Table (4): Effect of nitrogen fertilizer, natural antidiseases substance and their interaction on strawberry chemical constituents of plant foliage during the two seasons of study.

Treatments		2005/2006 Chlorophyll a mg/ 100g f.w.	2005/2006 Chlorophyll b mg/ 100 g f.w.	2005/2006 Cartnoides mg/ 100g f.w.	2005/2006 % N	2005/2006 % P	2005/2006 % K	2006/2007 Chlorophyll a mg/ 100g f.w.	2006/2007 Chlorophyll b mg/ 100 g f.w.	2006/2007 Cartnoides mg/ 100g f.w.	2006/2007 % N	2006/2007 % P	2006/2007 % K
N fertilizers													
100% compost -N		312.30	157.06	152.66	2.40	0.47	1.74	316.56	159.23	154.57	2.49	0.45	1.76
75 % compost-N+25% mineral-N		330.95	161.72	154.42	2.62	0.42	1.71	335.19	165.51	162.26	2.66	0.43	1.74
50 % compost-N+50% mineral-N		356.44	175.04	163.01	2.82	0.41	1.64	374.72	173.68	179.25	2.87	0.42	1.69
25 % compost-N+ 75%mineral-N		341.12	171.58	155.92	2.73	0.38	1.56	352.01	179.45	164.84	2.77	0.37	1.56
100 % mineral –N fertilizer		318.27	157.34	152.56	2.54	0.31	1.35	322.42	160.88	155.90	2.58	0.32	1.36
L.S.D. at 0.05		16.21	5.44	9.67	0.04	0.01	0.08	18.32	9.3	8.72	0.04	0.02	0.06
Natural antidiseases substance													
Control		309.20	158.69	144.73	2.54	0.36	1.52	323.41	166.66	156.43	2.59	0.37	1.55
Garlic extract		334.46	164.68	155.87	2.62	0.39	1.60	340.99	167.40	164.07	2.69	0.40	1.62
Plant guard		334.52	164.11	155.45	2.62	0.41	1.62	339.12	163.74	162.98	2.66	0.39	1.64
Salicylic acid		349.08	170.76	166.91	2.71	0.43	1.68	357.21	173.20	168.04	2.75	0.43	1.68
L.S.D. at 0.05		9.93	5.76	9.37	0.02	0.02	0.07	6.08	2.42	7.99	0.03	0.01	0.05
Interactions													
100% compost-N	Control	280.14	154.08	142.09	2.34	0.40	1.57	293.63	150.15	148.86	2.42	0.42	1.60
	Garlic extract	318.56	157.68	154.91	2.37	0.46	1.57	320.00	159.87	156.9	2.50	0.45	1.76
	Plant guard	318.35	157.18	153.16	2.39	0.48	1.81	321.05	158.62	151.91	2.46	0.42	1.82
	Salicylic acid	332.15	159.36	161.25	2.51	0.52	1.83	331.58	168.29	160.70	2.57	0.51	1.85
75 % compost-N+ 25% mineral-N	Control	308.81	158.23	148.43	2.54	0.39	1.65	315.73	160.87	155.33	2.57	0.40	1.67
	Garlic extract	326.46	159.76	151.12	2.61	0.41	1.69	329.92	165.51	161.61	2.68	0.43	1.73
	Plant guard	341.02	159.31	154.35	2.62	0.43	1.72	338.20	168.45	163.49	2.68	0.42	1.75
	Salicylic acid	347.50	169.58	163.79	2.70	0.46	1.81	356.92	169.21	168.62	2.74	0.47	1.82
50 % compost-N+50% mineral-N	Control	337.88	166.52	151.6	2.72	0.38	1.58	362.56	168.35	176.57	2.77	0.39	1.67
	Garlic extract	364.56	175.06	160.17	2.82	0.39	1.64	376.44	176.69	179.10	2.88	0.42	1.67
	Plant guard	347.01	175.31	160.07	2.85	0.42	1.65	364.64	174.77	179.15	2.85	0.42	1.67
	Salicylic acid	376.32	183.38	180.20	2.92	0.43	1.71	395.26	188.92	182.21	2.96	0.44	1.74
25 % compost-N+ 75% mineral-N	Control	319.03	163.97	139.99	2.64	0.33	1.47	338.90	165.44	153.05	2.66	0.33	1.46
	Garlic extract	338.33	174.73	161.20	2.72	0.37	1.54	351.58	179.96	169.79	2.77	0.37	1.54
	Plant guard	349.81	168.83	158.46	2.75	0.39	1.56	349.98	177.99	164.97	2.79	0.39	1.60
	Salicylic acid	357.33	178.77	163.84	2.80	0.41	1.68	367.56	182.10	171.42	2.85	0.40	1.65
100 % mineral –N fertilizer	Control	300.15	150.66	141.59	2.47	0.28	1.33	306.21	152.18	148.33	2.51	0.30	1.35
	Garlic extract	324.40	156.18	151.96	2.56	0.32	1.35	327.02	158.99	166.84	2.60	0.32	1.39
	Plant guard	316.43	159.93	151.21	2.52	0.32	1.36	321.71	157.87	152.97	2.54	0.32	1.34
	Salicylic acid	332.10	162.74	165.49	2.61	0.34	1.37	334.73	174.46	166.84	2.66	0.34	1.36
L.S.D. at 0.05		36.19	23.64	18.4	0.24	0.11	0.21	41.81	17.95	15.62	0.09	0.18	0.23

2.3. Effect of the interaction:
As for the effect of the interaction between N-fertilization and natural antidiseases substances (Table 4) ,indicated that the highest values in all measured photosynthetic pigments and total nitrogen percentage as well as phosphorus and potassium percentage were recoded due to using salicylic acid at 5mM/l combined with 50% mineral nitrogen plus 50% organic nitrogen in case of photosynthetic pigments and total nitrogen, and salicylic acid combined with 100% organic nitrogen (compost) in case of phosphorus and potassium content.

3. Total fruit yield and its component:

3.1.Effect of nitrogen fertilization:
Data recorded in Table (5) reveal that using compost only at arate of 200kg N/fed (45.58m^3/fed in the first season and 38.8m^3/fed In the second one) exhibited the highest early fruit yield and the lowest percentage of infected fruits during the two seasons of study compared with other studied fertilization treatments. However, plants fertilized with 50% organic nitrogen plus 50% mineral nitrogen produced the highest total fruit yield either per plant or feddan during the two seasons of growth. Also, the same data indicated that the highest marketable yield was recorded in case of fertilizing the plants with 50% compost combined with 50% of recommended dose from mineral nitrogen fertilizer, followed by treatment of 75% compost combined with 25% mineral nitrogen .
Obtained results are nearly similar during the two seasons of study. The increase in early yield when the organic fertilizer was only applied may be due to the slow release of N which reduced plant uptake of N than needed. Accordingly the plant increased the early yield in the expense of total and marketable yield.
The highest total yield and marketable yield in case of fertilization using half of recommended dose of nitrogen as compost and other half as mineral nitrogen may be attributed to the balanced uptake of N which resulted in the highest produced yield per plant or per feddan and marketable yield beside the reasonable percentage of infected fruit (Table, 5). Obtained results are parallel with those reported by Turemis (2002), Wang and Lin(2002),Ali et al. (2003) Arancon et al. (2003), Ghoneim et al. (2003)Arancon et al (2004) and Ezzo (2004) concerning the use of organic fertilizer in strawberry plant. And Essia (2002), Auter and Gaur(2003), Khalaf(2003), El-Sayed (2004), Gutal et al. (2005), Abo-El-Hamed et al. (2006) and Karlidag and Yildirim (2007) in the case of using mineral nitrogen fertilizer

Table (5): Effect of nitrogen fertilizer , natural antidiseases substance and their interaction on strawberry total fruit yield and its components during the two seasons of study.

Treatments		2005/2006					2006/2007				
		Early yield (t/ fed.)	Total yield (t/ fed.)	Total yield (g) /plant	Marketable yield (t/fed)	% infection	Early yield (t/ fed.)	Total yield (t/ fed.)	Total yield (g) /plant	Marketable yield (t/fed)	% infection
N fertilizers											
100% compost -N		2.77	10.30	228.38	8.97	12.88	2.93	10.68	238.78	9.25	13.32
75 % compost-N+25% mineral-N		2.69	10.72	237.75	9.21	14.04	2.76	10.94	242.25	9.38	14.24
50 % compost-N+50% mineral-N		2.65	11.26	249..10	9.51	15.58	2.70	11.41	253.04	9.60	15.78
25 % compost-N+ 75%mineral-N		2.46	10.83	238.54	9.05	16.41	2.55	10.96	243.34	9.11	16.88
100 % mineral –N fertilizer		2.37	10. 32	228.82	8.32	19.29	2.57	10.77	239.25	8.73	18.85
L.S.D. at 0.05		0.11	0.16	4.19	0.20	0.82	0.08	0.17	3.94	0.18	0.76
Natural antidiseases substance											
Control		2.37	9.97	221.07	8.16	18.07	2.50	10.20	226.25	8.32	18.36
Garlic extract		2.59	10.76	238.58	9.17	15.36	2.71	11.05	246.45	9.33	15.52
Plant guard		2.63	10.73	236.14	9.07	15.38	2.72	10.92	242.20	9.22	15.51
Salicylic acid		2.77	11. 29	250.29	9.72	13.85	2.89	11.63	258.26	10.01	13.87
L.S.D. at 0.05		0.09	0.14	3.74	0.17	0.73	0.07	0.15	3.52	0.16	0.68
Interactions											
100% compost-N	Control	2.53	9.64	213.86	8.12	15.71	2.67	9.93	220.27	8.33	16.03
	Garlic extract	2.81	10.27	227.74	8.95	12.76	3.03	10.81	241.72	9.40	13.04
	Plant guard	2.81	10.43	231.30	9.09	12.78	2.83	10.70	240.55	10.16	13.12
	Salicylic acid	2.93	10.85	240.62	9.73	10.26	3.18	11.30	252.58	10.04	11.08
75 % compost-N+ 25% mineral-N	Control	2.48	10.16	225.2	8.36	16.80	2.56	10.31	228.57	8.55	17.01
	Garlic extract	2.72	10.63	235.67	9.52	13.29	2.77	10.95	245.61	9.49	13.33
	Plant guard	2.69	10.63	235.76	9.41	14.06	2.81	10.90	241.60	9.33	14.34
	Salicylic acid	2.88	11.47	254.35	9.56	12.00	2.91	11.62	254.57	10.19	12.28
50 % compost-N+50% mineral-N	Control	2.40	10.21	226.51	8.34	18.24	2.56	10.41	230.91	8.54	17.88
	Garlic extract	2.62	11.61	257.55	9.84	15.20	2.65	11.78	261.14	9.92	15.78
	Plant guard	2.77	11.28	247.71	9.57	15.12	2.73	11.31	250.82	9.55	15.52
	Salicylic acid	2.82	11.94	264.64	10.29	13.76	2.89	12.15	269.31	10.45	13.95
25 % compost-N+ 75% mineral-N	Control	2.32	10.05	222.97	8.20	19.25	2.43	10.30	228.32	8.22	20.18
	Garlic extract	2.42	10..99	243.74	8.93	15.96	2.53	10.89	241.47	9.12	16.20
	Plant guard	2.46	10.95	235.88	8.98	15.50	2.55	10.95	239.00	9.32	16.25
	Salicylic acid	2.64	11.34	251.56	10.09	14.94	2.70	11.70	264.57	9.95	14.88
100 % mineral –N fertilizer	Control	2.11	9.77	216.73	7.77	20.37	2..28	10.06	223.18	7.98	20.67
	Garlic extract	2.36	10.29	228.18	8.27	19.57	2.57	10.85	242.32	8.76	19.23
	Plant guard	2.43	10.37	230.05	8.35	19.43	2.66	10.77	239.04	8.79	18.32
	Salicylic acid	2.57	10.84	240.33	8.97	17.81	2.76	11.39	252.45	9.43	17.16
L.S.D. at 0.05		0.19	0.33	8.38	0.39	1.64	0.16	0.34	7.87	0.36	1.53

2.2. Effect of natural antidiseases substances:
Such data in Table (5) indicate that early and total fruit yield either per plant or per Fadden as well as marketable yield were positively affected due to spraying the plants with all tested growth stimulants(natural antidiseases substances)compared with the control treatments. Obtained results were nearly similar during the two seasons of study. Moreover, such treatments had detrimental and reducing effect on the percentage of infected fruit during the two seasons of growth. In this connection, the highest early and total produced fruit yield and the lowest percentage of infection were obtained as a result of spraying plants with salicylic acid at 5mM/l every two weeks intervals starting 75 days form transplanting. In addition, treatment of garlic extract at 10% ranked the second followed by plant guard without significant difference between them. Such increments in fruit yield (early, marketable, and total yield) due to treating the plants with tested natural products were connected with their effect on increasing the vegetative growth parameters (Table, 3) and photosynthetic pigments and macro-nutrients (Table, 4) which affect plant growth and in turn increased it's productivity. Obtained results are in parallel to that reported by Abada *et al* (2002), El-Shafie (2003) Saber *et al.* (2003), El-Fouly (2004) and Porras *et al.* (2007) on strawberry

3.3. Effect of the interaction:
With regard to the effect of the interaction between nitrogen fertilization treatments and natural antidiseases substances on total fruit yield and it's components (Table, 5) show clearly that the highest total produced yield either for plant or feddan as well as marketable yield were obtained as a result of fertilizing the plant with nitrogen at 200kgN/fed in the form of 50% compost plus 50% mineral nitrogen combined with salicylic acid sprays at a rate of 5mM/l. However, fertilizing plants with nitrogen at 200kgN/fed. as compost and spraying plants with salicylic acid reflected the highest early yield and the lowest infected fruit percentage during the two season of growth.

4. Fruit quality:

4.1. Physical quality:

4.1.1. Effect of nitrogen fertilization:
Concerning the effect of nitrogen fertilization on physical fruit characters, i.e., average fruit length, diameter and weight, data in Table (6) show that application of nitrogen fertilizer at the recommended dose (200kgN/fed) as mineral nitrogen fertilizer exhibited the highest values in all measured fruit traits compared with other studied fertilization treatments during both seasons of study. On the other hand, application of nitrogen fertilizer at 100% compost reflected the lowest values of average fruit length, diameter and weight during the two seasons of growth.
In this concern, the highest values in fruit parameters due to using nitrogen fertilizer in a mineral form (200kg/fed) may be due to the role of nitrogen in increasing the moisture content of fruit cells and also increasing the size and number of cells in fruit receptacle which affect the measured fruit parameter. In this respect Essia (2002), Wang and Lin (2002), Ghoneim *et al.*(2003), El-Sayed (2004)and Abo-El-Hamed *et al.* (2006) reported that nitrogen fertilizer application had an increasing effect on increasing measured physical fruit characters.

4.1.2. Effect of natural antidiseases substances:
With regard to the effect of tested natural antidiseases substances (Table 6),data revealed that spraying plants with salicylic acid at 5 mM/l, garlic extract at 10% and plant guard at 3ml/l every two weeks intervals starting 75 days after transplanting significantly increased average fruit length, diameter and weight compared with the control treatment. In addition, treating plants with salicylic acid at 5 mM/l was superior than the other tested natural antidiseases substances and the control treatment during both season of growth. Such increment in fruit parameters due to salicylic acid treatment may be attributed to the role of salicylic acid on increasing the uptake of NPK (Table, 4) and the absorption of water by roots which in turn increased fruit size. Similar observations were recorded by El-Shafie (2003) and Babalar *et al.* (2007) on strawberry.

4.1.3. Effect of the interaction :

As for the effect of the interaction, data in Table (6) indicate that the highest values in all measured fruit parameters (weight, length and diameter) were obtained as a result of the combination between nitrogen fertilization at 200 kg N/fed. as a mineral form combined with the salicylic acid at 5mM/l sprays during4 the two seasons of growth.

4.2..Chemical fruit quality:

Table(6): Effect of nitrogen fertilizer level and natural antidiseases substance on strawberry physical fruit quality during the two seasons of study.

Treatments		2005/2006			2006/2007		
		fruit length (cm)	fruit diameter (cm)	fruit weight (g)	fruit length (cm)	fruit diameter (cm)	fruit weight (g)
N fertilizers							
100% compost -N		3.12	2.24	13.01	3.21	2.26	12.91
75 % compost-N+25% mineral-N		3.19	2.34	13.43	3.26	2.31	13.96
50 % compost-N+50% mineral-N		3.21	2.35	14.43	3.27	2.38	14.13
25 % compost-N+ 75%mineral-N		3.30	2.40	14.73	3.30	2.42	14.72
100 % mineral –N fertilizer		3.37	2.40	16.21	3.39	2.49	15.76
L.S.D. at 0.05		0.096	0.082	0.75	0.01	0.077	0.64
Natural antidiseases substance							
Control		3.13	2.22	13.01	3.22	2.25	13.45
Garlic extract		3.21	2.33	14.40	3.26	2.36	14.11
Plant guard		3.21	2.33	14.32	3.28	2.37	14.42
Salicylic acid		3.39	2.50	15.72	3.38	2.51	15.20
L.S.D. at 0.05		0.064	0.06	0.67	0.07	0.04	0.57
Interactions							
100% compost-N	Control	3.00	2.17	11.50	3.12	2.12	11.90
	Garlic extract	3.15	2.16	13.15	3.21	2.23	13.25
	Plant guard	3.12	2.24	13.15	3.19	2.31	12.67
	Salicylic acid	3.22	2.38	14.27	3.31	2.37	13.85
75 % compost-N+ 25% mineral-N	Control	3.08	2.15	12.85	3.17	2.13	13.05
	Garlic extract	3.22	2.34	13.87	3.27	2.34	14.0
	Plant guard	3.17	2.32	12.45	3.29	2.29	14.20
	Salicylic acid	3.27	2.57	14.55	3.30	2.47	14.62
50 % compost-N+50% mineral-N	Control	3.15	2.23	13.42	3.22	2.21	13.70
	Garlic extract	3.18	2.36	14.02	3.20	2.40	13.80
	Plant guard	3.17	2.31	14.45	3.28	2.40	13.80
	Salicylic acid	3.35	2.48	15.85	3.37	2.51	15.22
25 % compost-N+ 75% mineral-N	Control	3.22	2.26	12.90	3.27	2.36	14.22
	Garlic extract	3.23	2.40	14.90	3.33	2.35	14.40
	Plant guard	3.30	2.40	15.07	3.25	2.39	14.97
	Salicylic acid	3.46	2.52	16.05	3.37	2.59	15.25
100 % mineral –N fertilizer	Control	3.24	2.28	14.40	3.34	2.42	14.40
	Garlic extract	3.29	2.40	16.07	3.31	2.49	15.12
	Plant guard	3.31	2.40	16.50	3.38	2.45	16.47
	Salicylic acid	3.65	2.54	17.90	3.56	2.61	17.07
L.S.D. at 0.05		0.11	0.13	1.5	0.12	0.16	1.3

Table (7): Effect of nitrogen fertilizer level and natural antidiseases substance on strawberry chemical constituents in fruit during the two seasons of study.

Treatments		2005/2006						2006/2007					
		T. S. S %	Vit. C mg/100 g	Anthocyanin mg/ 100 g	Acidity %	Total sugars %	Reducing sugars %	T. S. S %	Vit. C mg/ 100 g	Anthocyanin mg/ 100 g	Acidity %	Total sugars %	Reducing sugars %
N fertilizers													
100% compost -N		9.20	59.34	84.36	1.02	7.26	4.65	9.45	60.44	86.52	0.98	7.37	4.68
75 % compost-N+25% mineral-N		8.87	56.87	82.56	1.10	6.78	4.43	9.10	58.15	84.32	1.04	6.92	4.45
50 % compost-N+50% mineral-N		8.56	54.58	81.16	1.18	6.45	4.07	8.86	56.00	82.41	1.12	6.65	4.25
25 % compost-N+ 75%mineral-N		8.28	51.37	78.83	1.26	6.03	3.83	8.55	53.17	80.42	1.23	6.18	3.98
100 % mineral –N fertilizer		7.83	49.77	75.48	1.31	5.74	3.66	8.06	50.54	77.19	1.26	5.89	3..79
L.S.D. at 0.05		0.27	1.31	1.16	0.09	0.16	0.79	0.22	0.96	0.99	0.08	0.14	0.09
Natural antidiseases substance													
Control		8.09	52.25	78.22	1.24	6.11	3.93	8.43	53.49	80.68	1.20	6.23	4.22
Garlic extract		8.68	55.16	81.33	1.15	6.55	4.35	8.84	56.38	82.83	1.11	6.68	4.14
Plant guard		8.44	53.67	79.80	1.20	6.34	4.04	8.69	55.04	81.41	1.15	6.57	4.23
Salicylic acid		8.98	56.42	82.40	1.11	6.80	4.34	9.27	57.81	83.86	1.05	6.93	4.37
L.S.D. at 0.05		0.21	0.59	1.21	0.05	0.15	0.24	0.17	0.62	0.93	0.08	0.12	N.S
Interactions													
100% compost-N	Control	8.25	55.99	81.17	1.10	6.88	4.48	8.97	57.67	84.53	1.06	6.90	4.2
	Garlic extract	9.17	60.37	85.07	1.00	7.21	4.61	9.35	61.05	86.76	0.96	7.38	4.8
	Plant guard	9.07	58.88	83.91	1.05	7.16	4.51	9.27	59.87	85.09	1.00	7.20	4.5
	Salicylic acid	9.85	62.11	87.32	0.94	7.80	4.98	10.20	63.29	89.72	0.91	8.01	5.1
75 % compost-N+ 25% mineral-N	Control	8.45	53.75	80.50	1.19	6.23	4.26	8.67	55.02	82.50	1.13	6.41	4.03
	Garlic extract	9.00	57.77	83.09	1.06	7.07	4.57	9.15	58.88	85.22	1.02	7.08	4.60
	Plant guard	8.85	56.29	81.43	1.12	6.68	4.36	9.12	58.02	82.96	1.05	6.96	4.50
	Salicylic acid	9.20	59.52	85.07	1.02	7.16	4.54	9.47	60.69	86.87	0.96	7.25	4.70
50 % compost-N+50% mineral-N	Control	7.97	52.03	78.74	1.24	6.09	3.78	8.35	52.61	80.82	1.20	6.18	3.87
	Garlic extract	8.75	55.93	82.45	1.16	6.51	4.16	8.92	57.70	83.51	1.11	6.80	4.41
	Plant guard	8.50	53.00	80.46	1.21	6.31	4.06	8.87	54.65	81.65	1.14	6.64	4.21
	Salicylic acid	9.02	57.34	82.41	1.12	6.88	4.33	9.32	59.05	83.68	1.05	6.99	4.54
25 % compost-N+ 75% mineral-N	Control	7.82	50.52	76.78	1.31	5.84	3.67	8.22	51.93	79.15	1.30	6.00	3.77
	Garlic extract	8.45	51.85	80.24	1.25	6.12	3.91	8.67	53.21	81.80	1.22	6.23	4.10
	Plant guard	8.12	50.64	78.20	1.28	5.98	3.76	8.30	52.77	80.31	1.26	6.13	3.90
	Salicylic acid	8.75	52.46	80.09	1.22	6.18	3.98	9.00	54.70	80.66	1.15	6.39	4.18
100 % mineral –N fertilizer	Control	7.50	48.95	73.91	1.36	5.52	3.50	7.92	49.83	76.45	1.31	5.69	3.61
	Garlic extract	8.05	49.90	76.85	1.29	5.86	3.7	8.10	51.11	76.87	1.23	5.89	3.82
	Plant guard	7.67	49.55	75.05	1.33	5.58	3.51	7.87	49.95	77.05	1.29	5.93	3.84
	Salicylic acid	8.10	50.69	77.11	1.27	5.99	3.89	8.37	51.26	78.38	1.21	6.05	3.95
L.S.D. at 0.05		1.38	3.42	5.29	0.17	1.12	0.82	1.53	5.38	8.69	0.18	0.27	0.63

4.2.1. Effect of nitrogen fertilization :

Data recorded in Table (7) indicate that irrespective of total acidity percentage which was increased as a result of using 100% mineral nitrogen fertilizer at the recommended dose, total soluble solids, vitamin C, anthocyanin, total sugars and reducing sugars percentage were significantly increased as a result of using nitrogen fertilizer as 100% organic form (compost) compared with the other tested fertilizer treatment. Such results are true during the two seasons of growth. In this regard, Such reduction in TSS%, vitamin C, anthocyanin with increasing mineral nitrogen application from 25, 50, 75 up to 100% of recommended dose are connected with reducing the total and reducing sugars which is used in catabolism or formation of new cells in fruits and consequently increased fruit physical parameters (average fruit weight, fruit length and fruit diameter). Also increasing the ratio of mineral nitrogen increased the moisture content of fruit and inturn had a negative effect on sugars content in fruit juice Obtained results are agree with those reported by Wang and Lin (2002 and 2003) and Ghoneim *et al.* (2003), Ezzo (2004) concerning the use of organic fertilizer and Essia (2002), Ali *et al.* (2003), Gaur and Gangwar (2003), El-Sayed (2004), Moor *et al.* (2005), Abo-El-Hamed *et al.* (2006) and Karlidag and Yildirim (2007) in case of using mineral nitrogen fertilizer.

4.2.2. Effect of natural ant diseases substances:

Table(7) shows the effect of garlic extract, plant guard and salicylic acid on chemical constituents of fruit, i.e., TSS%, vitamin C, anthocyanin, total acidity, total sugars and reducing sugars concentration. As shown, all aforementioned chemical constituents were significantly affected by spraying plants with tested natural antidiseases substances compared with the control treatments. Obtained results are the same during the two seasons of growth. In addition, the highest values in all assayed chemical constituents except total acidity were recorded in case of spraying plants with salicylic acid at a rate of 5m M/l during the two growth seasons. However, the highest values for total acidity were obtained in case of fruit harvested from the control treatment during both seasons of study. Such increments in chemical fruit quality agents due to the effect of different studied growth stimulants are connected with the increase in photosynthetic pigments which in turn affect on the rate of organic compound assimilation and consequently increased such assayed organic constituents. Obtained results are in the same direction to those recorded by Youness (2002), El-Shafie (2003) and El-Fouly (2004) on strawberry

4.2.3. Effect of the interaction:

As for the effect of the interaction, data recorded in Table (7) show that the highest values in TSS, vitamin C, anthocyanin, total sugars and reducing sugars concentration and the lowest value in total acidity were obtained in case of application of nitrogen fertilizer at the recommended dose (200 kgN/fed.) in the form of 100% organic manure and spraying the plants with salicylic acid at 5mM/l every 15 days intervals starting 75days after transplanting. The obtained results followed similar trend in both seasons of study.

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AGRICULTURAL QUALITY PRODUCTS FOR TERRITORIAL EVALUATION AND TOURISM DEVELOPMENT IN SICILY: THE PANTELLERIA CASE.

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Abstract

The Agri-Food system is determined and conditioned by the effects of great phenomena, strictly related to territorial, environmental, social, political and economical aspects.
Thus, agriculture has to carry out complex roles within the multi-functionality framework throughout production of healthy products, safeguard and protection of environment and territory, preservation and safeguard of bio-diversity, and by supplying goods and services to public, integrating with industry and agrifood distribution.
Within such scenery, developed Countries, and in particular those of the EU, carry out strategies in order to adjust to new agrifood market conditions, and to respond to citizens-consumers increasing requests, aiming at quality of agrifood products by recurring to certification marks as a competitive instrument.
Rural development becomes the mean to increase industrial and territorial competitiveness in European countries; agriculture is not only linked to industry and distribution, but it undertakes a new role which brings to its integration with tourism, handicraft and the restaurant industry, therefore contributing to the evaluation and to the development of the rural areas.
Over 850 certified products are present within the Union, whereas 79.0% of approvals belong to the Mediterranean Area, and where Italy is, with 182 denominations, the richest European country for typical products.
Besides these products, it is also necessary to stress the role of wines, them constituting one of the most prominent sectors of the Italian agrifood system, together with the numerous traditional products, still not certified but which, nevertheless, represent a great opportunity for territorial development. Quality products, qualify and reinforce productive and economical local sectors, thus increasing competitiveness and prestige of rural territories.
Sicily is, due to the extension of its territory and its population, the biggest Mediterranean island and it boasts with an old agrifood tradition proven true by over 130 typical products, deriving from different agricultural productive fields and from the food handicraft sector. This last is able to trigger a type of tourism that may count upon environmental, naturalistic and the eno-gastronomic patrimony, typical of rural areas and that brings, out of season, tourist request.
Within this context, the island of Pantelleria, has been object, during the past twenty years, to radical changes within the socio-economic framework due to the decrease of population territorial abandonment, but mostly because of expertise differentiation, it no longer depending on agricultural activity and by now employed in other sectors, almost all linked to the island's tourist vocation that has come to being during the second half of the 80s.
The greater presence of tourists promotes the development of correlated activities, predominantly constituted by small commercial activities. The acquired visibility brought to the island external capital: investments were put forward on public and private housing as well as on infrastructures able to sustain tourism. Increase of the registered number of houses, starting from last decade, makes Pantelleria an area with an "elevated tourist vocation".

The new tourist flow increases the request of typical local products, and among these, the most required product is "Passito di Pantelleria" wine, nowadays also produced by many of the VIPs, owners of homes and lands in Pantelleria.
The changes have substantially modified the island's economy with undoubted benefits for the activities carried out. The turmoil that was therefore recorded for tourism as well as for the more recent wine- wine-growing sector, was not accompanied by an adequate infrastructure development, nor it was favoured by significant public administration measures.
The island of Pantelleria represents an example of how the interaction between agriculture and territory brought to life and developed, on the island, in a medium term period, a tourism sector that allowed relaunch of quality wine-growing production.

Key words: Agrifood, Typical products, Tourism, Evaluation, Rural areas

INTRODUCTION

The Agri-food system is influenced by the effects of great phenomena strictly linked to territorial, social and economical aspects.
In respect to these phenomena, agriculture is called to carry out complex roles within the multi-functional framework, it has therefore produce healthy products by means of ethically acceptable and eco-compatible techniques, safeguard the environment and the territory for present and future generations, preserve and protect biodiversity, supply goods and services for the entire community, integrate with agri-food industry and food distribution.
Within such context, in order to strengthen the EU competitiveness it is necessary to exalt specialities of agricultural and food sector, also by reinforcing and extending the European system of origin denomination marks and certification, which are able to
enlarge the distinctive ability of the Union's production, motivating industries to the production of quality products within appropriate productive systems.
Rural areas development is also a valid opportunity able to increase European industries and territorial competitiveness.

METHODOLOGY "NOTE"

All necessary and useful information for our studies was acquired throughout a document research and afterwards we proceeded with a direct control on territory, adjourning data concerning typical Sicilian products. We also included products recognized or that are being recognized for certified quality. Many quality agri-food products are certified and safeguarded by enforcement of a EU and national law, others are identified as being typical and/or traditional, better yet as being specific of a well determined area[1].
In the E.U. the certified and safeguarded agri-food products, are identified as PDO (protected designation of origin), PGI (protected geographical indication) according to the Reg.. (UE) 510/06. As far as wines are concerned, the reference law is the Decreto Legge n.164/92 ruling PDO and PGI marks.
A good example of territory interaction which finds proof through its agricultural production and its tourism development, is represented by the island of Pantelleria. Data furnished by the Ministero dei Trasporti (transport Ministry of Italy), by the Ente Nazionale per l'Aviazione Civile (ENAC - National Civil Aviation), by the Provincia Regionale di Trapani e dal Comune di Pantelleria (regional province of Trapani and by the Municipality of Pantelleria) were used in order to understand what has happened, during recent years, on the island.

1 Characteristic products of a well determined area surveyed in 2005 by CORERAS.

QUALITY AGRICULTURAL PRODUCTS

To 2009 in Europe, the products having a mark (Reg. CE 510/06) are 853: Italy with 182 denominations is placed at first place, followed by France (166), Spain (132), Portugal (116) and Greece (86), them representing 80% of European denominations.

In Italy the PDO and PGI products, are so subdivided: fruit, vegetables and cereals (33%), extra virgin olive oils (21%), cheeses (19%), meat products (17%), other products (10%). The total value of such production (at consumer) is of over 7,7 million of Euros. Together with certified products the role of denominated wines has to be remarked, since it's one of the force points of the Italian agri-food system with 476 types: 316 PDO, 41 GPDO e 120 PGI (December 2008). Products awaiting to be recognized and typical products have also to be added to this product food basket.

In view of a competitive development in Southern Italian territories, agriculture has a role of great importance, and many certified products find origin in it, representing, even if not duly evaluated, a big opportunity for territorial development and competitiveness.

There are 17 products in Sicily that have already been certified with PDO and PGI marks, 11 with recognition in progress, 22 PDO wines, 1 GPDO and 6 PGI. If with these we also consider the Historical foods and dishes, we will reach a total of 132 typical products distributed all over the entire Region that, nevertheless presently represent and evaluate the territory only for a very small part.

The most represented one is the vegetable fruit and cereal sector with 65 products (49% of the total), followed by wines with 29 products, cheeses (18) and extra virgin olive oils (10). Much more modest is the presence of products coming from other compartments and meat products, respectively with 6 and 4 products.

The wine production predominantly concerns western Sicily with the territories of Trapani, Agrigento and Palermo; the only territory that does not have quality wines is Enna. Fruit is present in all 9 Sicilian provinces, but the greatest number of products is found in the territories of Catania, Agrigento and Palermo. Vegetables, found in all Sicilian provinces, finds an only exception with Enna, and they are present in big quantity of products per hectare in Ragusa, Caltanissetta, Siracusa and Palermo.

Oils also involve the entire region, but the biggest quantity of products per ha is in the territory of Trapani followed by Agrigento and Catania.

Cheeses are produced especially in the territory of Palermo, which gathers 50% of the typical Sicilian production, whilst there is no presence of typical cheeses in the provinces of Caltanissetta and Catania.

Other typical products, as honey, manna and lentils, are present in the entire island with the only exception of Agrigento. And finally meat products are found exclusively in the territory of Catania, Enna, Messina and Palermo.

Typical products recognized by the enforced law are 46 (34.8% of the total) whilst 11 are waiting to be recognized and exclusively concern fruit, vegetable, cereal and chesses (table 1).

The sector that represents the biggest number of certifications is the wine sector.

Table.1 – Products with a quality mark in Sicily (n° of products)

Products	Certificates	Recognition in progress	Tot.
Vegetables, fruit and cereals	7	9	16
Extra virgin olive oils	6		6
Cheese	2	2	4
Meat products	1		1
Other products	1		1
Wines	29		29
Total	46	11	57

Pantelleria is present in this context with two typical and exclusive products typical of the territory and both certified: "cappero di Pantelleria" (PGI) – the caper of Pantelleria and the wine "Moscato-Passito di Pantelleria DPO", and wine "Pantelleria PDO".

THE ISLAND OF PANTELLERIA

Pantelleria is closer to Africa than Sicily. It's only 70 kilometers away from the African coast; its surface area is of 83 square kilometers and its perimeter is of 51,5 km.

History of the island begins in 5000 BC when the first "*Sesioti*" arrived in Pantelleria. Different populations followed in time, among which Phoenicians, Carthaginians, and Romans, later Byzantines and Normans, and ages after Angevins and Aragoneses.

All these populations left, on the island, evident signs of their presence, and among them, nowadays the most observable is certainly the typical architectural structure of houses in Pantelleria, called *dammusi* which are built with volcanic rocks and that have a domed roof able to capture and convey rainy water in due interred tanks. The island is rich of these houses since the last ones were realized, within the scheme of the original project, a couple of decades ago, and are still used as common homes.

In the modern age Pantelleria was dominated by the Dukedom of Savoia, of Austria, by the Bourbons and it was then, finally, annexed to the Italian Reign in 1861.

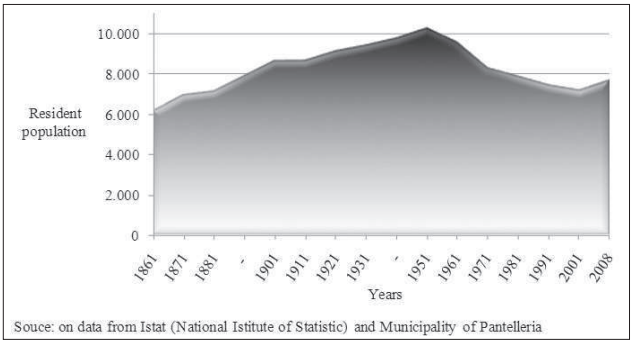
Wars that took place during last decade changed the aspect of the island, object of intense bombardment especially during world war II, it being headquarters of an important military airport that was, at the end of the war, also destined to a civil use as well (1950).

Beginning in 1950 up to nowadays Pantelleria has become an island where the agricultural activity still has an important role, especially for its vineyard activity, even though, during the last decade, it acquired a strong tourist vocation, adapting to the due changes that have consequently taken place during recent years.

THE EVOLUTION OF THE HOME-BUILDING INDUSTRY POPULATION

In the last 140 years the island has seen changes in population; first an increase of the resident population from 6.000 in 1861 to 10.000 in 1951, which then decreased to 7.736 in 2008 (Fig.1 and table 2).

Fig 1, Evolution of the resident population in the Island of Pantelleria



Souce: on data from Istat (National Istitute of Statistic) and Municipality of Pantelleria

Tab.2, Territorial surface, resident population and density.

year	Sup. (km^2)	Density ab/km^2	Resident population			
			Males	Females	Total	var. %
1961	83,00	116	4.719	4.882	9.601	100,0
1971	83,01	100	4.097	4.230	8.327	86,7
1981	83,01	95	3.902	4.012	7.914	82,4
1991	83,02	90	3.713	3.771	7.484	78,0
2001	83,02	87	3.564	3.660	7.224	75,2
2008	83,02	93	3.833	3.903	7.736	80,6

Source: on data from Istat and Municipality of Pantelleria

In 1961, 64% of the active population on the Island was engaged in activities linked to agriculture; 12% carried out activities linked to industry (food, handicraft, building industry), and just 20% carried out *other activities* (linked to services).
During following years, due to the reduction of surface destined to agriculture and because of the use of more modern technologies, and also the increase of activities linked to service, the *active population* involved in the tertiary changed. As the 2001 census showed, the population involved in *other activities* rose to 58%, while only 13% resulted engaged in agriculture.
Together with the population evolution, the number of dwellings on the island is also of great interest. From the last census it seems that there are 5.739 dwelling units in Pantelleria, an increase of 76% in comparison to 1961.

Tab.3, Evolution of the number of dwellings in Pantelleria.

	n° dwellings						n° total		n° average of
	n° total	%	occupied	%	unoccupied	%	rooms	%	rooms
1961	3.267	*100*	2.669	*100*	598	*100*	8.802	*100*	2,7
1971	3.279	*100*	2.609	*98*	670	*112*	10.254	*116*	3,1
1981	5.475	*168*	2.660	*100*	2.815	*471*	19.196	*218*	3,5
1991	5.656	*173*	2.771	*104*	2.885	*482*	17.227	*196*	3,7
2001	5.739	*176*	2.859	*107*	2.880	*482*	22.568	*256*	3,9

Source: on data from Istat

Form this data, it is also clear that, from 1961 to 2001, occupied dwelling increased just by 7%, while the number of unoccupied dwellings reached 2.880 (+382% in comparison to 1961).
This data, opposite to the one concerning the evolution of the resident population, has to be associated to the building activity carried out illegally in the 70s, and with the importance of tourism acquired in time by the island. Since the resident population progressively decreased, many new dwellings were destined to a tourist and seasonal[2] use.
From data concerning the real estate market of the tourist areas in Italy, the island of Pantelleria shows quite elevated buying and selling values per square metre or sometimes even higher, than those found in other Italian destination popular with tourist. During recent years the selling prices reached 5.500 €/m^2. Many of the dwellings are *dammusi* (typical homes in Pantelleria) bought and totally renovated, in total respect of their old aspect, by wealthy businessmen and by famous stars (Armani the stylist, Carole Bouquet, etc.)

2 In this case owners are residents in other Italian regions or abroad.

AGRICULTURE

In 1970, according to Agriculture Census data (Tab.4), the total agricultural surface on the island of Pantelleria was of 5.782 Ha, of which 3.883 were destined to agricultural land use; of these 80% were destined to vineyards (3.066 Ha).

Tab.4, Total of agricultural land use and vineyard use.

	Area Total		UAA		Vineyard area	UAA/Area Tot.	Vineyard area/SAU
	hectares	%	hectares	%	hectares	%	%
1970	5.782	*100*	3.883	*100*	3.066	67,2	79,0
1982	3.684	*63,7*	2.781	*71,6*	2.200	75,5	79,1
1990	3.557	*61,5*	2.338	*60,2*	1.670	65,7	71,4
2000	2.251	*38,9*	1.340	*34,5*	924	59,5	69,0

Source: on data from Istat

In time, the total amount of agricultural land decreased together with the Agricultural surface used (ASU), and in particular vineyards.

The majority of farming companies on the island are *run personally by the owner/framer* and in years, the percentage incidence of this type of farming stayed very high (93% during last census).

Data show the large decrease of vineyards surface on the island of Pantelleria: from 1970 to 2000, the surface area for vineyards decreased in fact of 2.142 hectares (-70%).

During recent years, nevertheless, a change has taken place, and land destined for vineyards incremented. According to the U.O. Repression for Vineyards Frauds, the actual vineyard surface is of about 1.536 hectares, 1.424 of which cultivated with *Zibibbo* (typical local variety of grape). The production obtained by growth in this particular type of grape is used to obtain the wines of the island, that are almost all PDO: *Moscato di Pantelleria*, the *Passito di Pantelleria* and the *Pantelleria (are dessert wines)*.

From a research carried out on 24 passito producing wineries[3], it can be deducted that many of these are of small dimensions and they make profit from products exclusively cultivated on the island of Pantelleria. Together with the *passito* having a PDO mark and other wine liquors, many wineries have begun to produce, during recent years, "table wines" that are often with the PGI Sicilian label (typical geographic indication).

Many of the wineries have entered the bottled wine market only recently: in fact 13 of the 24 wineries analysed, began bottling the product after 1996, and in particular 30% after the 2000 (Fig.2).

Fig.2, Beginning of Bottling year – n° of wineries.

In recent year the annual income of the winery sector in Pantelleria has reached a considerable (about 16 million Euros). Even famous stars, such as the actress *Carole Bouquet*, have vineyard in Pantelleria and produces the Passito di Pantelleria PDO. They have done a lot for the island image abroad.

3 In Altamore L., Corona G. Il ruolo del settore vitivinicolo nei processi di sviluppo sostenibile.

TOURISM ON THE ISLAND OF PANTELLERIA

Beginning in the 90s, Pantelleria started being one of the most important tourist attractions offered by tour operators. Promotion of the island, carried out through the mass- media thanks to well-known[4] and famous personalities, owners of *dammusi (typical Pantellerian houses), visitors who return frequently t*o Pantelleria, was decisive for in tourists choosing Pantelleria for their holidays and it contributed to consumers knowledge about the *passito* wine, in part produced by those same VIPs.

A link was therefore created between the *wild and uncontaminated* island and its wine, that helps, in summer, to attract more and more tourists and to activate the demand for local[5] products. Data show an increasing trend of tourist fluxes beginning in the early 90s, when Pantelleria became, as not many other Italian tourist sites, a VIP's island. As already mentioned, other activities were advantaged by such change and among them winery is the most important.

The binomial *Pantelleria-Passito* has therefore contributed to increase notoriety and diffusion of both corresponding markets, resulting today, independently one from the other, as very well known products in Italy and abroad, and the demand for the *Passito di Pantelleria* is nowadays still increasing (also among new consumers) and the island of Pantelleria continues to attract more tourist.

In 2008 there were 18.976 arrivals in Pantelleria, and of these only 1.135 (6%) were foreigners (tab.5)

Research on the data concerning the period 2000-2008 shows some differences in behaviour between Italian and foreign tourists: Italian tourists, quantitatively superior, are present during the months that go from June to September, and reach their peak during the month of August; foreign tourist, cover a bigger period ranging from April-May to October, with peaks in the months of June and September (Fig.3). A similar circumstance is also revealed by analysing data about all presence on the island.

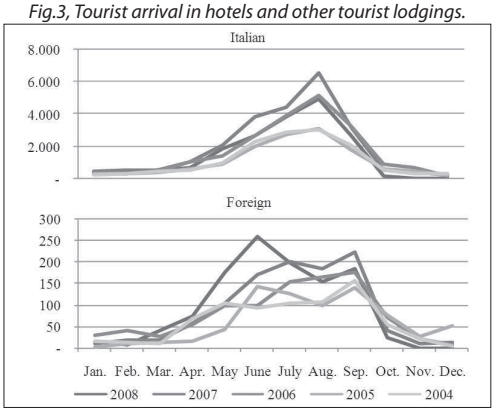
Tab.5, Arrivals and departures in hotels and other tourist lodgings - year 2008.

Months	Italian		Foreign		Total	
	Arrivals	Presence	Arrivals	Presence	Arrivals	Presence
January	356	790	16	23	372	813
February	286	845	7	27	293	872
March	485	1.191	42	259	527	1.450
April	663	1.875	73	249	736	2.124
May	1.817	5.840	177	641	1.994	6.481
June	2.663	13.318	258	1.240	2.921	14.558
July	3.809	31.288	197	826	4.006	32.114
August	4.931	38.318	154	717	5.085	39.035
September	2.634	27.252	185	930	2.819	28.182
October	178	704	26	82	204	786
November	14	53	0	0	14	53
December	5	15	0	0	5	15
Total	17.841	121.489	1.135	4.994	18.976	126.483

Source: on data from Provincia Regionale Trapani

4 Among these actors Gerard Depardieu and Carole Bouquet, fashion stylist Giorgio Armani, e football coach Fabio Capello.
5 Other then the already mentioned one (Passito di Pantelleria) another typical production id that of the "caper of Pantelleria" marked PGI.

Fig.3, Tourist arrival in hotels and other tourist lodgings.



According to data of the Province of Trapani, there are 26 hosting structures, present on the island: 11 hotels, 3 tourist villages, and 8 holiday-houses. Some of these structures have been present since the 70s, others instead, have been recently built, in specific 13 (50%) were built after 2000.
In total room availability on the island is of 1.892 units We must also consider the unofficial tourist arrivals, which can be quantified through the observation of the flux analysis relative to air or sea departures and arrivals.
During the last decade air traffic generated on the island has considerably increased ranging, according to the Enac data, from 58.603 transit passengers in 1994 to 153.268 in 2008, with an increase of 262% (Tab.6).

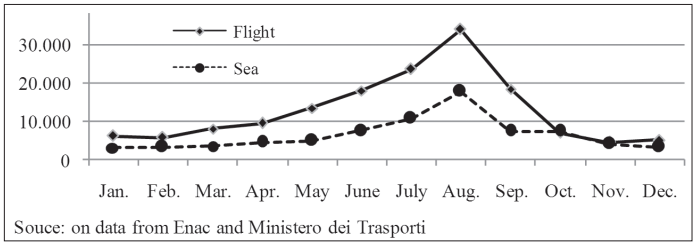
Tab.6, Air traffic, passengers and n° of flights

year	n° flights	Passenger	
		total traffic	var. %
1994	2.035	58.603	*100,0*
1995	1.922	64.911	*110,8*
1996	2.962	81.865	*139,7*
1997	2.778	87.288	*148,9*
1998	2.966	89.163	*152,1*
1999	1.590	57.693	*98,4*
2000	2.324	64.539	*110,1*
2001	2.039	80.263	*137,0*
2002	2.450	84.760	*144,6*
2003	3.045	101.396	*173,0*
2004	3.444	134.669	*229,8*
2005	4.026	138.057	*235,6*
2006	4.585	149.120	*254,5*
2007	4.869	165.826	*283,0*
2008	4.047	153.268	*261,5*

Source: on data from Enac

Sea traffic has also to be considered, and even though inferior, it reaches, during summer months considerable numbers. In specific, from data of 2008, we can see that the highest concentration of air (33.972 passengers) and sea (17.797 passengers) traffic takes place in August. (Fig.4).

Fig.4 – Total of air and sea passengers traffic in 2008.



Souce: on data from Enac and Ministero dei Trasporti

By analysing data about passenger traffic between the years 2005 and 2008, it appears that the greatest concentration (60%) takes place during the months of June and September (tab.7). It is obvious that not all tourist arriving on the island stay in official commercial accommodation, instead preferring to rent the so-called unoccupied homes. These number of unofficial tourist do not form part of the official data.
A considerable increase in fact, of unoccupied dwellings had been noticed (2.880), and they are now 50% of the total number of homes present on the island. (Tab.2).
According to the data of the province of Trapani, in 2008, registrations in hotels or similar were 18.976, which is an irrelevant quantity in comparison to that generated by transport companies (Tab.7). It seems therefore obvious that the remaining tourist arriving, found accommodation in *second homes* (unoccupied homes) which can be considered the most important accommodation dwelling, hosting tourists on the island of Pantelleria.

Tab.7, Air and sea traffic on the Island of Pantelleria from 2005 to 2008.

periodo	Passenger traffic						
	Sea	%	Flight	%	Total	%	%
			year 2005				
Summer (G-L-A-S)	45.650	*37,9*	74.924	*62,1*	120.574	*100,0*	*59,9*
Rest year	18.396	*22,8*	62.337	*77,2*	80.733	*100,0*	*40,1*
Total	64.046	*31,8*	137.261	*68,2*	201.307	*100,0*	*100,0*
			year 2006				
Summer (G-L-A-S)	48.836	*36,8*	83.982	*63,2*	132.818	*100,0*	*60,6*
Rest year	21.969	*25,4*	64.438	*74,6*	86.407	*100,0*	*39,4*
Total	70.805	*32,3*	148.420	*67,7*	219.225	*100,0*	*100,0*
			year 2007				
Summer (G-L-A-S)	31.054	*24,4*	96.375	*75,6*	127.429	*100,0*	*59,3*
Rest year	18.065	*20,6*	69.451	*79,4*	87.516	*100,0*	*40,7*
Total	49.119	*22,9*	165.826	*77,1*	214.945	*100,0*	*100,0*
			year 2008				
Summer (G-L-A-S)	43.624	*31,7*	93.890	*68,3*	137.514	*100,0*	*59,5*
Rest year	34.083	*36,5*	59.378	*63,5*	93.461	*100,0*	*40,5*
Total	77.707	*33,6*	153.268	*66,4*	230.975	*100,0*	*100,0*

Source: on data from Enac and Ministero dei trasporti

CONCLUSIONS

The production of certified quality products may acquire, within the territory a considerable relevance since they generate an "added value", they safeguard biodiversity, they contribute to maintain the environmental/landscape identity, they qualify and strengthen the productive and economical local sectors (agriculture, commerce, craftsmanship, restaurants, tourism...) They represent real "markers" of local systems, contributing to the increase of competitiveness and notoriety, therefore generating, in the consumer, the availability in buying and paying a "*premium price*".

A clear example of interaction among the territory, tourism and quality products, is given by the Island of Pantelleria whose recent history seems strictly linked to agricultural crisis, and in particular to the winery, on one side, and to the development of the tourism sector on the other, that, beginning in the late 90s, involved the island.

During the last two decades Pantelleria underwent radical changes within its social-economic aspect: there is proof of a reduction of farmer abandoning their land, but most important there is an extreme change in skills no longer depending on agriculture, now occupied by the service sector, particulary tourism. New hotels were built during the 90s in Pantelleria owned by companies that are not Sicilian and that began to promote the island placing it in important tourist circuits, ruled by national and international *tour operators*. Therefore, parallel activities were originated, mainly characterized by small productive and commercial activities: people began to invest in building destined to tourist use, but private properties also invested in dwellings destined to tourism.

Beginning in the 90s the island has became a more and more of a tourists destination. The evolution of the number of dwellings, already registered beginning the previous decade, made Pantelleria an area with a *considerable tourist vocation*[6]

This growth contributed to the increase of the demand of typical local products.

Among then, the most popular is the wine "*Passito di Pantelleria*" which is now produced not only by the few local farmers, but also by important Sicilian winery companies that bought land on the island, but mostly by the numerous famous house and land owners in Pantelleria. The new vocation of the island also attracted considerable income coming from other places other than Sicily, and that allowed a raise of the winery sector which brought international recognition of this field.

There was also an increase for the request for cultivated land and of the *dammusi* (typical homes) and consequently the buying-selling prices constantly increased reaching 4-5 thousand square metre and the vineyards, for about 90 thousand Euros for hectare[7].

The great majority of properties were bought by non Sicilian investors, in fact most part of the island is not any longer owned by locals. Nevertheless the territory was advantaged by all this, since abandoned areas were given back to agriculture and most part of the urban patrimony was recuperated, especially its typical homes (that are called *dammusi*) built using lava stone walls. This lava stone is also used for the typical terracing of the area.

Pantelleria therefore represents an example of how interaction between agriculture, in specifically the winery sector and the territory developed not only tourism but winery quality production on the island as well.

The strong marketing action carried out by the VIPs producers, has led to the merging of the sun, the smells and the colours of this island to the wine locally produced, therefore creating that involvement that was not yet present 20 years ago, and promoting the island internationally, giving it back its old and typical rural feature.

6 A high touristic vocation areas is intended an area on which the percentage of holidays homes if higher than the total 59%
7 The buying and selling value are given by local mediators.

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SUSTAINABILITY AND MULTIFUNCTIONALITY IN MEDITERRANEAN CROPPING SYSTEMS: THE ROLE OF MEDICINAL AND AROMATIC PLANTS

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Abstract

Medicinal and Aromatic Plants, shortly termed MAPs, are a huge category of plant species, which have in common their aptitude to supply substances, respectively medicines and flavours, that are or may be used by people for a large number of uses, having a various level of complexity: from plants which are used by man "as they are" or after a minimum transformation, addressed to human food (the spices), or herbal self-therapy (the traditional medicinal plants), it is possible to drop to species employed by highly sophisticated industrial sectors such as perfume or cosmetic industries, passing through almost all intermediate ways and complexities. Many of these plants find the best growing conditions inside the Mediterranean territories, where they represent a large part of spontaneous flora and where their use is, in many cases, an ancient and consolidated praxis.
For a number of reasons, many Mediterranean areas, including many areas of inner Sicily, cope with severe conditions of social and economical marginality, sometimes so strong to lead to the interruption of any agricultural activity and to abandonment of the territory. Due to their special configuration, marginal areas cannot be cultivated like all other territories, simply because their resources cannot sustain the weight of an ordinarily managed agriculture, and with an appropriate management they are at risk of irreversible degradation. Hence, it is necessary to find for these areas some "sustainable" agroecosystems, able to guarantee the optimal use of resources and their proper maintenance in time, keeping in mind the maximum economy of off-farm inputs. With this goal, many intervention lines have been suggested in time, variously differentiated in the diverse specific contexts, but always unified by the effort towards the integration of economical development, social development and environmental protection as "interdependent and mutually reinforcing pillars of sustainable development". One of the major strategic lines may be summarized in the promotion of all economical activities that may be inserted in unitary economic pathways, besides than production of raw matter also including the first transformation and, whenever possible, the packaging and marketing processes, and all services that are linked to them. MAPs bear many features that make them suitable to fit in such contexts, and may be considered a valid tool for a sustainable development of many areas, expecially when marginal or at risk of marginalization.
Besides being suitable to fit in unitary productive pathways, due to many of their features, MAPs may easily find room in low-input productive systems, able to enhance the multifunctionality traits of agricultural sector. With the help of the newest tools offered by the Common Agricultural Policy, addressed to the exploitation of low input agricultural productive systems oriented to "typical", "safe" and "traditional" productions, duly integrated by agro-touristic activities, MAPs may represent, therefore, an important resource for the exploitation of many Mediterranean areas.

Key words: Medicinal and Aromatic plants, sustainable agriculture, multifunctionality, rural development, integrated development.

INTRODUCTION

The general term "Medicinal and Aromatic Plants" (MAPs) embraces a large number of plant species largely used for centuries by almost all populations on Earth, for a great number of diverse purposes, ranging from the "classical" uses in human and animal therapy (medicinal plants) and in the seasoning of foods (aromatic plants), to various different utilizations as e.g. in dyes, food preservatives, insecticides, and sources of raw matters for industrial and domestic applications. MAPs include therefore a number of plants that are used "as they are" or after minimal transformation processes, e.g. for seasoning foods (spices) or for self-made therapy (traditional medicinal plants), but also others which represent the raw matter for sophisticated industrial branches such as perfumes or medicinal production, throughout rather all intermediate ways and complexity levels. Their history is extremely old and actually there is no people or culture, both inside and outside the Mediterranean, that have not used in the past, and presently do not use, such plants for a great deal of different applications.

Hence, we are talking about a number of species that is quite difficult to push into a unique category: generally speaking, however, it is possible to say that the characteristic that all these plants have in common is that they owe their economic interest to the presence, inside the whole plant or in some part of it, of some special substances, or group of substances, that represent the so-called "active principle".

The active principle represents, therefore, the real reason for cultivating, harvesting or somehow using a MAP. In some cases, it is an unique and well identified substance (thymole or carvacrole in oregano or thyme; anetole in wild fennel; silimarine in milk thistle); sometime else it is a mixture of simple substances, such as in the case of essential oils. Essential oils are mixtures of volatile liposoluble substances, whose production in plants is linked to the concurrence of genetic and environmental mechanisms, in reciprocal interaction. Most of the compounds which form the different essential oils are always the same, but their proportion is deeply variable, so that each plant possesses an oil having a typical and unique composition, and most users refer to it as for an unique ingredient, rather than a mixture as it actually is.

The reasons why plants produce essential oils are not completely clear by far, and not completely clear are also the functions that they act inside the plant: many authors tribute to them an important role in the enhancement of attractiveness towards pollinating insects, or in generic repellant or inhibitory activities towards noxious insects, or in some defense mechanisms of plants themselves against stress conditions. It is ascertained, as a matter of fact, that in many species essential oil content is higher under stress conditions, both for water and temperature. Mediterranean environments, where water supply is limited and temperature and light conditions often are excessive, very commonly experience such conditions.

Actually, inside Mediterranean environments a great deal of plant species find optimal growth conditions; Mediterranean basin is, as a matter of fact, one of the most important "centres of diversification" on Earth (Frankel et al., 1995), and many species inside Mediterranean wild flora possess medicinal, tinctorial, insecticidal properties.

The examples of Mediterranean plants having such kind of characteristics are many and different (table 1); many of them are so famous, and so commonly utilized, to be considered with some kind of superiority by both the users and, that is worse, by the "official" research, that until now has addressed to them an extremely sparse attention. Their cultivation has been considered for a long time just as a secondary agricultural practice, and their inclusion among the so-called "niche" crops has gained the result that in most cases they are by default excluded from the number of species to be cultivated in order to obtain some income.

The researches performed by far about cultivation and breeding of MAPs, therefore, have been very few. Their genetic improvement is affected, moreover, by some difficulties linked to their special nature, being species addressed to the production of secondary metabolites. It is well known that plants may "choose" to address their production, and therefore to allocate the available resources, towards the primary metabolism (hence the carbohydrates production) or the secondary metabolism (that is, the

production of essential oils or other products useful for industry), according to their genetic features and to the domestication level by mankind. Most of the efforts addressed to the genetic improvement of crops has been devoted to the enhancement of yields (i.e. the production of primary metabolites), with scarce (when not negative) effects on the production of secondary metabolites. This is the reason why a decision about the goal of cultivation should be taken as first, and the same species could be cultivated according different cropping protocols, in relation with the kind of product to be obtained.

SUSTAINABILITY

Inside the intervention lines feasible for the sustainable exploitation of marginal lands, a great attention is paid to the integration of economic development, social development and environmental protection as "interdependent and mutually reinforcing pillars of sustainable development" (UN-CSD, 2007). One of the main goals is to promote all those economical activities that fit in unitary production pathways, besides the production of raw matter also including the first transformation and, whenever possible packaging and marketing processes. Most MAPs fit very well in such line, having a strong aptitude to be transformed by means of low-cost in-farm equipments, that could help farmers in increasing their income level by retaining in farm the added value due to the transformation process.

Many features give to MAPs the ability to perform as useful tools for a sustainable development of many areas, above all when marginal or at risk of marginalization, and many recent studies have been performed all over the world with the purpose to include "alternative" or "not common" crops in a large number of cropping systems (Amri et al. 2006, Cristóbal et al., 2005, Milanović 2002, Quinn et al. 1998, Carrubba and Catalano 2007). As a result, also the cultivation of MAPs nowadays may take different aspects according to the environmental and socio-economical features of the interested areas, with all the possible gradations from the intensive and highly efficient farming systems in the most developed areas to the extensive and scarcely efficient ones in developing countries. Therefore, once defined the most significant traits of the area under study, even inside Mediterranean marginal lands it shall be possible to find a productive strategy in which MAPs will find a proper fitting.

The growing diffusion in Mediterranean environments of the organic production technique offers to MAPs new possibilities, being such crops very often associated with a widely perceived "naturality" character. When their "naturality" features are enhanced by means of the organic labeling, MAPs have the possibility to obtain on market a higher price. The reasons underlying this feature are basically two. First, MAPs are generally recognized as crops having a low request of off-farm inputs. The problem is not that they simply "don't need" a proper management: they are crops, and they need it. But it is true that they owe their economic and market value to the occurrence of secondary metabolites.

Some authors (McConnell and Anderson 2002) consider MAPs as "weedy" plants, that is, plants showing some tendency to perform better under low fertility conditions, without a significant yield increase with increasing the fertility conditions. Just to give an example, *Origanum* is grown for obtaining the inflorescences, whose commercial value depends on their scent and aroma, that on its turn depends on its quantity of essential oil and on the relative presence of aromatic fenols inside it. A nitrogen fertilization will possibly enhance the biomass yield of oregano, but could have a detrimental effect on its essential oil concentration. This is the first reason why MAPs could take an advantage, more than other crops, of organic management.

The second consideration is linked to a special conformation of herbal market, that is mostly addressed to buyers who have a special care for their health conditions, and who are often willing to pay a higher price for a product labeled as "natural" or "naturally grown". Many European buyers expressly require the herbs to be cultivated with the "organic" method, in the belief that such a method confers to the product a higher healthiness value. Even if it is certain that, for example, pesticides residuals in herbs may cause

injury to the direct consumer, it is still uncertain if they may influence other traits, such as the essential oil composition. Up to now, it is only possible to conclude that the higher prices that consumers are willing to pay for an "organic" product may in many cases compensate the higher production costs linked to the organic management. Very simply, putting herbal products on this special market segment could allow producers to get a higher price for a product that is often a bit expensive to produce.

MULTIFUNCTIONALITY

Multifunctionality is one of the major concerns in agri-environmental issues. All over-national organizations, such as EU, FAO and UN, unanimously claim that the opportunity to supply goods and services other than the "classical" ones is one of the basic steps in order to promote a sustainable and effective development of rural areas. In many Mediterranean environments, often called to severe marginality conditions, such a goal is especially important – and somehow especially difficult to achieve. MAPs may play a decisive role in this, and their potentialities involve the environmental, economic and social benefits that are, sensu FAO (1999), identified as crucial for a multifunctional development of agricultural activity. Fig. 1 illustrates a broad relational scheme of the major issues that are linked to the cultivation – and related economic activities - of MAPs inside rural territories. This aspect involves the new role which is today assigned to agriculture, that is also the satisfaction of different needs, not only coming from the agricultural community, but also from the whole society. According to its new "multifunctional role", besides ensuring food and fibre production, agriculture should also contribute to the environmental safeguard, to the supply of recreational services, to the creation of alternative opportunities for income and employment for the farmers, and so on. MAPs fit very well in this, and represent a good opportunity for agro-touristic concerns, helping in attracting people from the cities by means of the development of herbs-based commercial items (handicraft, oils, extracts, honey) besides representing a further source of aesthetic land valorization.

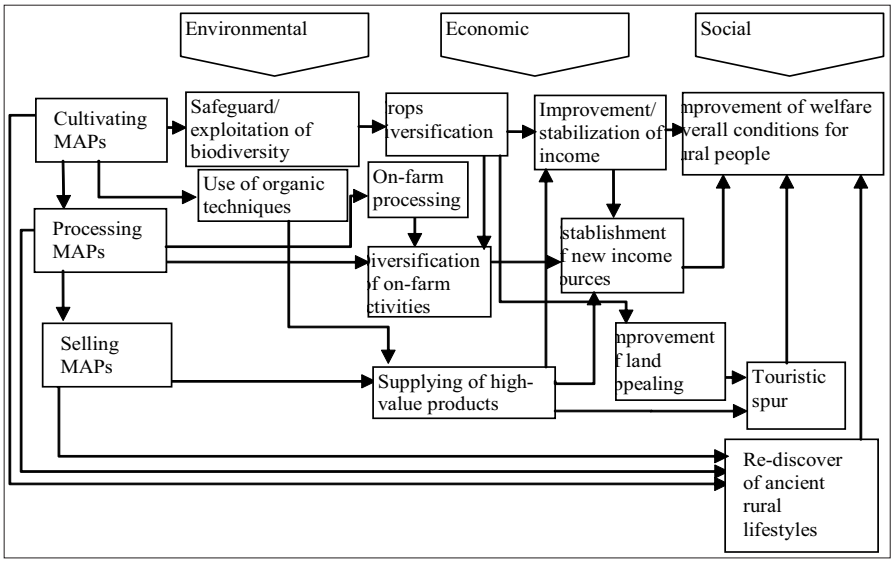
In traditional Mediterranean farming systems, as a matter of fact, the usual approach used to be a multifunctional one. Various forms of multiple cropping were used, including alley cropping, agroforestry or silvopastural systems including the simultaneous occurrence on the same territory of different plants, with or without the presence of animals. The shift towards the intensive farming methods has caused the interruption of such activities, and monocropping and specialized production methods have prevailed. Nowadays, a new impulse towards the diversification of farming systems has been given, and the traditional production methods are addressed to a new interest. MAPs may fit very well in diversified production patterns. Besides having per se the potentiality to be addressed to a number of utilizations, MAPs may enhance the multifunctional aptitude of the agricultural system as a whole. Such an issue is especially true in agroforestry, where the role of MAPs is well established by a plentiful literature.

The new trends in agroforestry claim that the introduction of MAPs inside the agroforestry system is a useful way to increase biodiversity and gain a significant increase in income (Huang et al., 2002). In such sense, they could be grown together with trees (that should however remain the main crop) generating highly positive interactions. As a matter of fact, in many areas of the world non-wood forest products, including MAPs, are the main income generating activity from the forests and several rural communities depend on these products for their living.

First, it should be pointed out that there is a tight relationship between MAPs and biodiversity. Besides the obvious consideration that they represent a crucial component in wild flora, their cultivation allows to supply the market without depleting the natural stands. As in many places on Earth, also in the Mediterranean areas MAPs have been representing for centuries the basic sources for food and medicines for local populations. In the oldest utilization form, they were collected from the wild - a practice that did not endangered species until it was not too massive. Today, the increasing interest of industry towards some wild plants has in some cases led to a depletion of natural populations, and many species all around

the world are presently at risk of extinction. In many tropical and subtropical areas, the alarming levels of deforestation and ecosystem degradation have strongly contributed to a decline in MAPs populations. It is obvious that the cultivation on a medium-large scale of the plants that bear a major interest for industrial purposes could be an important step in order to safeguard their natural populations. This concern has a great importance for many species native to the rainy forests of Amazzonia, but it is also important for many Mediterranean plants, since a depletion in natural stands has been claimed already for some wild population of Rosemary, Spanish Arnica, Gentian and so on.

Figure 1. Multifunctional potentialities of MAPs (Source: Carrubba et al., 2007).



The first constraint in the exploitation of Mediterranean grown MAPs is productivity: to improve all aspects of productivity of such crops is the first step in order to strengthen their competitiveness, also enhancing their suitability to transformation. In such sense, much work is still to be done in order to set at optimum level the cropping technique to be applied, also under organic management, by setting out the best practices for fertilization, weeds management and mechanization, especially for the more time-consuming operations such as harvest. Some other constraints are still to be solved, such as the scarce availability of specific equipments to be used on-farm, the low market transparency (that makes difficult the establishment of market channels), the high investment costs, the still low level of integration between the various steps from herbs production to marketing, and the rapid expansion of competitive production above all from developing countries.

The major economic benefit of growing MAPs is linked to the fact that their production may fit in agro-industrial pathways that involve various industrial sectors. Based on the a priori choices that farmers may perform, on market needs, on cultural and local tendencies, the introduction of MAPs inside usual cropping systems may represent a land use option to provide new income streams: e.g. Rosemary herb is a commercial item per se, but a cultivation of Rosemary may also sustain honey production and beekeeping, or supply the raw matter for further industrial processing (manufacturing of plant extracts, liqueurs, perfumes, antioxidants, and so on). Such a movement of rural economy may lead to decisive economic benefits for farmers.

CONCLUSIONS

Plants producing medicinal or aromatic substances have been used throughout history for a great deal of purposes, ranging from healing and flavouring to religious ceremonies, personal use, adornment and so on. Today there is considerable pressure world-wide by consumers to use perceived natural compounds in edible and personal products. It is essential that producers be able to service this growing demand efficiently, economically, and above all, reliably. It is therefore important to understand and develop ways of ensuring maximum return on the investments made in establishing and growing these crops (Weiss, 1997). There is scope for farmers in growing such crops, both in developed territories and in marginal ones, where their sustainable cultivation, integrated with tourism and other forms of land exploitation, may form a significant part of local economy.

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BOTANICAL TRAITS		USES (1)				CULTIVATION/MARKET	
Species/Family	Habitus	Used part(s) of plant	Active principle(s)	Main (Traditional) use	Secondary (potential) use	Distribution	Status of Cultivation (2)
ALLIACEAE							
Garlic (Allium sativum L.)	Annual herb	Bulbs	Allicina, ajoene	FSN - MED	AOX- PHA		C
Onion (Allium cepa L.)	Annual herb	Bulbs	Allicine	FSN	AOX- PHA		C
AMARYLLIDACEAE							
Tuberose (Polianthes tuberosa L.)	Perennial herb	Inflorescences	Essential oils	PERF		Absent in the wild; cultivated throughout the Mediterranean (Southern France, Morocco).	C
APIACEAE							
Angelica (Angelica archangelica L.)	Biennial or perennial herb	Fruits – leaves-roots	Essential oils, β-terebangelene	SSN-MED	PHA	Cultivated in Northern and Central Europe.	D
Athamantha sicula L.		Roots		MED		Southern Mediterranean, Sicily.	D
Carvi (Carum carvi L.)	Biennial or perennial herb	Fruit	Essential oils	FSN	AOX	Asia and Europe.	S
Celery (Apium graveolens L.)	Biennial herb	Leaves – whole plant	Essential oils	FSN	MED-PHA	Ubiquitous (worldwide). Clayey soils are not suitable.	C
Coriander (Coriandrum sativum L.)	Annual herb	Fruit, leaves	Essential oils, linalool	FSN	AOX	Absent in the wild, but escaped from cultivation and naturalized in Asia, Europe, Central and South America.	C
Cumin (Cuminum cyminum L.)	Annual herb	Fruit	Essential oils	FSN	AOX	Cultivated in the whole Mediterranean, India, Iran.	C
Dill (Anethum graveolens L.)	Annual herb	Fruit, umbels	Essential oils	FSN	AOX	Wild throughout the Mediterranean except than Sicily. Cultivated in N Europe and worldwide.	S
False bishop's weeds (Ammi majus L.)				MED	PHA	Ubiquitous (worldwide).	D
Fennel (Foeniculum vulgare Mill.)	Annual or perennial herb	Fruits, umbels	Essential oils, anethole, fenchone	FSN	PHA - AOX	Bitter f. grows wild in South Western Europe and North-West Africa; Sweet f. does not grow wild, and it is cultivated worldwide	C
Parsley (Petroselinum sativum Hoffm., nom. nud. (=Petroselinum crispum (Mill.) Nyman ex A. W. Hill)	Annual herb	Leaves, roots	Essential oils, apiin	FSN	PHA	Cultivated worldwide	C
Anise (Pimpinella anisum L.)	Annual herb	Fruits		FSN - LIQ	PHA	Cultivated worldwide	C

ASTERACEAE							
Chamomile (Chamomilla recutita (L.) Rausch.)	Annual herb	Flowers	Anthemic acid Essential oil	HTE - MED	PHA - DYE	Ubiquitous, cultivated in central and eastern Europe	C
Great Burdock (Arctium lappa L.)	Biennial herb	Roots, fruit, whole plant	Extracts	MED	PHA	Ubiquitous, widespread in N and central Europe	E
Marigold (Calendula officinalis L.)	Annual or perennial herb	Flowers	Extracts	MED	PHA	Absent in the wild; cultivated worldwide.	C
Roman Chamomile (Anthemis nobilis L. (=Chamaemelum nobile (L.) All.))	Perennial herb	Flowers	Essential oils, chamazulene	HTE - MED	PHA	Rarely in the wild, cultivated in central and eastern Europe.	C
Roman wormwood (Artemisia pontica L.)	Perennial herb	Leaves, whole plant	Essential oils	MED - LIQ	PHA	Absent in the wild in Italy; cultivated in Europe (France, Italy, Austria, Germany, Switzerland), Southern Canada and USA.	C
Milk Thistle (Silybum marianum Gaertn.)	Annual or biennial herb	Fruit	Silimarine	MED	PHA	Wild in Southern Europe. Climate: sunny and dry, elevation rarely > 700 m.	E
Tagetes spp.	Annual or perennial herb	Flowers	Extracts	MED	PHA	Worldwide (India, France).	E
Tarragon (Artemisia dracunculus L.)	Perennial herb	Leaves	Essential oils, estra-gole, caffeic acid	FSN - MED (Virus, elmints)	PHA	Ubiquitous, cultivated in whole Europe and Western Asia	C
Coltsfoot (Tussilago farfara L.)	Perennial herb	Flowers, leaves	Essential oils, alkaloids, mucilages, inuline	MED	PHA	Ubiquitous, spontaneous worldwide	E
BERBERIDACEAE							
Barberry (Berberis vulgaris L.)	Perennial shrub	Fruit, root bark,	Berberine Tannins	FDI - MED - ABC	PHA	Ubiquitous	C
BORAGINACEAE							
Borage (Borago officinalis L.	Annual herb	Leaves, seed	Mucilages, linolenic acid	FDI - MED	PHA	Ubiquitous	E
FABACEAE							
Fababean (Vicia faba L.)	Annual herb	Fruit	Fabatine; phytoestrogens	FDI	PHA – AOX - ABC	Ubiquitous (worldwide).	C
Liquorice (Glycyrrhiza glabra L.)	Perennial herb	Roots	Glycirrhyzine	LIQ - FDI	FDA (SWE); PHA	Wild and cultivated throughout the Southern and eastern Mediterranean.	C
Fenugreek (Trigonella foenum-graecum L.)	Annual herb	Seed, whole plant	Phytoestrogens	FDI	PHA	Wild and cultivated in Southern and eastern Europe.	C

HYPERICACEAE (ex GUTTIFERAE p.p.)							
St. John's Wort (Hypericum perforatum L.)	Perennial herb	Whole plant	Hypericine, others	MED	PHA - DYE	Ubiquitous, cultivated in central and eastern Europe	C
LAMIACEAE							
Basil (Ocimum basilicum L.)	Annual herb	Leaves	Essential oils	FSN	PHA-AOX	Ubiquitous (worldwide). Warmer regions of both hemispheres from sea level to 1800 m.	C
Hyssop (Hyssopus officinalis L.)	Perennial herb	Inflorescences	Essential oils	FSN	PHA – AOX (Virus)	Mediterranean in the wild, cultivated in Europe (France)	C
Lemon balm (Melissa officinalis L.)	Perennial herb	Leaves	Tannins	HTE	PHA (Virus)	Wild in whole Italy, up to 1000-1500 m a.s.l.; cultivated throughout all temperate areas.	C
Mint (Mentha piperita L., Mentha arvensis L.)	Perennial herb	Leaves	Essential oils, menthol	HTE - FSN	PHA - AOX	Ubiquitous (worldwide)	C
Oregano (Origanum vulgare L.; ssp hirtum (Link) letswaart (= Origanum heracleoticum auct.n.L.).	Perennial herb	Inflorescences,leaves	Essential oils Thymole	FSN	FDA (AOX)	Ubiquitous (whole Mediterranean)	
LAURACEAE							
Laurel (Laurus nobilis L.)	Shrub	Leaves	Essential oils	FSN	AOX- PHA	Ubiquitous (whole Mediterranean)	C
XANTHORRHOEACEAE (LILIACEAE p.p.)							
Aloe (A. barbadensis, A. vera)		Leaves	Latex	MED	PHA	Ubiquitous (whole Mediterranean)	D
PEDALIACEAE							
Sesame (Sesamum indicum L.)	Annual herb	Seeds	Oil Sesamol	FDI - AOX	PHA	Mediterranean area, warmer regions of Asia and Africa.	C
Caper (Capparis spinosa L.)	Perennial herb	Flower buds, fruits		FDI – FSN - MED			
MALVACEAE							
Common Mallow (Malva sylvestris L.)	Biennal or perennial herb	Leaves; flowers; roots (rarely)	Mucilages; saponins	FSN - MED	PHA	Ubiquitous, uncertain origin, maybe Northern Africa, Temperate Tropical Asia (including Caucasus and Indian subcontinent), N and S Europe.	E
OLEACEAE							
Jasmine (Jasminum grandiflorum L.)	Perennial shrub	Flowers	Essential oil	PERF		Ubiquitous, probably native to the Mediterranean.	C

PAPAVERACEAE							
Opium poppy Papaver somniferum L.	Annual herb	Latex; seeds (for bakery)	Alkaloids	MED	PHA	Native to Central Western Mediterranean, widespread in Europe, Asia Minor.	C
PLANTAGINACEAE							
Psyllium (Plantago psyllium L. (= P. arenaria Waldst. & Kit.))	Annual herb	Seeds	Mucilages	MED	PHA	Native to Mediterranean Southern Europe and Northern Africa.	E
POACEAE							
Cynodon dactylon (L.) Pers.	Perennial herb	Rhizomes	Extracts	MED	PHA	Ubiquitous.	E
POLYGONACEAE							
Polygonum bistorta L.	Perennial herb	Roots		MED	PHA	Wild in Sicily.	**D**
ROSACEAE							
Rose (Rosa spp.)	Perennial shrub	Flowers	Essential oil	PERF - MED	PHA	Widely distributed in Europe (Bulgaria) and middle east countries (Iran, Afghanistan, Turkey).	C
Rubus ulmifolius Schott.	Perennial shrub	Fruits, tops	Extracts	FDI - MED	PHA	Wild in Southern Europe.	E
PEDALIACEAE							
Sesame (Sesamum indicum L.)	Annual herb	Seeds	Oil Sesamol	FDI - AOX	PHA	Mediterranean area, warmer regions of Asia and Africa.	C
Caper (Capparis spinosa L.)	Perennial herb	Flower buds, fruits		FDI – FSN - MED			
URTICACEAE							
Common hop (Humulus lupulus L.)	Perennial herb	Flower cones		FDI	PHA	Cultivated throughout Europe for the production of beer.	C
Stinging nettle (Urtica sp.pl.)	Annual or perennial herb	Leaves, whole plant	Extracts (chlorophyll)	MED	PHA-DYE	Ubiquitous (worldwide)	D

Table 1. Major data about botanical aspects, uses and perspectives for some selected MAPs native to or cultivated in Mediterranean environments

(1) PERF: perfumer; MED: medicinal; PHA: pharmaceutical; FSN: Food seasoning; LIQ: liqueur; HTE: Herbal teas; DYE: dye, colorant; FDI: Food item; FDA: Food additive; SWE: Sweetening; AOX: antioxidant; ABC: antibacterial; AFU: antifungal.; INS: insecticide/repellant.
(2) Transition phases from wild harvesting to cultivation (after Schippmann et al., 2002): D discovery, E expansion (wild), S stabilization (wild), D decline (wild), C (cultivation); a species is labeled with "C" also when its cultivation is addressed differently than to the medicinal and aromatic purposes.

ECONOMIC ASPECT OF OLIVE-GROWING AND OIL PRODUCTION IN THE NEBRODI RURAL AREAS[1]

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Abstract

Olive trees have characterized the Mediterranean landscape for thousands of years. Their cultivation originated in eastern Mediterranean countries - known as 'fertile crescent' -where oil production and trade became one of the main economic resources for the regions and peoples of the time. In fact, thanks to the work of Myceneans, Phoenicians, Greeks and Romans, olives came to be one of the major agricultural crops in the Mediterranean.
With a value of 2,4 billion Euros (average of the years 2005-08), over 85% of Italian olive production is developed in the regions of southern Italy. In these regions, less encouraged by economic development, the olive and oil sector plays a fundamental social and economic role, generating a high demand for working days every year. In addition, olive-growing is an important source of income for many peasant families in several areas of Calabria, Apulia and Sicily, if not the only work opportunity for many farmers. Moreover, olive oil is a key healthy ingredient in the Mediterranean diet.
In addition to these significant economic and health aspects, olive-growing also performs irreplaceable functions of protection of the environment, landscape and agricultural ecosystem.
However, in spite of playing such a crucial role, Italian olive-growing has had to face stiffer competition over the last few years, especially in Sicily; this moment of crisis is mainly due to the higher competitiveness of the olive oil produced in other EU and non-EU countries.
In the era of globalisation, the problems related to the protection and development of rural areas are extremely relevant: to valorise and protect the agricultural landscape and promote eco-sustainable agriculture - encouraging local products at the same time - are not only economic and social needs but also cultural and environmental necessities.
The present investigation has been carried out within this context, in order to assess the competitiveness of olive growers and oil producers in the Nebrodi area, where the a significant part of the olive-growing of the province of Messina is located.
In particular, the research has analysed a sample of olive-growers, properly selected in order to measure their profitability and the strategies which they adopt to be competitive in an increasingly globalised market.
Finally, the investigation has made it possible to reveal the challenges and opportunities of olive-growing, which is particularly inclined to promote multifunctional agriculture in order to improve rural development in the Nebrodi area.

1 The authors cooperated closely in writing the present essay. In particular, E. Donia wrote paragraphs 4 and 5, F. Sgroi wrote paragraphs 6 and 7, and S. Tudisca wrote paragraphs 1, 2, 3 and 8

Key words: olive-growing - competitiveness - local development

INTRODUCTION

In addition to its production function, olive-growing also plays an extremely important environmental role, as its cultivation has strongly contributed to shape the rural landscape and prevent phenomena of erosion and landslides in a number of rural contexts.

Olive groves belong to those '*agrosystems*' that, in spite of being created by human activity, encourage animal and vegetable biodiversity by giving shelter and nourishment to wild fauna.

The functions of rural development performed by olive growers are also indisputable, especially because olive cultivation is a traditional activity, developed all over Sicily for a long time. In fact, along with contributing to increase rural employment, especially on a seasonal basis, olive cultivation is connected with a series of activities that multifunctional olive growers can carry out, such as farm tourism, catering and direct sale in the farm (short supply chain). In addition, olive growers can be included in food-and-wine or museum routes and can arrange particular activities (e.g. olive picking open to visitors, oil tasting courses, seminars on themes related to health or medicine and craft, which includes the processing of olive wood or other parts of the plant). Finally, the recovery of disused facilities is important for the promotion of multifunctionality. Most of them are old oil mills, which can also be reused for production and demonstrative purposes.

Furthermore, the recovery and protection of olive-growing even in the most marginal zones should be included in a general process of development and revitalization of rural areas through the valorisation of local human, cultural and environmental resources, able to offer a number of work opportunities, provide specific services to improve the quality of life of residents and visitors and offer non-agricultural enterprises the opportunity to set up their businesses. Indeed, the increased appeal of rural areas encourages local sales and benefits all local operators.

The food safety function performed by olive oil production is as important as others. However, it is difficult to benefit from it because high production costs have an impact on final selling prices, which, consequently, are not affordable for the majority of consumers. On top of that is the limited spread of a '*culture of oil*'. Although oil has numerous healthy properties, price is the crucial variable in affecting consumers' choices in most cases, whereas the quality of the product purchased is disregarded. As a result, very low quality, sophisticated, altered, counterfeit and unhealthy products, mainly of non-European origin, are often found on the market.

The present work was based upon the above considerations, in order to point out how olive growers manage to understand market changes and turn them into '*new*' offer opportunities within an increasingly globalised economy.

OLIVE-GROWING AND TOURISM

There is a close relationship between tourist development and landscape, food-and-wine and cultural resources. Tourist-oriented areas, which are sometimes victims of their own success, are losing those elements of appeal that had made them attractive. A growing number of tourists are looking for unspoilt places where they can buy and taste local products.

Olive trees characterize the Mediterranean environment, culture and tradition. The pursuit of common strategies between olive producers and the tourist sector for sustainable development could make territories more competitive and improve the welfare of rural populations.

The activities of marginal areas, often characterized by a marked tendency to biodiversity protection but high costs for landscape preservation and business running, should be supported through the creation of synergies between enterprises.

The in-depth analysis of the opportunities offered by these areas and of the greater difficulties faced by olive producers is a useful evaluation instrument to develop initiatives in line with the growth objectives of these areas.
The creation of a network between the operators in the olive supply chain, the local craftspeople and the landscape or cultural opportunities existing in rural areas may be the right strategy for the promotion of olive growers, territories and the cultivation of extra virgin olive oil among citizens, tourists and stakeholders. In fact, a number of routes starting from multifunctional olive farms can be created in each area, in order to originate new forms of economy and promotion of activities in synergy with other local businesses.

SICILIAN OLIVE-GROWING

Sicily is the third Italian region in terms of surface and production after Calabria and Apulia. Olive trees characterize the Sicilian agricultural landscape and olive-growing is spread all over the region with 18 million plants.
About 200 thousand farms grow olive trees in Sicily. Hilly olive groves prevail in the region with an altimetric distribution of 65%, whereas 17% and 18% of olive groves are observed on the mountains and plains respectively.
As stated above, olive-growing is spread almost all over the region, especially over the provinces of Agrigento, Messina, Palermo, Trapani and Catania, which cover about 74% of surface and 78.1% of production of the island. Although the pulverization of the lands under olive cultivation is spread throughout the region, this phenomenon is more marked in the provinces of Messina, Catania and Palermo, where respectively 70%, 57% and 54% of olive growers own less than a hectare of land. The division of businesses into groups based on the surface covered shows that most Sicilian olive groves are of very small size (51.6% of Sicilian olive growers have less than a hectare of land under olive cultivation); at the same time, it is important to point out the presence of a limited number (393) of large-sized farms (over 100 hectares).
The recognized Protected Designations of Origin (PDO) for extra virgin olive oil production are: '*Monti Iblei*', '*Valli Trapanesi*', '*Val di Mazara*', '*Monte Etna*', '*Valle del Belice*' and '*Valdemone*', whereas two others are in a transitory stage agreed on a national level ('*Colline Nisseni*' and '*Colline Ennesi*').
The PDO designations are a source of competitive advantage for olive growers since they promote local production, which otherwise may have troubles establishing itself on the market. However, the strong competitive pressure from other producing countries often forces olive producers to sell PDO products at cheap prices.

OLIVE-GROWING IN THE NEBRODI AREA

The Nebrodi area extends along the provinces of Messina, Catania and Caltanissetta. In particular, most of the Nebrodi area belonging to the region of Messina[2] follows the provinces of Catania and Caltanissetta[3].
There are 11.187 olive producers in the Nebrodi area, with 7.267,03 hectares of land under olive cultivation.

2 With over 24 thousand hectares of land, the province of Messina is the area with the largest amount of land under olive cultivation, but it is also the province with the highest number (70%) of farms that are less than a hectare large.
3 The following municipal districts in the Nebrodi park belong to the province of Messina: Acquedolci, Alcara li Fusi, Capizzi, Baronia, Cesarò, Floresta, Galati Mamertino, Longi, Militello Rosmarino, Ristretta, San Fratello, San Marco d'Alunzio, Santa Domenica Vittoria, Sant'Agata di Militello, San Teodoro, Santo Stefano di Camastra, Tortrici and Ucria. Troina (in the province of Caltanissetta), Bronte and Randazzo (which both belong to the province of Catania) are the other three municipal districts in the park.

With 1.934 producers, Bronte is the municipal district with the highest number of olive-growing businesses, followed by Sant'Agata di Militello (1.432 businesses) and Santo Stefano di Camastra (1.009 businesses). Caronia is the municipal district with the largest amount of land dedicated to olive-growing (856,39 hectares, corresponding to 11,8% of the land under olive cultivation in the whole Nebrodi area) and is followed by Sant'Agata di Militello (817,98 hectares) and Santo Stefano di Camastra (676,64 hectares) .
The municipal districts of the Nebrodi area belonging to the province of Messina are included in the territory of the PDO called '*Valdemone*'[4]. Olive-growing in the area of '*Valdemone*' PDO dates back to late 1400s. It is more present in the hilly regions on the coast and less common on the valleys that run along the torrents of Messina. The cultivar called '*Ogliarola Messinese*' prevails in all the municipal districts on the Ionian coast (from Taormina to Messina) and in those on the Tyrrhenian coast (Patti, Barcellona, Castroreale, Milazzo). It is followed by '*Santagatese*' and other minor cultivars, such as '*Nocellara Etnea*', '*Minuta*', '*Coratina*', '*Verdello*', '*Nocellara del Belice*' and '*Ottobratica*'.

COMPETITIVENESS OF THE OLIVE-GROWING SYSTEM AND MODELS FOR LOCAL DEVELOPMENT

In order to analyse business competitiveness, attention must be paid to the relationships which the business has with the environment in which it operates.
The business environment can be subdivided into two parts: the competitive environment and the social environment.
Both have become extremely complex and, very often, the agricultural entrepreneur finds it difficult to make the right choices. From an analysis of the competitive and social environments, the entrepreneur can make his or her own strategic choices in order to create a sustainable competitive advantage.
The factors underlying the increase in the complexity of the business environment can be traced to the internationalisation of businesses and markets, to globalisation, to the decline in consumption of material goods relative to the consumption of services, to the increase in tertiary production, and to the socioeconomic and institutional integration of these diverse areas. To these factors must be added increasing diversification and the growth in autonomy of various business contexts (Babinard, Josling, 1999).
All these factors modify the environment in which the producer operates and, as a result, necessitate great changes within the organisational structure of olive-growing and oil-producing businesses.
In the light of these changes, and in consideration of the limited size of the typical olive-growing business, which certainly does not help the business to respond quickly to changes in the environment, it will be increasingly important to develop relationships and projects among business people and businesses which are able to produce flexible solutions, to vary the productive and social context, but also to implement synergies and technological opportunities for the development of formal and informal networks for internal transmission of information and knowledge. The accumulation of differentiated knowledge and the transferability of information are, in fact, sources of competitive advantage (Alberitini, Pilotti, 1996).
All this is not to disparage specificity of territory but to promote knowledge and appreciation on the part of the consumer of all these local products which may have trouble making themselves better-known. Relationship skills and unspoken knowledge are essential for a business which, through these means, can identify itself as a system of the ideas, values and skills which constitute its own intangible heritage and which could not be imitated by other business systems. This is precisely because the olive producer gains its competitive advantage through having a well-defined product made in a well-defined territory and from the synergies that come about from its own competitiveness.

4 According to Article 3 of the Rules and Regulations for the production of 'Valdemone' PDO oil, the production area includes all the municipal districts in the province of Messina, with the exception of Floresta and part of Moio Alcantara and Malvagna.

It is, however, becoming more obvious that we need to develop managerial abilities which will be able to dominate local contexts where agriculture takes place (Basile and Cecchi, 1997).
In the light of these observations, the small olive-producing business should orient itself towards organisational models based on the interaction between firms, where the single firm represents a part of a network of firms in which strategies, procedures and risks are shared.
In the rural context, interventions for improving competitiveness of olive producers should look at the quality of human resources, and therefore the promotion and development of creative abilities, which are bound up in the cultural heritage of the territory, all in order to create systems of effective and efficient businesses.
Consequently, there are two principal dimensions of the business: territorial and strategic-relational (Begalli 2003). A competitive business system must come from the interaction between these two dimensions. The territorial dimension refers to the land, which determines the agricultural direction of the business; the strategic-relational dimension, on the other hand, refers to the capacity of the enterprise to activate inter-organisational strategies so as to promote, through interaction between the competitive and social environment, the growth of the business and the adoption of innovative processes and products. The two dimensions of the business are thus closely interdependent. While the first refers to micro-economic choices around which entrepreneurial decisions are made, the second dimension represents a synthetic macro variable for entrepreneurial action. For this reason, the traditional, territorial approach of the olive producer is substituted with the strategic-relational approach.
According to this set-up, the network takes on a fundamental role. The network represents a channel through which goods and services, information and knowledge can flow, and businesses, other organisations and institutions can interact. This is, therefore, a network system with which competitive local olive producing systems can be interpreted. The strength of the local system should consist of finding synergies with other local business sectors (craftspeople, tourism), in order to create a network system which will interact at the local, regional and global levels.
If, on one hand, business systems set up according to this standard represent effective systems, on the other hand, they need flexibility on the strategic side, even to the extent of being able to redefine their objectives and strategies along with changes in environmental conditions.
The set-up described above could represent a solution to the problem of uncompetitiveness of small olive producers: however, it is necessary to highlight that, in many cases, these businesses are run by businesspeople who are advanced in age and often not well-disposed to innovations, whether material or not. In fact, in many areas it is possible to see olive producers where the farmer grows olives just for the love of them and for the land: he or she is not interested in profit but only in seeing the land cultivated and not abandoned. While for these producers such a strategy may be valid, in the long term, and for subsequent generations, this strategy will bring about the abandonment of the olive grove, with all the negative environmental consequences which are bound to follow.
Competitiveness is gauged by both the capacity for institutional activity (checking mechanisms, guarantees and certifications by training centres for general education and professional training), and the capacity for development of system-wide structures, in particular intermediary institutions, such as consortia and associations of producers, and service centres. The competitive context, configured in this way, demands continuous changes at the level of governance, at the level of equilibrium of micro- and macro-networks, and at the level of strategic guidance locally and globally.
Networking, in the final analysis, represents the strategic variable of success for small businesses. The characteristics of the network can be differentiated in relation to the degree of local development, the institutional level, the social and productive assets of the territory, and the structure and goals of each business.

OLIVE OIL: THE FOUNDATION OF HUMAN HEALTH

The ancients attributed therapeutic functions to olive oil. Recently several studies have also attributed important health properties to olive oil. In 1950 Stamler, one of the greatest medical scientists carrying out research into the epidemiology of arteriosclerosis, stated that *'we should copy the diet of the Mediterranean peoples, based on pasta, vegetables, olive oil and wine'.* However, in the following years in industrialised countries people continued to eat a diet with a high calorie content, heavy with saturated fat.

It has only been since the 1970s, thanks to the studies of Ancel Kedys and other American researchers who showed the correlation between heart problems and the dietary habits in industrialised nations, that people have been rediscovering the value of the Mediterranean diet and, in particular, of olive oil, the only fat to contain high levels of monounsaturated fat, a moderate amount of saturated fat and a small amount of polyunsaturates.

Extra-virgin olive oil, as a result of synergy between the quality and quantity of its fatty acids and other components, plays a protective role on the human body, reducing cardiovascular illnesses and the growth of tumours (particularly those of the colon, the prostate and the breasts).

However, in the developed nations, along with the consumer lifestyle, we are seeing a growing dietary catastrophe as a result of eating too many calories. People are eating too much saturated and polyunsaturated fat, and not enough monounsaturates.

A healthy diet would give a pre-eminent role to olive oil because of its balanced composition of fatty acids and antioxidants. In the final analysis, olive oil is a fat of vegetable origin which should form part of every diet as a substitute for less healthy fats.

INCOME OF OLIVE PRODUCERS IN THE NEBRODI AREA AND COMPETITIVE STRATEGIES ADOPTED

With the goal of analysing the current situation of the reality of olive cultivation in the Nebrodi area, a sample of 10 olive producers from this territory was chosen. The producers were all businesses producing extra-virgin olive oil. Another element taken into consideration during the selection of producers was the state of their olive groves. Mature olive groves were chosen for this study.

The farm businesses studied had a total of 93.10 hectares, of which 57.5% (53.50 hectares) were under olive cultivation. The planting distances were, in nine cases out of ten, irregular in shape: in only one case did we find a regular planting distances of 6 x 5 metres. The density of planting varied between a minimum of 100 and a maximum of 300 plants per hectare.

The most common cultivars were Santagatese and Minuta, one or both of which were present on each farm as either the dominant or the secondary variety. Other secondary varieties included *Oglialora*, *Nocellara* and *Verdello*.

As far as labour was concerned, in 6 cases a capitalist work relationship was found, and in the other 4 cases the owner worked the land him or herself.

Looking now at the relationship between the business and the ownership of capital funding, each business was situated on privately owned land.

In order to study the strategies for market positioning, we analysed the methods of selling the product. In particular, we noted that five businesses sold unbottled oil directly to the processor, while the other five added value to the product by selling it in packaging (bottles and cans)[5].

Finally, we noted that the farm businesses that sold packaged oil also had an agri-tourism component.

In order to analyse the profitability of olive production in the area under study, the chosen businesses were categorised according to their business goals. We identified two groups of businesses that mirrored the realities of olive production in the area: businesses that sold unbottled oil and those which added value to their products.

5 Packaged oil is sold in bottles of 0.75 and 0.50 litres and in cans of 5 litres.

We showed that the two types of olive cultivation are very similar and can be categorised in two groups (Table 1): a) businesses that have traditional olive plantations and sell unbottled oil, harvest the olives by hand and have a mean annual yield of 26.40 q of olives per hectare; b) businesses that have traditional and non-traditional olive plantations and sell packaged oil, but also harvest the olives by hand, and have a mean annual yield of 28.20 q of olives per hectare.
For each of these two types of olive cultivation, the mean costs of production of extra-virgin olive oil were estimated, with reference to technical and economic data given to us by olive growers from the area in which the study took place; the data came from the seasons 2004/05, 2005/06, 2006/07 and 2007/08.

Table 1 - Asalysis of the cost of production and calculation of the break-even point of extra-virgin olive oil from the Nebrodi area

	Units of measurement	Olive business selling unbottled oil	Olive business selling packaged oil
Yield in olives	kg olive/ha	2.640	2.820
Yield in oil	kg oil/ha	422,40	451,20
Total cost of coltivation	euro/kg oil	8,26	11,66
of which			
- cost of harvesting	"	4,23	5,83
Total cost of processing of olives		0,69	4,34
of which			
- cost of pressing	"	0,69	0,69
- cost of conditioning	"	-	3,50
- cost of certification	"	-	0,15
Total costs	euro/kg oil	8,95	16,00
EU subsidy	"	1,32	1,32
Break-even point	"	7,63	14,68

Source: our workings on data supplied by farm businesses

From an analysis of the costs, the following points emerge:

- Total production costs, including explicit costs as well as those which are implicit or hidden in the remuneration of the labour performed by the farm entrepreneur with his or her family, in capital funding and in agricultural capital, and considering a yield of 16%, amount to €8.95 per kilo of oil in businesses which sell unbottled oil and €16.00 euros per kilo of oil produced in businesses which add value to the product.
- The costs of the pressing, conditioning and PDO certification are, in total, equal to €0.69 per kilo of oil produced in businesses which sell unbottled oil[6] and €4.34 per kilo of oil produced in businesses which add value to the product.
- The total costs of the production of one kilogram of extra-virgin olive oil range from €8.95 in enterprises which sell unbottled oil to €16.00 for PDO certified oil from enterprises which add value.

6 Unbottled oil is sold without PDO designation.

Taking into consideration the subsidy which the olive growers receive from the European Union (formerly under the Common Agricultural Policy), equal to €1.32 per kilo of oil, it is easy to determine which value would make it possible to reach a break-even point in the two cases examined. The sale price of oil should be in the range from €7.63 to €14.68 per kilogram.
We should highlight that while Sicilian oil has gained a good reputation, even at the international level, the wholesale price registered in the last season 2007/08 (but also until September 2009) has been far below the break-even point estimated. In fact, last season, unbottled oil registered a price of €3.50 per kilo of oil. As for packaged oil, it registered a price no higher than €10 per kilo. Under current market conditions, a negative profit of €1,744.51 is being made by businesses that sell processed oil and €2,111.62 by businesses that bottle their own. This means a subtraction of resources from entrepreneurs in the agricultural sector. In the first category the loss represents 50% of the estimated costs of cultivation, while in the second category the loss represents 40.1% of the costs of cultivation.
This analysis was done bearing in mind the accompanying subsidies under the old Common Agricultural Policy. Considering that from the 2006 season the subsidy per kilo of oil was transformed into a subsidy per hectare (value based on land ownership documents), shifting a premium based on productivity per hectare into a subsidy based on the amount of land under ownership, it is possible to make some further points. This research allows us to determine how far the changes in subsidies have impacted on the competitiveness of olive production in the Nebrodi area. In the case of businesses that send processed oil, a loss per hectare has been noted of around €1,744.51 (which becomes €2,111.62 for businesses which bottle their own oil), compared with an estimated land value of €555.57 per hectare (€595.58 per hectare for the second type of enterprise). In the light of this, the survival of the olive grove is no longer tenable if it continues to be linked only to their productive aspects. On the other hand, their role in the landscape and their health properties may mean that they will not be abandoned.
We also researched into how olive producers can work with the environment with the aim of creating a lasting competitive advantage.
As stated above, in five out of ten of the enterprises chosen for this study, we noted the presence of a farm tourism business.
Demand for farm tourism is linked to several factors, among which are:

- the pleasure of staying for several days in the peace of the countryside;
- the need to rediscover old country ways;
- the desire to visit religious sites in the territory;
- the search for green spaces where children can play.

The farm tourism facilities which we investigated work year-round, although most of the guests come in the spring, summer and autumn. In some businesses, besides the classic agritouristic activities (horse riding, day trips), harvest activities are starting to be organised (picking olives, hazelnuts and chestnuts).
In the management of a rural business, in the territory under study, farm tourism represents a way to restart competitiveness for olive producers. In fact, in a holiday farm, the entrepreneurs can sell their packaged products at a higher price than the break-even point. Direct sale to the consumer, who spends several days in the place of business, allows the entrepreneur to apply a mark up and in this way to make a profit. It must be emphasised, however, that not all the products of the business can be sold with this strategy. But the diversification of sales strategy allows the olive-producing farm tourism business- to gain a competitive advantage.

CONCLUSIONS

The analysis of the current state of olive production in the Nebrodi area has shown that there are two types of olive producer. The classic olive producer which sells processed oil, and which minimises agricultural

interventions; and the olive-producing company which, especially in the last few years, and bearing in mind the increased competition, has been set up through a farm holiday business.
The research has shown that in both types of business, the sale of olive oil alone does not allow the business to make a profit. Farm tourism, however, is a strategy that has allowed businesses to continue and survive.
In the long term, businesses of the first type are destined to disappear, as market forces push them off the scene, with all the environmental consequences that this will bring for the territory.
However, if we recognise the important uses of the olive grove, from the environmental and hydro-geological points of view, it is important to define the strategies that we should adopt in order to look after them.
Besides, if we recognise the health benefits which olive oil brings, and if we consider the traditional beauty of the olive tree in the local landscape (also from a touristic point of view), then the desirability of safeguarding this heritage goes beyond its cost to the agricultural or political budget: the cost should also weigh upon all those who reap any benefit, however indirect, from olive cultivation. While this is doable from the microeconomic point of view, because of the attractive look and positive feelings produced by olive groves, on the macroeconomic side, the analysis of the per-capita income of the local consumers appears to be a difficult-to-reach objective. It is up to the public to preserve this heritage of our culture, landscape and environment, promoting the creation of networks of small businesses in such a way as to augment the products available and to compete on the market.

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TEMPERATURE VARIABILITY ALONG THE MEDITERRANEAN COAST OF EGYPT WITH LINKS TO LARGE ATMOSPHERIC CIRCULATIONS DURING THE PERIOD (1957-2006)

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Abstract

Spatial and temporal variability of interannual and decadal maximum and minimum temperatures were analyzed during the period (1957-2006) based on data from 12 observatories distributed along the Mediterranean coast in Egypt. Monthly average series were analyzed for evident of trends. The role of large atmospheric circulations: including the NAO, the EA, and the EAWR patterns on the interannual variability of trends was also investigated. Annual, summer and fall maximum temperatures have tended to increase, particularly over the western portions of the Mediterranean coast of Egypt. Also, the maximum temperature of the Mediterranean coast seems to have more tendencies towards warming compared with other continental regions in Egypt. This may be attributed to impact of large atmospheric circulations in addition to anthropogenic effects. For minimum temperature, it was evident that there was a statistically significant positive trend of the annual and seasonal trends, except those of winter, along the Mediterranean coast. The positive trends were greater in the west than in the east. Also, the magnitudes of the trends were obviously weaker than the remaining geographical regions of Egypt. It was noted that the behavior of annual maximum temperature and maximum summer and fall temperatures is significantly correlated with the positive mode of the EA pattern and the negative mode of the EAWR mode. The variability of the NAO has significantly correlated with only maximum winter temperature. Similarly, the variability of annual, summer and fall minimum temperature was associated with the behavior of the EA pattern. It is necessary to review the tourism seasons considering the observed trends of air surface temperature. In this context, it is advised to encourage tourism activity in winter and spring. Following the fact that the Mediterranean region seems to be a unique environment for tourism development, a set of actions must be featured in minds of planners taken to cope with climate variability along the Mediterranean coast in Egypt, particularly increasing temperatures.

Key words: Climate variability, temperature, atmospheric circulations, the Mediterranean, Egypt.

INTRODUCTION

Complete and reliable climatic data are a basic requirement for climate analyses, hydrological, ecological modeling and climate impact assessment at different temporal and spatial scales (Ramos-Calzado et al. 2008). Over the last two decades, there has been an ongoing interest in numerical estimation of not only change in the means of climatic series but also change in frequency, intensity and duration of extreme events (Easterling et al. 2000). Most of studies reported significant upward trends of maximum and minimum temperature in many areas of the world (e.g. Nicholls et al. 1996; Folland et al. 2001). However, this warming is not uniform in both space and time. Climate variability varies from season to

season and across regions. Under the global warming, an increase in intensity and frequency of climate-related hazards is considerably expected (Beniston and Stephenson 2004). Continued greenhouse gas emissions would cause further warming and induce many changes in the global climate system during the 21st century. Extreme events, such as floods, droughts, hot spells, have apparent impact on mortality, human comfort, energy consumption, ecology, agriculture, tourism and hydrology (Johnson et al. 2005; Trigo et al. 2005). For instance, heat waves are likely more frequent in many parts worldwide (IPCC 2007). Also, the European Climate Assessment (ECA) has recently proven changes in frequency of European extreme temperatures (Klein-Tank et al. 2002). More obviously, the unprecedented summer heatwave of 2003 had potential influences on Mediterranean communities (Grynszpan 2004; Luterbacher et al. 2004).

The Mediterranean region is a transitional zone between low latitudes in the north of Africa and high latitudes in the north. It is affected by the westerly all over the year besides the south Asian monsoon in summer (Xoplaki et al 2003). Accordingly, it is one of the most vulnerable regions in terms of global warming. It is broadly reported that the Mediterranean natural systems and biodiversity have substantially been affected by climate change (Perry 2000). For instance, many regional climatic models (RCM) such as the HadCM3 global circulation model have projected a warming rate of 4^{o} C and 2^{o} C for summer and both spring and winter respectively over the period 2031-2060. Following this finding, summer tourism will negatively be affected (Giannakopoulos et al 2009). In accordance with these results, an increase in the number of hot days (Tmax > 30^{o} C) and tropical nights (Tmin >20^{o} C) will also be exhibited. However, this increase is more evident in the northern basin compared with the southern Mediterranean.

Climate change is an issue of particular concern in the Mediterranean region. Although the Mediterranean region only contributes 7 % of the world population, it receives more than 33% of the global tourism (Jenner and Smith 1993). For example, the marine shorelines extend for more than 3500 km in Egypt, of which more than 1000 km expands along the Mediterranean Sea. More than 40 % of the population lives in coastal areas, particularly Alexandria, Port Said and Damietta (Robaa and Hasanean 2007). Climate change has potential direct and indirect influences on tourism in the Mediterranean countries. The extent of tourism activity is mainly influenced by climate and weather events. This includes density of air traffic, time and daily operation of aviation, travels time, insurance claims, temporal availability of snow cover for winter skiing, increasing demand of water in hotels and gulf courses, decline of coral reefs, fisheries and other marine-based resources in certain resorts. For example, sea-level rise is expected to damage infrastructure of tourism sector in the Mediterranean region such as international airports, roads and hotels, specifically in small islands which mainly depend on tourism due to the scarcity of other natural resources such as the Tunisian island of Jerba. The Mediterranean basin has more than 580 coastal towns and 280 trade ports. Surface air temperature is of great concern due to important environmental, economical and social implications, particularly extreme temperatures. Thereby, studies of climate variability at finer spatial resolution such as sub-regional scales can prove to be an essential tool to help stakeholders and decision maker draw appropriate strategies to develop tourism. Temperature variability along the Mediterranean coast in Egypt is not well-documented or fully understood.

Many studies investigated the association between temperature and precipitation variability and large atmospheric circulations over the last few decades. These studies varied from national (e.g. Hasanean 2004; Hasanean and Basset 2006), regional (e.g. Kutiel and Maheras 1998) to continental scales (Jacobiet et al. 2001, Fu et al.1999).

The main objectives of this study was (1) to characterize spatial and temporal variability of surface air maximum and minimum temperature along the Mediterranean coast, (2) to compare the trends at individual observatories at both local and regional scales, and (3) to determine the cause of the observed trends through assessing the impact of large atmospheric circulations on temperature variability at seasonal and annual timescales.

DATA AND METHODS

STUDY AREA:

Egypt extends between 22º N and 31º 30 N and 25º E and 35º E with an overall area of approximately 1 × 106 km2. It is surrounded by the Mediterranean Sea from the north and the Red Sea from the East. In general, the altitude varies gently from -133 m (EL Qattarta Depression) 2550 m (mountains of Southern Sinai) with an average of 306 m above the mean sea level. The "real" Mediterranean climate is mainly concentrated in Northwestern portions along the Mediterranean coast. This sector is generally characterized by moderate and rainy winters and hot and dry summers. The climate is particularly influenced by maritime influences from the Mediterranean Sea. However, recent projections towards more drier and hotter conditions are expected in the following decades. Along the Mediterranean coast, the wet season only extends from December to February due to proximity to the Mediterranean. The mean annual precipitation reaches 52.8 mm along the Mediterranean. The annual averages of maximum and minimum temperatures are 24.6º C and 15.8 º C respectively. Summer maximum temperatures commonly exceed 30ºC, whilst winters minimum temperatures rarely fall below 10º C. Egypt has a population of more than 70 million people heavily concentrated in the Nile Delta and along the Nile Valley . The annual average of growth population exceeds 1.9 % giving more pressure on national sources of income (Shaalan 2005). Tourism is one of the most important and rapidly growing service industries and represents one of the promising sectors in ambitious development plans for the future.

Table 1: Weather station characteristics

ID	Station Name	Latitude. (N)	Longitude.(E)	Altitude (m) above M.S.L
62300	Salloum	31° 34 '	25° 18 '	4
62303	Sidi Barrani	31° 27 '	25° 52 '	21
62306	Mersa Matroh	31° 20'	27° 13'	18,3
62309	Dabaa	30° 56 '	28° 28 '	17
62316	Dekhiyla	31º 08'	29 º 48'	3,11
62318	Alexandria	31° 12'	29° 57'	3,4
62324	Rosetta	30° 24 '	30° 24 '	1,7
62325	Baltim	31° 33 '	31° 05 '	1
62330	Damietta	31° 28 '	31° 45 '	1,9
62332	Port Said	31° 17'	32° 14'	1
62337	El Arish	31° 04'	33° 49'	15
62342	Janklees	31° 49 '	30° 12 '	10

DATA DESCRIPTION:

The analysis was carried out based on a set of 12 observatories distributed along the Mediterranean coast of Egypt. A list of the stations and their coordinates are shown in Fig. 1 and Table 1. The base period for current analysis spans from 1957 to 2006. The dataset included quality controlled, homogenized and reconstructed series of monthly air temperature. More concern was given to check the quality of the original dataset obtained from the Egyptian Meteorological Authority.

The quality control is a fundamental task to ensure the quality of climatic data before performing climatic analyses such as long-term climate change and extreme events (Aguilar et al. 2003). This procedure aimed to minimize uncertainty related to the dataset by identification of anomalous and suspious data in the observatories, specifically outliers (Reek et al. 1992; Eischeid 1995).

In our procedure, the quality control process was operationally subjected to several quality control procedures to test internal and external consistency. Initially, typical tests to identify "gross" systematic errors resulting from archiving, transcription, digitization processes or other potential sources of error (e.g. non-existent dates, Tmin ≥ Tmax, Tmax > 50 ºC, Tmin < - 50 ºC, 3 consecutive months with identical records) were accomplished; subsequently, inconsistencies were flagged. The internal consistency was designed to screen for the within-station data inconsistencies by checking the observed value in question against other values following the procedures described by Reek et al. (1992). The external consistency refers to the process of checking out each value on a given month with values of the same month in a given number of nearby stations (Hubbard 2001). This procedure was designed to eliminate the worst data by identifying potential outliers and trimming extreme values that differ greatly from the neighbors.
Also, one of the most popular problems in handling raw climatic data is the presence of inhomogeneities arising from a variety of non-climatic factors such as alterations in the observatory locations, observer, surrounding environments or instruments (Costa and Soares 2009). Inhomogeneities can make the data unrepresentative of the real climate variations and lead to invalid conclusions. Thus, accurate long-term variability and trends and climate change analyses require homogeneous dataset. Historically, numerous attempts have been made to develop appropriate method to detect and correct inhomogeneities at low temporal resolution (i.e. monthly and annual) (Alexandersson 1986; Petrovic 2004). In absence of accurate, complete and well-documented metadata (station history) to identify supporting evident of significant change in observational routines, methodologies based on building a composite reference time series from well correlated series was an adequate choice for our research. Following the standard procedures of Peterson and Easterling (1994), a reference series was objectively built for each target series using information from the most highly correlated series. This procedure was automatically performed using the PROCLIM software developed by Stipanek (2007).

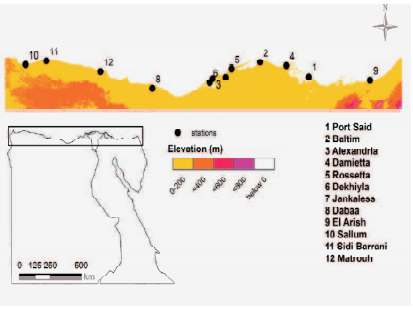


Fig.1 Location of the study area and spatial distribution of the observatories

Homogeneity testing techniques vary in their theoretical background and algorithms. Hence, there is no one single test to be recommended as optimal for each situation. In the current research, three well-established tests were proved to be useful to check homogeneity of the monthly series at a 5% significance level: the Standard Normal Homogeneity Test (SHNT) for a single break, Easterling and Peterson Test and Vincent method.
An application of different statistical methods in combination with accurate and complete metadata can improve the overall degree of certainty about identification of discontinuities in the series (Wijngaard et al. 2003; Menne and Williams 2005). Homogeneity tests were performed at monthly and annual scales. The AnClim software developed by Stipanek (2007) was used for carrying out this task.

Once the assessments are made, the outcomes of significant breaks resulted from the three tests were grouped together. This procedure enables not only identify the same break in one series, but also track down in homogeneities not identified by any of the other two tests. This approach has been recommended by many researchers (cf. Wijngaard et al., 2003; Costa and Soares; 2008). Based on the combined results, a subjective decision was made about correcting the abrupt changes, deleing the break of the series or excluding the series entirely from the new dataset. When abrupt changes are identified, a correction (adjustment) factor is computed as the average difference between the reference series and the candidate series. Afterwards, the monthly adjustments were applied to the candidate series resulting in a homogenized monthly dataset of maximum and minimum temperatures and precipitation. As shown in Fig. 1, the distribution of the meteorological observatories is evenly well-distributed along the entire coast with low density in Sinai.

The indices of atmospheric circulations were obtained from the Climate Prediction Center, NOAA, USA. The indices included the ENSO (El Niño southern oscillation), the North Atlantic Oscillation (NAO) index, the East Atlantic-West Russia (EAWR) index and the East Atlantic (EA) index. The NAO is a north hemispheric mode and calculated as the difference between the high surface pressure located in the Azores and the sub-polar low pressure near Iceland. On the other hand, the EAWR pattern has two main centers: the first is located in the Caspian Sea and the latter is found in Western Europe.

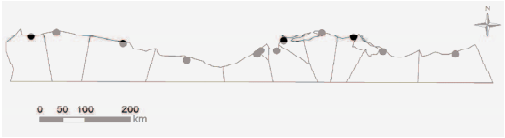
TRENDS CALCULATION:

Possible trends of maximum and minimum temperatures at each weather station were calculated seasonally and annually using the nonparametric Spearman (Rho) test at the 95% level of significance. This statistic is a least square likelihood method commonly used in climatological and hydrological applications. This test is robust to outliers and does not assume prior probability distribution of the residuals. The slope was estimated at a significance level of 95% (p value < 0.05) using the ordinary least-square fitting and expressed in ^{o}C per decade. Moreover, seasonal averages were obtained from monthly data for each year and defined as winter (December-February), spring (March-May), summer (June-August), and fall (September-November). Low-path filter of 7 yrs was applied to smooth out the interannual variability and reduce random fluctuations (De Luis et al. 2000). Also, a regional series was obtained to test whether detected trend at each station occurred by chance or reflected spatial structure. Thereby, the regional series helped provide an overall picture of climate variability along the Mediterranean coast in Egypt. In this context, the area-based weighting based on application of the simple Thiessen polygon was performed to create the regional series (Fig.2). On the contrary, upon application of the simple arithmetic average, more weight may be given to areas with dense data (e.g. west of Alexandria) resulting in overrepresentation and clear bias.

INFLUENCES OF LARGE ATMOSPHERIC CIRCULATIONS:

To account for impact of large atmospheric circulations (NAO, EAWR and EA) on variability of maximum and minimum temperature, the Pearson correlation coefficient was computed between the climatic series and the teleconnections series for the period (1957-2006) at p value < 0.05. The association between the trends of maximum and minimum temperature and phases of teleconnections (i.e. positive and negative) were also examined at seasonal and annual time steps.

(A)



(B)

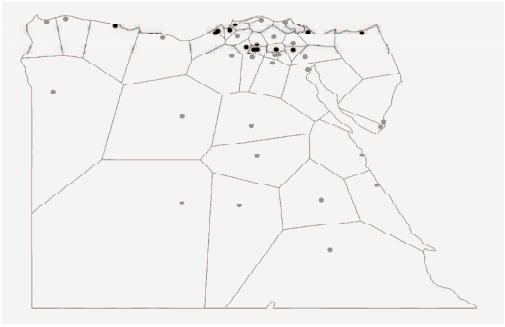


Fig.2. the Thiessen polygon for (a) the selected 12 observatories and (b) for Egypt

RESULTS AND DISCUSSION:

SPATIAL AND TEMPORAL PATTERNS OF TEMPERATURE:

In this section, the results of the spatio-temporal variability of maximum and minimum temperature based on individual observatories are discussed.

MAXIMUM TEMPERATURE:

As shown in Table 2, it is evident that the annual maximum temperature exhibited an upward trend in most of observatories along the Mediterranean. Interestingly, the trends were statistically insignificant on the eastern Mediterranean confirming more warming along the western coast. Among all seasons, the upwarding tendency was more evident in summer compared with other regions. In this regard, majority of the observatories in summer showed a positive and significant trend along the coast. Only Damietta and Port Said showed statistically insignificant behavior. On the contrary, the trends were statistically insignificant in most of stations in winter and spring. This finding confirmed that the increase of annual maximum temperature is spatially coherent with the increase in summer and fall temperatures rather than winter and spring. A long the coast, there is a more clear gradient from the west to the east. This result may have some undesirable implications in terms of summer tourism across the entire coast. Practically, more concern may be given in future to increasingly develop strategies and plans to enrich tourism in winter and spring rather than summer and fall. These findings likely come in contrast with the results found by (El Kenawy et al. 2009) for the Libyan coast during the period (1951-1999) where clear positive trends were confirmed during winter and spring, whereas non significant trends were documented in summer and fall.