase price as shown by the SIAP on becoming of this shape to the increased productivity that is achieved in the conventional system with regard to what we achieved in organic form, that goes from a -26 to 33% according to Seufert *et al.* (2012).

The B/C to the system of conventional production expressed that during the life of the project to a discount rate of 1.28%, for every peso invested will be 1.32 pesos of benefit. As the ratio is >1, complies with the criteria for selection and assessment, indicating that the project is viable and profitable. Given that these results are very similar to those obtained by towers and Sanchez-Del (2011), who obtained a B/C of 1.57 in one of their treatments of conventional production of tomato under greenhouse is credited the obtained in this study.

For the organic production system the B/C expresses that during the life of the project to a discount rate of 1.28% for every peso invested will be 2152 pesos of benefit. As the ratio is >1, complies with the criteria for selection and assessment, indicating that the project is viable and profitable with better results than the conventional production system, given that these results agree with what was said by Marquez-Hernandez *et al.* (2008) who reiterated that organic production in the greenhouse increases the cost-benefit ratio, reflected in the increase of organic production on the conventional as marks the IFOAM, who record an annual growth of the market of 10.4 %, from 2012 to date.

For N/K tells us that during the life of the project to a discount rate of 1.28% for every peso invested initially obtained total net benefits of 3.52 pesos in the conventional and 12.36 pesos for the organic. The result of this indicator meets the formal criterion of selection and evaluation to be greater than 1. Given that the outcome of N/K to the conventional system is very similar to that obtained by Garcia *et al.* (2006) who obtained a N/K 3.86 pesos in the production of tomato under greenhouse of the conventional way in the state of Chihuahua, reiterating with this comparison, that N/K in organic production is greater than that obtained by conventional, this because the value of the organic production of tomato can reach trading at a price 5.84 times greater than the conventional (Anonymous, 2005).

The TIR means that during the life of the project to the system of conventional production will recover the investment and you will get a return of 18.8%. This indicator also reflects the maximum interest rate that the project can bear to be viable. By be the TIR greater than the update rate, it is concluded that there is a need to continue with the project, however, the organic production system presents a better profitability 22.9% that the conventional system, this thanks to what was mentioned by Alvajana *et al.* (2004), Marquez and Cano (2005) and Marquez-Hernandez *et al.* (2006). Who claimed an increase in the trend of consumers to prefer food free

of agrochemicals, innocuous and with high nutritional value in particular those which are consumed fresh as the tomato.

CONCLUSION

In the evaluation of the profitability of the production systems of tomato (*L. esculentum* Mill) type Saladette, under greenhouse conditions in the community of San Bernardino Tepenene belonging to the municipality of San Juan Tzicatlacoyan, Puebla-Mexico, it was demonstrated that the same crop under different management of production in this case organic, encourages greater generation of economic benefits to the household production unit (UPF), representing in this way a better utilization of by-products generated by the agricultural activity of the region with the emphasis on greater use of labor resource, generating with this greater self-employment for the rural family.

According to the analysis undertaken, the main variables that demonstrate the benefits of organic production on the conventional are fixed costs and a best quote of value of purchase that the market offers to organic products with regard to those produced from conventional shape in this way it is demonstrated that although the volume of production in the organic system is less than in the conventional economic benefits obtained by the first system are greater.

Fixed costs, variables and the point of balance can be achieved and overcome when handling economies of scale or by the increase in the volume of sales. The organic production system, reaches its equilibrium point with 5,677.36 kg which generates an economic resource of $51,323.27 pesos in the conventional production system the point of equilibrium is reached with 17,783.07 kg which generates an economic resource of $88 204.00 pesos, showing greater profitability in the system with organic management. At the same time dare any production system promotes the social organization and is achieved the development of small family businesses at the rural level.

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