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Tropical Fruits as an Opportunity for Sustainable Development in Rural Areas: The Case of Mango in Small-Sized Sicilian Farms

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Abstract: Over the last decades, in many rural areas in Southern Europe, farmers have abandoned agricultural activity, especially on small-sized farms, leading to an exodus from rural areas towards urbanized ones. In this context, in the early 1980s, some Sicilian farmers introduced mango on their small-sized farms, as certain areas of Sicily are well suited to tropical and subtropical crops, but also to meet increasing consumer interest for these fruits, as they are perceived as functional foods. This paper aimed to evaluate the economic sustainability of mango and to determine whether its introduction could be considered as an alternative to traditional crops. In particular, an economic-financial analysis of mango orchards on small-sized Sicilian farms was performed by adopting a discounted cash flow approach. In order to provide as comprehensive information as possible, mango was compared with two traditional crops that have always played an important socio-economic role in Southern Italy: wine grape and orange. Results showed a clear economic convenience for mango orchards, denoting an annual gross margin of 14,617.03 €/ha, on average 20 times higher than orange orchards and just less than 40 times higher in respect to vineyards. The higher profitability of mango was also confirmed without considering public grants for the planting phase, and by varying current sales prices and costs. However, it should be considered that the cultivation of mango could represent an opportunity for sustainable development only for certain Sicilian areas, as it is closely related to favorable pedo-climatic conditions.

Keywords: discounted cash flow; economic sustainability; *Mangifera indica*; sensitivity analysis

1. Introduction

The most widely used definition of the term "sustainable development" is by the United Nations World Commission on Environment and Development (WCED) in 1987, according to which it is "development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs" [1] (p. 43). Recently, the Europe 2020 Strategy, launched at the European level, set economic growth based on the coexistence of both competitiveness and sustainable development as an objective [2]. Sustainable development is an essential prerequisite for the development of rural areas, and consists of three fundamental and inseparable dimensions that are "integrated" and "interlinked": the environmental, economic, and social dimensions, better known as the "3Es" of sustainable development [3,4]. In other words, sustainable development is not only linked to an economic point of view, but it should lead to an increase in the quality of the environment and/or social equity [5].

In rural areas, where agriculture is the main economic activity, the re-launch of the primary sector plays a key role in the sustainable development of entire territories, avoiding the phenomenon of rural exodus [6]. In fact, agricultural activity, thanks to its multifunctional role, has always contributed to the creation of rural landscapes, provided a range of benefits that are vital to human well-being, maintained farmers in areas that are otherwise exposed to degradation, and determined and preserved social values [7–9].

In Sothern European countries, agricultural activity is characterized by the presence of arable crops, olive groves, citrus trees, and vineyards, which are integral parts of rural landscapes [10]. These crops, in addition to generating income for many farmers, as well as providing a positive social impact by granting employment, have an irreplaceable role in environmental protection, both safeguarding the agricultural ecosystem and preserving the landscape [11]. However, over the last decades in many rural areas, farmers have abandoned agricultural activity, especially on small-sized farms, leading to an exodus from rural areas towards urbanized ones. This is due on the one hand to low sale prices, an inability to confer added value to agricultural products, and lack of marketing strategies, and on the other hand to the increase in production costs, reducing farmers' profit with the inevitable effect of agricultural abandonment [12]. In particular, in Sicily, the largest Italian region, during the last two decades (1990–2010), a decline both in terms of farms (−44.1%) and utilized agricultural area (−13.2%) has been registered [13]. According to the latest Agricultural Census, Sicilian farms in 2010 accounted for 219,677 units, 94.3% of them managed directly by the farmer's family, and 53.7% of productive structures had a size less than two hectares, highlighting a very important incidence of small-sized farms for primary sector. The extreme pulverization of Sicilian farms, in fact, has a negative impact on the economic performance of the enterprises, because it increases the production costs per unit and limits the introduction of technological innovation on the farm, as showed in other studies [14]. Furthermore, the majority of these farms deliver products directly to local wholesalers, obtaining a low sales price that does not often allow farmers to remunerate the factors used in the productive process [15]. This scenario determined that in 2010 just under half of Sicilian farms (49.4% of units) had a gross production value less than 4000 €/year [13]. Finally, considering the period after the Agricultural Census (2011–2015), the latest available data [16] denoted a reduction in the average net income of Sicilian farms, decreasing from 18,583 to 16,414 €, as current costs increased (+13.3%) more significantly than annual revenues (+8.8%). In this context, instead of abandoning agricultural activity, in the early 1980s some Sicilian farmers introduced mango cultivation on their small-sized farms, considering that some areas of Sicily are well suited to tropical and subtropical crops.

According to the latest available data [17], in 2014, mango (*Mangifera indica* L.) was the most important tropical fruit in terms of cultivated areas (27.9%), and the second for harvested production (18.0%) after bananas. In particular, mango cultivation in the world amounted to 5.7 million hectares with a production equal to 45.8 million tons, and it is grown in more than 110 countries located in tropical and subtropical regions. Over one thousand mango fruit varieties are available worldwide, although only a few are produced on a commercial scale. India was the largest producer of mango (18.4 million tons), followed by China (4.7 million tons), Thailand (3.6 million tons), and Indonesia (2.4 million tons). Over a period of ten years (2004–2014), mango denoted an increase both in terms of cultivated areas (+36.0%) and harvested production (+53.0%), being grown in new producer countries [18]. Though mango is a tropical tree nowadays, it is cultivated from Australia to Spain, especially in regions at sea level up to 600 m in altitude, in a wide range of frost-free climates, even if the congenial temperature range favorable for mango cultivation during growing season is 24–30 °C [19]. The main reason for this expansion is due to increasing consumer interest in tropical fruits, both in fresh and processed forms, that are perceived as nutritious, healthy, good in taste, attractive, and special [20,21]. Several studies, in fact, established the positive effects of tropical fruits for human health, especially for their anti-obesogenic, anti-inflammatory, anti-carcinogenic, and anti-diabetic potential [22,23]. In particular, mango plants produce fleshy stone fruits rich in phytochemicals with an undisputed nutritional value for its high content of polyphenolics and vitamins. This makes mango a fruit that should be included in everyone's diet for its multifaceted biochemical actions and health-enhancing properties [24]. Therefore, consumers attributed an added value to tropical fruits, perceiving them as functional foods, and consequently, increased their willingness to pay for these products [25,26]. In this way, mango cultivation allows many farmers to obtain economic sustainability, granting human permanence in farms and sustainable development of rural territories.

According to the latest estimates, today in Sicily there are about 55 hectares of mango orchards present along coastal areas [27], in well-draining soils, and where the average temperature is at least higher than 10 °C eight months a year, and the average temperature during the coldest months is not less than 6 °C. Of fundamental importance for the success of mango cultivation in Sicily are windbreaks around plant and farm borders (i.e., cypress), providing shelter or protection from the wind. Currently, several varieties of mango (Kensington Pride, Keitt, Glenn, Maya, and Tommy Atkins), whose fruits weigh from 150 g to around 750 g, are cultivated in Sicily [28].

Therefore, given that some Sicilian environments are well adapted to tropical and subtropical crops, this paper aimed to evaluate the economic sustainability of mango cultivation in Sicily, and whether its introduction could be considered an alternative to traditional crops in certain agricultural areas. In particular, since economics is one of the fundamental aspects of determining the sustainable development of a rural territory, an economic–financial analysis of mango orchards in farms located on the Northwest Sicilian coast was performed by adopting the discounted cash flow (DCF) approach. In order to provide as comprehensive information as possible, mango was compared with two traditional crops that have always played an important socio-economic role in Sicily: wine grape (the widespread crop) and orange (the most similar crop from an agronomic point of view). The choice to estimate the economic sustainability of mango orchards was due to the fact that profitability is the most important factor for the adoption of a crop for a farmer, and because it is also a fundamental prerequisite to evaluate how agricultural activity can incentivize the sustainable development of an entire rural territory. Moreover, in order to determine how much the European Union's (EU) agricultural policy affects farmer's revenues of surveyed crops, every financial indicator determined by DCF approach, without considering public grants for planting phases according to Measure 121 of the 2007/2013 Sicilian Rural Development Plan (RDP), have been recalculated. Finally, a sensitivity analysis showed if variations in sales price and costs could determine significant impacts on economic sustainability of crops.

2. Materials and Methods

2.1. Farm Sample and Data Collection

Considering that the collected data in this research responded mainly to economic purposes rather than probabilistic and statistical others [29], we have chosen to analyze a representative sample of four Sicilian farms located on the Northwest Sicilian coast, among the municipalities of Terrasini, Balestrate, and Trappeto, in Palermo Province. In our sample, the selected farms were representative of Sicilian farms cultivating mango, only in terms of average size (equal to 1.5 hectares), and in terms of utilized agricultural area (UAA), since in the four farms, the overall UAA cultivated with mango was about six hectares, corresponding to 10.9% of the total Sicilian mango UAA [27].

The study was conducted in 2017, and in order to estimate the economic sustainability of mango, we analyzed the four mango orchards and compared them with four vineyards and four orange orchards. The choice to compare mango orchards with these two traditional crops was due to the fact that wine grape represents the most widespread crop in this area and orange is the most similar crop from an agronomic point of view. In fact, in this area, even though wine grape and orange have always played an important socio-economic role, in the last two decades, an ever increasing number of farmers have decided to replace them with this tropical fruit because of the favorable pedo-climatic conditions, instead of abandoning agricultural activity due to the unsatisfactory profits of traditional crops. As regards traditional crops, the sampled farms were selected for their ordinary agronomic and economic management, but also for the availability of historic data. Moreover, the characteristics taken into consideration in the selection of the sample units for traditional crops were those most frequently observed in Sicilian farms with poliannual crops, according to the most recent Italian Agricultural Census data: small farm size (39.1% of them ranged from one to four ha); farm managed directly by farmer's family, which is also the owner of land; and local sales modality (mainly to wholesalers). Since among surveyed farms a low variability in terms of farming operations and sales modality have been detected, for each crop we referred to the average of the technical-economic data collected by farms.

Technical-economic data were collected by means of direct interviews with farmers, as well as in other studies [30,31]. In particular, the questionnaire included several questions, divided into two main parts. The first gathered structural data (i.e., farm size, farm investments), while the second part focused on the production process (i.e., farming operations, inputs required for crop growing, human labor) and farmers' revenues (i.e., yield, sales price).

With regard to vineyards, surveyed farms ranged from 1.80 to 3.50 hectares. The detected wine grape cultivars were Grillo and Cataratto (Sicilian autochthonous varieties), and the average planting density was equal to 4000 plants/ha (2.50 × 1.00 m). In all detected vineyards, the espalier farming system for mechanized harvest was utilized, a sub-irrigation system was detected, and the planting year ranged from 2009 to 2013. Considering that the economic life of a vineyard is 20 years, during the maturity phase (from the 3rd to 17th year), the average yield was 12.0 tons/ha a year, while in the increasing production phase (2nd year) and in the decreasing one (from the 18th to 20th year), the yield was estimated to be 60% and 80% of the maturity phase, respectively. All detected farms produced wine grapes according to the production disciplinary of "Alcamo" Controlled Designation of Origin (CDO), and conferred their product to local cooperative wine cellars. The average wine-grape market price was equal to 380.00 €/ton.

For orange farms, they covered an area ranging from 1.50 to 2.30 hectares, Washington Navel was the cultivar detected in all cases, and the bitter orange was the used rootstock. The average planting density was equal to 625 plants/ha (4.00 × 4.00 m), and the orange orchards registered a planting year ranging from 1996 to 2011. During the production cycle of orange orchards (equal to 50 years), four phases can be distinguished: (a) planting phase, from the first to the fifth year, in which plants are still developing and revenue does not exceed costs; (b) increasing production phase, from the sixth to the ninth year, in which revenue exceeds costs as plants continue to grow; (c) maturity phase, from the tenth to the forty-second year, in which plant growth is complete, guaranteeing a constant yearly production throughout the period; and (d) decreasing-production phase, from the forty-third to the fiftieth year, in which average yield decreases. Therefore, the annual average yield of detected orange orchards was: 30.0 tons/ha in the maturity phase, 12.0 tons/ha in the 4th and 5th years (40% of maturity phase), 21.0 tons/ha from the 6th to 9th year (70%), and 24.0 tons/ha from the 43rd to 50th year (80%). In all orange orchards the farming system was the globular tree form that favors the production of drooping branches, and sprinkler irrigation was utilized. Regarding product commercialization, farmers sold oranges directly to local fruit and vegetable wholesalers and the average market price was equal to 320.00 €/ton.

The detected mango farms had an area between 2.30 and 3.80 hectares, of which about 60% was cultivated with tropical fruit, while in the remaining parts were olive trees and vegetables. Plants had a planting year ranging from 2000 to 2015, and were introduced in farms instead of wine grape and orange. The average planting density was equal to 666 plants/ha (3.00 × 5.00 m) and the predominant detected cultivar was Kensington Pride. In all farms, plants in the maturity phase had a pyramid-shaped tree crown with a maximum height of 2.50 m, and sprinkler irrigation was utilized. The production cycle of mango (equal to 30 years), similarly to orange one, it can be distinguished in four phases: (a) planting phase (from the 1st to the 3rd year), in which there is no production; (b) increasing production phase (from the 4th to the 9th year), with a yield equal to 6.66 tons/ha (4th and 5th years), 8.00 tons/ha (6th and 7th years), and 10.0 tons/ha (8th and 9th years; (c) maturity phase (from the 10th to the 25th year), with an annual average yield of 13.32 tons/ha; (d) decreasing production phase (from the 26th to the 30th year), with an average yield equal to 11.98 tons/ha. Farmers delivered mangos to local Pakistani and Indian traders, with an average market price (farm to gate) equal to 2400.00 €/ton. The fruit was then resold fruits in fruit and vegetable shops in Palermo to their compatriots, as Sicilian consumers are becoming an increasingly large market share. The high sales price of mango, compared to other traditional crops, was due essentially to its low sales volume and to the high consumer demand for this tropical fruit. The same is also true for the price of imported mango. In fact, according to data from the wholesale agri-food market in Sicily [32], the average price in 2018 is about 3800 €/ton on the local market, while on the global market, according to the latest available FAO data, the average price in 2016 was around 2300 €/ton [17]. It is worth noting that the average market price (farm to gate) of the surveyed farms is slightly more expensive because farmers reduced the supply chain, as they sold fruits directly to local traders (not to wholesalers), allowing farmers to have a higher contractual power during price negotiations.

2.2. Financial Analysis

In order to determine the economic sustainability of surveyed crops, a financial analysis was carried out by means of a DCF approach [33,34]. This is a financial technique used to assess the effects of a project, program or investment, verifying whether or not an investor can obtain a benefit from its realization [35]. In particular, the methodology to determine the economic sustainability of surveyed crops can be divided in three different steps.

Firstly, financial analysis was carried out by determining the net present value (NPV), the internal rate of return (IRR), the discounted benefit-cost rate (DBCR), and the discounted pay-back time (DPBT) for each surveyed crop.

Net present value is the main criterion for assessing the suitability of any investment program, and according to this financial indicator, an investment will be convenient for the farmer if the NPV is greater than zero and, given two investment options, the more convenient one has the greater NPV value. Net present value is represented by the difference between discounted annual revenues (benefits) and discounted annual costs, and was calculated applying the following formula [36]:

$$NPV = \sum_{k=0}^{n} \frac{R_k - C_k}{(1+r)^k} \quad (1)$$

where NPV is the net present value; R_k represents the annual discounted revenues; C_k is the annual discounted costs; k is the time of the cash flow; n corresponds to the duration of the investment, and r is the discount rate, and it was assumed equal to 5%, equal to Weighted Average Cost of Capital (WAAC). The WACC takes into account the cost of all sources of capital, whether they are equity capital or debt. The choice of a particular interest rate, in fact, depends on the current market conditions and on the nature, duration, and risk of the investment [37]. The discounted annual revenues included the gross production value of the crop during the productive cycle of each crop (i.e., increasing, maturity, and decreasing phase). In this paper, the Single Payment Scheme (SPS) granted under Council Regulation (EC) No. 1307/2013, and the community integration provisions on common market organization for agricultural products under Council Regulation (EC) No. 1308/2013, in view of the fact that they are independent of the typology of surveyed crops, were not taken into consideration. Among discounted annual costs of crops, direct costs (all monetary costs required for productive cycle without taxes), and the planting cost were calculated. In particular, planting cost was determined by considering non-repayable public grant according to Measure 121 of the 2007/2013 Sicilian Rural Development Plan (RDP), when the majority of investments were made [38]. During the productive cycle, the replacement of irrigation equipment every 15 years was calculated (both for orange and mango). For each crop, the economic analysis referred to the current prices of the last crop year (2016/2017), and it considered that transport, mechanized harvest (for vineyards), and farming operations (i.e., soil tillage, weed mowing, fertilization, pesticide treatments) were carried out exclusively through rentals. Labor included all human inputs required for pruning, irrigation, maintenance of windbreaks (only for mango), harvest (for orange and mango), and other manual operations. Both annual profits and costs incurred were calculated assuming that financial conditions remained constant over the whole period [39]. All costs and revenues were computed per hectare rather than for the entire orchard in order to more effectively compare results.

The Internal Rate of Return (IRR) is the interest rate at which the NPV of all the cash flow from an investment becomes zero, and therefore, it is the discount rate r for which the following equation is satisfied [40]:

$$\sum_{k=0}^{n} \frac{R_k - C_k}{(1+r)^k} = 0 \quad (2)$$

A project will be acceptable, if the IRR is not lower than the predetermined reference rate (as mentioned above it was 5%).

DBCR is defined as the ratio between the discounted annual revenue values generated during the investment life and the corresponding costs [41]. It was calculated according to the following formula:

$$DBCR = \sum_{k=0}^{n} \frac{R_k}{(1+r)^k} / \sum_{k=0}^{n} \frac{C_k}{(1+r)^k} \quad (3)$$

The investment will be convenient if the ratio is greater than one and, given multiple options, the choice with the highest ratio is most preferable [42].

DPBT is a financial indicator representing the number of years needed for the cumulative discounted cash flows to equal the initial investment costs [43] and was determined by the following formula:

$$DPBT = n_n + \frac{C_a}{C_b} \quad (4)$$

where n_n is the last period with a negative cumulative cash flow, C_a is the absolute value of cumulative cash flow at the end of the period n_n, and C_b is the total cash flow during the period after n_n.

For the second step, since the planting phase usually represents the main cost item for poliannual crops [44–46], these four financial indicators, without considering the public grant for the planting phase according to Measure 121 of the 2007/2013 Sicilian RDP, have been recalculated. In this hypothesized scenario it was possible to compare the different discounted cash flows of each crop and better understand the incidence of EU public grants for the economic sustainability of surveyed crops.

Finally, since surveyed crops have a different productive life cycle, in order to compare them from an economic-financial point of view, and being able to give an exhaustive and correct indication, from Equation (1) annual gross margin (AGM) of each crop was determined [47,48], converting positive and negative cash flows to an average annual value:

$$AGM = NPV \cdot \frac{r \cdot (1+r)^k}{(1+r)^k - 1} \quad (5)$$

where AGM is the annual gross margin, NPV is net present value, r is the discount rate, and k corresponds to the lifetime of the investment for each crop. So, the higher the value of the AGM, the more convenient the investment will be for farmers, from an economic point of view.

3. Results and Discussion

Cash flows of vineyards showed that the average planting cost accounted for 17,215.60 €/ha, by determining a value of 8607.80 €/ha thanks to public grants (Table 1). The most representative expense for farmers, as highlighted in other studies [49,50], was the purchase of rootings and plant setting (7600.00 €/ha), followed by planting equipment (3600.00 €/ha), and irrigation equipment (2500.00 €/ha).

During the maturity phase (from the 3rd to the 17th year), the average annual cash flows were equal to 1322.00 €/ha, derived from the difference between annual revenues (4560.00 €/ha) and annual costs (3238.00 €/ha). Farming operations and labor (almost exclusively expenses related to pruning) were the most representative costs, with a value of 1060.00 €/ha (33.4% of costs) and 832.00 €/ha (25.7%), respectively. It is interesting to note that harvest and transport, with a value of 470.00 €/ha, was the third cost item thanks to the grape harvester, which allowed farmers to obtain higher profits and lower costs compared to manual harvesting [51].

Table 1. Cash flows of vineyards.

Items (€/ha)	Years			
	0–1	2	3–17	18–20
Revenues	-	**3192.00**	**4560.00**	**3648.00**
Costs	**17,215.60**	**2942.90**	**3238.00**	**3059.60**
Deep tillage	800.00	-	-	-
Rootings and plant setting	7600.00	-	-	-
Planting equipment (espalier, tutors)	3600.00	-	-	-
Irrigation equipment	2500.00	-	-	-
Fertilizers	450.00	360.00	360.00	360.00
Pesticides	200.00	300.00	300.00	300.00
Irrigation water	100.00	196.00	196.00	196.00
Labor	1065.60	582.40	832.00	665.60
Farming operations	900.00	1060.00	1080.00	1080.00
Grape harvester and transport	-	444.50	470.00	458.00
Costs net of non-returnable public grant	**8607.80**			
Cash flows	**−8607.80**	**249.10**	**1322.00**	**588.40**

The numbers in bold highlight main economic results.

As regards orange orchards, the average planting cost was equal to 15,090.13 €/ha, halved to 7545.06 €/ha with the public grant from the 2007/2013 Sicilian RDP (Table 2). The first cost item, as shown by other studies [52], was the purchase of plants and plant setting (7500.00 €/ha), followed by irrigation equipment (3500.00 €/ha), and farming operations (1530.00 €/ha).

Table 2. Cash flows of orange orchards.

Items (€/ha)	Years					
	0	1–3	4–5	6–9	10–42	43–50
Revenues	-	-	**3840.00**	**6720.00**	**9600.00**	**7680.00**
Costs [a]	**15,090.13**	**3010.75**	**4493.09**	**5643.81**	**7114.65**	**6837.12**
Deep tillage	900.00	-	-	-		
Plants and plant setting	7500.00	-	-	-		
Irrigation equipment	3500.00	-	-	-		
Fertilizers	878.13	218.75	240.63	262.50	437.50	466.20
Pesticides	282.00	282.00	352.00	387.00	387.00	408.00
Irrigation water	372.00	372.00	460.00	460.00	548.00	548.00
Labor	128.00	608.00	1370.46	2284.31	3222.15	2984.92
Farming operations	1530.00	1530.00	1710.00	1620.00	1620.00	1710.00
Boxes and transport	-	-	360.00	630.00	900.00	720.00
Costs net of non-returnable public grant	**7545.06**					
Cash flows	**−7545.06**	**−3010.75**	**−653.09**	**1076.19**	**2485.35**	**842.88**

[a] The value of costs at the 15th and 30th years was 10,614.65 €/ha because it included the replacement of irrigation equipment. The numbers in bold highlight main economic results.

The average cash flows of the maturity phase (from the 10th to the 42nd year) accounted for 2485.35 €/ha. In particular, annual revenues were 9600.00 €/ha, while annual costs reached a value of 7114.65 €/ha. The main cost item of the maturity phase was labor, with an average value of 3222.15 €/ha (45.3% of costs), followed by farming operations (22.8%), and expenses related to boxes and transport (12.6%). Within the labor category, harvesting and pruning represented the main manual operations with an annual work requirement of 230 and 150 h/ha, respectively. The elevated annual workforce necessary for these two manual operations made costs related to the remuneration of human labor the highest item of production cost, as evidenced in other similar analyses [53].

The average planting cost of mango orchards accounted for 29,832.03 €/ha, the value equal to 14,916.02 €/ha considering the public grant (Table 3). The establishment phase represented the main cost item during the life-cycle of mango orchards, such as in other studies [54,55], and its highest value in respect to other surveyed crops was due essentially to two aspects. The first issue was represented by the highest cost of plants and plant setting (11,322.00 €/ha), because mango is an allochthone species, and in Italy there are not yet nurseries able to supply plants and certify varieties and rootstocks, forcing farmers to buy from others countries (especially Spain). The second reason is due to the costs of windbreaks (8164.50 €/ha), because the mango is a species very susceptible to the wind [19], and farmers adopted windbreaks both around each plant (shading and sheep nets) and farm borders (i.e., cypress), providing shelter or protection from the wind.

However, mango orchards showed also the highest value of cash flows during the maturity phase (from the 10th to the 25th year), equal to 23,259.00 €/ha, thanks to significant annual revenues (31,968.00 €/ha). This high value is granted by the highest sales price among the surveyed crops (2400.00 €/ton), despite a lower yield compared to other tropical countries in which mango is widely cultivated, allowing farmers to cover broad annual costs, which were equal to 8709.00 €/ha.

The high sales price was due to the growing interest of local, national, and European consumers towards a product that seems to have qualitative and nutraceutical properties similar to those imported from tropical areas, with the advantage of ripening on the tree and offering a fresh fruit [56]. Farmers reduced supply chains compared to other traditional crops, as they sold fruits directly to local traders and were able to have a higher contractual power during price negotiations [57]. In fact, for other surveyed crops, farmers sold products to local wholesalers that later resold them to fruit and vegetable markets and/or to Large Organized Distribution (orange) or to local cooperative wine cellars (wine grape). In this way, farmers did not have a product differentiation and obtained a low sales price that did not often allow them to remunerate the factors used in the productive process [58,59].

Among annual costs of mango orchards, boxes and transport (2797.20 €/ha) and human labor (2765.60 €/ha), together represented 63.9% of total costs. This was due to the fact that mango, for its high perishability and a relatively short postharvest life [60], and in order to avoid a loss of consumer appreciation and consequently of its market value, required both a careful manual harvest and to be marketed in just 5 kg boxes.

Harvest, in fact, represented a significant manual farming operation with an annual work requirement of 133.20 h/ha. However, the main cost item within the labor category was pruning, which required 166.50 h/ha a year. This manual operation aimed at obtaining a pyramid-shaped crown with a structure capable of supporting the weight of the fruit, and making sure that the fruit was exposed to light in order to reach a reddish-tinged color to make them more commercially attractive. It is worth noting that expenses for irrigation water (548.00 €/ha) were comparable to orange orchards ones, due to the similar irrigation requirement of two crops in Sicily, equal to 5000 m^3/ha a year [61].

Since economic analysis showed that the planting phase represented the main cost item for surveyed crops, cash flows without public grants according to Measure 121 of the 2007–2013 Sicilian Rural Development Plan (RDP) (equal to 50% of the total planting costs) have been recalculated, as showed by Figures 1–3.

In this way, financial parameters (with and without public grant) have been determined and compared in Table 4.

Table 3. Cash flows of mango orchards.

Items (€/ha)	Years						
	0	1–3	4–5	6–7	8–9	10–25	26–30
Revenues	-	-	**15,984.00**	**19,180.80**	**23,976.00**	**31,968.00**	**28,771.20**
Costs [a]	**29,832.03**	**3269.90**	**5719.81**	**5949.40**	**7050.44**	**8709.00**	**8433.72**
Deep tillage	900.00	-	-	-	-	-	-
Plants and plant setting	11,322.00	-	-	-	-	-	-
Planting equipment (windbreak)	8164.50	-	-	-	-	-	-
Planting equipment (tutors)	2197.80	-	-	-	-	-	-
Irrigation equipment	4000.00	-	-	-	-	-	-
Fertilizers	935.73	233.10	256.41	279.72	326.34	466.20	466.20
Pesticides	282.00	282.00	352.00	352.00	387.00	422.00	443.00
Irrigation water	372.00	372.00	460.00	460.00	548.00	548.00	548.00
Labor	128.00	852.80	1542.80	1649.36	2071.20	2765.60	2659.04
Farming operations	1530.00	1530.00	1710.00	1530.00	1620.00	1710.00	1800.00
Boxes and transport	-	-	1398.60	1678.32	2097.90	2797.20	2517.48
Costs net of non-returnable public grant	**14,916.02**						
Cash flows	**−14,916.02**	**−3269.90**	**10,264.19**	**13,231.40**	**16,925.56**	**23,259.00**	**20,337.48**

[a] The value of costs at the 15th year was 12,517.00 €/ha because it included the replacement of irrigation equipment. The numbers in bold highlight main economic results.

Table 4. Financial analysis.

Financial Indicators	Vineyard		Orange Orchard		Mango Orchard	
	with P.G.	**without P.G.**	**with P.G.**	**without P.G.**	**with P.G.**	**without P.G.**
NPV [a] (€)	4759.71	−3438.19	13,269.42	6083.64	224,701.15	210,495.42
IRR [b] (%)	11.07	2.30	9.70	6.79	37.95	26.92
DBCR [c]	1.11	TOT	1.58	1.48	2.86	2.56
DPBT [d] (years)	10.5	-	17.5	27.0	5.5	7.0

[a] Net present value. [b] Internal rate of return. [c] Discounted benefit-cost rate. [d] Discounted pay-back time.

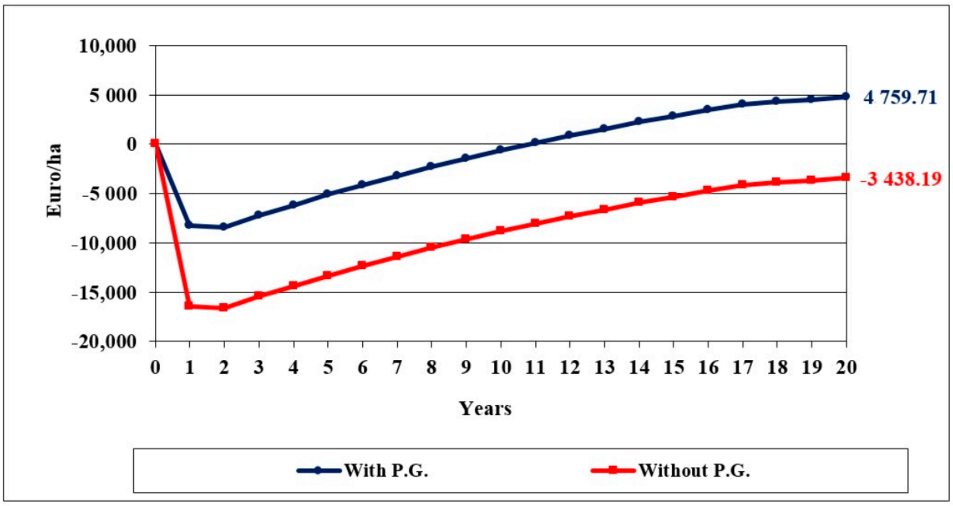

Figure 1. Discounted cash flows of vineyards.

Analyzing the surveyed crops, it is evident that, under current market conditions, investments without public grant would have a lower economic convenience, and that economic sustainability of the wine grape depends exclusively on public grants for the planting phase.

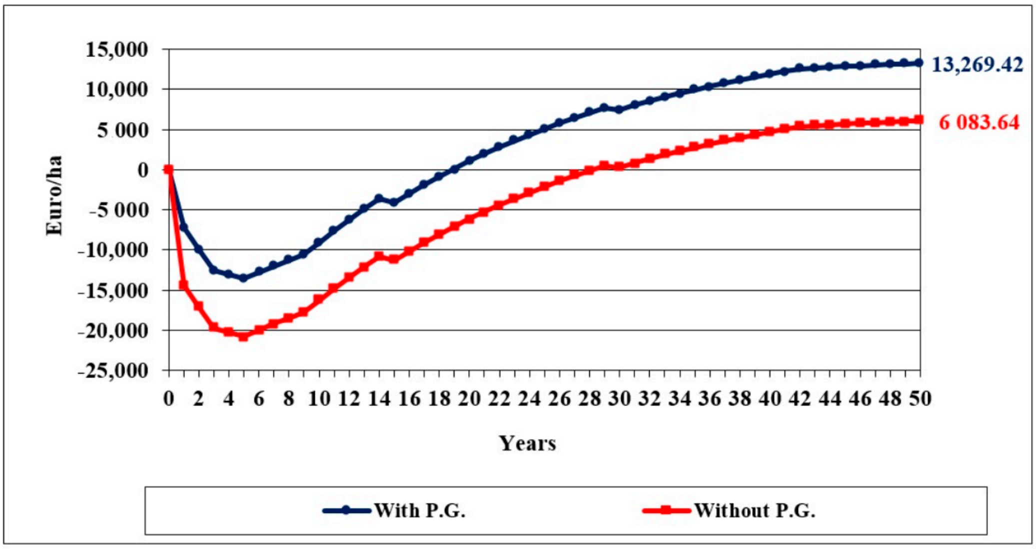

Figure 2. Discounted cash flows of orange orchards.

In particular, values of financial parameters considering public grant for vineyards were equal to 4759.71 €/ha for NPV, 11.07% for IRR, 1.11 for DBCR, and 10.5 years for DPBT; vice versa without public grant we calculated a NPV of −3438.19 €/ha, an IRR of 2.30%, a DBCR of 0.94, while for DPBT there was no value as farmers during the economic life of a vineyard would not be able to recover the initial cash outflow of the investment.

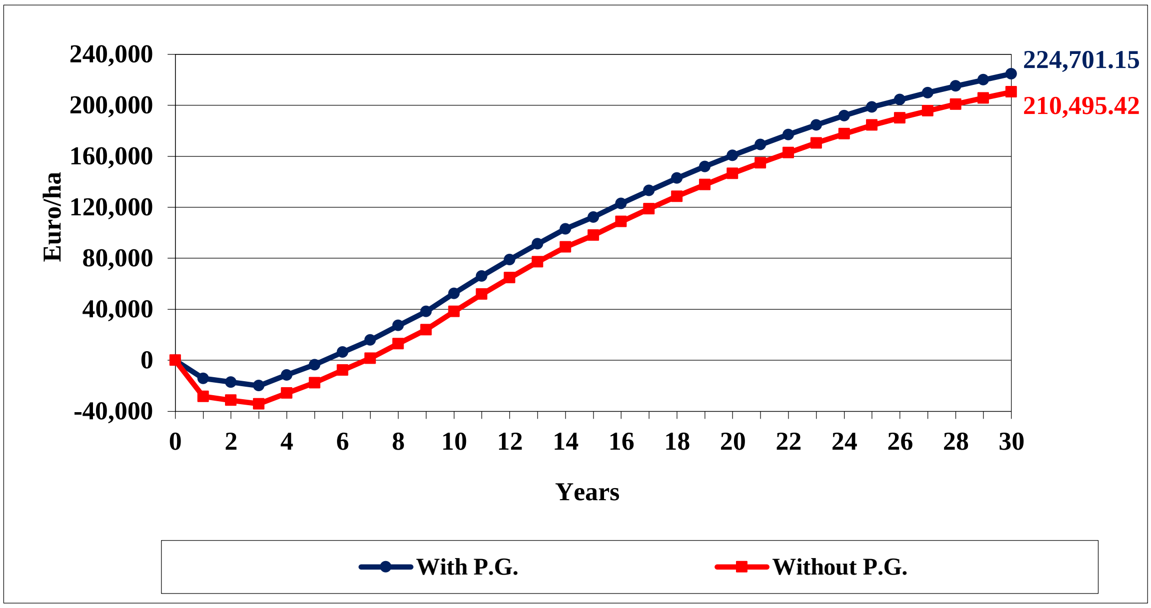

Figure 3. Discounted cash flows of mango orchards.

As regards orange orchards, the absence of public grant during the planting phase reduced economic sustainability, but it would have a lower significant incidence in respect to wine grape, continuing to justify the investment for farmers. Financial parameters would pass from values of 13,269.42 €/ha (NPV), 9.70% (IRR), 1.58 (DBCR), 17.5 years (DPBT) to others of 6083.64 €/ha, 6.79%, 1.48, 27.0 years, respectively.

Among surveyed crops, mango showed the highest values of financial parameters and suffered less than other ones with the eventual abolition of public grants. This was due essentially to the highest sales price, that also without public grants, recovered the initial cost of the investment just after 7.0 years, reached a NPV value of 210,495.42 €/ha, an IRR equal to 26.92%, and a DBCR of 2.56.

Finally, in order to compare the surveyed crops from an economic point of view, and being able to give an exhaustive and correct indication on economic sustainability, we calculated the annual gross margin (AGM) for each of them, as they have a different life-cycle of investment.

Among crops, mango showed the highest profitability, both with and without public grants, with a value of AGM equal to 14,617.03 €/ha and 13,692.94 €/ha, respectively (Figure 4).

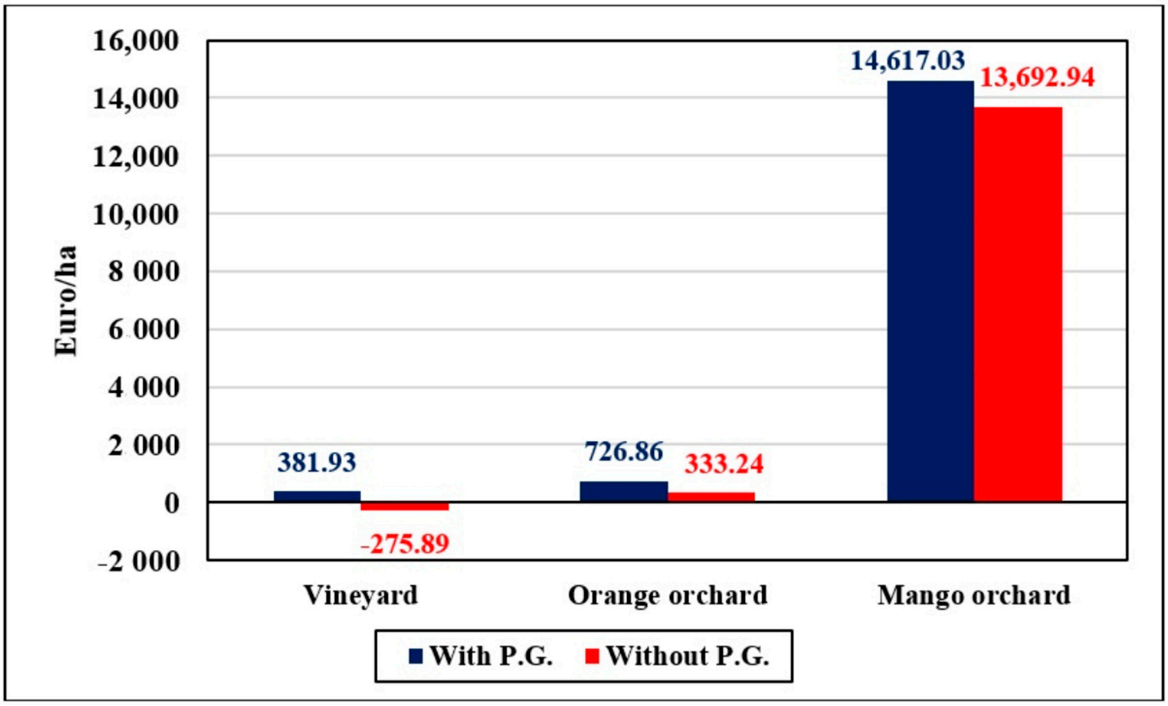

Figure 4. Annual gross margin of surveyed crops.

As regards traditional crops, taking into consideration the public grant for the planting phase, orange showed an AGM value of 726.86 €/ha against 381.93 €/ha of wine grape; vice versa, only orange denoted a positive value (333.24 €/ha), while wine grape (−275.89 €/ha) highlighted a non-convenience of investment, as already showed by financial indicators.

So, results showed a clear economic convenience for mango orchards that had on average an AGM value twenty times higher than orange orchards, and just less than forty times higher compared to vineyards.

4. Sensitivity Analysis

Sensitivity analysis is widely used in investment project evaluation [62]. In order to provide a more exhaustive economic assessment of surveyed crops, a sensitivity analysis was carried out by varying separately the sales prices and the annual costs. Each parameter was varied by 10% and 20% above and below its baseline value, by determining for each agricultural investment new AGM values (Table 5).

As regards traditional crops, sensitivity analysis showed that considering the public grants for the planting phase, sales price variations would have a higher incidence on farm profitability compared to costs, highlighting how low current sales prices did not allow farmers a satisfactory remuneration of productive factors. Conversely, without public grants, costs variations would represent the parameter that mostly affects the value of AGM, as the planting phase is the main cost item during the economic life of crops.

Table 5. AGM values according to sales price and costs variation (€/ha).

Parameter	% Var.	Vineyard		Orange Orchard		Mango Orchard	
		with P.G.	without P.G.	with P.G.	without P.G.	with P.G.	without P.G.
Sales price	−20%	−416.43	**−1074.26**	**−700.21**	**−1093.82**	10,123.08	9198.98
	−10%	−17.25	**−675.07**	13.33	**−380.29**	12,370.06	11,445.96
	Baseline	*381.93*	***−275.89***	*726.86*	*333.24*	*14,617.03*	*13,692.94*
	+10%	781.12	123.29	1440.39	1046.78	16,864.01	15,939.92
	+20%	1180.30	522.48	2153.92	1760.31	19,110.99	18,186.89
Costs	−20%	1103.91	577.65	2008.55	1693.66	16,187.58	15,448.31
	−10%	742.92	150.88	1367.71	1013.45	15,402.31	14,570.62
	Baseline	*381.93*	***−275.89***	*726.86*	*333.24*	*14,617.03*	*13,692.94*
	+10%	20.94	**−702.66**	86.01	**−346.96**	13,831.76	12,815.25
	+20%	**−340.05**	**−1129.44**	**−554.83**	**−1027.17**	13,046.48	11,937.57

The numbers in bold highlight negative economic results. The numbers in italic differentiate the baseline values from simulations.

Wine grape was the most sensible crop both for a minimum variation of sales price and costs. In particular, just a 10% reduction of market price would determine a non-convenience of investment both with and without public grants, with an AGM value of −17.25 €/ha and −675.07 €/ha, respectively. A 10% increase of costs, instead, would determine an AGM substantially equal to zero (20.94 €/ha), while without public grants it would be evident the non-convenience of the investment (−702.66 €/ha).

With regard to orange, the subsidy for the planting phase showed a lower incidence on profitability compared to wine grape. In this case, simulations denoted that a 10% variation of parameters would determine a clear non-convenience of investment only without public grant hypothesis.

In this case, AGM would reach a negative value of −380.29 €/ha for a 10% sales price decrease and of −346.96 €/ha for a 10% annual costs increase. However, in the presence of public grants, investments would have an almost nothing profitability, with an AGM value of 13.33 €/ha (−10% sales price) and 86.01 €/ha (+10% costs).

Finally, simulations showed that mango was able to support hypothesized fluctuations thanks to its high market price, which ensured farmers considerable annual revenues. In fact, it denoted the highest AGM values also with a 20% variation of each parameters and without public grants. In this last scenario, simulations showed that a 20% reduction in sales price would determine an AGM value of 9198.98 €/ha, against 11,937.57 €/ha with a 20% increase of annual costs, continuing to highlight the highest profitability among surveyed crops.

Thus, sensitivity analysis highlighted the economic fragility of traditional crops, characterized by constantly growing production costs and increasingly compressed sales prices. A practical and sustainable solution to this persistent economic problem would require a restructuring of the marketing system, encouraging the association of few farmers in order to realize wine cellars or packaging centers, reducing the supply chain, and granting added value to products [63]. The growing demand for improved and differentiated agri-food products was recognized both in the short supply chain and in the collaboration among producers as key factors to increasing farm competitiveness and economic sustainability [64].

5. Conclusions

In the last two decades, traditional crops have not ensured many Sicilian farmers acceptable incomes, thus they have had to choose whether to abandon agricultural activity or to introduce new crops into their small-sized farms. The majority of Sicilian farms are small in size, managed directly by the farmer's family, and sell their products by means of a local and undifferentiated sales modality, without establishing any form of vertical or horizontal cooperation. In this context, low sales prices due to the lack of added value to agricultural products, absence of marketing strategies, increase in production costs, and the reduced economic sustainability of traditional crops, did not justify the agricultural activity. This scenario induced the abandonment of rural areas by farmers, with a significant negative impact on sustainable development of the entire territory. Agricultural activity, in fact, in addition to generating income for farmers, provides a positive social impact granting employment, and it also has an irreplaceable role in environmental protection, safeguarding the agricultural ecosystem, as well as preserving the landscape from the phenomenon of hydrogeological instability.

In order to provide a crop alternative to many agricultural sectors now in crisis, and considering that some areas of Sicily are well suited to tropical and subtropical crops, in the early 1980s some Sicilian farmers introduced mango cultivation on their small-sized farms. Since economic sustainability is the most important aspect to maintain a farmer in a rural territory, we analyzed the profitability of mango, by comparing it with two traditional crops that have always played an important socio-economic role in Sicily: wine grape (the widespread crop) and orange (the most similar crop from an agronomic point of view).

Results showed a clear economic convenience for mango orchards that on average had a profitability 20 times higher than orange orchards and just less than 40 times higher in respect to vineyards. The high profitability of mango was confirmed also without considering public grants for the planting phase, according to Measure 121 of the Sicilian 2007/2013 RDP, and by varying current sales prices and costs. This was due essentially to two aspects. Firstly, the high sales price of mango, granted by the growing interest of local, national, and European consumers towards a product that seems to have qualitative and nutraceutical properties similar to those imported from tropical areas, allowed farmers to cover wide annual costs and obtain more than satisfying profits. Over the last years, consumers attributed an added value to tropical fruits, perceiving them as functional foods, and consequently, increased their willingness to pay for these products. The second aspect was that farmers had a higher contractual power during price negotiations in respect to other traditional crops, as they sold fruits directly to local traders, reducing the supply chain.

Conversely, economic analysis showed an economic fragility for traditional crops, characterized by constantly growing production costs and increasingly compressed sales prices. In particular, economic sustainability of vineyards depended almost exclusively on public grants for the planting phase, and just a 10% reduction in sales price would determine a non-convenience of investment.

However, although economic analysis denoted that mango is a product that allows farmers to obtain considerable profits, it should also be considered that its cultivation could represent an opportunity for sustainable development only for certain Sicilian areas, as it is closely related to favorable pedo-climatic conditions. It would be unthinkable to introduce mango in every Sicilian farm, as this tropical fruit is very susceptible to low temperatures, frost, and wind, and it also requires well-draining soils and a water availability similar to citrus fruits. However, it is worth noting that in light of climate change forecasting which emerged in Ensembles' EU project (2009), there will be in the future (2021–2050) an increase in temperature of about 1.5 °C and a decrease in precipitations of about 7.5% [65]. Consequently, farmers who want to undertake this cultivation in suitable areas could find some limitations mainly due to the lesser rainfall that will result in a greater demand for water available for irrigation of the crop.

Therefore, in order to stimulate the sustainable development of a rural territory from an economic, environmental, and social point of view, mango cultivation should re-launch the whole primary sector, including the introduction of new and environmentally sustainable crops, but above all, by valorizing the traditional ones. As regarding the surveyed traditional crops, a practicable and sustainable solution to increase the profitability of Sicilian small-sized farms would require a re-structuring of the marketing system, encouraging forms of vertical or horizontal cooperation among farmers, and the realization of wine cellars or packaging centers in order to reduce the supply chain and to grant added value to products. This would guarantee an aggregation of the productive supply that would increase the negotiation power of farmers, allowing them to place their product on national and international markets thanks to an improved commercial organization.

However, the improvement of entrepreneurial and marketing strategies represents a fundamental aspect not only for traditional crops but also for mango. Despite this tropical fruit allowing farmers a high profitability under current market conditions, these strategies are essential for farms to remain in markets for the long-term and to avoid the rural exodus phenomenon.

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