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The Cost Advantage of Sicilian Wine Farms

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ABSTRACT

This study presents the results of research carried out on a Sicilian wine farm in order to demonstrate the economic convenience of the mechanized harvest. After the determination of the minimum optimal farm size that justifies the introduction of grape harvester in the farm, it has been estimated production cost and the relative profitability of two wine grape cultivars (Chardonnay and Nero d'Avola), comparing three hypotheses of harvest: manual, with farm property grape harvester and with rented grape harvester. The economic analysis shows that the introduction of the grape harvester in the wine farm is justified in large sized farms. However, even in small farms the use of rented grape harvester decreases the harvest costs, increasing profit and achieving a cost advantage for the wine-producer farm.

Keywords: Minimum Optimal Farm Size, Production Cost, Profitability

1. INTRODUCTION

The competitiveness of the farm must be achieved reducing, where possible, the production costs. The achievement of a cost advantage for a farm that operates in a free competition market determines a profitability increase. The competitive advantage represents the result of a strategy that leads the enterprise to occupy and maintain a favorable position in the market in which it operates, obtaining a higher profitability than its competitors. In a market where there are undifferentiated products, the achievement of a level of total unit costs lower than competitors represents the only strategy to realize a competitive advantage. In this way the enterprise may decide to reduce the sales price of its offer to a level which, while remaining over its average cost, is lower than price of competitors. These last unless they are able to quickly reduce their average costs and decrease the sales price, are destined to lose market shares to the advantage of the cost leader enterprise (Fontana and Caroli, 2006).

However, the advantage resulting from the cost leadership does not necessarily manifest itself in the price reduction. Indeed, it is clear that if the cost leader enterprise maintains the price of its product at the average levels of competitors, will benefit from a higher profit margin (Rodriguez *et al*., 2002). This condition has an important effect on the financial structure and investment capacity of the enterprise.

The higher margin allows (on equal terms) on the one hand a higher level of self-financing, on the other hand a greater remuneration of the invested risk capital (Santeramo *et al*., 2012). In the first case the enterprise increases the size of its equity capital and hence, at the same leverage, of stock of debt capital that is able to acquire. In the second case, it creates the suitable conditions for a possible acquisition of new risk capital. In both situations the higher margin of profit deriving from cost leadership is reflected in an increase of the available financial resources.

Considering the difficulties that farms have to be competitive (high production costs, low sales prices of agricultural products, lack of human labor), the mechanization of the harvest could represent a way to achieve a cost leadership and improve profit margin (Barber, 2012). This is valid especially in rural territories where the agriculture is the mainly economic activity and represents the strategic variable of success on which to intervene for the relaunch of the farm competitiveness and local economy (Zhou and Lu, 2012), avoiding phenomena of rural exodus. This is possible for the multifunctional role of farms (Tudisca *et al*., 2013). Among the agricultural products, grapes are particularly adapt to mechanized harvest (Diago *et al*., 2010).

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The grape harvest, in fact, affects in a decisive way on the production costs of the vineyard for the high and concentrated human labor required, representing one of the farming operations on which to intervene in order to achieve the cost leadership. The mechanized grape harvest allows to overcome the disadvantages of the manual harvesting, especially concerning the technical-economic nature, such as timely intervention and grapes harvested with uniform maturity. This allows wine farmers to make an accurate planning of harvesting operations according to the grape variety and the seasonal climatic conditions (Taplin, 2012).

The grape area in the world, according to the latest available data FAO, 2013, in 2011 amounted to 7.1 million hectares, denoting over the last ten years a decline of 4.6%. The European continent, although denoted the largest reduction in relative terms (-15.0%), was the main area of grape cultivation (50.2% of the world areas), followed by Asia (25.6%) and America (13.7%). Taking into consideration other areas of production, unlike the European continent, the rest of the world denoted a general increase in the grape area, ranged between 7.4% (America) and 28.2% (Oceania).

At the country level, Spain in 2011 was the main growing area with one million hectares (14.1% of the grape areas in the world), followed by France (10.8%), Italy (10.2%), China (8.0%), Turkey (6.7%) and USA (5.5%). As regards the grape production, as opposed to areas, in the last ten years increased by 12.3%, reaching a value of 69.6 million tons. The main production area in 2011 was Europe which, with 27.6 million tons, represented 39.6% of world production, followed by Asia (30.5%) and America (21.7%). As observed for the grape areas, Europe represented the only Continent that over the last ten years denoted a decline in the quantities of harvested grapes (-3.8%), while Asia showed the greatest increase in relative terms (+35.9%). This is attributable to the productive expansion of China (+101.0%) which in 2011 became the first producer of grapes in the world (9.2 million tons), constituting 13.2% of the harvested quantities. Italy represented the second producer (10.2% of world production), followed by USA (9.6%), France (9.5%), Spain (8.8%) and Turkey (6.2%).

According the latest available data (ISTAT, 2013), Sicily in 2011, with 106,092 hectares and a production of 700,581 tons, is first Italian Region in terms of wine grape area (16.5% of the national wine grapes area) and the fourth for harvested production (11.6% of the Italian wine grapes production) (**Table 1 and 2**). Over the last decade there has been a decline both in terms of wine grape area (-11.2%) and harvested production (-13,5%).

Table 1. Evolution of Italian wine grape area (ha)

Regions	2002	(%)	2011	(%)
Sicily	119,462	17.2	106,092	16.5
Puglia	106,927	15.4	85,125	13.2
Veneto	67,255	9.7	71,092	11.1
Tuscany	56,104	8.1	57,277	8.9
Piedmont	51,555	7.4	52,556	8.2
Emilia romagna	56,247	8.1	52,027	8.1
Other regions	235,973	34.0	218,742	34.0
Italy	693,523	100.0	642,911	100.0

Source: ISTAT (2013)

Table 2. Evolution of Italian wine grape production (t)

Regions	2002	(%)	2011	(%)
Veneto	918,062	15.1	1,117,336	18.5
Puglia	775,084	12.7	913,450	15.1
Emilia romagna	775,506	12.7	859,233	14.2
Sicily	809,607	13.3	700,581	11.6
Tuscany	328,011	5.4	387,590	6.4
Piedmont	334,60	45.5	384,107	6.4
Other regions	2,153,770	35.3	1,671,928	27.7
Italy	6,094,644	100.0	6,034,225	100.0

Source: ISTAT (2013)

This negative trend is mainly attributable to the grubbing-up premium per hectare granted by the wine Common Market Organization (CMO), which have encouraged many Sicilian and European farmers to uproot their vineyards (CR, 1999; 2009). However, these two regulatory references has also led the Sicilian vineyards, over the years, to an intense process of restructuring and conversion. This process has increased the quality of the wine grapes and the cultivation techniques, obtaining excellent wines that are appreciated all over the world (Tudisca *et al*., 2012). In Sicily there are 10.4% of Italian wine-growing farms (40,629 units), with an average farm size amounting to 0.35 ha (ISTAT, 2012). The distribution of Sicilian productive structures according to wine grape area shows that 41.4% of farms have a size less than one hectare, while those less than 5 hectares account for 85% of the total.

The extreme pulverization of the Sicilian wine farms, which very often is combined with phenomena of farm fragmentation, has a negative impact on the economic performance of the wine enterprises, because it increases the production costs and limits the introduction of technological innovation on the farm.

The majority of these farms confer the grapes directly to the wineries, while less than one hundred (normally medium-large sized farms) transform and bottling their product. In the first case the low grapes prices granted by

wineries do not allow, very often, to remunerate the factors used in the productive process. In the second case a differentiated product, as well as the wine, allows to increase the added value of the farm and the farmer can obtain a high income.

So, in this productive scenario, after the determination of the minimum optimal farm size that justifies the introduction of grape harvester in farm, in order to calculate the economic convenience of mechanized harvest, it has been determined the profitability of the two wine grape varieties cultivated in the farm, comparing three hypotheses of the wine grape harvest: manual, with farm property grape harvester and with rented grape harvester. In this way it has been possible to determine if also the small sized Sicilian wine farms that are placed in the first part of the supply chain and that are price takers (they are subjected to the grapes prices fixed by the wineries), may obtain a cost leadership through the mechanized harvest with a rented grape harvester respect to the manual harvest.

2. MATERIALS AND METHODS

The empirical analysis aimed at determination of cost advantage resulting from mechanization of the grape harvest, it has been carried out considering a wine-producer farm located in the hills of northwestern Sicily with farm property grape harvester. The detected case study is specialized in the wine grapes cultivation, has a farm size equal to 80 ha and sells its product directly to wineries. For research purposes, even if most of the vineyards in Sicily have a modest size, it has been decided to take into consideration this large-sized farm to verify if the investment made by farmer results economically convenient. In fact, the purchase of a machine for grape harvesting involves a cost (with own capital or third party capital) that small farms can not afford according to the modest size of cultivated area.

The wine grape area is evenly distributed between cultivars of Nero d'Avola and Chardonnay. Chardonnay is an international variety that, in recent years, it has spread in the Sicilian viticulture thanks to the interventions of agricultural policy adopted by the public operator. The Nero d'Avola, conversely, is a native Sicilian cultivar that more and more it is cultivated in other wine grape areas (Cravero *et al*., 2012). The planting density is 4,000 vines/ha (2.50×1.00 m) for both varieties and the yield amounts to 120 q/ha for the Nero d'Avola and 80 q/ha for Chardonnay. The farming system is espalier form. The pruning operations are performed manually and the vineyards have a system of drip irrigation. The vineyards have been planted between 2002 and 2005 and farmer has adhered to the restructuring and conversion plan of Sicilian vineyards within the wine CMO. In order to highlight the cost advantage resulting from the introduction of the mechanical grape harvester on the farm, it has been determined the profitability of the two wine grape varieties cultivated in the farm, comparing three hypotheses of the wine grape harvest: manual (Hypothesis A), with farm property grape harvester (Hypothesis B) and with rented grape harvester (Hypothesis C).

2.1. Determination of Grape Harvester Costs and Minimum Optimal Farm Size

For the two hypotheses that provide mechanized harvest (B and C) it has been taken into account a self-propelled grape harvester, of which the main technical and economic characteristics are showed in **Table 3**. This type of machine is utilized by detected case study and it has been purchased with a non-returnable public grant provided by the Sicilian Rural Development Plan (RDP) 2007-2013, equal to 40% of the purchase value. Given a certain area planted with wine grapes, the total unit cost per hectare of grape harvester results from the sum between fixed costs and the variable costs (Fiala and Bacenetti, 2012).

The total unit cost of grape harvester may be written, in general, as follows:

$$TUC = \frac{FC}{ha} + VC \quad (1)$$

Where:
TUC = Total unit cost of grape harvester (euro/ha)
FC = Fixed costs (euro/year)
VC = Variable costs (euro/ha)
ha = Hectares of wine grape area

The total unit cost, therefore, according the Equation 1 diminishes with increasing of the hectares on which the harvest is done.

The fixed costs of the grape harvester are represented by those cost items which does not change at varying of the hours of machine operation and they are: depreciation quota, interests on invested capital, cost of insurance and interests on recovery area.

Table 3. Main technical and economic characteristics of self-propelled grape harvester

Items	Value
Purchase value (€)	170,000
Purchase value net of non-returnable public grant (€)	102,000
Value at the end of economic life (€)	10,200
Economic life (years)	10
Annual hours of operation	250
Recovery area (m^2)	20

Source: Our processing of directly collected data

The depreciation quota of grape harvester (Equation 2) it has been determined through the mathematical process, as the difference between the purchase value net of non-returnable public grant provided by the Sicilian RDP and the residual value attributed at the end of the economic life of the machine, by dividing the value for the economic life of the grape harvester:

$$Q_r = \frac{V_0 - V_n}{n} \quad (2)$$

Where:
Q_r = Reinstatement quota of grape harvester
V_0 = Purchase value net of non-returnable public grant
V_n = Value at the end of economic life
n = Economic life

The interests on invested capital (Equation 3) have been determined by applying a interest rate of 4% to average value of grape harvester, as follows:

$$V_a = \left(\frac{V_0 + V_n}{2}\right) \cdot r \quad (3)$$

Where:
V_a = Average value of grape harvester
V_0 = Purchase value net of non-returnable public grant
V_n = Value at the end of economic life
r = Interest rate

The cost of insurance has been calculated considering the effective monetary outlay incurred during the crop year.

With regard to the interests on recovery area of the grape harvester, have been determined by applying the interest rate of 3% to the reconstruction value of warehouse considering the effective area occupied by machine.

The variable costs, also called marginal costs due to the fact that vary with the hours of the machine operation (or with harvested hectares) include: costs for repair and maintenance, costs for fuel and lubricants, labor for the machine operation and interests on advanced capital for use of the grape harvester.

The repair cost of grape harvester (Equation 4) has been calculated according the following formula:

$$R = \frac{V_0}{h \cdot n} \cdot c_r \quad (4)$$

Where:
R = Hourly repair cost
V_0 = Purchase value net of non-returnable public grant
h = Annual hours of operation
n = Economic life
c_r = Coefficient of repair

The maintenance cost (Equation 5) has been determined according the follow expression:

$$M = C_m \cdot L \quad (5)$$

Where:
M = hourly maintenance cost
C_m = coefficient of maintenance
L = hourly pay of maintenance worker

The fuels and lubricants costs have been calculated by applying the unit consumptions to current prices of 2012/2013 crop year.

For fuel cost (Equation 6) the formula is the following:

$$F = E_p \cdot E_{al} \cdot C_s \cdot P_f \quad (6)$$

Where:
F = Hourly fuel cost
E_p = Engine power (kW)
E_{al} = Engine average load
C_s = Specific consumption
P_f = Fuel price

For lubricant cost (Equation 7) the expression is:

$$L = E_p \cdot E_{al} \cdot C_s \cdot P_l \quad (7)$$

Where:
L = Hourly lubricant cost
E_p = Engine power (kW)
E_{al} = Engine average load
C_s = Specific consumption
P_l = Lubricant price

The labor for the machine operation has been determined by applying the hourly pay provided for the collective employment agreement to the hours of work for a hectare.

The interests on advanced capital for use of the grape harvester have been calculated applying a interest rate of 5% to advanced expenses sustained by the farmer considering a period equal to 6 months.

After determining the grape harvester costs, it has been estimated the minimum optimal farm size that makes convenient the introduction of the machine in the farm.

The judgment of economic convenience it has been determined by comparing the total cost of grape harvester with the respective rental rate (Guerrieri *et al*., 1995). The economic advantage exists when the total unit cost (per hectare) of the grape harvester that has to be introduced in the farm is less or equal than the cost of the rental. The minimum optimal farm size, in terms of hectares, is given by the following formula Equation 8:

$$\frac{FC}{ha} + VC \leq R \quad (8)$$

Where:
FC = Fixed costs (euro/year)
VC = Variable costs (euro/ha)
ha = Hectares of wine grape area
R = Rental rate (euro/ha)

2.2. Determination of Production Costs

For each cultivar the profitability it has been determined by subtracting from the gross production value of grape the related production cost.

The technical-economic data have been collected through a questionnaire by means of direct interviews to farmers, referring both the yield and the cost items to the current prices of the last crop year (2012/2013). The production cost has been divided into explicit costs and calculated ones (Gasol *et al*., 2010; Peris-Moll and Julia-Igual, 2006).

The first ones include costs related to the soil management, fertilization, pesticide treatments, weeding, pruning, elimination and binding of grape shoots, shredding of sarments, irrigation, harvest. Each item of cost includes materials and services coming from outside the farm (fertilizers, fuels and lubricants, pesticides, irrigation water) and its required human labor.

The remuneration of human labor it has been determined by applying to the hours of work for the various farming operations the hourly pay provided for the collective employment agreement. In this way the explicit costs differ only for the grape harvest: in the hypothesis A the harvest contains only the cost of human labor; in the hypothesis B includes the costs of the grape harvester, while in the hypothesis C concerns exclusively the rental rate of grape harvester.

The calculated costs include all cost items which are not directly attributable to the productive process: quotas of reinstatement, maintenance and insurance of durable capital, compensation for intellectual work (direction, administration and surveillance), taxes, interests on advanced capital by farmer during the crop year, farm machines and land value.

3. RESULTS

3.1. Grape Harvester Costs and Minimum Optimal Farm Size

According to data provided to us by farmer, it has been established that the grape harvester taken into consideration is able to harvest a hectare of vineyard in 1.5 h. The total cost of grape harvester, therefore, is resulted equal to 12,082.39 €, of which 11,970.00 € are fixed costs and 112.39 € variable ones (**Table 4**). The higher incidence of fixed costs is given essentially by the depreciation quota that, with 9,180.00 €/year, constituted 76.7% of the total fixed costs, followed by interests on invested capital (18.7%).

Among variable costs the major cost item is represented by repair (73,44 €/ha), followed by labor (18.75 €/ha) and cost of fuel (14.25 €/ha). Together, these three items account for 94.7% of the variable costs per hectare.

Table 4. Costs of self-propelled grape harvester

Costs	Value
Fixed costs (€/year)	
Depreciation quota	9,180.00
Interests on invested capital	2,244.00
Interests on recovery area	96.00
Insurance	450.00
Total	11,970.00
Variable costs (€/ha)	
Repair	73.44
Maintenance	3.00
Fuel	14.25
Lubricant	0.75
Labor	18.75
Interests on advanced capital	2.20
Total	112.39

Source: Our processing of directly collected data

Table 5. Economic results (euro/ha)

	Chardonnay			Nero d'Avola		
Items	Hypothesis A	Hypothesis B	Hypothesis C	Hypothesis A	Hypothesis B	Hypothesis C
Fertilization	223.50	223.50	223.50	191.75	191.75	191.75
Elimination of grape shoots	228.00	228.00	228.00	190.00	190.00	190.00
Shredding of sarments	23.50	23.50	23.50	17.63	17.63	17.63
Binding of grape shoots	142.50	142.50	142.50	161.50	161.50	161.50
Soil management	94.00	94.00	94.00	117.50	117.50	117.50
Weeding	26.75	26.75	26.75	31.75	31.75	31.75
Pesticide treatments	282.25	282.25	282.25	177.00	177.00	177.00
Pruning	522.50	522.50	522.50	408.50	408.50	408.50
Irrigation	87.00	87.00	87.00	71.00	71.00	71.00
Harvest	1,063.00	262.02	400.00	807.00	262.02	400.00
A) Explicit costs	2,693.00	1,892.02	2,030.00	2,173.63	1,628.65	1,766.63
Quotas on durable capital	456.08	456.08	456.08	450.98	450.98	450.98
Intellectual work	160.00	160.00	160.00	180.00	180.00	180.00
Taxes	110.55	110.55	102.96	120.36	120.36	112.76
Interests	362.70	362.70	370.70	360.44	362.70	365.43
B) Calculated costs	1,089.33	1,089.33	1,089.74	1,111.78	1,114.04	1,109.17
C) Production costs (A+B)	3,782.33	2,981.35	3,119.74	3,285.41	2,742.69	2,875.80
D) Gross production value	3,200.00	3,200.00	3,200.00	3,600.00	3,600.00	3,600.00
E) Profit (D-C)	-582.33	218.65	80.26	314.59	857.31	724.20

Source: Our processing of directly collected data

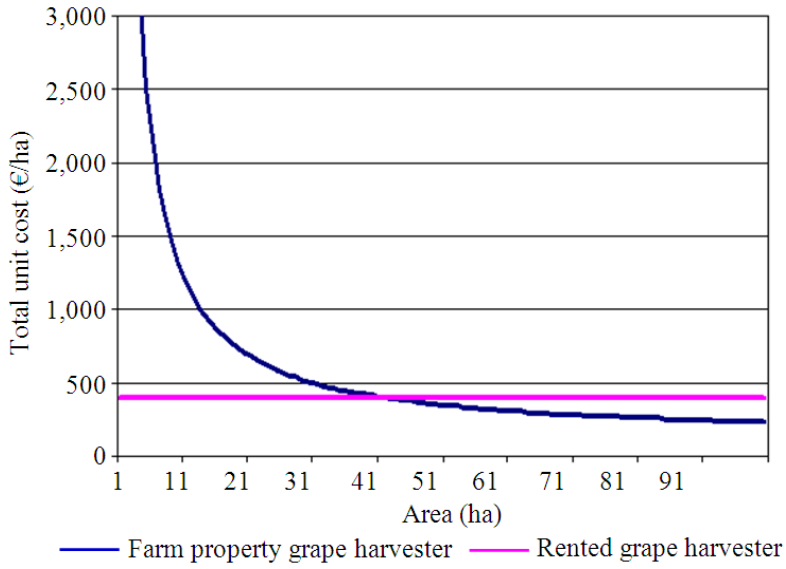

Fig. 1. Determination of minimum optimal farm size

Finally, by dividing the fixed costs for the wine grape area of detected farm (80 ha), in relation to Equration 1, the total unit cost of the grape harvester is equal to 262.02 €/ha. Considering that the rental rate for the 2012/2013 crop year has been equal to 400.00 €/ha, the minimum optimal farm size that justifies from economic point of view the introduction of grape harvester in wine farm, according the Equation 8 is 41.62 ha (**Fig. 1**).

3.2. Productions Costs

The profitability of the two wine grape varieties is showed in **Table 5**.

In the case in which the harvest is done manually (hypothesis A), the production cost of the Chardonnay amounted to 3,782.33 €/ha, of which explicit costs represented 2,693.00 € and calculated ones 1,089.33 €. The first cost item was the harvest that with 1,063.00 €/ha constituted 28.1% of the total production cost, followed by pruning (13.8%) an quotas on durable capital (12.1%). In particular, in this cost item is included the depreciation quota for the planting cost of the vineyard which amounted to 383.58 €/ha. For the Nero d'Avola cultivar the explicit costs for farming operations amounted to 2,173.63 €/ha while the value of calculated costs was equal to 1,111.78 €/ha. So the total production cost amounted to 3,285.41 €/ha. The harvest, also in this case, represented the first cost item (24.6% of the total production cost), followed by the quotas on durable capital (13.7%). The production cost per unit of product, considering a yield of 80 q/ha for the Chardonnay and 120 q/ha for the Nero d'Avola, amounted to 47.28 €/q in the first case and 27.38 €/q in second one. To be able to express an economic judgment on detected wine grape cultivars, it is necessary to quantify their profit. Taken into consideration the current market grape prices of 40.00 €/q for Chardonnay and 30.00 €/q for the Nero d'Avola, the first variety denoted a loss equal to -582.33 €/ha, while the Nero d'Avola showed a profit of 314.59 €/ha.

In the case of harvest with farm property grape harvester (hypothesis B), the total production cost resulted lower than previous hypothesis for both wine grape varieties. In particular, in Chardonnay the production cost decreased from 3,782.33 to 2,981.35 €/ha (-21.2%) and in the case of Nero d'Avola passed from a value of 3,285.41 €/ha to one of 2,742.69 €/ha (-16.5%). In this hypothesis the harvest is no more the main item of the total production cost, becoming the fourth item cost for Chardonnay (8.8% of production cost) and the third for Nero d'Avola (9.6%).

The introduction of the grape harvester in the farm, in fact, decreases the cost of the farming operation of 75.4% in the case of Chardonnay and 67.5% in the case of Nero d'Avola. The reduction of production costs affects the profitability of the two cultivars: Chardonnay passed from a loss to a profit of 218.65 €/ha, while in Nero d'Avola the profit increased up to 857.31 €/ha.

In hypothesis C results showed a decrease in total production costs respectively of 17.5% (Chardonnay) and 12.4% (Nero d'Avola) respect to the manual harvest (hypothesis A). The profitability in this case denoted a value of 80.26 €/ha for Chardonnay and 724.20 €/ha for Nero d'Avola.

4. DISCUSSION

The difference between the total production cost of the two cultivars is attributable to the high labor requirements of Chardonnay respect to Nero d'Avola, especially for harvest, summer pruning and also for pesticide treatments (Mannini, 2004). So economic results showed two different scenarios: (a) for Chardonnay production cost is far higher than sale price granted by the market; (b) for the Nero d'Avola grape price allows to cover the production cost and to achieve a profit margin. The introduction of grape harvester in farm allows to obtain higher profits in both cultivars, reducing the high human labor required for harvest (Dokoozlian, 2013; Sarig, 2012), also when farmers use rented harvester. It is interesting to note, in fact, that in hypothesis B and C the harvest, as well as in previous studies (Chinnici *et al*., 2013; Tudisca *et al*., 2011), is no more the main item of the total production cost. In this way, also small wine farms in Sicily could introduce in their productive process the grape harvester, obtaining a competitive advantage in a international wine market (Clingeleffer, 2013). Finally, it needs to be highlighted that in case in which harvest is carried out with farm property harvester (hypothesis B) profits could assume higher values if wine grape area would be greater than 80 ha (size of case study).

In this case, in fact, the cost per hectare of mechanized harvest decreases with increasing of harvested hectares in consideration that the fixed costs of the grape harvester are spread over a greater number of hectares (Messori, 2007).

5. CONCLUSION

Among the various choices, the entrepreneur makes those which allow him to achieve the maximum profit. Considering the difficulties that farms have to be competitive (high production costs, low grapes prices, lack of human labor), the mechanization of the harvest represents a way to achieve a cost leadership and improve profit margin.

The economic analysis carried out in this study has showed how the wine farmers could improve their profit by adopting the mechanized harvest both with farm property or rented grape harvester. In fact, despite the minimum optimal farm size to introduce the grape harvester in the farm is 41.62 hectares, justifying the investment in wine-producer farms with large size, the results of the analysis have highlighted that also for

small-sized vineyards, it is convenient to harvest with a rented grape harvester respect to the manual harvest.

The diffusion of mechanized harvest in next years, could reduce the rental rate, with positive effects on the economic performances of small and medium-sized wine farms which decide to mechanize the harvest.

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