

COOPERATIVE STRATEGIES AND VALUE CREATION IN SUSTAINABLE FOOD SUPPLY CHAIN

**Proceedings of the 54th
SIDEA Conference - 25th
SIEA Conference
Bisceglie/Trani,
September 13th - 16th 2017**

**a cura di
Francesco Contò
Mariantonietta Fiore
Piermichele La Sala
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SUSTAINABILITY OF PRECISION VITICULTURE: AN ECONOMIC ASSESSMENT OF THE ADOPTION OF UAV TECHNOLOGY IN VINEYARD MANAGEMENT

by *Ruggiero Sardaro**, *Vincenzo Fucilli***,
*Bernardo de Gennaro***, *Francesco Bozzo*** and *Luigi Roselli***

1. Introduction

Precision viticulture is an innovative approach aimed to support the management of vineyards, raising the efficiency and quality of production and reducing the environmental impact (Whelan and McBratney, 2000; Rouse et al., 1973).

Over the last years, precision viticulture is implementing improved instruments and methodologies for remote monitoring and data acquisition and analysis, such as Unmanned Aerial Vehicles (UAV) (Matese e Di Gennaro, 2015). This approach enables the optimization of Decision Support System (DSS) through the production of prescription maps for variable-rate applications and allowing the implementation of rapid and specific intervention strategies.

The aim of this study is to assess the economic sustainability of the UAV technology on the wine-growing sector of Apulia.

2. Materials and Methods

2.1. *Experimental site and remote sensing analysis*

The study was implemented on a 4.5-hectare wine farm located in the territory of Cerignola, province of Foggia, Apulia, Italy. The vineyard was based on a 9-year espalier plant of Uva di Troia (*Vitis Vinifera* L.) vines. The farm was managed by the ordinary wine growing practices of the area,

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based on deficit irrigation, winter fertilization and weekly pest control. Pruning and harvesting were manual, while tillage was mechanized. The experimental design of this study was based on the two adjacent land plots of the same area, which were respectively managed with and without the UAV technology. Three indices were used in this study: the Normalized Difference Vegetation Index (NDVI) (Rouse, 1972), the Soil-Adjusted Vegetation Index (SAVI) (Huete, 1988), and the enhanced NDVI (ENDVI).

2.2. Economic analysis

The economic analysis focused on two main issues: i) the assessment of the potential economic impact of the UAV technology on vineyard management practices; ii) the estimation of the minimum farming area for an efficient adoption of the UAV technology. The economic impact of this innovation was assessed through a budget analysis and the net margin index, this last equal to revenues minus total management costs, defined as specific costs (fertilizers, pesticides, irrigation water) and other non-specific operating costs (upkeep of machinery, energy, contract work, etc.) (De Gennaro et al., 2012; Sardaro et al., 2017).

The budget analysis was based on the following assumptions:

- management costs were assessed considering the current hourly wage of workers for the manual operations and current tariffs charged by agricultural service providers for the mechanical operations;
- revenues included the selling of grapes, but excluded the direct CAP aids;
- revenues were calculated considering the same price of production.

The budget analysis compared the annual net margin between the “ordinary management scenario” (OMS) and the “innovative management scenario” (IMS).

The estimation of the minimum farming area for the adoption of the UAV technology was based on Cash Flow Analysis and the OMS and IMS scenarios were compared through Net Present Value (NPV). To this aim, the following assumptions were defined:

- UAV technology could be used by wine growers of the area through a cooperative management approach, and projections were carried out varying the vineyard size (i.e. the number of farmers involved);
- costs’ and revenues’ flows were set constant and equal to the average values from the budget analysis of the two scenarios (excluding the UAV costs);

- costs of UAV use by farms were estimated considering instrumental and maintenance costs, as well as operative costs for the phases of acquisition, georeferencing, orthorectification and image processing, calculated as man-hour cost;
- technical lifespan of UAV technology was set equal to 7 years;
- discount rate was initially set equal to 5% (r5), and then to 2% (r2) and 8% (r8) in order to assess the sensitivity of results.

3. Results

The results (Table 1) highlighted that the UAV technology may have a very high potential impact on economic sustainability of wine growing sector. In details, this innovative management system allowed a significant reduction of vineyard management costs (-16%), a slight increase of yields (+8%) and revenues (+8%) and a sensible raising of net margin (+34%). In particular, the implementation of the innovative technology allowed the reduction of costs related to fertilization (-22%), irrigation (-65%), and weed and pest control (-31%). On the contrary, the higher yield caused an increase in the harvesting (+12%) and transportation (+8%) phases.

Supposing an on farm use of such a technology, the costs in the table 2 were collected through a market survey.

Tab. 1 – Economic comparison of the two scenarios.

Management practices	OMS			IMS			Aver. diff. (%)
	2014	2015	Aver.	2014	2015	Aver.	
Soil tillage	443.42	447.67	445.54	446.42	448.47	447.45	+0.4
Hoeing	171.00	171.00	171.00	171.00	171.00	171.00	0.0
Fertilization	131.24	138.10	134.67	102.78	105.93	104.35	-22.5
Irrigation	583.63	617.35	600.49	210.48	213.71	212.10	-64.7
Weed and pest control	599.95	621.93	610.94	414.65	433.65	424.15	-30.6
Green pruning	171.00	171.00	171.00	171.00	171.00	171.00	0.0
Pruning	342.00	342.00	342.00	342.00	342.00	342.00	0.0
Harvesting and transport	788.56	791.75	790.16	874.60	876.26	875.43	+10.79
Total management costs (€/ha)	3,230.79	3,300.80	3,265.80	2,732.93	2,762.02	2,747.48	-15.9
Grapes production (ton/ha)	15.70	16.60	16.15	16.80	18.10	17.45	+8.0
Price (€/ton)	383.60	388.70	386.15	383.60	388.70	386.15	0.0
Revenues (€/ha)	6,022.52	6,452.42	6,237.47	6,444.48	7,035.47	6,739.98	+8.1
Net Margin (€/ha)	2,791.73	3,151.62	2,971.68	3,711.55	4,273.45	3,992.50	+34.40

Tab. 2 – Costs of the UAV technology.

Items	Amount
Instrumental costs (UAV + Camera + Personal computer + software + patent) + administrative costs	€ 14,500.00
Maintenance costs (UAV + insurance + hardware + processing software)	€ 750.00
Operating costs (power, rent, taxes)	€ 1,000.00
Specialized operator costs (acquisition, georeferencing, orthorectification and image processing)*	€ 16,800.00
Restoration costs	€ 2,115.00
Total costs	€ 37,465.00

* Equal to six months' (April - September) wage for one specialized operator.

Given the small average area of the wine farms in the considered territory (2.4 hectares – Istat, 2010), and assuming a cooperative management of this technology among farmers, the trend of NPV for adoption of UAV technology is heavily affected by vineyard size (figure 1).

The estimated minimum farming area was equal to 36.7 hectares (figure 2), i.e. the minimum threshold for which the UAV costs per hectare equalled the gain in net margin per hectare, switching from the OMS to the IMS.

Fig. 1 – Net Present Value of the UAV technology

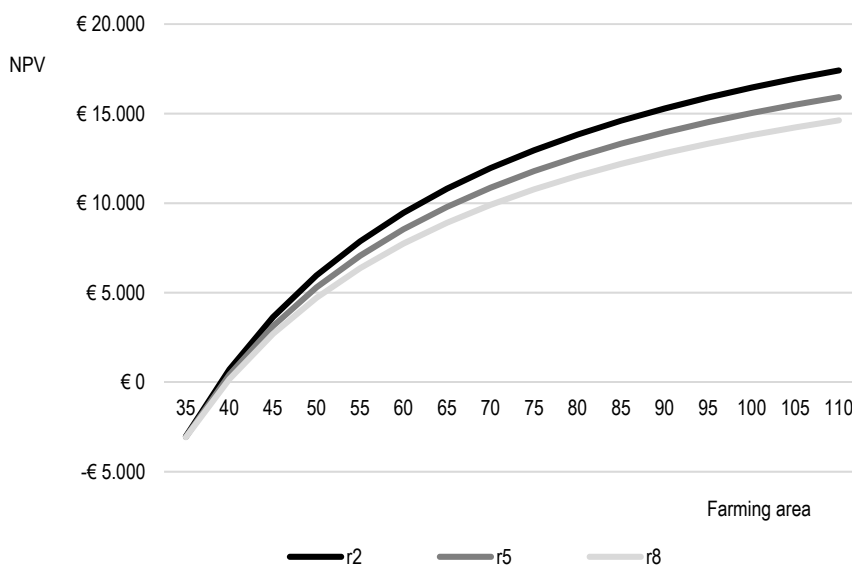
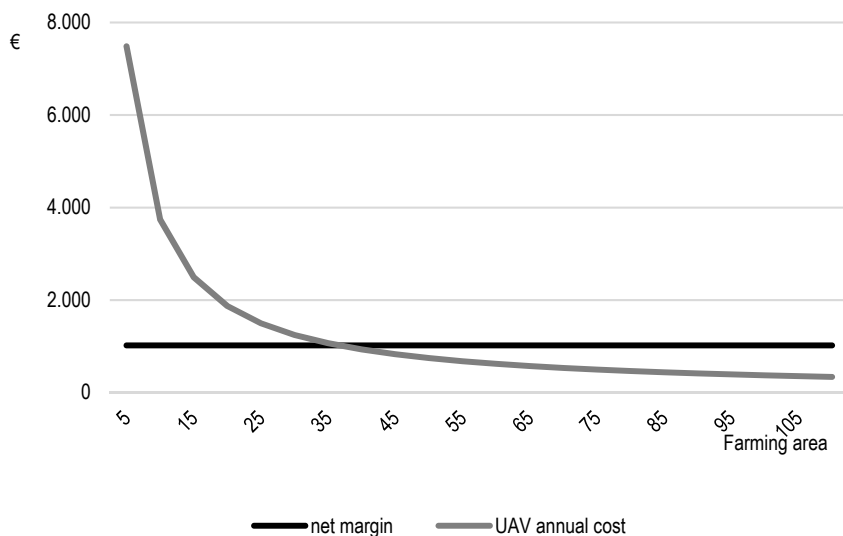


Fig. 2 – Minimum farming area for the UAV technology.



4. Conclusions

The results of this study pointed out that the use of UAV technology in the wine growing of the northern Apulia was profitable only for large vineyards, i.e. higher than 40 hectares. In this regional area, due to the high fragmentation of farms, the reliable adoption of this innovation maybe fostered only if cooperative solution is promoted. This strategy could represent a source of added value and a strategic development tool for territories, fostering social cohesion, economic development, environmental protection and territorial identity. Cooperation in wine growing could favour the definition of new horizons of development and the building of new organizational models in the sector, according to a sustainable approach referred to the totality of farmers.

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This book contains the proceedings of the LIV Conference SIDEA and the XXV Convention SIEA, which were organized by the Department of Economics of the University of Foggia, for the first time, with the formula of a joint Conference titled “Cooperative strategies and value creation in sustainable food supply chain”, held in Bisceglie-Trani, from September 13th to 16th, 2017.

Cooperation in all its forms represents a valuable paradigm to define new horizons of development and build new organizational models of value creation according to a sustainable approach not referred to a single unit, but to the entire supply chain. Consequently, research perspectives affect the value added distribution issues along the value chain, the agricultural supply regulation, the social responsibility, the ability to offer a higher degree of food safety, and the promotion of organizational and social innovation.

Nevertheless, these concepts, which are valid in themselves, risk being infected by an exasperating interpretation of the current productivist logic and, thus, lose sight of the same value of those cooperative strategies and of the logic of fair distribution of the value, generated within the agri-food supply chains, and that this conference has debated.

Compared to all this, Italian agricultural economists wanted to reflect on how to bring the issue of cooperation back to the centre of economic logic and the governance of agri-food supply chains, also in relation to the use of environmental factors, which must be increasingly aimed at respecting the principles and values of the circular economy.

In this framework, the thematic areas, in which the First Joint SIDEA-SIEA Conference were structured, have allowed us to investigate the issue in all its aspects, starting from the analysis of the main production and consumption models, up to organizational models, forms of territorial, sectoral and environmental cooperation, and policies with which to add value to the supply chain.

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