

Analysis of economic sustainability of tomato greenhouses in Almería (Spain)

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Abstract

During the past 40 years, the region of Almería (Spain) has become one of the main world's producer of fruits and vegetables in greenhouses, with a surface area that has stabilized at approximately around 30,000 ha over the last decade. The development of greenhouses has enabled considerable socio-economic progress of the region. However, in recent years, land use and crop productivity are reaching their limits. At the same time, producers are faced with an increase in greenhouse production costs and a decrease in the tomato price. These trends affect the long-term viability of commercial greenhouse tomato production in Almería, as is the case in other regions of the world. Within this economic environment, the present study aims to estimate investment requirements, the annual costs of production and the value of tomato yield. During the 2015/2016 crop season, an economic analysis was carried out on ten greenhouses. Depending on the cultivar of tomato cultivated and the crop management system, the cost of labor ranged from 19,300 to 46,583 € ha⁻¹ i.e., 46% of overall production cost. The input cost (water, energy, fertilizer, seedlings, pesticides and auxiliary insects) ranged from 5,200 to 10,900 € ha⁻¹ (14% of overall production cost). The total variable costs ranged between 41,840 and 77,240 € ha⁻¹, while fixed costs were 4,170-18,450 € ha⁻¹. The construction cost of Almería-type greenhouses was 7-10 € m⁻², increasing to 12.5 € m⁻² for multi-span structures, with a total investment requirement of 156,500-355,150 € ha⁻¹. Annual tomato yields were 7.1-16.0 kg m⁻², with prices of 0.46-1.10 € kg⁻¹, providing annual gross incomes of 62,400-100,000 € ha⁻¹. Taking into account the depreciation costs, most of growers surveyed obtained a negative profit of 0.1-0.2 € kg⁻¹. These results show the urgent need to adopt appropriate measures to guarantee success and economic profitability to farmers, in order to maintain the viability of greenhouse tomato production in southern Spain.

Keywords: economic viability, production costs, profit, yield, horticulture

INTRODUCTION

Tomato crops in the world occupied approximately 3.9 million ha in 2001, with a production of about 105 million t (Naika et al., 2005). The average production of tomato for the period of 2008-12 in the 27 countries of the European Union was 15.8 million t (around 15% of the world production), of which 4.2 million t corresponded to Spain (GTPT, 2014). The area in Spain dedicated to tomato the period of 2008-12 was 53,800 ha (239,300 ha in the EU27), with an average yield of 7.64 kg m⁻², well below the 47.3 kg m⁻² of Belgium and the 47.8 kg m⁻² of the Netherlands. Spanish production data included outdoor cultivation and greenhouses, which are 40% of the surface area cultivated with tomato. In Belgium and the Netherlands, tomato is produced entirely in glasshouses with heating. The prices of the production in origin were 0.63-0.71 € kg⁻¹ in Spain, 0.72 € kg⁻¹ in the Netherlands and 1.06 € kg⁻¹ in Belgium (GTPT, 2014).

The worldwide surface area of greenhouses continues to grow almost exponentially due to its development in emerging countries and, above all, to the increase of this production

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system in southeast Asia. In the 2015/16 season, the surface of greenhouses in Almería increased to 30,007 ha (CAPDR, 2016) of which approximately 40% were used for tomato production.

The levels of production of the different agro-systems are very variable due to the different climatic conditions of each country, the technological levels used, and the inputs of energy and other factors. Thus, the average level of production of tomato in long cycle in Almería was 16.8 kg m⁻², although the farmers with better yields reach 20.9 kg m⁻², in multispan greenhouses with air heating systems, and in some Almería-type greenhouses without heating (Valera et al., 2016). These productive levels are well below the yields obtained in highly technical greenhouses of Northern Europe or America of 55 kg m⁻² of tomato or even of the values that are obtained in greenhouses of China of 20-35 kg m⁻² (Costa et al., 2004).

Production costs are also very variable due to the large differences in the technological levels used in each country. One of the main components of the costs is the amortization of the investment in the structure of the greenhouse and the equipment of fertigation and climatic control. In the 2015/16 agricultural season, the costs of tomato production in greenhouses of Almería (Spain) were estimated through consultations with ten farmers. The main objective of this study was to provide estimates of the investment needs, the annual production costs and the yields of tomatoes greenhouses in Almería. Other objectives of the work were to identify the main factors influencing the production and marketing of greenhouse tomato crops, and to provide producers with data for analyzing the profitability of tomato production.

MATERIALS AND METHODS

Survey data collection

The data of this work correspond to ten exploitations that are representative of the productive system of greenhouses in Almería. Information was obtained on the type of structure, the management of the soil and crop, equipment, and the technological level. In addition, economic data were collected of the various costs and the income of the farmers, in order to characterize production costs, the remuneration from marketable fruits, and the main characteristics of the farms for the 2015/16 agricultural season.

The technical-economic data were collected through a survey through direct interviews with farmers, who provided information on tomato production costs and revenues and cultural production practices and characteristics of the equipment and facilities (Valera et al., 2016). The questionnaire was divided into two main parts. The first focused on the costs of tomato production (inputs required for crop, labor and investment) and the income of farmers (production and price of sale), while the second part collected structural and management data (personal data of the producer, crop management, machinery, soil management, auxiliary infrastructures, irrigation system, greenhouse structure, and climate control systems).

Variable costs

The variable costs associated with the tomato crops were the labor required for agricultural operations (transplantation, weeding, elimination of side shoots, harvesting, packing, etc.) and the costs of materials and services outside the holding related to the production process (seeds, fertilizers, pesticides, auxiliary insects, water, energy, transport, communication, fuels and lubricants, repair and maintenance of greenhouses and agricultural machinery, etc.). Labour costs include wages and benefits received by the hired workers, such as contributions to pension plans and unemployment insurance (Laate, 2013). The costs of production of materials and supplies are figures provided by the participant growers in the study, and in some cases by the cooperative where the farmers buy all the agricultural supplies, increasing the accuracy of the data. Almost all the producers surveyed accurately provided the costs associated with energy consumption in greenhouses as they had monthly electricity and fuel invoices. This section includes the energy required for the operation of all the equipment installed in the greenhouse (fans, pumps, etc.) and machinery engines (Laate,

2013).

Fixed production costs

Fixed costs are those that do not vary with production, such as amortization and maintenance fees for durable goods (greenhouses, irrigation equipment, agricultural machinery and buildings), compensation for intellectual work (expenses of administration and management), taxes and interests of the value of capital and land (Engindeniz and Gül, 2009). The exact amounts of the property and business taxes were included in the financial costs. When the producers did not provide the administrative expenses, they were estimated at 3% of the total gross production (Engindeniz and Gül, 2009). The depreciation or amortisation of equipment has been considered as a fixed cost that represents the loss of value over time of an asset, mainly due to obsolescence (Laate, 2013).

The calculation of the depreciation of installations and equipment has been carried out using the following equation of the linear method (Wachira et al., 2014):

$$D = (p_p - S_v) / N (\text{€ year}^{-1}) \quad (1)$$

where D is the depreciation, p_p is the purchase price, S_v is the remaining value (selling price when it was replaced) and N the years of useful life.

Interest on investment

The cost of the interest of production represents the money to be returned to lending entities (public or private) and can be estimated as the amount paid annually to the bank or calculated by the use of capital invested in the acquisition of the greenhouse, equipment and machinery. These costs may be real interest payments in credits used to finance exploitation operations and physical capital investments, or maybe opportunity costs or a combination of both (Galinato et al., 2012).

Management indicators

The indicators of financial management of the greenhouses show the gross margin, return of the investment and the net profit or return to equity. The economic results were referred to the surface of greenhouse (ha) in order to compare different farms of tomato in greenhouses (Oplanić et al., 2007) and both the costs and the yield refer to the agricultural season 2015/16. The total income was calculated as the product of the marketable yield of the farms and the average price of sale obtained by each producer (some farmers supplied the data of production and the total income). In the economic analysis, profitability is a relative term derived from the earnings, corresponding to the total income minus the total costs. In order to evaluate the profitability of the tomato greenhouses, specific indicators were used, such as the net profit per unit of area and the net profit per unit of production (Testa et al., 2014).

Gross revenue T_R is the total income received by the company before deducting any expenditure. This parameter was calculated from the total production of tomatoes in the crop cycle Y (kg m^{-2}) developed in the reference season (2015/16) and the average sales price of the production p (€ kg^{-1}) indicated by farmers (Testa et al., 2014):

$$T_R = Y \cdot p \cdot 10000 (\text{€ ha}^{-1}) \quad (2)$$

The gross profit or margin G_m was calculated by subtracting the total variable costs T_{VC} from gross revenue (Wachira et al., 2014):

$$G_m = T_R - T_{VC} (\text{€ ha}^{-1}) \quad (3)$$

Although gross margin has been used as an indicator of profitability in many studies (Bayramoglu et al., 2010), it has the weakness of using only the variable costs, not including fixed costs, depreciation and capital interest costs (Sullivan and Greer, 2002).

The return to equity R_E was calculated by subtracting the total costs of tomato production T_C (including current expenses and depreciation) to the gross revenue, but without regard to the interests of invested capital (Laate, 2013):

$$R_E = T_R - T_C (\text{€ ha}^{-1}) \quad (4)$$

The net profit or return to investment N_P was calculated as the value of the gross revenue minus the total production costs T_C and the interest of the invested capital I_C (Wachira et al., 2014):

$$N_P = T_R - T_C - I_C (\text{€ ha}^{-1}) \quad (5)$$

Finally, we have calculated the profit of production as the rate between the net profit and the yield:

$$N_{PK} = N_P / (Y \times 10000) (\text{€ kg}^{-1}) \quad (6)$$

RESULTS AND DISCUSSION

Farms characteristics

The farmers interviewed all belonged to cooperatives that were members of the regulating Council of the “Tomate La Cañada-Níjar” Geographic Indications Protected (IGP). In all cases, the farmers sold their products in only one place, and 90% had been members of their cooperative for more than 10 years. The farms analyzed had an average surface area of 2.0 ha and the farmers have between 1 and 4 greenhouses in their holding. The average size of the greenhouses surveyed was 1.2 ha, and the average greenhouse age was 12 years (Table 1). These similar to the average values of greenhouses in Almeria of 1.05 ha and 12.7 years (Valera et al., 2016).

Most of greenhouses had an “arenado” sand mulch soil, typical of Almería greenhouses (Valera et al., 2016). The cost of construction of the Almeria-type greenhouses which are known locally as “Raspa y amagado”, which comprised 80% of those analyzed, varied between 7.2 and 10 € m⁻² (with an average of 8.6 € m⁻²). The cost of asymmetric greenhouses was similar (8.5 € m⁻²) while the cost of multi-span type was higher, 12.5 € m⁻². Most greenhouses had been constructed with rectangular ground plan, of very variable dimensions, ranging from 100 to 200 m in length, to 40-120 m wide, corresponding to surface areas of 5,500 to 12,960 m².

Greenhouse production costs in tomato greenhouses

In the greenhouses of Almería, the cost of the labor represents 46% of the total costs (Figure 1), varying between 14,900 and 46,583 € ha⁻¹ depending on the type of tomato cultivated and its management. In the Dutch greenhouses, the labor cost is 28%, due to the relative importance of heating expenditure (26% of the total costs). Something similar to Dutch greenhouses, happens with the multispan greenhouses (35%) and glass (25%) of France, despite the absolute value of the labor costs being almost 3 times higher than those of Spain (Molina-Aiz et al., 2016).

Production value

The best income was obtained with cherry tomatoes that have production levels similar to those of round tomatoes on the truss, but have a much higher price (Table 2). Other options that improve the value of round long-life tomato, the most produced in Almeria, are those of furrowed type, which, although its production is inferior, have higher prices than other varieties (Table 2).

Table 1. Average profile of farms surveyed in Almeria during the agricultural season 2015/16.

Growers profile						
Average age	Years of experience	Ownership of the farm		Study level		
51	23	Owner (90%) Tenant (10%)		Basic (50%) - University (20%) Professional Training (30%)		
Characteristic of the crop						
Cycle	Yield (kg m ⁻²)	Crop orientation	Density (plants m ⁻²)	Foliar analysis		Pest control
September May	11.6	North-South (60%)	0.89	100%		Integrated pest control (70%) Biological control (20%)
		East-West (40%)	2 stem plant ⁻¹ (20%)	Grafting 1005		
Soil characteristics						
Type	Disinfection	Fertilizer	Cost (€ m ⁻²)	Dose (kg m ⁻²)	Soil analysis	Humic acids
“Arenado” (90%)	Yearly solarization	Sheep manure (40%) Compost or humus	0.18	0.52	100%	100%
Drip irrigation systems						
Water		Consumption (m ³ ha ⁻¹)	Cost (€ m ⁻³)	Conductivity (dS m ⁻¹)	Fertilizer dosage	
Own well (50%) Irrigation communities (50%)		5600	0.29	3.35	Venturi injectors	
Commercialization						
Point of sale	Associate to cooperative	Years associated	Technical advice	Certification systems		
Cooperative	100%	>10	100%	Global GAP, UNE-155000 and Integrated Production		
Greenhouse structure						
Age	Type	Cost (€ m ⁻²)		Orientation	Surface S _c (m ²)	
12 years	Almería (90%)	8.6 (Almería type)		N-S (70%)	12000	
	Multispan (10%)	12.5 (Multispan)		E-O (30%)		
Cover		Materials		Ridge height (m)	Gutter height (m)	
Thermic three-layer plastic		Galvanised iron supports		4.8 (Almería) 6.0 (Multispan)	3.8 (Almería type) 4.5 (Multispan)	
Ventilation system						
Roof ventilation (RV)	Vents span ⁻¹	Surface ^a S _{RV} /S _c	Side ventilation (SV)	Location	Surface ^a S _{SV} /S _c	Total ^a S _V /S _c
Flap vent (80%) Fixed openings (20%)	Alternate ridges	6.1%	Sliding openings None (Multispan)	All walls	9.7%	15.8%
Protection against insects				Cover whitening		
Double doors	Insect-proof screens	Date		Dose (kg m ⁻²)	Washing method	
100%	10×20 threads cm ⁻² White (90%) Black (10%)	August-February (90%) September-March (10%)		0.017	Natural (10%) Pressured water (30%) Water + Brush (60%)	

^aVentilation surface S_V with respect to the soil surface covered by the greenhouse S_c.

Table 2. Incomes of farmers surveyed in 2015/16 according to the type of long-cycle tomato.

Tomato type	Furrowed tomato	Cherry	Cherry on branch	Kumato	Round on branch
Price (€ kg ⁻¹)	1.09	0.71-0.80	0.75-0.80	0.65	0.46-0.63
Yield (kg m ⁻²)	7.1	10.0-12.0	11.0-12.5	11.0	12.0-16.0
Average income (€ m ⁻²)	7.7	8.3	9.1	7.2	7.7

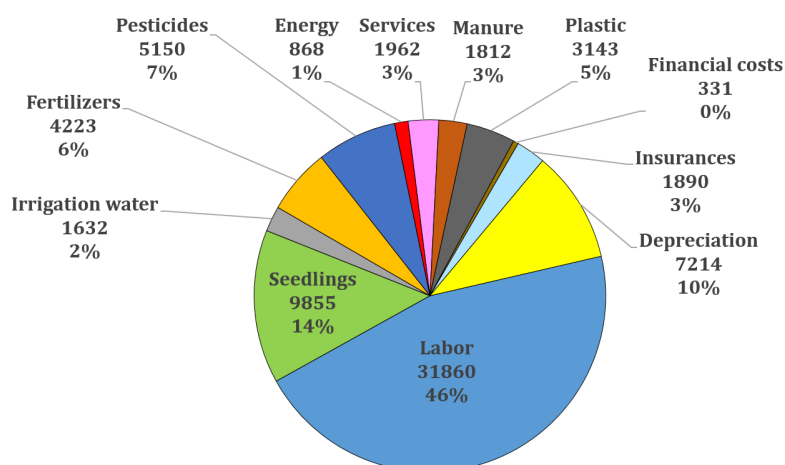


Figure 1. Breakdown of greenhouse tomato production costs (in € ha⁻¹) in Almería in the season 2015/16.

In terms of production costs, those of seeds and seedlings (approximately 14% of total production costs) and phytosanitary treatments (about 7% of the total) were almost double for cherry tomatoes than for the other types of tomatoes (Table 2). The cost of cherry tomato seedlings was 1.39 € m⁻² compared to 0.72 € m⁻², for conventional tomato. Likewise, the expenditure on phytosanitary treatments (including the cost of predatory insects used in the integrated pest control) was 0.78 € m⁻² for cherry tomato and 0.34 € m⁻² for the other types of tomato. Labour costs was also 14% higher for cherry tomatoes. Because of these three sections, the variable costs were 22% higher in cherry tomatoes than for the rest of cultivars. For all types of tomato, there were some growers with negative values of net profit obtained by discounting an interest of 5% of the capital invested in the greenhouse. The average value for the 10 greenhouse analyzed was also negative (Table 3).

As technical measures to improve the profitability of tomato-producing farmers without the need for large investments, we recommended the increase of the available ventilation surface area. We have observed that this factor directly affects the production capacity of tomato greenhouses (Figure 2).

CONCLUSIONS

From the analysis of the data of the 10 surveys carried out for the 2015/16 season in tomato-producing greenhouses in Almería, the following conclusions can be obtained:

- In general, the producers of tomato in the greenhouse do not carry out an exhaustive accounting of the costs that could allow them to evaluate their profitability in the medium and long-term;
- The main factor determinant of the economic profitability of the long-term farms is the sale price of the tomato;
- The greenhouses of Almería presented in the season 2015/16 lower levels of profitability, with an average net margin (difference between revenue and total costs) of 10,406 € ha⁻¹.

Table 3. Average production costs and returns for tomato producing greenhouses of farms surveyed in Almeria during the agricultural season 2015/16.

	(€ ha ⁻¹)	(%)
Variable costs (€ ha ⁻¹)		
Labour	31860	45.6
Inputs	21728	31.1
Seedlings	9855	14.1
Irrigation water	1632	2.3
Fertilizers	4223	6.0
Pesticides	5150	7.4
Energy	868	1.2
Services	1962	2.8
Transport	1751	2.5
Telephone	211	0.3
Total variable costs – T_{VC}	55551	79.5
Fixed costs		
Manure/substrate	1812	2.6
Plastic yearly cost	3143	4.5
Financial costs and taxes	331	0.5
Agricultural insurances	1890	2.7
Total fixed costs – T_{FC}	7143	10.2
Current expenses – T_{CE}	62694	89.7
Purchase price (€ ha ⁻¹)		
Land	108500	
Greenhouse structure	88700	
Irrigation system	13515	
Irrigation pond	7510	
Other investments	10500	
Total investments	228725	
Equipment and Installation depreciation		(%)
Depreciation	7214	10.3
Total costs – T_C	69908	100
Interest cost of the production		
Interest on capital – I _c	11436	
Value of the production		
Yield – Y (kg m ⁻²)	11.3	
Average price – p (€ kg ⁻¹)	0.71	
Gross revenue – T _R (€ ha ⁻²)	80314	
Management indicators		
Gross margin – G _M (€ ha ⁻¹)	24763	
Return to equity – R _E (€ ha ⁻¹)	10406	
Net profit – N _P (€ ha ⁻¹)	-1030	
Profit of production – N _{PK} (€ kg ⁻¹)	-0.009	

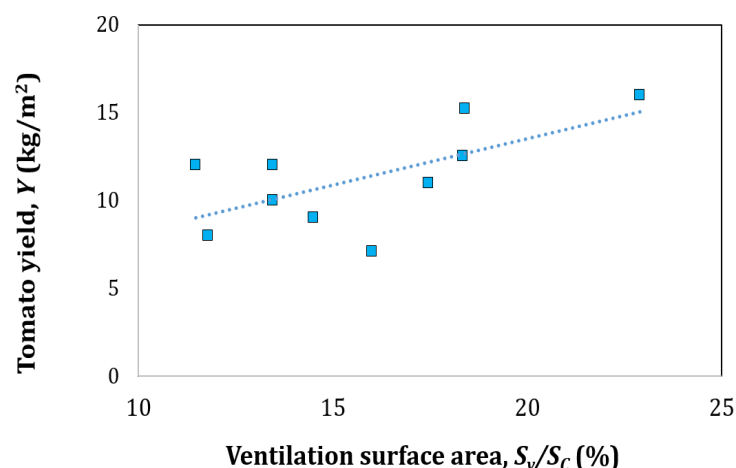


Figure 2. Variation of the tomato production with the maximum ventilation surface area available in the ten greenhouses analyzed in Almería in the season 2015/16. Correlation curve: Y (kg m⁻²) = $0.5259 S_v / S_c$ (%) + 2.9810 ($R^2=0.42$ and p -value=0.044).

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