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RECTOR'S SPEECH

The Bioterra Journal „BULLETIN OF SCIENTIFIC INFORMATION", ISBN registered, being at the 9th consecutive edition, it forms itself into a real information and display of the most recent and valuable research in the field of agriculture and conected sciences (food industry, agro-tourism, ecology, agricultural economy etc.)

This way I greet our Journal contributors, well known academic and collegiate names whose works are found in the performed selection by our selection board of our Journal.

Due to the limited publishing space we were forced to select for this edition only a part of the valuable works reported at the International Conference „Global Strategies in Agriculture, Agro-tourism, Alimentation, and Envirnment Protection", organized this Spring by our University in alliance with the Academy of Romanian Scientists.

We express our gratification to our co-workers from the worldwide well known universities and institutes, that accepted our invitation to atend the international conference, co-workers with whom we have relations of very tight collaboration and mutual benefit in the development of some jointed research projects.

I wish to the Journal many and consequent editions.

Prof. Floarea NICOLAE, PhD
Rector of the Bioterra University of Bucharest

Cuprins:

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RESEARCH OF THE FOLIAGE DISEASES OF GRAPEVINE WITH LOW INPUT OF PESTICIDES

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Abstract: ***Advances in knowledge of epidemiology have paved the way for improved disease control. Low fungicide input strategies have been developed for powdery mildew (Uncinula necator) and downy mildew (Plasmopara viticola). The foundation of these strategies is to apply fungicides when disease levels are low and stop the epidemics before they gain momentum. This relies upon a „clean vineyard" approach where disease carryover is minimised each season. In so doing, there is a strong reliance upon monitoring of the vineyard and the weather to predict/determine the occurrence of primary infection events.***

Key words : *Uncinula necator, Plasmopara viticola, grapevine, pesticides.*

Introduction

Many times in history, diseases and pests have compromised the economic practice of grapegrowers. Notable examples have been downy and powdery mildew and phylloxera. Even today, despite a large body of disease information and an arsenal of effective fungicides, crop losses continue. The challenge for effective management is even greater in organic viticulture, where many effective chemical treatments can not used. In the past, disease controls have often been applied with little understanding of the biology of the pathogens. In the last 15 years, there has been a rapid increase in under-standing the epidemiology of important grape diseases. In this paper, we explain how this understanding has lead to minimal intervention strategies for disease control. This means managing diseases with low chemical inputs. Our results have shown that fewer fungicides are needed when intervention takes place early in the progress of the epidemic. That progress can be easily halted if treatments are made to remove sources of overwintering inoculum or when the population of disease (inoculum) is small. Finally, we show that the outcome can be a management strategy based on inoculum removal by hand when this is timed and executed with extreme precision. European viticulture with small plots and intensive labour practices represents one of the most likely proving grounds of such a strategy. To illustrate this approach we will demonstrate how an improved understanding of epidemiology has led to improved and finally minimal intervention management for two diseases: powdery mildew and downy mildew. After introducing strategies for each disease we discuss the monitoring techniques that make this possible.

Material and method

» Powdery mildew

Powdery mildew is a good example of how our understanding of epidemiology has improved. The pathogen Uncinula necator causes a widespread, persistent disease of grapevines in world vineyards. It often causes major crop loss and decreases wine quality. In 1996, it was estimated that powdery mildew caused $17m in lost production in viticulture (approximately 2% of estimated crop value) and a further $10m were spent on control measures. Premium wine grape varieties such as Chardonnay are highly susceptible. Entire crops of susceptible

varieties are lost when control measures are inadequate. Shipments of grapes with as little as 3-5% bunch disease have been rejected by wineries. Each season, 4-8 pre-infection (protectant) fungicide sprays are applied for disease control, an inefficient and costly approach that is not always successful because of poor spray timing and application.

The main reason for this inefficiency was that fungicide applications were taking place too late in the season. Control of disease is most easily achieved prior to flowering (figure 1). Powdery mildew schedules were often recommended to begin at the 40 cm shoots stage, but in many cases sprays were not applied until after bunch closure when the disease became obvious in the vineyard. By this time the epidemic was so well advanced that control even with three applications of systemic fungicides, was impossible (figure 1). Although disease is not obvious until bunch closure, it has actually begun to spread in vineyards as soon as two weeks after bud burst. Primary infection begins from spores (conidia) from flag shoots (diseased shoots from infected buds) or from spores (ascospores) released from cleistothecia (fruiting bodies of the fungus). Where vineyards with poor disease control are in close proximity (<40m), conidia from adjacent vineyards will be another important source of primary infection.

Once primary infection has occurred, the powdery mildew spreads rapidly under most weather conditions. In five to seven weeks from budburst, the disease spreads from foci of initial infection to produce isolated colonies on leaves and bunches throughout unsprayed vineyards.

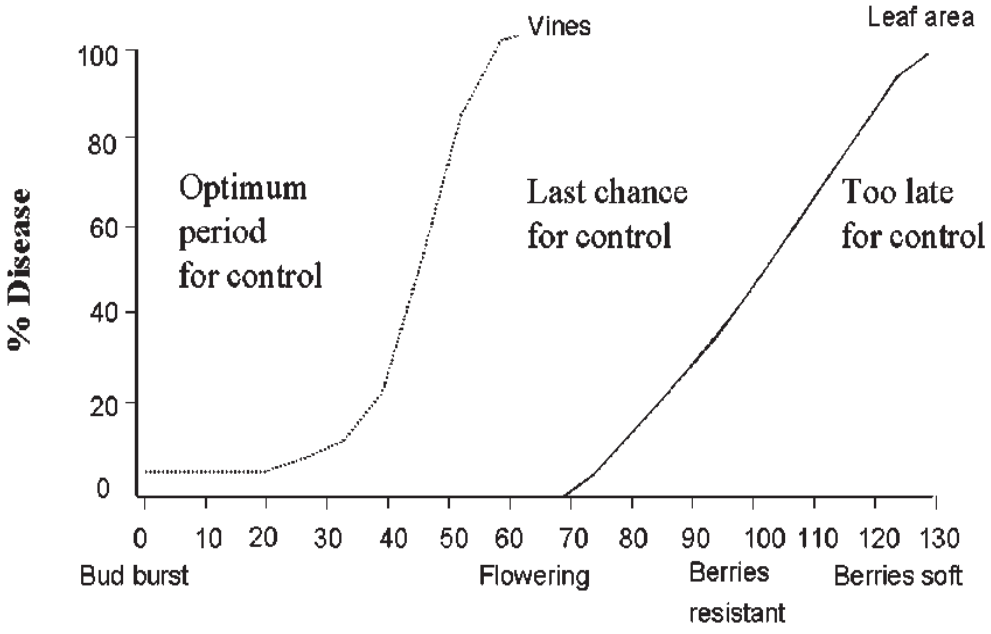

Figure 1 - The influence of progress in the disease epidemic upon ease and effectiveness of controlling grapevine powdery mildew in Romania

After this, disease severity also increases rapidly (figure 1). Leaves, shoots and berry stems remain susceptible while green. However, berries are susceptible only until 4-6 weeks after flowering, ie. until pea size and bunch closure. Consequently, early season control of disease is critical. An early and high level of primary infection will lead to a severe epidemic and crop loss. Conversely, when primary infection does not begin until after flowering, berry damage and substantial crop loss is unlikely.

A second important principle is the concept of 'clean' and 'dirty' vineyards. Vineyards with severe disease will have high levels of flagshoots (shoots that arise from diseased buds) and cleistothecia ready to initiate disease next season. Studies in Germany have shown that by controlling the disease before flowering, particularly before EL 15, can over several seasons, eliminate flagshoots and even possibly eradicate the disease from some localities or regions. Cleistothecia are hard to control once formed but a good control program can be greatly reduce the numbers produced.

As a result of the above developments, we developed and tested two strategies for control of powdery mildew. In the so-called „2-4-6 strategy", fungicide sprays are applied at two week intervals three times before flowering. In warmer districts, sprays should be applied 2, 4 and 6 weeks after budburst. The timing of individual sprays may need to be adjusted for vine growth in other districts. Vineyards should be monitored soon after flowering (usually nine weeks after budburst) and sprayed at 10 and 12 weeks after bud burst or later in the season but only if monitoring indicates the disease is spreading in the vineyard, eg. disease is present on more than one vine in ten. To avoid crop loss, sprays are only effective until bunch closure. The 2-4-6 strategy slowed early season spread and delayed the onset of epidemics. With good spray coverage over several seasons, it also reduced bud-infection and hence, flag shoot inoculum in vineyards.

The so-called 'Look-first strategy' is for clean vineyards and involves monitoring for disease and spraying fortnightly only after powdery mildew is found. To be successful, mildew must be detected before it appears on 10% of vines. The look-first strategy reduced spraying but risked crop loss when monitoring failed to find very low levels of disease especially in dense canopies. An extension of this strategy is to remove disease by hand instead of using a fungicide program. A third strategy, is the so-called 'Inoculum removal strategy'. Although our testing of this is incomplete, it may offer benefit to some growers. This strategy is only possible where labour is plentiful or blocks are small and it requires the cooperation of neighbouring growers to ensure that disease does not spread from adjoining blocks. It would also only be possible in a 'clean' vineyard. In this strategy, e inoculum removal strategy the vineyard must be monitored for powdery mildew every week beginning two weeks after bud-burst and continuing until flowering. The timing of the monitoring periods could be adjusted to accommodate de-tection of ascosporic infection after favourable weather events. Once detected, flag-shoots and mildewed leaves are removed and adjacent shoots are tagged. In subsequent inspections, greater searching time is spent searching for disease near these tags. If disease has spread to > 10% of vines prior to bunch closure then a fungicide spray is re-quired.

» Downy mildew

In Romania, the conditions required for primary infection of downy mildew (Plasmopara viticola) are summed by the rule of thumb, 10:10:24, ie. the temperature

must be at least 10oC, while at least 10 mm of rain falls in a 24 hour period. The soil must remain wet for at least 16 hours for oospores to germinate. Then subsequent rain slash is needed to disperse spores from the ground to the undersides of leaves which must remain wet for at least 2 hours.
If 10:10:24 conditions and primary infection do not occur, downy mildew infection does not occur.

Levels of disease that result from primary infection are usually very low but rapid and destructive (secondary) spread of disease can occur during a warm (>12oC) humid night. High relative humidity (>97% RH) is needed at night to promote the production of spores on the underside of oilspots. These spores give the undersides of oilspots a white down-like appearance. Once the spores are produced they are dispersed to adjacent foliage and if the leaves remain wet for (a minimum) of 2 hours, secondary infection may occur. New generation oilspots appear 5-20 days after infection depending upon the prevailing temperature.

Downy mildew overwinters as oospores in decomposed leaf litter in the soil, where it may survive for many years. However, an inoculum removal strategy can be enhanced by knowledge of when infection events occur and when oilspots appear. Perhaps in some situations, physical removal of the oilspots can be undertaken to prevent additions to overwintering reservoirs. In vineyards where disease has been well managed, oilspots from primary infection are likely to be present on at most one vine in every 20. The vineyard could be monitored and oilspots removed once a downy mildew simulator had indicated that the oilspots had appeared on the leaf. It would be essential to remove in-oculum before a subsequent secondary infection period. There is possibility in this to use soft fungicides such as phosphorous acid which has proven highly effective in post-infection management programs.

Results and discussion

» Alternatives to conventional fungicides

The search for alternatives to present fungicides continues especially the development of environmentally friendly (soft) fungicides. A range of fungicides of varying efficacy have been tested for powdery mildew control including sodium bicarbonate (baking sodium), mineral oils, potassium phosphates and wetters. These chemicals are not as effective as conventional fungicides especially when coverage is poor. For downy mildew control a simple molecule, potassium phosphonate has proven effective.

Biological control for grape diseases has received considerable attention. Hyperparasites have been tested for powdery and downy mildew control and may have some merit. A tydeid mite has provided some control of powdery mildew, but is killed by some fungicide sprays and does not survive well on Vitis vinifera. Other research has shown the potential of a novel method of disease control. However, concerns about the effect of UV radiation on plant toxins makes this approach publicly unpopular. Likewise, the same researchers experimented with steam cleaning as a method of sanitation but abandoned this approach because of the cumbersome nature of the equipment.

Another important influence on disease levels is canopy management. Some canopy management systems promote foliage arrays with increased airflow and reduced disease pressure. Leaf removal has been found effective in reducing the severity of both powdery mildew and Botrytis. In our studies, we found that minimal pruning systems produce a canopy with shorter shoots but smaller and more open bunches and thus berries that are more exposed to airflow and

drying. This proves advantageous against diseases like downy mildew and Botrytis.

» Monitoring

Strategies that rely on low chemical inputs or inoculum removal are critically dependent upon accurate vineyard monitoring techniques. This monitoring includes the observations of disease in the canopy.

This is probably the most important facet of any low-chemical input strategy. The monitoring procedure we use involves scanning as many leaves as possible during a slow walk past the vines. Occasionally turn or part the foliage to reveal the undersides of leaves or to inspect bunches. This procedure has been shown to detect downy mildew and powdery mildew at incidence as low as 0.5% of vines pro-vided that 200-300 vines are searched. In test of this procedure in commercial vineyards, the monitoring program successfully detected powdery mildew at incidences below 10%, on 37 out of 41 occasions and below 3%, on 28 occasions. However, on two occasions disease was not found until 11 weeks after bud burst when it had spread throughout the vineyard. Although this was an undesirable outcome it was still possible to apply effective controls and to avoid crop loss in these vineyards.

Late detection of powdery mildew occasionally occurred because: (1) vine foliage was above 2.0 m height and could not be thoroughly inspected early in the season; (2) there was a rapid increase in disease as a result of windblown spores dispersed from an adja-cent diseased vineyard; and/or (3) intervals between site inspections exceeded two weeks. A major requirement of effective monitoring procedures is correct identification of symptoms in the vineyard. A pocket-sized field guide to good diagnosis includes standard monitoring protocol and is now available for Romanian grapegrowers to maximise efficiency and effectiveness of monitoring for diseases.

Table 1

The influence of the number of vines monitored on the time and level of first detection of grapevine powdery mildew on unsprayed, Valea Calugareasca, 2002-2007

# Vines Monitored	Time when disease was first detected: # weeks after bud-burst (level of initial infection as % vines)			
	50	100	200	300
Year				
2002-03	5 (4)	3 (2)	3 (2)	3 (2)
2003-04	2 (4)	2 (3)	*	*
2004-05	6 (8)	3 (1)	3 (0.5)	3 (0.3)
2005-06	11 (18)	11 (12)	8 (1)	5 (0.3)
2006-07	3 (30)	3 (20)	*	*

* Sampling was not necessary due to high disease incidence

Conclusions

In this paper, we have outlined strategies for reducing (and possibly eliminating) the need for fungicides in commercial Romanian viticulture. Each strategy relies upon a thorough understanding of pathogen biology and adopting the concept of a 'clean' vineyard. We are hopeful that the principle of inoculum removal may find use for some

specialised applications in the future. We also make a final speculation on climate change. Although this question should not be trivialised, it is important to point out that variation between seasons often exceeds that anticipated in many climate change scenarios. Consequently, we encourage grape growers to be vigilant in managing disease and in vineyard monitoring programs regardless of the ultimate impact of climate change. The correct use of present knowledge of the foliage diseases of grapes and of procedures and equipment to monitor their development in the vineyard will, we hope, allow growers to reduce the use of chemical controls. Careful and astute use of inoculum removal and/or depletion strategies has potential for success in the organic viticulture industry of Europe.

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CONTENTS OF RESVERATROL IN WINE OF ORGANIC AND CONVENTIONAL VINEYARDS

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Abstract: ***Phytoalexins are compounds synthesised by plants in response to various stresses. In grapevines, these compounds belong to the stilbene family. Several studies have shown that resveratrol is usually triggered by infection of berries by Botrytis cinerea. In organic viticulture, grapevines are usually more stressed by attempted or successful infections of various pathogens than in conventionally grown grapevines. The preliminary results will be used as a starting point for further research of quality aspects of organic grape-vine production.***

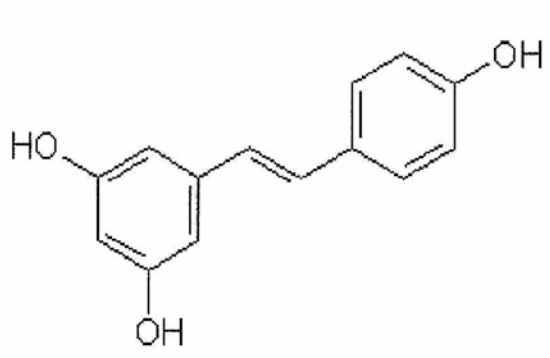
Key words: *resveratrol, wine, grapevines, Botrytis cinerea.*

Introduction

Furthermore, crop protection agents such as acidified clays or copper may trigger defence reactions of the plants. The aim of this study was to verify if differences between organically and conventionally produced wines exist. The preliminary results will be used as a starting point for further research of quality aspects of organic grape-vine production.

» Importance of resveratrol

Resveratrol has been used as an antioxidant for some time. However, the really important story of resveratrol starts in August 2003 when a landmark paper was published showing resveratrol increased the life span of laboratory yeast by 70%. Later, life span extension was produced using resveratrol in round worms, fruit flies, and fish. Then in November 2006 two mouse studies were published: the first described increased life span and protection from diseases of aging such as atherosclerosis, and the second showed doubling of exercise endurance and reduced body fat. The ability of resveratrol to produce these effects in a mammal means that it will probably work in humans in a similar way since humans have the same genes which are activated by resveratrol.



For 70 years, scientists have known that lifespan could be prolonged and many diseases prevented by restricting the calories an animal eats. The molecular mechanism which is turned on by restricting calories is also activated by resveratrol. The importance of this discovery is hard to overestimate. Much research remains to be done but the potential implications of activating a process which appears to prevent or delay virtually all diseases in animals are unparalleled in the history of human medicine. Resveratrol is likely to have an impact on human health comparable to the changes brought by antisepsis, vaccines and antibiotics during the 19th and early 20th centuries. These developments prolonged human lifespan mainly by reducing the death rate among the very young. Resveratrol will affect chronic diseases associated with aging,

including atherosclerosis (heart disease, stroke), diabetes, cancer, brain diseases (Alzheimer's, Parkinson's).

It is my opinion that resveratrol has the potential to change the health of the world. It is derived from a plant source which is classified as an herbal supplement under FDA rules. A giant self-experiment has begun: millions of people are or will be soon taking resveratrol. It will be used to treat a wide range of diseases and disease prevention, and dieters and athletes will use it for the fat loss, increased metabolic rate, and the increase in exercise endurance. New drugs based on the resveratrol molecule are being developed which will be more potent, but it will be years before they are available, and such drugs may therefore be superfluous if resveratrol becomes widely used.

Resveratrol is present in certain kinds of red grapes, but the high purity material used in eResveratrol is derived from the giant knotweed plant, Polygonum cuspidatum, which is native to Asia. The giant knot weed is a much less expensive and more abundant source of resveratrol than grapes.

Resveratrol interferes with influenza virus replication, and through SIRT1 activation, would improve resistance to infection. It is likely that widespread use of eResveratrol would reduce the incidence and severity of clinical influenza in the next widely anticipated pandemic. It would also probably reduce susceptibility to secondary pneumococcal pneumonia, the main cause of death due to influenza.

Perhaps the most amazing effect of resveratrol described in a recent mouse study is that mitochondria, the power sources of the cells, actually were altered to be more youthful. Mitochondrial dysfunction is believed to be the basic cause of aging, and as an animal ages its mitochondria become leaky and less efficient at energy generation. In the study, resveratrol actually made mitochondria function better than normal. In other words, resveratrol actually could restore an animal to a younger physiologic state, or make a young animal's mitochondria better than normal. Until now, it was thought that the aging process could only be slowed, but not reversed, and such slowing could only be accomplished by calorie restriction. The finding that new mitochondria are formed which are more effective than normal mitochondria suggests that the aging process can actually be reversed, at least in part!

Materials and methods

Sample wines (vintage 2007) were taken from six sites in south-east of Romania (Murfatlar, Medgidia, Cernavoda, Adamclisi and Ostrov). In each site, one sample was taken from wines grown organically and one from a conventionally maintained vineyard. In all but one sample, neighbouring vinyards were chosen in order to compensate for diffences in soil properties.

Wine samples were analysed for contents of resveratrol by means of high performance liquid chromatography.

Results and discussion

Contents of resveratrol varied between 0 and 32,8 ppm depending on variety, site, and production type. There was a clear distinction between white and red wines: In samples from Murfatlar, for instance, white wines had resveratrol contents of 0,3 (organic) and 0,2 ppm (conventional), whereas samples from Pinot noir contained 12,7 ppm (organic) and 13,7 ppm (conventional), respectively. Organic wines showed higher resveratrol contents rather constantly: in 7 cases, resveratrol content in organic wine was higher whereas in 2 cases resveratrol contents were inferior. These preliminary results indicate that there may be substantial differences between organic and conventional wine. However, further

research is needed to verify if differences of resveratrol contents occur on a regular base. If such differences exist, further research is needed to identify other primary or secondary metabolites as well as an assessment of the impact of such substances on wine quality and human health.

was higher whereas in 2 cases resveratrol contents were inferior.

The preliminary results indicate that there may be substantial differences between organic and conventional wine.

Table 1

Contents of resveratrol in wine samples (vintage 2007)

Site	Production Type	Variety	Resveratrol (ppm)
Murfatlar	organic	Pinot noir	12,7
	conventional	Pinot noir	13,9
Medgidia	organic	Merlot	32,8
	conventional	Merlot	23,6
Medgidia	organic	Pinot noir	17,6
	conventional	Pinot noir	13,5
Cernavoda	organic	Pinot noir	11,0
	conventional	Pinot noir	8,0
Adamclisi	organic	Pinot noir	14,9
	conventional	Pinot noir	8,0
Murfatlar	organic	Chardonnay	0,3
	conventional	Chardonnay	0,2
Ostrov	organic	Chasselas dore	0,13
	conventional	Chasselas dore	0,10
Murfatlar	organic	Pinot gris	0,8
	conventional	Pinot gris	0,9
Adamclisi	organic	Chasselas dore	0,53
	conventional	Chasselas dore	0,05

Conclusions

Resveratrol will affect chronic diseases associated with aging, including atherosclerosis (heart disease, stroke), diabetes, cancer, brain diseases.

Resveratrol interferes with influenza virus replication, and through SIRT1 activation, would improve resistance to infection.

Resveratrol is present in certain kinds of red grapes.Organic wines showed higher resveratrol contents rather constantly: in 7 cases, resveratrol content in organic wine

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ORGANIC FARMING IN THE NATURAL PARKS OF TUSCANY

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Abstract: ***This paper explain why and how to develop organic agriculture in Protected Areas of Tuscany. Although it could seem obvious, there are many obstacles that need to be removed in order that the rural territory rich of natural and human activities can be protected, conserve and valorised by the development of organic agriculture. A pilot project, coordinated by the Tuscan Association of Organic Producers and financed by ARSIA, provided to the rural farmers of Protected Areas information, exchange of knowledge, economic opportunity and to consumers and Park visitors promotion of farms activities and of organic products of this areas. The project was carried out in two steps: 1997/2001 and 2004/2008. In 1997/2001 involved the 3 Parks of 'Alpi Apuane', 'Maremma', and 'Migliarino, San Rossore, and Massaciuccoli'. In 2004/2008 The objective of the project was to convert into organic agriculture farms inside 11 areas of Tuscany and to support those who already adopted this method.***

Key words: *organic farming, organic agriculture, Tuscany.*

Introduction

The Protected Areas are a cornerstone of the international policies on natural conservation and sustainable development, particularly for biodiversity, basis of the protection of the wealth of life on earth. In Italy the law 394/91, the framework law on Protected Areas, has redefined the entire matter and gave new force for the protection of the environment and nature, establishing Natural Protected Areas. Protected Areas preserve and care for the environment and the landscape, defend biodiversity and natural resources but have also another very important role: the valorisation of the territory from the economic and social point of view developing sustainable economic activities such as the use of the Parks by the visitors. Parks and Protected Areas are generally located in rural areas of great natural value, but subject to abandonment and depopulation that could cause biodiversity and cultural traditions loss, breaking the delicate and the wonderful balance of that territory.

Materials and methods

» The role of organic agriculture in protected areas

The agricultural activity can be an important economic and social resource of these areas if done with agro-ecological approach. In fact intensive agriculture is responsible for the well-documented loss of soil fertility and biodiversity around the world at genetic resources level, as well as at farm and landscape level, reducing number of crops and animals.

Organic farming (EU Regulations n. 834/2007, and n. 889/2008 EU) it is a model of rural development as combines preservation of the environment, preservation of natural resources, protection and enouncement of biodiversity with the maintaining of the productivity of the agricultural systems. Organic farming is a sustainable production system from ecological, economic and social aspects. Indeed organic farming

reduces the use of renewable resources, does not use chemical inputs and GMO, cancelling the release of pollutants, maintaining biodiversity, preserving the territory, developing landscape, offering access to rural area and giving added value to agricultural products. To ensure that farmers in rural and marginal areas develop organic agriculture some obstacles have to be removed and the following crucial point have to be reached:

1) Affordable cost of production process
2) Increase of sale price of products through the valorisation of the method (organic farming certification) and the land (origin of products certification)
3) Public incentives in the Rural Development Plans, Park Plans, etc. for these farms
4) Redistribution of wealth at the local level
5) Sale of rural services: rural hospitality, green trails, environmental didactic, direct sales, horse trekking, etc.

» The protected areas system in Tuscany

In Tuscany the system of Protected Areas covers an area of 227.000 hectares, equivalent to 10% of regional territory and is now composed of 3 National Parks, 35 National Reserves, 3 Regional Parks, 3 Provincial Parks, 42 Nature Reserves Provinces and 52 Protected Natural Areas of Local Interest (ANPIL). Besides, a network of 156 Sites of Regional Interest (SIR) includes Bioitaly (D.C.R. 342/98) and Natura 2000 Sites (pSIC and ZPS).

These areas are often rural and marginal areas characterized by very different geo-physical aspects and unique peculiarities. Some of these areas are fully under integral protection, other only partial and into other areas the agricultural practice is allowed, although organic farming is not spread.

Currently organic farming represents in Tuscany approximately 15,8% (102.408 ha) of total Utilised Agricultural Area (UAA = 646.891 ha) and the 80% completed the conversion period, but in protected areas is necessary to encourage its diffusion.

Even when the Park Plan encourages the farmers to the adoption of organic farming methods, they have difficult access to information, agricultural development services and market. The development of the Protected Areas and Ecological Sites Network of Tuscany, supported by new policy of the Community Directives, has the main objective of integration between environmental resources and human activity. The development of organic agriculture in Protected Areas facilitates this integration maintaining biodiversity, ensuring environmental protection, enhancing soils fertility together with the production of quality, local and certified agricultural products and secondary economic activities such as didactic and educational.

» The project

A pilot project, coordinated by the Tuscan Association of Organic Producers (CTPB) provided to the rural farmers of Protected Areas information, exchange of knowledge, economic opportunity and to consumers and Park visitors promotion of farms activities and of organic products of this areas. The project was carried out in two steps: 1997/2001 and 2004/2008. In the first one it involved the three Regional Parks of 'Alpi Apuane', 'Maremma', and 'Migliarino, San Rossore and Massaciuccoli'. In 2004/2008 the objects were extended to 11 protected areas of Tuscany to convert conventional farms into organic and to support those who already adopted this method.

Results and discussion

» 1st step

The Pilot Project on the 'Development of Agriculture and Organic Livestock Production in the Regional Parks of Tuscany' was enforced following the protocol of agreement among the Councillorship for the Environment, the Councillorship for Agriculture, ARSIA (Tuscan Regional Agency for the agriculture development and innovation), the Tuscan Association of Organic Producers (CTPB), the Park Service of the Alpi Apuane, the Park Service of Maremma, the Park Service of Migliarino, San Rossore, and Massaciuccoli. The Project had a duration of three years (1997/2001), with regional funds of about €100.000 per year.The project objective was that of promoting organic agriculture in the Parks, in order to reach the conversion of 30% of the farms in the parks, with an organic UAA (Utilised Agricultural Area) that represented 20% of the total (Migliorini, 2000; Battino et al., 2000; Martini et al., 2004).

The advisors of the Tuscan Association of Organic Producers, CTPB (agronomists, livestock production experts, veterinarians), together with ARSIA and the Park Services, performed the following actions:

1) Information and dissemination of the techniques of organic agriculture, in order to favour the conversion of the farms in the parks through contacts with the farmers, field visits and meetings

2) Technical support and live demonstrations to agronomics, livestock productions and veterinary medicine, for the farms already converted to organic production or currently in the process of conversion

3) Promotion of organic products in the parks and identification of possible commercial outlets

4) Activity of co-ordination and promotion of the project

» Park of Alpi Apuane

Area: 20.598 ha

Provinces: Lucca, Massa Carrara

Since 1985

Website: www.parcapuane.it

The territory of the Park is made up of the area of the park and by a contiguous area, as identified by the Regional Law 65/1997, in which there are 230 farms, with a medium age of the farmers of about 53 years. The farms are mostly small or very small, often family-run, with prevalent use of spare time remaining from other main activities.

Livestock production in the area is characterised by the presence of cattle and sheep farms, mostly in the areas adjoining the park. The animal products consist of pork sausages, beef, sheep and goat meat, rabbits, fresh milk, cow, sheep and goat cheese, ricotta cheese, trout, honey, beeswax, bee propolis, royal jelly and bee pollen. The most important agricultural products are fresh chestnuts, chestnut flour, wheat flour (corn, spelt), firewood, potatoes, beans, tomatoes, forage for animal use, apples, pears, herbs, wine, oil and undergrowth products such as wild strawberries, mushrooms, blueberries and raspberries.

The project activity regarded the valorisation of the chestnut flour with saving the chestnut groves through free-climbing techniques, forming an association of producers and saving a historical stone water mill.

Principal results of the project in 2000 were:

1) Conversion of 5 farms to organic production

2) Creation of semi-free livestock production of Cinta Senese (autochthonous pig breed), and production of organic Lardo di Colonnata.

3) Creation of a fruit arboretum with autochthonous species

4) Production of organic chestnut flour using the ancient water mill

» Park of Migliarino, San Rossore, Massaciuccoli (MSRM)
Area: 24.000 ha
Provinces: Lucca, Pisa, Livorno
Since 1979
Website: www.parcosanrossore.it

The Regional Park of MSRM, founded in 1979, covers about 24.000 hectares along the coastline between Viareggio and Livorno. Although it is in the centre of a highly urbanised area, this territory has maintained remarkable natural characteristics, and it is one of the rare examples of a coastline which has not been built up.

The agricultural surface inside the Park is of 9.400 hectares, with an utilisable agricultural area (UAA) of 7.000 hectares. In the Park Estates (Coltano, Tombolo, Padule Nord, Padule Sud, Migliarino, San Rossore) the main products are grain, forage, livestock production, industrial cultivations of fruit orchards and horticulture.
The project activities regarded:
1) High-quality tomato in protected cultivation
2) Potato cultivated in open fields
3) Precocious peach trees
4) Strawberries in protected cultivation
50 Veterinary homeopathy

In 2000 4% of the active farms have converted to organic production (6 farms within the Park and 2 farms in the adjoining areas).The total converted UAA was 600 hectares, representing 8.5% of the park UAA.

» Park of Maremma
Area: 10.000 ha
Province: Grosseto
Since 1975
Website: www.parco-maremma.it

The territory of the park extends along the Tirrenian coast from Principina a Mare to Alberese and to Talamone. Significant geographic points are represented by the Ombrone River, the mountains of Uccellina, the swamp area of Trappola, as well as the marine coast. The protected area and the adjoining area are part of the Municipalities of Grosseto, Magliano in Toscana and Orbetello, for a total of 18.000 hectares.

In the park, there are a high numbers of areas cultivated with grain (mostly durum wheat), sunflowers, olive trees and forage, those connected to the livestock sector for the production of milk and meat from cattle (for meat the Maremmana breed, for milk the Italian Holstein) and to a few sheep farms (the Sardinian breed). Other production in the park includes fruit (grape vines and peaches) and vegetables.

The main activities of the project regarded trials with olive tree fly abatement methods, using mass trapping and Bordeaux mixture (mixture of copper sulphate and hydrated lime in small doses), and trials of cultivation in open fields of watermelon, using beneficial insects.

The farms converted from the beginning of the project were 19 (30% of the total from the census) for a converted UAA of 742 hectares, equal to 27% of the convertible UAA. The number increased to 20, with the conversion of the Regional Farm of Alberese, a UAA of 1,232 hectares equal to 50% of the convertible UAA.

» 2nd step
After the success of the previous project 'Development of agriculture and livestock in Tuscan regional parks' (1997/2001), a second edition was financed by ARSIA (regional agency for agricultural development). The project (2004/2008) had a budget of € 350.000. The objective of the project was to convert into organic agriculture farms inside 11 areas of Tuscany and to support those who already adopt this method (Migliorini, 2008).

The Tuscan Association of Organic Producers (CTPB) in collaboration with other associations coordinated the project 'Development of organic farming in Protected Areas and Ecological Sites Network of Tuscany'.

The actions were:

1) Information and dissemination of organic agriculture and livestock techniques through visit to good organic farms, information desks, and demonstration trials.

2) Dissemination, education and didactic actions to consumers for promotion and marketing of organic products, trough organisation of meeting on short chain, analysis of the agriculture production and the census of products, valorisation actions of the targeted products to consumers, both informative (brochures, exhibitions, campaign) and educational (courses, seminars, tasting, workshops).

3) Creation of a network between all stakeholders to develop rural areas through implementation and maintenance of web site of the project (www.bioparchitoscani.it), creating and printing information material, organisation of a congress to present the project results and a Fair of Protected Areas.

This second phase was more difficult as the areas were larger and the economic period critic both for general economic problem and less public incentives and subsides from the public sector. Farmers' needs were less from technical and more related to market opportunity. The short chain is always a good alternative to sell directly organic, high quality, seasonal, local foods.

Main result of the project was to make work together the environmental sector with the agricultural sector at both regional and provincial level, often in contrast.

Conclusions

Not all of these issues can be resolved at one go and each farm has a different story. Solutions can be found only enhancing natural and human resources according to the peculiarity of the territory.

In fact, the farmers that convert its farm to organic agriculture need to find out a different mental approach to farming, to be informed about legal framework, to learn new agronomic techniques and to find innovative commercial channels. This goes together with the increase of both certification and production costs and with higher time cost spent on bureaucracy, without to be certainly supported by Rural Development Plans.

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THE EVOLUTION OF SHEEP MILK PRODUCTION ON NATIONAL AND WORLD PLAN DURING TO 1995-2007 PERIOD

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Abstract: ***The worldwide production of sheep's milk trend is to maintain the current level or a slight increase over its 2007 level, due to the increasing needs of the population for these nutritious sorts of cheese with a special flavor provided from this type of milk. In Romania the production of sheep's milk is only 8.2% of the total milk, being insignificant compared to that of cows (91.3%), having however an upward trend evolution in the last decade. The current share of livestock and productions of this species in Europe is far from the real possibilities of Romania, the only parameter which is optimal from this point of view being the milk production.***

Key words: *sheep's milk, sheep exploitation, milk production.*

Introduction

In Romania the present trend in sheep exploitation is for milk production and the need to increase this production, regardless of race and her direction of exploitation, is a priority due to its biological and economic features. Thus, because of its content rich in almost all nutrients and essential amino acids in particular, various enzymes, vitamins and mineral salts and refreshing effect and antitox, sheep's milk is one of the most complete and necessary food for human nutrition and lambs. As regards human consumption, it is known that sheep milk was used alone or in the form prepared since ancient times, in many countries are putting the foundations of a genuine traditions processing.

Materials and methods

» The evolution of sheep milk production

Of the total world production of milk, which is 671.3 million tons, the sheep milk represents only 1.36%, being thus totally insignificant compared to that obtained from the cows, respectively 83.49% (Table 1).

In the present social-economic situation already exists at the international level, according to FAO data, the requirements for sheep milk are slightly increased over the past decade. Thus the production of sheep's milk worldwide is 9,146 thousand tonnes in 2007 (table 2), wich is bigger with 15.1% compared to that obtained in 1995 and bigger with 4.9% than in 2006. Increases of sheep milk production are registered on all continents, but particularly

Table 1

The quantity and percentage of the main types of milk in the world (source: FAO website, 2009) -thousand tonnes-

Specification	Total milk	Cow milk	Buffalo milk	Goat milk	Sheep milk	Camel milk
World Milk	671,307	560,487	85,397	14,801	9,146	1,476
Percentage (%)	100	83.49	12.72	2.21	1.36	0.22

on the Asian and African continents (28.1% and respectively16.6%). In the first place on the sheep milk production is Asia with 4,580 thousand tonnes, or about 50% of total world production, followed by Europe and Africa. Also from table 1 data we can remark a slight decrease of sheep milk production in Europe and European Union.

An economic importance is given less to the sheep milk in Canada, USA, Argentina, England, the countries of northern Europe, Australia and New Zealand, because these countries have favorable environmental conditions to develop bovine herds. In the countries of Oceania and North

Table 2

The evolution of sheep milk production worldwide
(source: FAO website, 2009) -thousand tonnes-

Specificare	1995	2000	2007	Differences (±%) 2007/1995
Total world	**7,946**	**8,046**	**9,146**	**+15.1**
Africa	1,468	1,578	1,711	**+16.6**
N+C America	-	-	-	**-**
South America	34	35	36	**+5.9**
Asia	3,576	3,531	4,580	**+28.1**
Europe	2,869	2,902	2,820	**-1.7**
Oceania	-	-	-	**-**
European Union	2,643	2,727	2,630	**-0.5**

Table 3

The evolution of sheep milk production in the main producing countries
(source: website FAO, 2009) -thousand tonnes-

Specification	1995	2000	2007	Differences (±%) 2007/1995
Sudan	388	462	480	**+23.7**
Algeria	192	180	205	**+6.8**
Iran	450	555	534	**+18.7**
Somalia	440	445	468	**+6.4**
Syria	454	446	610	**+34.4**
China	964	847	1,125	**+16.7**
France	224	254	254	**+13.4**
Greece	721	743	750	**+4.0**
Italy	784	742	560	**-28.6**
Spain	233	392	360	**+54.5**
Turkey	934	774	790	**-15.4**

Table 4

The evolution of sheep's milk yield (kg) and the number of sheep milked (thousand heads) worldwide (source: website FAO, 2009)

Specification	1995	2000	2007
Total world	44 177,094	42 188,703	47 195,361
Africa	30 48,621	30 52,300	30 56,532
N+C America	-	-	-
South America	25 1,329	25 1,364	26 1,376
Asia	38 92,328	34 103,244	43 107,055
Europe	82 34,815	91 31,795	93 30,398
Oceania	-	-	-
European Union	92 28,587	105 25,872	109 24,091
Developed countries	82 34,815	91 31,795	93 30,398
Developing countries	35 142,279	32 156,908	35 164,963

Table 5

The evolution of sheep milk production in Romania during 1995-2007 (source: website FAO, 2009)

Specification	1995	2000	2007	Differences (±%) 2007/1995
Total production -thousand tonnes-	407	321	485	**+19,2**
Average milk yield -kg/head-	52	56	90	**+73,1**
Number of sheep milked -thousand heads-	7,827	5,773	5,450	**-30,4**

America continents started only lately sporadic milking the sheep. In consequence, for Oceania and North America there are not data for sheep milk production. In these continents sheep are breeding only for meat or wool production or for both of them.

Analyzing data from table 3, where is presented the situation of sheep milk production in high producing countries it notes that a world leader in this direction is China, with 1,125 thousand tonnes, followed by Turkey and Greece, and the highest

increase is recorded in Spain (54.5%). A pronounced decreasing in sheep milk production is found in Italy and Turkey.

The research in the field of sheep milk production, reveals that only 195.4 million head sheep are milked annually worldwide (FAO, 2009), of which 107.1 million are milked in Asia, 56.5 million in Africa, 30.4 million in Europe (24 million EU), and only 1.4 million in South America (table 4). According to data provided by FAO, the average milk yield per head of sheep in the world are located in 2007 at 47 kg, which confirm the evidence that sheep milk in the world is produced unfortunately by unimproved breeds generally, with reduced individual average yields.

From the table 4 may be noted that, while in developed countries the average milk yield has increased in the last decade, due to continue selection for this character, in developing countries that remained almost at the same level. It also may be observed that while the number of sheep milked decreased in developed countries (12.3%), for diminish the costs of exploitation and increase the sheep farm profitability in developing countries it increased by 15.9%.

The highest average yields of sheep's milk in the world are recorded in Switzerland (350 kg), Austria (372 kg), Malta (227 kg), France (197 kg), Portugal (168 kg) and Spain (150 kg) and the lowest in Oman (12 kg), Guinea (20 kg), Ethiopia (25 kg), China and Moldova (28 kg) and Indonesia (30 kg). It is expected (in all countries with tradition in sheep breeding) as the average milk production per head of sheep to grow by improving various local races, using the infusion crosses with specialized breeds and selection for this character, along with improving the quantity and quality of the sheep feed.

In perspective, the worldwide production of sheep's milk trend is to maintain the current level or a slight increase over its 2007 level, due to the increasing needs of the population for these nutritious sorts of cheese with a special flavor provided from this type of milk.

Regarding the sheep milk production in Romania, milking all breeds of sheep applies since the ancient times in our country, sheep's milk as the main raw material which gave rise to traditional types of cheese.

Table 6

Romania share in Europe on the sheep livestock and yields in 2007
(source: website FAO and Eurostat, 2009)

Specification	MU	Europe	Romania	Share (%)
Sheep livestock	thousand heads	135,643	7,678	5.7
Meat production	thousand tonnes	1,296	57	4.4
Wool production	thousand tonnes	252	18	7.1
Milk production	thousand tonnes	2,820	485	17.2

However, the production of sheep's milk is only 8.2% (485 thousand tonnes) of the total nationally milk production, being insignificant compared to that of cows (91.8%), having however an upward trend evolution in the analyzed period (higher with 19.2%), as the data presented in table 5.

Of those presented, it appears that the total nationally production of sheep's milk is currently located at a good level, from this point of view instead of 7 in the world and 3 in place on Europe, which is due to the good average milk yield, which is 90 kg/head of sheep, and on the other hand, to the numbers of sheep milked, respectively 5.45 million heads.

Given the potential for mixed exploitation of local breeds of sheep, the favorable geo-climatic conditions of sheep breeding and fodder resources available, along with economic integration of Romania into the European Union proper and in terms of agriculture in the near future, we believe that the current share of livestock and production of this species in the European context is far from the real possibilities, which required a new reconsideration of this economic sector to enhance competitiveness of our country on the border (table 6).

Results and discussion

To achieve the aforesaid goal, the need for Romania is a situation of economic parameters in share values from Europe around 10-15%, so that milk production is the only parameter which is optimal from this point of view and although this may be increased to a level much higher (about 20%).

In countries with tradition of raising sheep is necessary, regardless of the direction of exploitation, to give a major importance of improving the breeds milk production in order to achieve high quantities of cheese from sheep's milk for domestic consumption or export recovery, so that the economic use of sheep to be justified for our country, to value the sheep. It is appropriate therefore that the total production of sheep's milk in Romania to be enhanced in particular by increasing the average milk yield, in relation to the productive capacity of each breed, either by the infusion crossbreeding of local breeds with specialized breeds, either by improving the selection level of each breed and the conditions of feeding and maintenance.

Conclusions

1. In perspective, the worldwide production of sheep's milk trend is to maintain the current level or a slight increase over its 2007 level, due to the increasing needs of the population for these nutritious sorts of cheese with a special flavor provided from this type of milk.
2. It is expected (in all countries with tradition in sheep breeding) as the average milk production per head of sheep to grow by improving various local races, using the infusion crosses with specialized breeds and selection for this character, along with improving the quantity and quality of sheep feed and maintenance.
3. In Romania the sheep milk production is currently located at a good level, being placed on the 3 in Europe and 7 in the world, which is due to consumer tradition, to satisfactory milk yields and to the numbers of sheep milked.
4. The current share of livestock and productions of this species in the European context is far from the real possibilities of Romania, the only parameter which is optimal from this point of view being the milk production.

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TWENTY YEARS OF GRAPEVINE VIROLOGY FOR A SUSTAINABLE VITICULTURE AT NRDIBH ŞTEFĂNEŞTI-ARGEŞ

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Abstract: ***Viticulture represents an important part of agriculture in Romania. The improvement of native and international cultivars and clones by sanitary selection, detecting the viruses using advanced methods and developing the virus elimination techniques is essential for a sustainable viticulture. It is well-known that a virus-infected plant decays after 4-5 years of growing, depending on genotype, type of virus/viruses, environment conditions and applied technology. A virus disease reduces the grape yield till 80%, also affecting the fruit quality (the accumulation of carbohydrates-sweetness of fresh fruits, or the alcoholic content of the wine, and the commercial aspects of the grapes). The plantations with healthy plant material have a longer exploitation period at the specific quantitative and qualitative parameters and needs lower costs for nutrients, pesticides treatments and maintenance. The activity for sanitary selection and virus elimination in vineyards has to be done in according to the national planning material capacity and based on the certification scheme used in countries having a major contribution to European grape production. The program initiated for obtaining virus-free grapevine plants was constantly developed over the last years due to the increasing number of cultivars and clones needed to be available as healthy material. According to the certification scheme followed by laboratory, the testing for virus detection was carried out by using herbaceous test plant and indexing on woody plant indicators and starting on 1993 by ELISA test. So, in this moment are detected the most economically important grapevine viruses: fanleaf + arabis mosaic (GFLV+ArMV), leafroll associated virus serotypes 1, 2, 3 (GLRaV-1, 2, 3), fleck (GFkV), virus A (GVA). These biological and biochemical tests for virus detection in combination with heat treatment and/or in vitro culture for virus elimination were the main procedures for obtaining virus-free plants which were used to establish a germplasm collection. In this moment the national grapevine germplasm collection contains 224 cultivars and clones (95 are native cultivars and 33 are autochthonous clones obtained from international cultivars) which are morphological and molecular authentified and periodically verified for their phytosanitary status, according to the European standards. This plant material represents a national fortune that could be used either as starting material for propagation and planting, or as plant material in studies concerning genetic variability of characters, adaptability to environment, and parental plants in breeding programs.***

Key words: *grapevine virology, ELISA test, tests for virus detection, in vitro culture.*

Introduction

Viticulture represents an important part of agriculture in România, both from the economic and social point of view. The total area under vines is about 189.7 thousands

ha, of which 177.1 thousands wine grapes and 12.6 thousands table grapes. Being an intensive culture, the area of vineyard covers only 2% of the agricultural area. However, economically, viticulture covers 10% from the value of the agriculture production. In our country, viticulture represents the labor activity of about 33 000 families that is about 1 million people.

The quality of the grape depends on several influences and one of the most essential production factors is grapevine planting material. For this purpose, the European Community has formulated an uniform Community certification scheme which aims to ensure both varietal identity and health status. România as UE country, in the viticulture field follows the strengthening of the viticulture patrimony and the promotion in the new vineyards especially of Romanian grapevine varieties for competitive quality of wine in European space. With the aim of establishing of long lasting vineyards it is necessary to use of healthy, virus-free planting material.

All known grapevine pests include about 70 infections agents belonging viruses (58), viroids (5), phytoplasmas (8), xylematic bacteria transmitted by insects (1). This represents the largest number of intracellular pathogen agents found for a single plant. The diseases produced by them reduce the vigour and longevity of plants or the quality and quantity of production. The contaminated propagating material is the first responsible for spreading these diseases in the viticultural areas of the world. Consequently all efforts should be done for improvement of sanitary conditions and the protection of healthy clones (Martelli and Boudon-Padieu, 2006).

A virus disease reduces the grape yield till 80%, also affecting the fruit quality (the accumulation of carbohydrates-sweetness of fresh fruits, or the alcoholic content of the wine, and the commercial aspects of the grapes). The plantations with healthy plant material have a longer exploitation period at the specific quantitative and qualitative parameters and needs lower costs for nutrients, pesticides treatments and maintenance.

Virological analyses carried out until now have been shown that Romanian grapevine varieties are infected with many viruses (Boscia and Demarinis, 1998; Milkus et al., 2000). In the future, a survey of the most spread grapevine viruses/virus diseases/virus-like diseases of this crop all over the vineyard of the country is necessary.

The improvement of native and foreign cultivars and clones by sanitary selection, detecting the viruses using advanced methods and developing the virus elimination techniques are essential for the efficiency of viticulture. Thus, the activity in grapevine virology field have been oriented to the following directions: establishing and maintenance of the initial grapevine plant-material collection, the study of grapevine biological material in the presence of virus infection, monitoring of grapevine viruses/virus diseases/virus-like diseases in vineyards, service activity.

One of the most important mission for National Research and Development Institute for Biotechnology in Horticulture Ştefăneşti-Argeş (NRDIBH Ştefăneşti-Argeş) is to establish the initial grapevine plant-material collection and to preserve it in proper conditions, as is required both by the European and national legislation.

Material and method

The activity for sanitary selection and virus elimination in grapevine was carried out at the NRDIBH Ştefăneşti-Argeş since 1988, according to the national planning for producing planting material and based on the certification scheme used in countries

having a major contribution to European grape production (Oşlobeanu et al., 1988).

Infected cultivars and clones detected as positive for virus infection were subjected to virus elimination through heat treatment and/or in vitro meristem, apex, or axillary bud culture by adapting the working protocols (especially the duration of the treatment) to the particularities of each virus (Buciumeanu and Vişoiu, 2000). During the in vitro culture and acclimatization phase, the persistence of the virus in regenerated plants was routinely checked. Thus, the efficiency of virus elimination by thermotherapy and/or in vitro culture was confirmed by ELISA tests in each step of the virus elimination technology (Buciumeanu and Vişoiu, 1996). The virus elimination activity has in view the most dangerous grapevine viruses: fanleaf virus + arabis mosaic virus (GFLV+ArMV), leafroll associated virus serotypes 1, 3 (GLRaV-1,3), fleck virus (GFkV) and virus A (GVA). Also, fleck virus (GFkV) was eliminated by somatic embryogenesis (Popescu et al., 2003).

The healthy plants have been transferred into nuclear stock greenhouse for germplasm preservation under a severe regime for avoiding any virus infection.

ELISA - enzyme-linked immunosorbent assay (with DAS-, TAS- and DAS- biotin variants) is the most used method both for diagnosis and studies regarding the sampling strategy for different viruses (detection of the most reliable source of antigen and period of the year in which the analyze is performed).

The diagnosis of leafroll, fleck, vein necrosis and corky bark diseases have been done by a rapid biological method, in vitro micrografting (Buciumeanu et al., 2001; Vişoiu et al., 2001; Vişoiu and Buciumeanu, 2002). This method allows the detection of virus/virus-like disease in 2-3 months comparatively to the woody indexing procedure (1–3 years). Grapevine virus-free indicators necessary for biological indexing procedures (wood grafting, green grafting, in vitro micrografting) are available in the germplasm collection.

Also, in order to use the virus infected biologic material as reference (positive controls) in our studies and virus diagnosis activity, a grapevine virus infected collection cultivars was established.

Results and discussion

The program initiated for obtaining virus-free grapevine plants was constantly developed over the last years due to the increasing number of cultivars and clones needed to be available as healthy material. The plant material introduced within collection is produced by applying thermotherapy and/or tissue culture, and guaranteed for authenticity and phytosanitary status.

According to the certification scheme followed by our laboratory, the testing for virus infection was carried out in the beginning by use herbaceous test plant and indexing on woody plant indicators. Since 1993, the research has done progress in the study of viruses and viral diseases of grapevine after introducing the ELISA method with commercial reagents, for the detection of the most economically important grapevine viruses: GFLV+ArMV, GLRaV-1,2,3, GFkV and GVA (Buciumeanu et al., 1999; Tiţa and Buciumeanu, 2004).

Moreover, a virus-free grapevine collection of 224 grapevine cultivars and clones from which 95 are native cultivars, 41 (33 scions and 8 rootstocks) are autochthonous clones obtained from international cultivars was established, including plants which were tested for their authenticity and phytosanitary status, according to the European standards. Each cultivar or clone is represented by 7-21 own-rooted plants. This collection is used either as starting material for propagation

Table 1. The grapevine virus-free collection

Specification	Cultivars and clones (No)			
	Autochthonous cvs.	Autochthonous clones from international cvs.	International cvs.	Total cvs. and clones
Seedless table cultivars	3	-	12	15
Seeded table cultivars	26	10	11	47
White, rose and flavoured wines	46	12	15	73
Red wines	11	11	13	35
Resistant cultivars	7	-	21	28
Rootstocks	2	8	16	26
Total	95	41	88	224

and planting, or as plant material in studies concerning genetic variability of characters, adaptability to environment, and parental plants in breeding programs.

These healthy plants are preserved in greenhouse as germplasm collection, dedicated to initial grapevine plant material generation, under a severe regime for avoiding any virus infection (Table 1).

The virus-free grapevine germplasm collection provides the initial planting material for the establishment of new base planting vineyards. The setting up of new plantations with healthy planting material would lead to a rise in the technical-economic competitiveness by the efficaciousness of all obtaining and exploitation steps, from grafting to preserving the production characteristics.

In order to establish grapevine basic mother plantations, in 2004-2008 period was delivered initial material (buds, cuttings, rooted plants) for 3,5 – 4 ha of scions and rootstocks to the viticultural research units. Traditional Romanian grapevine varieties and largely used rootstocks were predominant.

The germplasm collection is annually checked for the most dangerous grapevine viruses (GFLV, GLRaV-1,2,3, GFkV, GVA), quarantine viruses (arabis mosaic virus - ArMV, raspberry ringspot virus - RRSV, strawberry latent ringspot virus - SLRV, tomato black ringspot virus – TBRV, Tobacco ringspot virus - TRSV, tomato ringspot virus – ToRSV peach rosette mosaic virus - PRV) and phytoplasmas (flavescence doreé, bois noir). Common viruses (and also, phytoplasmas) for different crop plants are routinely analyzed by the quarantine laboratories.

Grapevine initial material of Romanian and international grapevine fruitful cultivars and rootstocks is mentained ex situ and in vitro conditions for medium and long term.

Conclusions

In order to obtain high quality grapevine planting material, service activity of the NRDBH Ştefănşti-Argeş follows the Romanian legislation, in accordance with EU and EPPO requirements. This activity goals with the virus diagnosis and elimination, maintenance and delivery of grapevine initial material.

The virus detection and elimination activity has in view the most dangerous grapevine viruses (GFLV+ArMV, GLRaV 1+3, GFkV, GVA) and their presence in the native varieties/clones important in the strengthening of the Romanian viticulture patrimony.

The main activity to prevent the spreading of the grapevine virus diseases until now is the rigorous sanitary selection. The sanitary selection has to be done in according to the national planning material capacity and based on the certification scheme used in countries having a major contribution to European grape production. The program initiated for obtaining virus-free grapevine plants was constantly developed over the last years due to the increasing number of cultivars and clones needed to be available as healthy material.

Grapevine germplasm collection represents a national fortune that could be used either as starting material for propagation and planting, or as plant material in studies concerning genetic variability of characters, adaptability to environment, and parental plants in breeding programs.

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THE TENDENCES REGARDING THE DEVELOPMENT OF THE AGROTOURISM IN ROMANIA

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Abstract: ***This paper examines the challenge faced by Romania to develop its agrotourism sector. We identify such context may be external factors such as world political situation and tourist income. They also come from internal factors such as the quality of the object, the services of the local people and the quality of access to the agrotourist sites. In this paper we report the strength and weaknesses of the internal factors based on the survey at the sites, the key players in the agrotourist business and the local tourist operators formulate correct policy to raise the sectors. This policy had some positive impacts on the practice of local government in providing services including the agrotourist sector. However, the need to increase the local government revenue could bring the development policy oriented towards short-listed policy of the local government. Such policy endangers the growth of the agrotourist sector in the future.***

Key words: *agrotourist sector, rural economies, natural attractions.*

Introduction

Agro-tourism is seen as a regenerative factor of rural economies and, at the same time, as an element for preserving the rural environment.This form of tourism uses for the accommodation and dining only the touristic pensions and the agrotouristic farms, benefiting of a not polluted and pictorial environment, of the natural attractions and cultural historical values, of the traditions.

In Romania, 'rural areas' were defined in 2005 as areas belonging to communes and to the periurban areas of towns and cities (MAFRD/MAI Ordinance no. 143/610/2005 published in the Romanian Official Journal no.382/6 May 2005).

Thus, agro-tourism is a tourist activity to help farmers to get some benefits by help of capitalization their own resources from agriculture, which is their main profit source.Through the prism of these considerations, Romania proves to be a country with touristic vocation of notoriety, comparable with that of some European states that are in the hierarchy's first places in the domain: Austria, Switzerland, Greece.

In Romania, the agrotourism and the related activities appear as especially appropriate tools to revitalize rural areas aiming a sustainable future through people retention and employment maintenance (or even job creation), as well as increasing job diversity, retaining services, supporting farms exploitations, broadening cultural provision, and also by maintenance of landscape, nature resources, and rural art and handicraft as attractions for visitors (Naghiu, Vázquez and Georgiev, 2005).

According with this authors, agrotourism can be considered as one of key-tools for an ambitious and effective rural development system in Romania. This systems is a result as a analysis of the internal factors formulate in the local goverment policy of the agrotourism sector. Such policy had some positive impacts because the rural economies interact with the national economy to shape a system of relationships between cities, suburbs, surrounding countryside, small towns and villages and allowing a substantial contribution to the improvement of life quality.

In the same time, agrotourism activities perform as a way of alternative income for farming communities either directly (by diversifying into, e.g., providing accommodation or holiday cottages for visitors) or indirectly through environmental stewardship to create and maintain the sort of countryside that visitors want to enjoy. Further from additional jobs and incomes, agrotourism provides a wide range of valuable social and cultural benefits to the population.

The World trends show the great increase of the agro-tourism form of tourism although the organizational differences influence its stronger and more systematic growth to a certain extent.

This paper purposes an evaluation of the actual state of agrotourism development in Romania as well as an overview on the favouring and disfavouring factors that must be considered by agrotourism marketing strategy.

Material and methods

The survey based on statistical sources data and information are currently used in field researches. As an instrument for data gathering, statistical figures are the most important and "diplomatic" element, determining the success of a selective research performed in a rural environment, subject of profound transformations. The analytical methods were organized considering the number the number of considered data etc.

The proposed targets were knowledge about agro-tourism objectives and management.

Considering its potential contribution to the general economic recovery agro-tourism is approached as one of the priority sectors of the Romanian economy.

If it is compared the Romanian agro-tourism with the organization of agro-tourism in other European countries we can see that non-existence of a unique model of agrotourism in today's Europe because each model is reflected in the diversity of its organization both on national as well as on regional levels. The reason are: popularity and demand of this type of a holiday and the rapid development of agrotourism in accordance to the market needs. Examples of agrotourism in Italy, Austria, France, Great Britain, Cyprus and Romania show different models in the organization of rural tourism. Italy is one of the rare countries which operates within a national legal framework but also practices regional laws which regulate it locally/ regionally. In all presented countries, rural tourism operates within various associations be they governmental organizations (Cyprus Agrotourism Company), non-governmental organizations (Agriturist in Italy, Farm Holidays in Austria, Gîtes de France in France, ANTREC in Romania) or professional organizations (Farm Stay UK in Great Britain). Different laws regulate some aspects of rural tourism but not its organizational aspect. Some counties are more active in this form of tourism (such as County of Istria or Dubrovnik and Neretva County) which affects also the geographical distribution of rural tourism households.

However, the agro-tourism has the function to economically potentiate the peasant household capacity. At the same time, the agro-tourism services (accommodation, services) are not carriers of additional indirect costs, overhead charges, commissions, etc., economic aspects that make the agro-tourism product price be much lower compared to the competitional tourism product. From the calculations made by the specialized tourism services, it results that the price of an agro-tourism dinner, in all the boarding houses, is

by 40–50% lower than the price of a dinner served in a restaurant from the tourism hotel network (from the same category). The explanation for this price difference is simple. The price of agricultural products obtained and consumed on the agro-tourism household does not include VAT, excise taxes, transport and storage costs, etc. The agrotourism policies should stimulate the rural tourism advantages, in the direction of tax and fee exemption, fiscal pressure diminution, in general, in order to reduce prices and maintain the traditional customers (town people with more modest incomes, foreigners willing to get familiar with the rural traditions of the area, town children, etc.).

In 1998, there were 600 pensions (hotels, guest houses etc.) with 3,776 places for accommodation and by 2003 there were 3,500 pensions with 28,000 places (National Strategic Plan for Rural Development 2007-2013, p.16- 17). Besides pensions, there are also the farms that offer agro-tourism services; at the 2002 GAC for 1,453 farms, agro-tourism was an alternative source of income (2002 GAC, p. 370). A greater concentration of accommodation for tourists can be observed in the Centre, North-East and North-West regions. The main attractions are Bucovina (with the valuable monasteries), Maramures (ethnography, wood architecture), Transylvania with the Carpathian Mountains (hiking, skiing, gastronomy, wine etc). The Danube Delta (in the South region) has also become an important tourist attraction that brings significant incomes and of course the Black Sea (National Strategic Plan for Rural Development 2007-2013, p.16-17). These are mainly the places where rural tourism and agro-tourism can be considered really an opportunity.

The fact that only 0.1% of Romania's rural economy comes from agro-tourism, compared to 4.4% in the EU countries is a relevant economic indicator for the Romanian agro-tourism situation. Significant investments are necessary in agrotourism in relation to the allocated resources (educational, financial, infrastructure, etc.)

Results and discussion

Particular aspects in implementing the principles of the environmental issue in agrotourism appear when space is explicitly taken into consideration. A great attention in discussions was given to the relationship between agrotourism – regional development – environmental sustainability starting from the requirements of an integral perspective on regional strategy and policy.

To conclud, the consideration of environmental issues regarding to development of the agrotourism sector was made regarding four categories, as follows: i) capacity to have influence on business results; ii) importance of environmental protection; iii) aspects of environmental strategy; and iv) barriers to and opportunities from implementation of an environmental management system. Influence of stakeholders (partners, guests, competitors, etc.) in agrotourism business was considered in groups i) and ii), as well as their final importance on environmental protection and management.

So, the challenges of agrotourism requirements induce specific concerns to regional development programmes, where space is explicitly taken into consideration as well as the problems of the communities living in certain areas. In the beginning only the big challenges of environmental preservation are to be focused on, so that some trade-offs in terms of positive and negative changes in some components will be allowed.

Conclusions

According to the opinion of thr business owners, in Romania, one of the main barriers in order to promote a suitable development of agrotourism aiming environmental respect and sustainability refers to the bad condition of a number of ways and transit spaces in rural areas. So, there is here an old claim for the infrastructure time ago, then making possible the reception of tourists, but the real fact is that nature care has become a real concern, not only due to environmental reasons, but also taking in mind the use as resource for current guests as well as to attract visitors in future. Offering priority support to agrotourism as a complementary form of social tourism.

On the other hand, it seems to be clear that the identification of opportunities will simplify the implementation of the environmental management strategies, but fall of barriers becomes the right starting point to make it possible, also increasing self-confidence of business owners and, even, public responsibles who are expected to support the agrotourism system.

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TOWARDS THE DEVELOPMENT OF E-SERVICES FOR TOURISM IN ROMANIAN BUSINESS ECOSYSTEM

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Abstract: ***The development and integration of tourism oriented e-services in Romania is becoming "a must" in order to a part of the European Tourism Business Ecosystem. In this paper, the authors discus the benefits of introducing e-Services that consider the specific needs of tourism oriented small and medium-sized enterprises (SMEs). The integration of such e-services becomes a mean to sustain a solid development of Romanian tourism.***

Key words: *e-services, ecosystem, tourism, medium-sized enterprises (smes).*

Introduction

During the Lisbon European Council [March, 2000], the European Union representatives set the goal of making Europe the world's most dynamic and competitive Knowledge-based Economy (KBE) with the need to promote "the Information Society for all"! According to this mission to be completed next decade The "Networked Enterprise and Radio Frequency Identification (RFID & EN)" unit of the European Commission's "Information Society" (IS) and Media aims at facilitating the emergence of future innovative business models within Global Economy and "e-market" based platforms.

Everybody could recognize that: "Business require for new technologies, applications and services to enable them to work as Networked, Knowledge-based, Enterprises" - Gerald Santucci, Head of Unit "NE & RFID.

Information and communication technology is the key to modernizing tourism services: making them more efficient and more responsive. Take-up of electronic invoicing, electronic procurement, feedback and notify public authorities and government institutions is predicted to save not only money but also to use properly time and money. All Member States already signed up to an ambitious agenda to achieve these goals. The action plan proposes concrete steps towards achieving these goals.

Paolo Dini, in the European FP6 project called Digital Business Ecosystem, proposed a first open-source platform to sustain the regional development of tourism at a primary level.

The following paper is concerning with a new approach to metamodeling-oriented synthesis of the complex, non-monolithic, (Internet-distributed system) adaptive System of Systems, targeting the synergetic research issues of Digital Business EcoSystems focusing on regional tourism development fostering the local SMEs .

Structural elements of the tourism ecosystem in general and the digitized tourism business web in particular are described, highlighting the emergence of the main stakeholders (local and national public authorities, governmental institutions) that will enable a more fluid, agile, innovative form of collaborative commerce to sustain the regional tourism development at a higher level.The present paper is structured in 5 chapters as follows: 2. e-Services as a necessity for the development of tourism, 3. A modeling framework in regional tourism development, 4. Conclusions & Further work.

Material and methods

» e-Services as a necessity for the development of tourism

Nowadays, e-services have proved to be the key in solving many business problems. Introducing e-services in tourism businesses becomes a necessity for the development of SMEs inside the region and the region as a whole, having as the main catalysts public administrations and Governmental institutions.

A two layer architecture model as a simplified version of the system is presented, consisting of a business network and a P2P communication that interact with each other and evolve over time. Using service oriented architecture makes communication much easier, solving the problem of interoperability at all levels, using a model driven architecture. Because the topology of the SMEs network affects the topology of the P2P communication network we will limit our model to SMEs that are directly connected to tourism area. At the higher level are situated the main stakeholders in Digital Business EcoSystems, the governmental institutions and local and national public administrations who play the role of "deciders" (see fig.1).

Because of the multitude of SMEs, customers and information, the need of knowledge management appears, data mining and decision support systems, regional policy maker correlated with micro/ macro economics (Econometrics, Statistics), social networks (Customer Relationship Management, Public Relations), political sciences, regional economic clusters, Natural Science as a multi-disciplinary approach all inside an evolutionary environment (EVE) (Bertrand Dory, 2008).It might be useful to use an Ecosystem Oriented Architecture

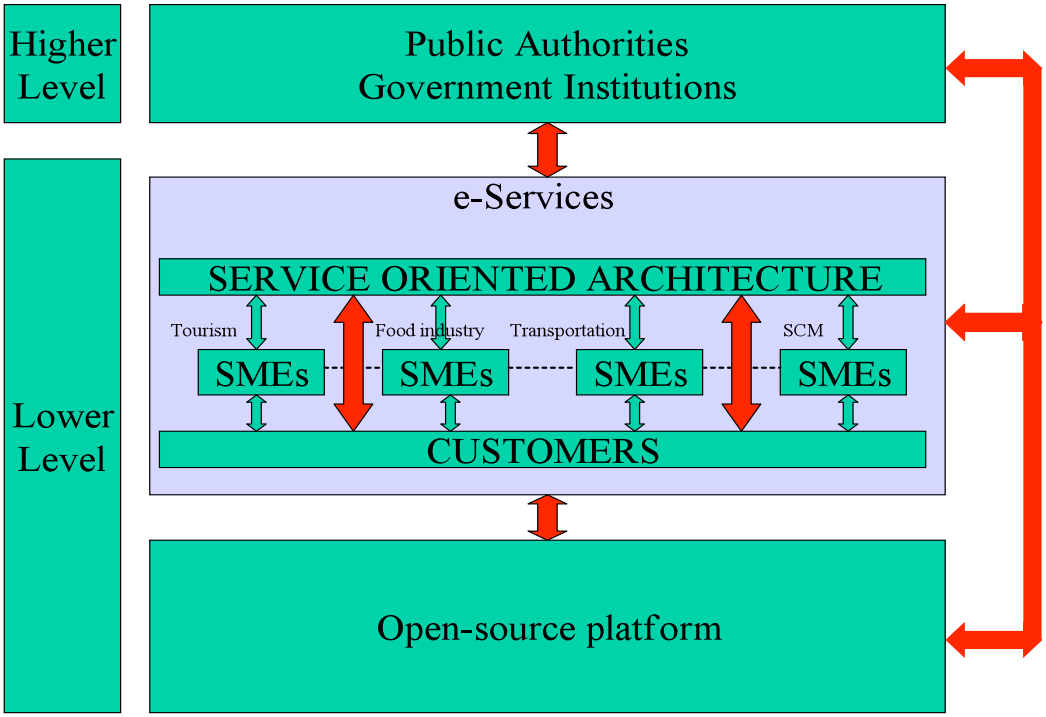

Fig.1: e-Services as a necessity in tourism business models

instead of Service Oriented Architecture because of the multitude of software services that SOA doesn't support and because there is no need for EOA to be centralized as SOA is. EOA represents a conceptual framework, a collection of best practices principles and patterns related to Ecosystem-aware decentralized computing and architectures.

DES need to support very loosely coupled communities which brings news challenges in SOA architecture, and dealing with this reality requires re-thinking the founding principles and technology of SOA. In this context EAO becomes the concept for this novel approach to DES architectures.

» A modeling framework in regional tourism development

Santucci stressed that "the concept of Digital Business EcoSystem (DBES) initiative responds ideally to this challenge of creating ICT instruments together with collaborative practices and paradigms that support economic growth and include all the societal and economic actors in the process. It has been commonly recognized as a new frontier for RTD in the knowledge-based economy. Indeed, SMEs and local clusters are now competing in a global and dynamic market where they need more interrelations, more specialized resources, more research and innovation as well as access to global value chains and knowledge. The research driven within the DBE Initiative supports all these necessities by offering an open infrastructure that combines"

- human capital,
- knowledge and practices,
- technical infrastructure,
- business and financial conditions all modeled within the European industrial policy agenda.

Digital business ecosystems may be a powerful solution in fostering effective adoption of ICT by SMEs towards increased competitiveness on both the European and local level. It is an underlying assumption that building such an ecosystem will require catalysing. The outcome of this conceptual, explorative study is a conceptual framework for Regional Catalysts in the case context of the Digital Business Ecosystem (DBE).

As mentioned above, the main stakeholders as catalysts in the process of decision making are needed in order to sustain the development of the region in the tourism area.

A modeling framework in regional tourism development is figured below (see fig.2).

In a global turbulent market, the problem to be solved is to extract from Terras of information the most important one in order to make the right decisions. A model that includes Discrete Mathematics, Micro / Macro Economics, Computer Science and Social, Political and Natural Sciences is used in order to create a modeling framework.

Results and discussion

The principle is very simple: using an open-source platform divided in different regions, anyone can make a reservation at any tourism unit in the region. The platform allows the customer to add his feedback concerning the respective unit and the region. On the other hand, the units can bring their opinions concerning the adjustments that need to be taken inside the region so it can evolve. All these feedbacks are viewed by the local catalysts, local administrations and governmental institutions, and using mathematic algorithms, predictions can be done concerning the respective region for the decisions they might take, all in real time in an evolutionary environment.

These catalysts use a OODA (Observe-Orient-Decide-Act) paradigm in the process of decision making (see Fig.3).

The development of e-services for

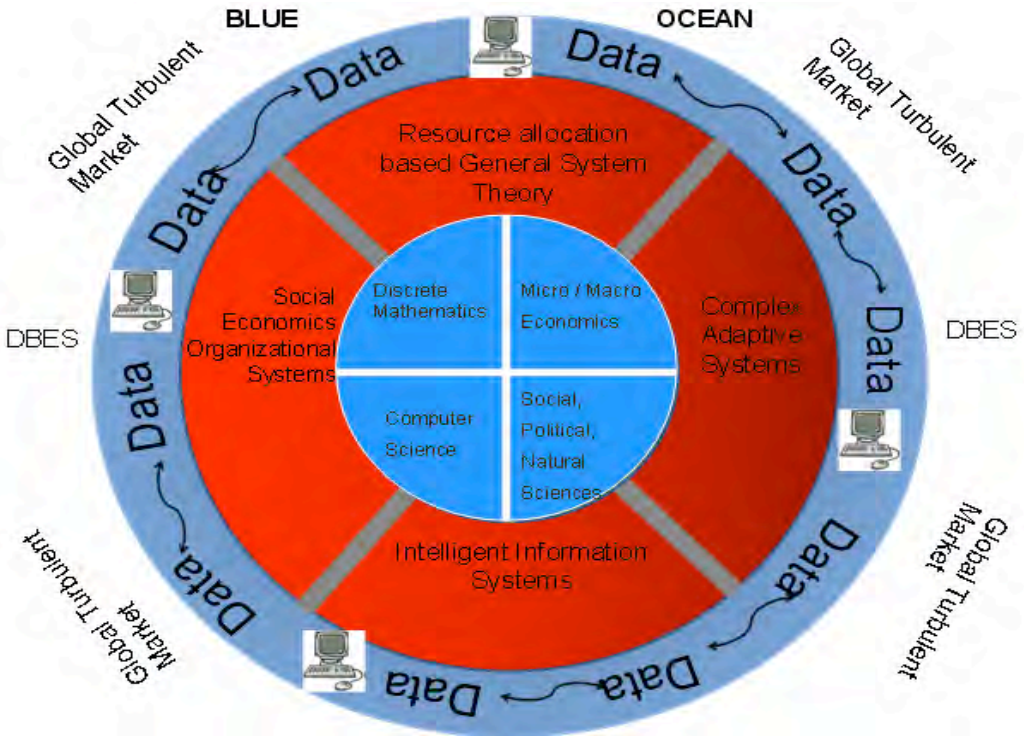

Fig.2: A metamodel for the regional tourism development

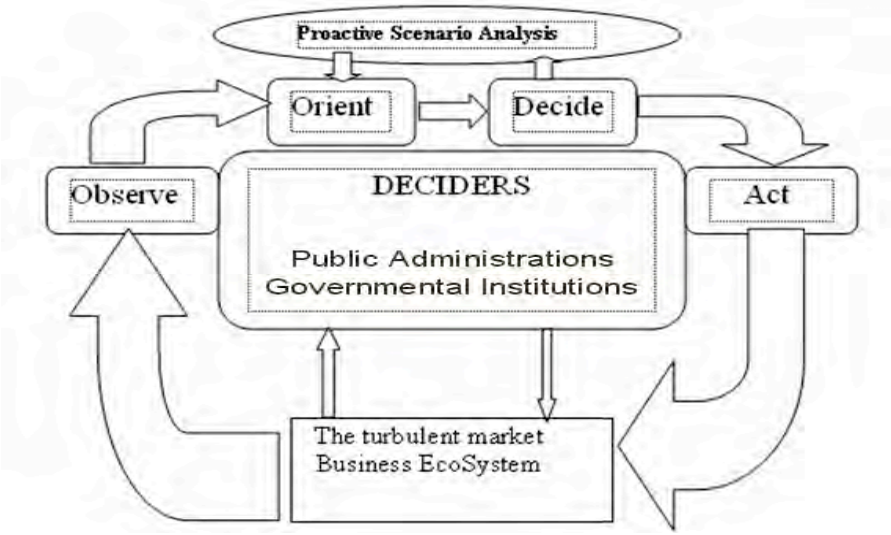

Fig.3 : O-O-D-A Paradigm in the decision making process for the main stakeholders

tourism is a very complex process that must take in consideration many constraints. For the moment we have limited to the SMEs in the tourism area, but the work must continue involving in the same DBES SMEs from Food Industry, Transportation, Wellbeing, Energy and Efficiency, Rural Development and Supply Chain Management.

Conclusions & Further work

The initial concerns and aims of this paper are related with the DBES analysis methodology, but this Complex Adaptive System of Systems needs much research efforts to fulfill next R&D "chapters" like:

1. DBES analysis (global & local performance evaluation)
2. DBES formal tools to prove the stability of such evolutive, self-organizing, complex systems
3. DBES synthesis methods and techniques
4. DBES-ICT-tools development and their integration e-Collaborative platform
5. Data-mining tools for open-source orient software platform
6. Compatibility, Interoperability and Integrability new methodologies
7. Formal support for Discrete-Event Dynamical System platform to aim at the Enterprise System Definition
8. Developing the scientifical bridge between Ecological Economics and DBES cross domains
9. Traceability, Availability concepts (Herve Panetto, Shimon Nof)

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RECENT ADVANCES IN THE WORLD ENOLOGICAL RESEARCH APPLICATIONS IN THE ROMANIAN WINEMAKING INDUSTRY. IMPLICATION ON THE HUMAN HEALTH AND ON THE ENVIRONMENT

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Abstract: ***Recent advances are related to the field of biological products and of tannins. Enzymatic products with protheolitic activities used to combat the Botrytis cinerea mould have been developed as well as formulas aimed at distroying the Brettanomyces yeasts. Selection of yeast strains capable of multiplication on grape must has been achieved, conferring them a better adaptability to the fermentative environment. Commercial formulas have been tested consisting of co-cultures of 3-4 strains of Oenococcus oeni which respond more efficiently to the the attack of bacteriophages, but also strains that retain their cellular viability at positive temperatures (1- 7 °C). The achievement of a tannin proanthocyanidolic attached to an ethanal molecule that can stabilize rapidly and efficiently the colour of red wines even from the prefermentative stage has been licensed. All these products have been successfully tested în Romania by the Sodinal company.***

Key words: *enological research, winemaking industry, botrytis cinerea, brettanomyces, oenococcus oeni, tannin proanthocyanidolic.*

Introduction

The most impressive advances in the worldwide oenological research have been recorded in the recent years in the domain of biological products (enzymatic mixtures, yeasts, and selected malolactic bacteria) and of active biological products (tannins of oenological origin).

Materials and methods

1. Special enzymatic preparations

Products capable of effective action against the Botrytis cinerea mould and against the Brettanomyces yeasts have been prepared.

» ENDOZYM ANTIBOTRYTIS enzymatic preparation

Practical experience in the wine production proved that by its destructive action, the Botrytis cinerea mould entails: the loss of a significant amount of the harvest by breaking of berries under the action of enzymes secreted by this mould (pectinases…); affecting of nutritional resources necessary for triggering AF and MLF since Botrytis cinerea consumes nitrogenous resources and grape must vitamins; impeding the filterability of wines due to the presence of β-1,3 and β-1,6 glucans resulted from hydrolysis ; color degradation as a result of the activity of the lactase enzyme (an oxidative enzyme) generated by the fungus besides the polyphenoloxidase activity (tyrosinase); serious affection of the sensorial quality of wines.

» Action of the new enzymatic preparation.

Having in view the above mentioned aspects the AEB-SPINDAL company has developed a complex enzymatic preparation aimed at the following process actions: hydrolysis of β-1,3 and β-1,6 glucans ; hydrolysis of the branched units of pectins that contain arabans and galactans ; the proteolysis of the tyrosinase and lactase activities through the action of acid protease of the

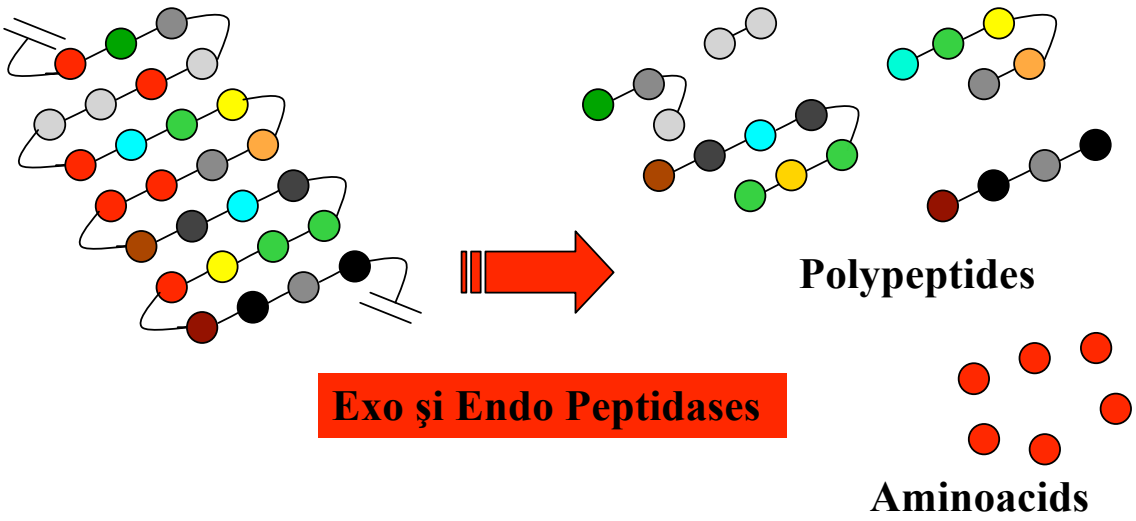

Fig. 1 – The endo-proteolytic activity of the ENDOZYM ANTIBOTRYTIS product

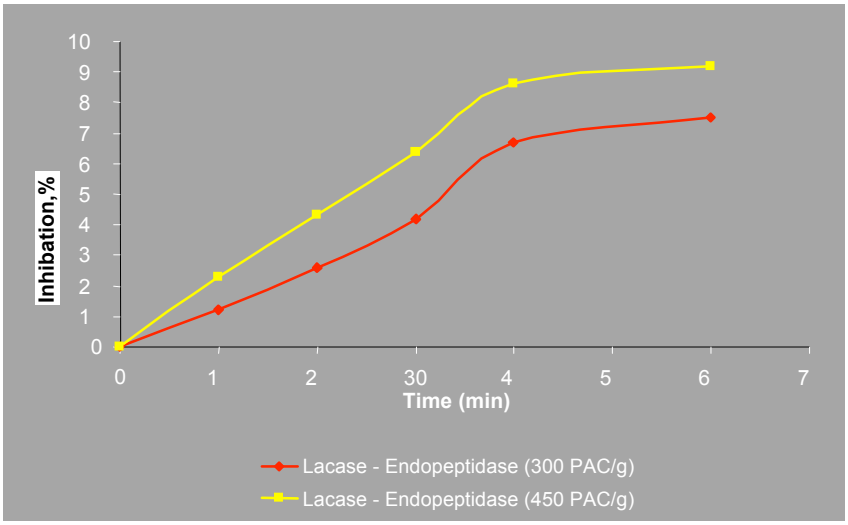

Fig. 2 – Evolution of lactase inhibition as a function of time for the ENDOZYM ANTIBOTRYTIS

Aspergillus niger mould.To this effect, it has been set out that the new enzymatic preparation contain the following activities: β-1,3 and β-1,6 glucanase; debranchilng activities: arabanases and galactanases; proteolytic activities : exopeptidases and endopeptidases (an exopeptidasic and three endopeptidasic activities).

» Main technological characteristics.

Owing to the structural and compositional similarity of the new enzymatic preparation with the Botrytis cinerea mould, this product enables an optimal degradation of soluble and insoluble pectins .

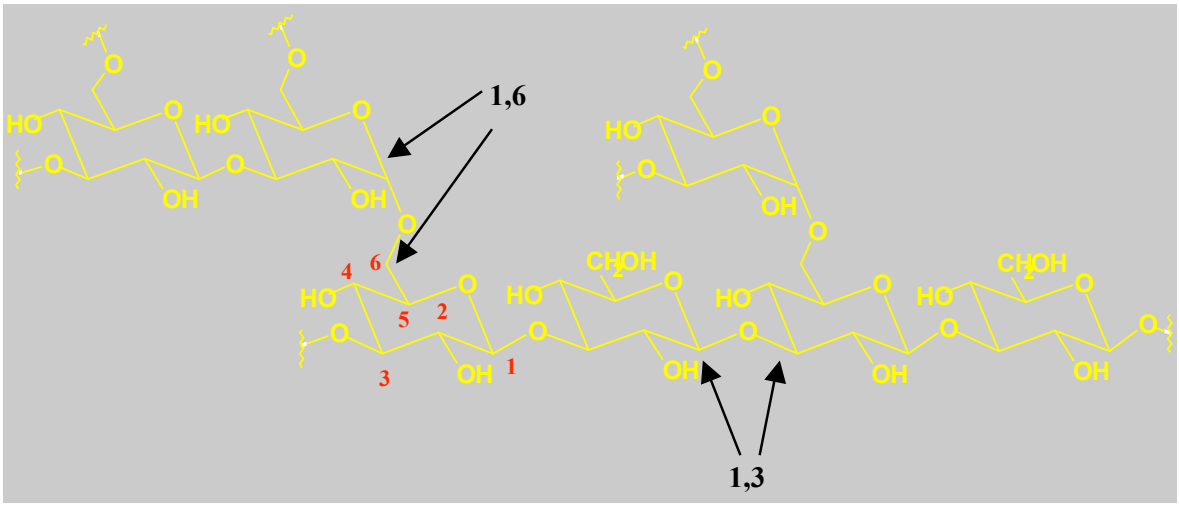

Fig. 3 – The energetic action in the positions β-1,3 and β-1,6 of the enzymatic product ENDOZYM ANTIBOTRYTIS over D-glucans generated by the *Botrytis cinerea*

Secondary activities: The efficiency of the new enzymatic preparation ensures the increase of the content in galactose and arabinose which are the main constituents of the lateral pectin chains through the galactase and arabanase enzymes that degrade the galactans and arabans macromolecules .

The endo-proteolytic activity of the ENDOZYM ANTIBOTRYTIS product is outlined in Figure 1, presenting the release of polypeptides and amino acids following the splitting off of protein macromolecules.

» Lactase inhibition.

The chart of Figure 2 presents the inhibition process of lactase from the Botrytis cinerea mould as a function of time under the action of endopeptidases from the ENDOZYM ANTIBOTRYTIS preparation.

The endopeptidase with 300 units PAC (acid protease)/ gram has a weaker action as compared to the protease with 500 PAC / g.

The exopeptidasic and endopeptidasic activities of the ENDOZYM ANTIBOTRYTIS preparation present a trend related to the pH. For these enzymatic activities it has been determined that the stability-pH varies between 2.3 and 6, while the optimal acting-pH is comprised within the 2.5 – 3 interval.

» Enzymatic action on glucans.

Owing to its composition, the ENDOZYM ANTIBOTRYTIS enzymatic preparation can have a powerful action over the chemical structure of 1,3-β-D-glucans with branches of glucopyranosile units linked in the positions 1,6 generated by the Botrytis cinerea mould (Fig. 3).

» Dosage and directions for use.

It is recommended to use doses of 2 - 4 g/100 kg of crushed grapes or 2 - 4 g/hl of grape must. Alternatively, the suspension of enzymatic product can be administered directly on crushed grapes or grape must. It is recommended to use the product as the vessel is being filled up with grape must in the case of settling of the latter.

2. The ANTIBRETT enzymatic product

Innovative system for preparation: The process for obtaining the constituents originated from the cellular walls of yeasts involves an exclusive degrading of the latter, especially of chitin, while keeping intact the cytoplasmic membrane structure that presents specific absorbent properties.

» Influence of the composition over the technological effectiveness.

The ANTIBRETT product is capable of triggering an effective destructive action on the cellular wall of the Brettanomyces yeasts (enzymatic hydrolysis of that wall causes the death of the cell, so the latter is no longer capable of producing or secreting the phenolvinylreductase enzym responsible for the formation of ethylephenol determining the most unpleasant sensorial deviation) by the presence of some β-glucanasic main activities and some proteolytic secondary activities; by reducing the cellular density of the viable population of this species, the activity of phenolvinylreductase is consequently diminished; it can also destroy the chitin of the cellular wall of Brettanomyces yeasts, although the chitinous activity remains lesser within its composition; it has the capacity to absorb part of the unwanted volatile phenols due to the presence in its composition of some derivatives of the cellular walls of autolysed yeasts obtained through thermal and enzymatic degradation.

Technological action: Contamination with Brettanomyces is practically always linked to a limited number of cells. The use merely of the ANTIBRETT product suffices to limit the number of viable cells of the Brettanomyces species, while the use of the sulfurous acid anhydride, in doses of at least 25 mg/l, complements the antiseptic action against cellular growth of the yeasts of this species.

Utilization domains: The complex enzymatic product ANTIBRETT proved its efficiency in the following technological situations: confirmed contamination with Brettanomyces, but also in the case of prevention of the latter; when there was an apprehension of contamination caused by weather and phyto-sanitary changes, or during irregular AF's; against unpleasant odors, such as those of unwashed or moldy smell casks, sometimes encountered with wines.

Recommended doses and utilization method: Doses up to 40 g/hl are recommended, depending on the degree of wine contamination. A level of free SO2 above the 15 mg/l limit is recommended. Proteinic stability of wine is checked after administration of the aqueous ANTIBRETT suspension.

» Selected yeasts multiplied on grape must

Commercial formulas of selected yeasts represent a biological environment which is obtained through cellular multiplication on a nutritive environment commonly comprised of molasses in association with other nutritional constituents. The use of grape must as a substrate for cellular multiplication ensures a higher bio-adaptability of the selected yeast strains aimed for wine-production as regards the technological conditions for performance of the AF. By multiplication of the biomass on grape must, the yeast strain develops its entire biological potential for obtaining wines with better sensorial qualities. The AEB – SPINDAL Group has patented, as a world first, a process for multiplication of selected yeast strains on concentrated grape must, offering to the wine-producers the commercial formula FERMOL GRAND ROUGE (FGR).

» *Factors influencing yeast activity.* Even in the case of strains multiplied on concentrated grape must, the activity of yeast will always depend on the following factors but also on its specific metabolism: the genetic heritage of the strain; the fermentation temperature; the nutritional requirements; the pH of the medium.

Results and discussion

» *Comparative experiments.*

The FGR yeast strain produces higher concentrations of isopentyl acetate (tropical plants) and lower concentrations of hexanoate and ethyl octanoate (fruits with a white texture such as apples and pears) than the yeast strain Lev 1; the content in izovalerianic acid and ethyl succinat are higher, while the content in octanoic acid and n-hexanol are lower on the wines obtained with the FGR yeast as compared to wines obtained with the Lev 1 yeast.

The FGR yeast is better than the Lev 1 yeast as regards production of 2-phenyl ethanol (petals of roses, cornflowers). The sensorial characteristics of wines obtained with the FGR and Lev 1 yeasts are represented on the chart in Figure 4. In the wines obtained with the FGRN yeast an enhancement of sensorial features typical of red fruits and berries has been noticed along with an improvement of the taste fineness accompanied by a diminishing of the floral feature (Figure 4). FGR releases a higher amount of odorant compounds (forest fruits, red fruit and spices). The wines obtained have a higher complexity and aromatic fineness. The comparison between the olfactory profile of the FGR strain and that of the witness strain (Lev 1) demonstrates that this yeast enhances the variety aromatic feature of the al variety (Figure 4).

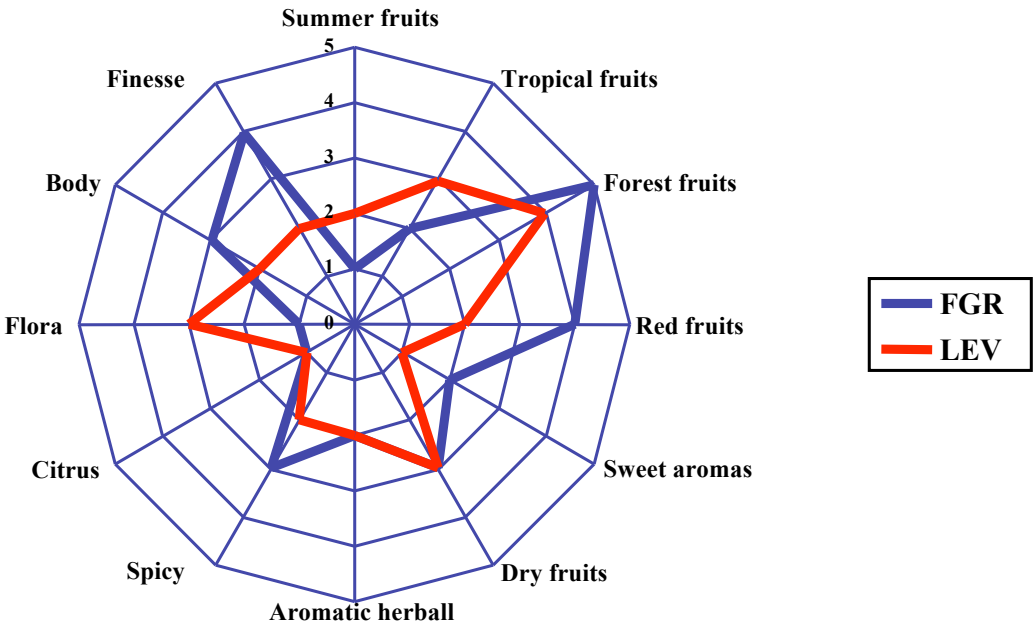

Fig. 4– Sensorial characteristics of the wines obtained with the FGR and Lev 1 yeasts

- *Co-cultures of selected strains of the Oenococcus oeni species*

Having in view the difficulty of the onset, and the risky technological conditions involving the attack of the bacteriophage, as well as the loss of cellular viability determined by the thermal shock incurred prior to administration into the wine, the Spindal – AEB Group has developed a co-culture of selected strains of the Oenococcus oeni species named BIOLACT FRESH.

The innovative system of production and the remarkable capacity of metabolization of the malic acid. It enables a preservation of the latter at a temperature comprised between + 1 and + 7 °C with appreciable advantages related to storage and utilization as it precludes the loss of cellular viability due to the thermal shock previously caused by keeping at negative temperatures of -18 °C. This type of system allows the addition of malolactic bacteria directly into

Table 1

Necessary parameters during the inoculation stage of the BIOLACT FRESH product

Analyzed parameters	**Biolact Fresh**
Number of strains	2
pH, minimum	3.2
Limit temperature, °C	18
Alcoholic concentration, % vol.	15
Minimum temperature at inoculation, °C	20
Maximum concentration in polyphenols (TPI-total polyphenols index)	70

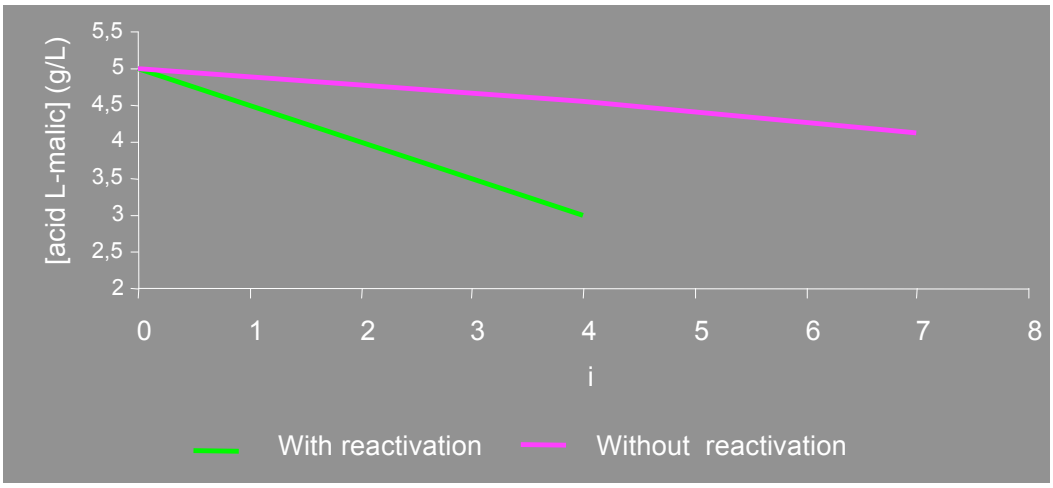

Fig. 5 - Degradation of the malic acid from wine under the action of BIOLACT FRESH

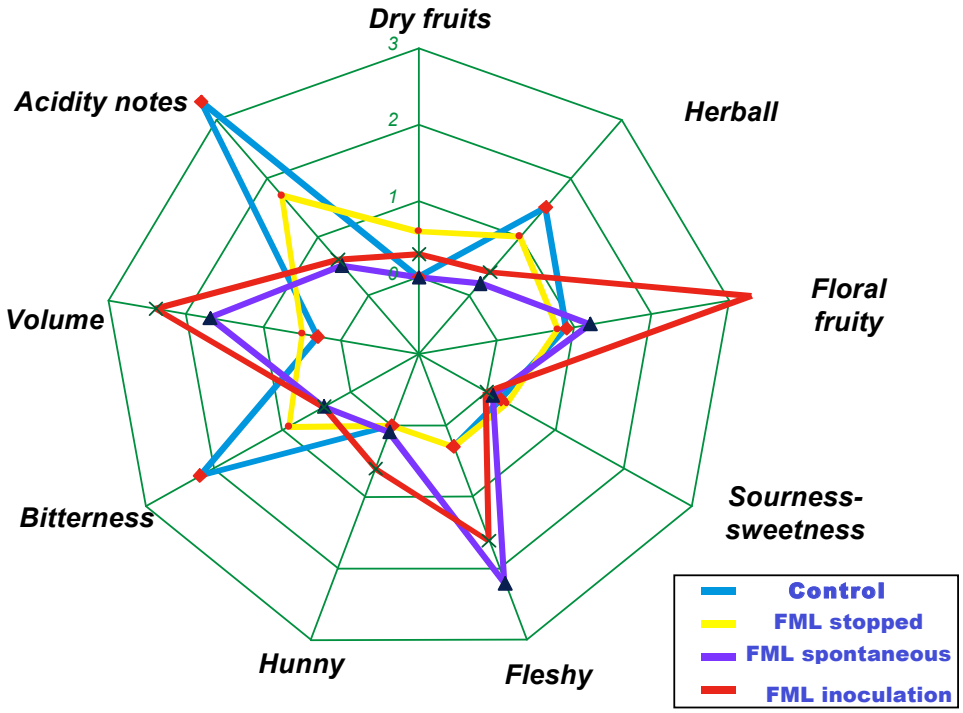

Fig. 6 – Influence over the sensorial profile of wines of the BIOLACT FRESH product

wine without the need for acclimatization and without jeopardizing the parameters regarding the performance of the MLF .

Necessary parameters during the inoculation stage. These parameters are presented in Table 1.

Impact of the inoculation method on the performance of the MLF. In the chart presented in Figure 5 it can be noticed that the degradation of the malic acid under the action of BIOLACT FRESH is more pronounced in the case of inoculation with reactivation of the biological material. Influence over the sensorial profile of wines. The Biolact Fresh product confers to wine a pleasant olfactory character and an additional plainness, accompanied by pleasant odor notes associated with the sensation of freshness (Fig. 6).

» Oenologic tannin coupled with a molecule of acetaldehyde

In view of rapid and lasting stabilization of color upon red vinification, an exogenous tannin has been developed which is coupled to a molecule of acetaldehyde ensuring the coupling of anthocyanins from skin's berries through formation of ethanal bridges. This formula contains a proanthocyanidolic tannin (the TANÉTHYL formula) or a mixture of proanthocyanidolic and elagic tannin (theTANÉTHYL EFFE formula) linked to molecules of ethanal .

These products are administered into the de-stemmed and crushed grapes after enzymatic treatment for extraction of anthocyans from the skin's berries; they may be coupled with an anthocyan of a heterosydic shape (connected to molecules of glucose - Glc) by breaking of the link from the reactive carbon of the ethanal bridge when a macrocarbocation is formed and coupled to the carbon atom

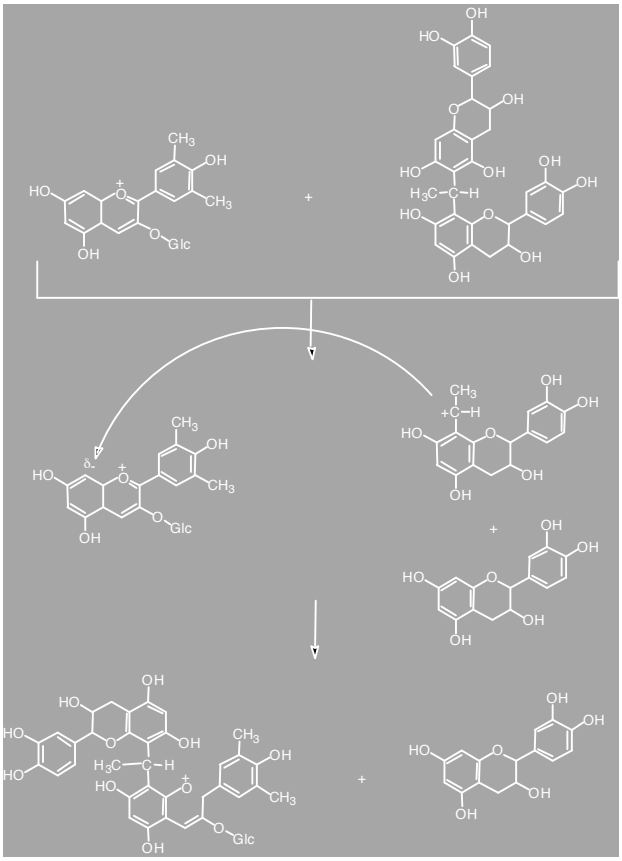

Fig. 7 – Acting mechanism of the TANÉTHYL and TANÉTHYL EFFE products

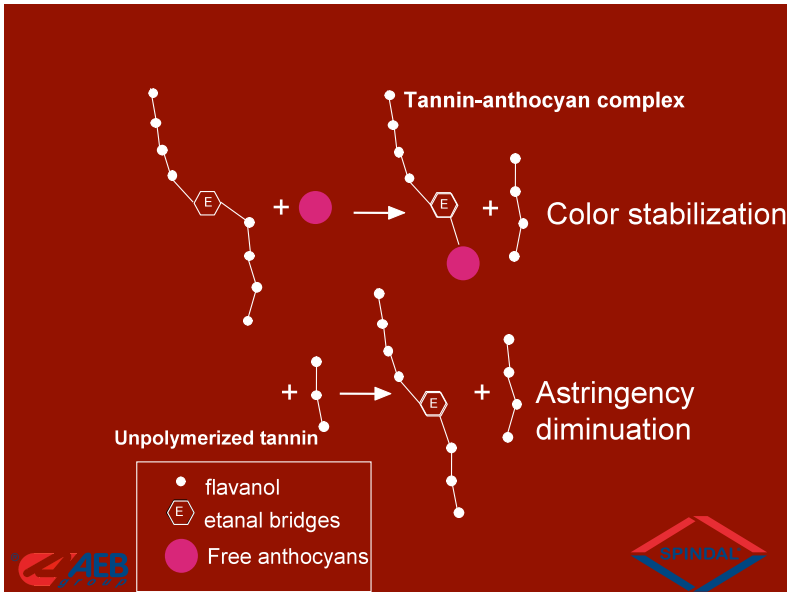

Fig. 8 – Acting method of TANÉTHYL and TANÉTHYL EFFE

Table 2

Merlot variety wine, 2003 harvest, prematurely treated in the laboratory with variable doses of TANETHYL

Merlot wine, 2003 harvest Evolution after 7 days of treatment		**Witness**	**250 mg/ l**	**500 mg/l**	**1000 mg/l**
Phenolic compounds	d_{280}	59	63	65	70
	% combinations tannins-anthocyanins	27	41	44	46
	Tannins, $g.l^{-1}$	2,96	3,10	3,17	3,46
Chromatic characteristics	Coloring intensity	1,23	1,28	1,32	1,42
	Hue	0,56	0,59	0,62	0,65
	$d_{420\%}$	32,9	33,3	33,1	33,1
	$d_{520\%}$	56,2	54,5	54,0	52,5
	$d_{620\%}$	10,9	12,2	12,9	14,7

with a partially negative charge from the flaviliu's carboanion (δ) and a molecule of anthocyan (or several, following the split off reaction....) is released. The mechanism and way of action of these products are schematically presented in figures 7 and 8.

The ethanal bridge of the exogenous tannin yields a molecule of flavonol and links a molecule of free anthocyan of a heterosydic form making up a complex tannin / anthocyan and releasing an un-polymerized tannin. This un-polymerized tannin reacts, in its turn, with the exogenous tannin and gradually forms polymerized tannins (by successive releases of ethanal of the exogenous tannin). The favorable consequences of the way of action are the lasting stabilization of color and the diminishing of astringency of young red wines. The evolution of some polyphenolic and chromatic parameters after treatment with variable doses of TANÉTHYL on some red varieties are shown in Table 2.

Recommended doses and method of utilization. For the de-stemmed and crushed grapes of red varieties, doses of 2.5 - 10 g/ hl are recommended, for red wines, doses of 5 - 10 g/hl, and for white and rosé wines, doses of 2.5 - 5 g/hl.

Remarks: It is recommended to measure the hue in order to establish the most effective treatment:

- A treatment with POLYGEL PLUS W is recommended prior to stabilization with TANETHYL when the value of the hue > 0.8

- A treatment with TANETHYL is recommended when the value of the hue is a maximum of 0.5 – 0.6

Conclusions

Spindal – AEB Group has opened the way to a new generation of complex enzymatic products (ENDOZYM ANTIBOTRYTIS) ensuring a synergic action of several categories of activities, starting with the standard ones (PL, PG and PE), continuing with the secondary de-branching ones (arabanase and galactanase) and of degradation of (β - 1,3 and β - 1,6 glucanase) glucans, and ending with proteolytic activities (exopeptidases and endopeptidases) allowing and efficient treatment of clarification of wine musts originating from harvests attacked by molds. Another biotechnological innovation

is represented by the association to the enzymatic activities of the components from the cellular walls of autolysed yeasts (ANTIBRETT).

The selected yeast strains multiplied on grape must demonstrated their effectiveness especially in AF of grape musts coming from super-matured harvests with very high sugar's concentrations.

Preparation of co-cultures of selected strains of malolactic bacteria Oenococcus oeni increases the degree of adaptability to the restrictive conditions imposed by the wine environment of the biological material aimed at carrying out the MLF, since it maintains its maximum cellular viability upon storage under reasonable thermal conditions (1 – 7 oC) and not at negative temperatures (-18 oC) that affect their viability due to the thermal shock prior to utilization.

Development of some oenologic tannins possessing a molecule of ehanal that achieves the rapid and lasting stabilization of color even since the pre-fermentative stage represents a historic discovery of the oenologic research at the beginning of the third millennium.

The use of biologic and biologically active products for wine-making contributes to the protection of the environment, and confers to them a pronounced health-promoting character by their specific way of action over the grapes – as raw material.

TOWARDS THE APPLICATION OF INTELLIGENT PACKAGING IN ROMANIAN FOOD INDUSTRY

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Abstract: ***Intelligent packaging is becoming a necessity to assure quality and safety regulations in the European Food Industry. The use of communication functions to enhance packaging properties becomes a necessity to facilitate decision making, quality control and Supply Chain Management. In this paper the authors propose a model, sustained by a case study, for adapting the intelligent package concept to the Romanian Food Industry.***

Key words: *European Food Industry, quality control, alimentary product.*

Introduction

The package is a very important piece of a whole especially when we think of a food industry product.

The package is defined as sum of all the elements that are used to contain an alimentary product or a multitude of products in a defined period of time with the purpose of delivering physical, biological or chemical protection and to maintain the quality of the product as high as possible until the product reaches the consumer or the expiration date.

There is a whole range of materials used to create the packages: glass, plastic, cartoon, various kinds of paper, metal and others.

Every package has an associated label where information about the product is printed. This information is either explicit information like the ingredients used to obtain the final product, or non-explicit like the bar code.

So, we can determine the specific ingredients used to create a product, but only trained personnel may understand it; we can find out the exact manufacturer of the product, but we will need a bar code scanner for the task, we can search on the label for the manufacturer address but we will need a map to exactly locate it, and there are other limitations for the average consumer.

Also we cannot determine whether the product was stored in a cold place if needed and if the temperatures where exact to the recommendation of the manufacturer, we cannot determine weather the product is good for our health if we suffer from a disease or if the product is compatible with a given diet plan. Even the personnel trained in the field is not able to offer us this kind of information.

Based on these problems and others that come from them, the authors of this paper propose a system that will bring consumer experience to a whole new level.

Recent studies in the RFID (radio frequency identifier) field led to the creation of a device that may be used to store a vast amount of information, and this information is interpreted and delivered in the exact way that is needed by the user with the help of a PDA (personal digital assistant).

An RFID device works like a storage chip that can be accessed wirelessly and information can be written to it, read from it and it can even acquire information from attached sensors, like temperature sensors, pressure sensors and any other kind of sensor [1],[2].

This means information can be stored in a RFID chip in the whole production – transport – consumer chain, like:
- product ingredients, and this information is not only generic but can be detailed by adding the address of each manufacturer of every specific ingredient and also all kind of desired details
- product weight
- product date of expiry
- the places where the product was stored and the addresses and phone numbers and e-mail addresses for each facility. Also the physical parameters used to store the product and the total time of storage
- the means of transportation that carried the product and the temperature, pressure and any other parameter that is required and their evolution in time for the period needed to transport the product.
- and a lot of other information [5]

And if we use a PDA we can read this information and based on specific software for the PDA the consumer can find out if the product needed is compatible with a specific diet, is recommended for his specific needs, and can find the manufacturer pinpointed on a city map on his PDA[9].

Specialized personnel can also find if the product was stored in proper conditions so they can accept the product for commercialization based on the RFID given data.

Materials and methods

» Current state of packages in Romania

The following information is usually found on each label that belongs to a alimentary product in the Romanian market:
- Product name
- Product manufacturer
- Address of the manufacturer
- Expiry date
- The bar code
- Product weight
- Ingredients used
- Energy value
- Storage recommended temperature

The bar code is completed by a number that gives the following information:
- Provenience country
- Manufacturer
- Product identification code
- Verification digit

The materials used in packaging vary a lot. The most common are plastic materials that take the form of foil or diverse solid objects like recipients. We can also find other materials like glass, metal and carton.
These materials are used in conformity with the packed product. Their usage can be more or less recommended.

» The Benefits of Introducing Intelligent Packaging

To introduce the concept of intelligent packaging we have to first discuss about smart and active packaging.
The term active packaging refers to the type of packages that can react, become active, to certain events. As opposed to the passive packaging, a certain trigger can make certain features of the package react as to draw attention. For example sensors can react to the changes in the environment and change colour. Such sensors can be classified in: Oxygen scavenging, Anti-microbial, Ethylene scavenging, Heating/cooling, Odour and flavour absorbing/releasing, Moisture absorbing.

The term ‘smart packaging’ refers to the type of packaging that covers a number of functionalities like: digitally stored product information, integrity monitoring, environment changes monitoring, authenticity proofing. In regard to these functions, this kind of package has the ability to inform the user not only about the product but also about the conditions of

shipment and condition of the product inside the package. The sensors can be classified as: Time-temperature, Light protection (photochromic), Physical shock indicators, Leakage, microbial spoilage indicating. The main capability of a smart package is provided by the use of RFID technology [3]. Using this technology the package can interface with electronic devices and communicate information.

The Intelligent packaging concept on the other hand integrates all of the above mentioned technologies. In some publications the terms "smart" and "intelligent" applied to packaging seem to have a similar meaning. This happens because the definition of intelligent packaging incorporates both the active and the smart packaging functions.
But the function that makes the difference is related to the ability to communicate to the customer, to the producer or to any entity involved in the supply chain, information about the state of the product.

This function is specific to "intelligent objects" and allows for the virtualization capability, meaning that such an object is able to interact with users and with other intelligent objects in the virtual world. An example of such an interaction may be between a refrigerator with "intelligent object" capabilities that will interact, through the internet, with an intelligent device, like a PDA, and provide for a grocery list to the owner returning home from work. In this example the refrigerator will be able to provide a grocery list by interacting with the intelligent packaging products within the refrigerator and with other systems which will provide for the owner's food preferences. [7]

The concept of enabling interaction between intelligent objects is closely related with the imminent change from the "Internet of Data" to the "Internet of Things". We can define the "internet of things" as: "the Internet of the future will be suffused with software, information, data archives, and populated with devices, appliances, and people who are interacting with and through this rich fabric". The 2D communication provided by the "internet of data" : any time, any place is completed to a 3D model by a new dimension: any thing. In this context "changing business strategies becomes the name of the game" [4],[10].

To provide for the development of new business strategies in the next chapter we will discuss the introduction of Intelligent Packaging for the Food Industry.

» Smart and Intelligent Packaging for the Food Industry

In this chapter we will discuss an architecture designed for enhancing the current capabilities of Supply Chain Management for the Food Industry with the potential provided by Smart and Intelligent Packaging. First we have to take in consideration the main concerns regarding a food product. These concerns are presented in table 1.

Table 1

Product Quality & Product Deterioration
Recycling
Counterfeiting & Manufacturer Information
Product Information

In regard to these concerns an architecture for the Supply Chain Management in Food Industry is presented in fig 1.

The first type of package to be discussed is the Passive Read Only RFID Package. This kind of package provides for an one way communication capability with any RFID reader equipped digital device. The stored information is "read only" and is provided by the manufacturer. The integration of such packages provides for the reasonable solution to three of the four

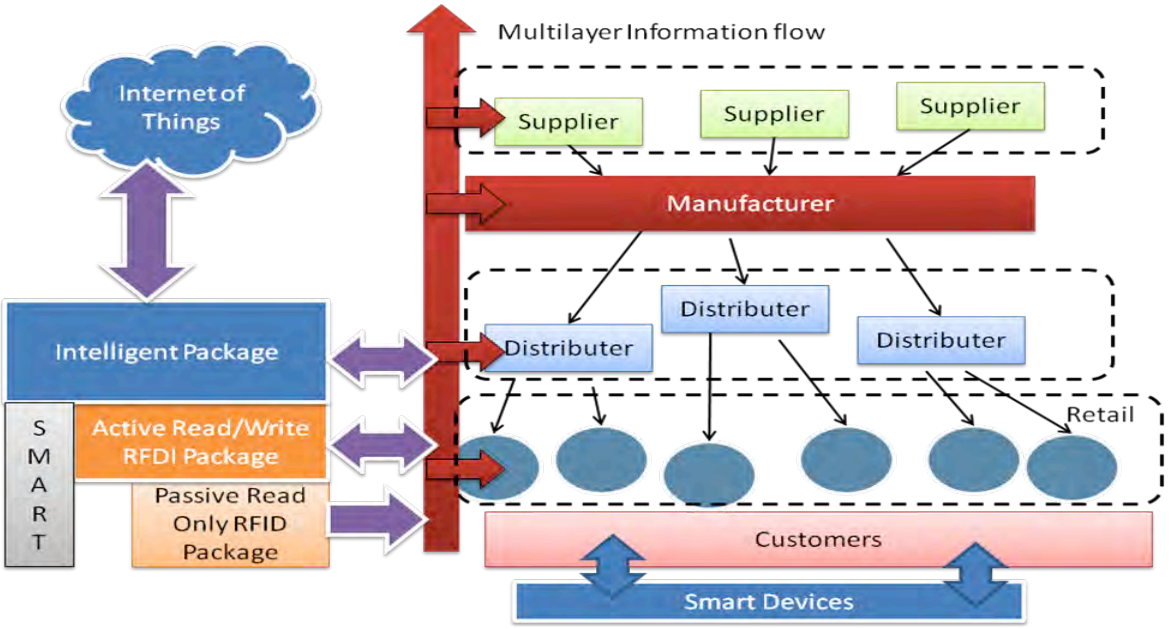

Fig 1. Smart & Intelligent Packaging for the Food Industry Supply Chain.

main concerns: provides information about recycling, provides information about the manufacturer and prevents counterfeiting and can store reasonable amount of information regarding the product, but the lack of interface capabilities makes it impossible to connect to any sensors incorporated in the package. But the main disadvantage is considered to be the one way communication capability which makes it impossible to store any data provided by entities involved in the Supply Chain.

Results and discussion

The introduction of Active Read/Write RDIF Package provides for the full capabilities of a Smart Package. The ability to store data at any level in the Supply Chain enables traceability which represents a key element both for product safety and for market feedback to the producers in a sector where the production is often planned well in advance and subject to the current economical crisis. The interface with sensors which provide for the food quality is also provided by the use of this technology allowing for digital data communication and storage.

A step forward for the Food Industry Supply Chain Management will be represented by the introduction of Intelligent Packages. These kind of packages are capable of unrestricted communication between themselves and with any entity involved in the Supply Chain through the infrastructure provided by the Internet of Things. The three main benefits in regarding to the Supply Chain concern: “things on the move”, "ubiquitous intelligent devices", "ambient and assisted living" [6] .

The “things on the move” concept will allow for: better identification and transport efficiency of food products along the Supply Chain from the producer to the distributer, the shop floor, cashier and check-out leading to the intelligent logistic management. This will also prevent counterfeiting and assure consumers of controlled origin of the food product.

The "ubiquitous intelligent devices" concept will allow for the possibility of information exchange between any intelligent object. Another capability is the implementation of reactive behaviors according to a predetermined set of actions. One of the main advantages for the consumer is the "ambient and assisted living" concept. The development of "digital assistants" connected to the internet of things makes the shopping choice easy in regard to diet and health issues. But the implementation of such devices has to account for the right of choice and opinion [8].

Conclusions

The development of new sensor and communication technologies allows for the large scale implementation of active and smart packaging, designed to ensure better product quality monitoring, product safety, traceability, and interactive product information.

Intelligent packages represent a natural step forward as they introduce brand new concepts regarding customer experience, traceability, product quality and safety and Supply Chain Management.

From the Supply Chain Management point of view, there is a great challenge to identify, model and implement intelligent object modeled "intelligent packages" within the new paradigm of "internet of things".

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REFORMULATIONS IN THE GLOBAL STRATEGY FOR ECOLOGICAL AGRICULTURE IMPLEMENTATION

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Abstract: ***Sustainable development, a global project of all nations, needs special scientific rigors in formulating terms and methods. Ecological agriculture is defined as being a modern agriculture that uses the entire arsenal of modern civilization and technique, in order to obtain big quantities of healthy food, keeping the environment safe. It can be applied everywhere, it is ubiquitous, adapting to any soil and climatic conditions. Paperwork contains aspects regarding organizing of farms, genetic material to be used, technologies, quality of labor force, steps of the strategies and international cooperation.***

Key words: *ecological agriculture, sustainable development, superior quality products.*

Introduction

The possibility to use a planetary strategy, in different fields, seems more and more plausible, as a result of modern society development. In this case, reformulations and adaptations configure new actualized versions, ready for an imminent global application.

Agriculture, known as one of the ancient human occupations, is constantly modernizing, becoming often, in numerous cases, an ecological agriculture. It is a new form of social activity that should be defined clearly and firmly because, at this moment, there are many grave ambiguities and confusions connected to it.

The reformulation-specification, primordial as importance, can be expressed by the following definition: Ecological agriculture is the agriculture that uses the entire arsenal of modern science, in order to obtain big quantities of superior quality products, keeping the environment unaltered. It appears explicit that ecological agriculture does not prohibit mechanization, neither the use of chemical substances– fertilizers, pesticides, adjuvants ... nor the new genetic material created through selection or in the laboratories. It provides that all the resources, the entire technical and scientific arsenal should be used just for the real society and environment demands.

The alternative agriculture methods, having closed names or purposes, should be impeded from using the term ecological. We can have biological, organic agriculture – named, more likely, due to confusion and ignorance, ecological – traditional, chemical agriculture … classifications can be numerous. They should express unmistakable and accurate the relevant content and forms.

Ecological agriculture is a distinct approach, covered by wide definitions and, still, with impassable barriers. It is based on co-evolution of ecologic, economic and social systems and on the interactions and feed-backs between them. And the ecologic and social systems, as systems, have an agricultural potential that can be developed on a superior level.

The ecosystem that became agro-ecosystem within the frame of ecological agriculture is the subject for research and holistic resolving, exceeding the stage of conventional sciences that, through the separate study of problems, are being atomistic.

An ecologic agro-ecosystem should be compatible with adapting biocenose

to biotope, with preserving the renewable resources and with obtaining a high, sustainable productivity.

Beginning from this last postulate we can define more exactly the concept of sustainable development that should be interpreted jointly with the attributes it needs: perseverance, patience, assiduity. A sustainable development, in any field, has as the precursor a universal way of thinking – especially in politics and science; the systemic type with ecologist background. A sustainable development has no way back; it is the platform that leads to the other, higher platforms. It answers to the needs of present generation without compromising the future generation development.

Ecological agriculture should consist of numerous ecosystems. Definition of an ecosystem – very close to the one of Odum – should be taking into account as another term reformulated for global utilization. Ecosystem consists of a biocenose and a biotope it occupies, a biotope that is determined both on administrative and homogeneity criteria.This formulation is the base for agro-ecosystem definition that represents a functional unit of biosphere, created and controlled by the man, in order to obtain agricultural products. In an artificial ecosystem, as the agro-ecosystem is, the predominant elements are human factor and its social-philosophic concepts (figure 1).

» Essential components of the Ecological agriculture

Ecological agriculture implementation at planetary level presumes recognizing its essential elements and the need of their periodical reformulation, in correlation with the fundamental requirements, established and modified by development of science and political relations, as a result of sociology progress.

» Soil fertilization.

It is based, mainly, on chemical fertilizers with nitrogen and phosphorus and, at the same time, on organic fertilizers, variants of composted waste – especially, the animal farm waste, marine algae (for the seaside areas) – and on crop rotation, where nitrogen fixing vegetable and optimum rotation of plants (usually, alternation between mono and dicotyledonous) are very important.

Computed studies can identify the fertilizers required for each cultivated surface, appreciating the export of nutritional substances for obtaining a production that is calculated on the basis of all the factors involved, beginning with the genetic potential of plants to the meteorological conditions.

» Soil works. Mechanization...

On the global level, for all the works performed in the process of agriculture production, including the one connected to the soil, the range of machines adapted for all the needs, known for a specific crop, is complete, at a high technical level of automation and reliability. The agrarian technologies might demand adaptation of these machines, taking into consideration, permanently, reducing of energy, seeds and auxiliary materials consumption.

» Land improvements – Irrigations.

Land improvements are intended to fight against soil erosion, to ensure protection against floods, to locate optimally - in the perimeter of considered ecosystem – the constructions, roads and cropland, to bring water in the best conditions to the crops, and to drain water. An efficient irrigation presumes that a high percentage of water is used by the plants. There are many irrigation methods and they are permanently improving. From the drip irrigation, to the bivalent one, containing both basin flood

irrigation and sprinkling irrigation. Water-supply channels should be bituminized, tiled, concreted, waterproofed with plastic material, or – in order to avoid infiltration – with chemical substances or resins. Concluding these few lines about the place of land improvements in ecological agriculture, we should underline the extreme importance of the shelterbelts, designed, mainly, as garden shelterbelts, semi-penetrable, with microclimate amelioration function.

» Genetic potential of plants.

Genetics and amelioration had developed species and hybrids with high productivity, capable to use the external factors at very superior levels. Hybridizations and repeated selections transformed the genetic potential of the autochthonous species, bringing them new, interesting for the agriculture, qualities: a) high productions and b) increased resistance to less favorable environment factors. Romanian examples, in this field, are numerous, and some of them are very spectacular. Barley Mirage specie has a productivity capacity of 10 tones per hectare, sunflower hybrids deliver heavy yields of seeds and – in consequence – a 10-14% of oil increase. There are plenty of such examples and each ecological area can adapt and ameliorate its productivity plants, through hereditary modifications obtained from hybridizations and selection.

A special chapter here is represented by genetically modified organisms (GMO). They are a large-scale achievement, bringing a great productivity for the agro-ecosystems. A genetically modified organism, created in the laboratory through DNA manipulation, in order to obtain new helpful for agriculture characteristics, may occur as a mutation in nature where, through different crosses, through the fight for survival and though selection it will try to conquer new areas.

Laboratories shorten these long and sinuous pathways, in order to create ideal-plants needed for production in different ecological zones. We have mentioned the possibility of any mutation natural occurring in order to underline the normality of this process, the fact that genetic manipulation is nothing else than redirecting the human intelligence, created by nature, in favor of society. The same intelligence might show that during the past time – last say – a millennium – mankind nether used a plant with an unchanged genetic structure. All the progresses in the crops field, during the 10.000 years of agriculture practice, were made through genetic manipulation, consciously or not … Artificial selection, crossings, mutations, grafting, the plenty of new species that appeared, hybridization … nothing happened beyond genetics or amelioration.

For contestants of these scientific achievements, especially ignorants and obscurants of the primordial jungle, we should remind that nothing new in agriculture – and most probably in other fields of human activity – is not being introduced without a preliminary, long-term testing proving its superior qualities and without a permanent monitoring, so that any potential danger, possible of course, could exist only in the world of imagination and not in the world of science, intelligence and responsibility.

We should also add here the importance of legislation in this field, as a measure of ensuring, both the environment health and agriculture production optimization. Un-cultivating the genetically modified Soya or Maize, means accepting from the very first beginning a loss of 10 – 50% of production that is totally inadmissible, even not keeping in mind the 2 billion of unfed people or hundreds of millions that are subject of endemic starvation. The *Bt*-gene induces in Soya resistance to pest attack, similarly with the synthesis function plasmids replication

in protection insecticides, for potato, tobacco and maize plants.

Genetic modifications can impregnate a favorable habitat for solar energy capturing, modifying the height, the foliar index, the position of leaves (figure 2) … the economic coefficient of transpiration. It can modify metabolism capacity of nutritional substances; it can change guidable the chemical composition.

We need obtaining the genetically modified organisms – in the laboratories – and not the aborted trials of the capricious nature. This is the essential distinction in the dispute regarding this problem.

Ecological agriculture is *in favor of* genetically modified organisms use in agriculture, is these organisms, after long and careful experiences, prove favorable qualities, including along the trophic chain.

» Integrated fight.

Control of diseases and pests. Ecological agriculture promotes this protection method, containing all known efficient means – agro-technical, biological, physical and chemical methods. Regarding the last ones, we mention the priority given to the pesticides, having a high specificity and a deep degree of decomposition. We insist on applying this integrated fight, in order to ensure an efficient and rapid control, on the real ecosystem understanding and on the knowledge of diseases and pest biology. We said before, on the other occasions, that the ecological agriculture does not presume more work and resources, but it needs superior knowledge, intelligence and responsibility

» Agro-phytoengineering.

There is a need of crops methods standardization for the species with the significant share in the global agriculture.

» Zoo-engineering.

An highly productivity agriculture ecosystem contains zoo-engineering sectors, interested to get forages obtained on the marchlands, and to use their own waste that, being composted, represents a precious natural fertilizer. Using the land with a special vocation, beside the croplands,zoo-engineering establishes, within the ecosystem frame, a relative autarchy, including under the aspect of ecologic balance.

» Management.

Its scientific purpose is to ensure ecologic balance in agro-ecosystems (forming the agro-climax) – through the supplementary supply of energy and through dimensioning and optimum development of the agriculture production. The economic goal – region developing, optimizing the products qualities, the environment and labor.

Alternative production systems can be used in ecological agriculture and therefore they should be considered as complementary parts. Important are the poly-culture systems (commensal, amensal, monopolysatric and inhibiting), the agro-forestry system, the covering plants system, the system of live mulch (formed from vegetable plants) and the minimum cultivation systems, having effects on the soil characteristics, on the weeds, diseases and pests.

This is the main package of ecological agriculture that should be implemented on the global scale, through a staged strategy and under the conditions of social factors that are in a philosophic, doctrinaire concordance, at the level of entire Terra.

Results and discussion

» Strategy stages

Neither the structure of ecological zones, nor the development level of the human society allows immediate, simultaneous and total application of the ecological agriculture. By

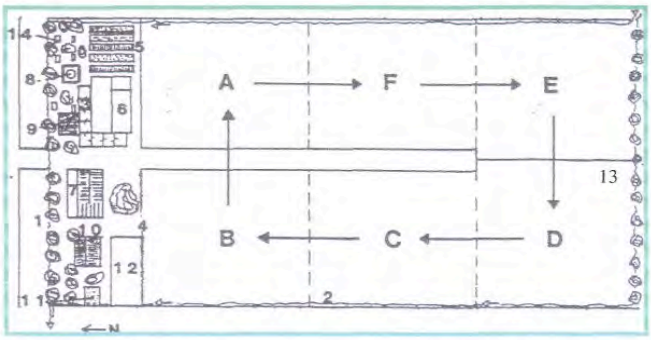

Fig. 1 - Model of agroecosystem: 1. fruit trees; 2. irrigation; 3. vine; 4. shrubs; 5. vegetables; 6. house; 7. aviculture; 8. well; 9. oven; 10. cows; 11. pigs; 12. compost; 13. trees; 14. beehive (from Altieri)

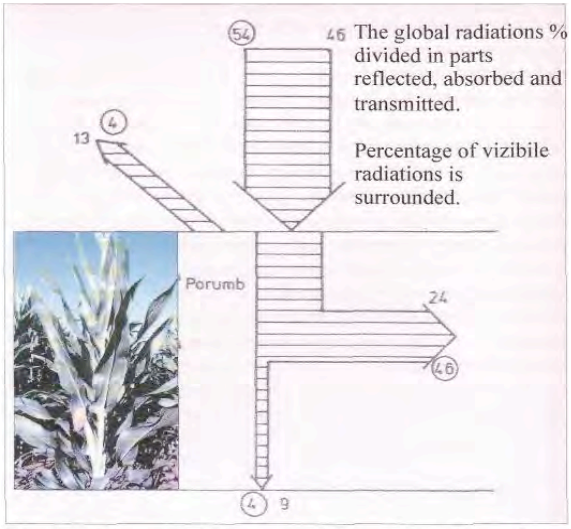

Fig. 2 - Energetic balance of a green plant (corn) depends both on height (2,65m) and foliar index (4,3). These two characteristics care be modified by genetic engineering (from Ionescu-Barbault)

the force of reality, the application strategy will be a fractioned one, in stages, for all the similar ecological zones, with the trial-experiment for the integral application of the ecological agriculture, in an extended region or even in small country. It is obvious that the task of ecological agriculture implementing in the third world countries will be performed by an international consortium that will have to take in concession the cropland area of the country, for approximately 15-20 years. Agro-ecosystem exploitations will be used as qualification schools for the labor force coming from indigene population or neighboring counties. The ecological agriculture implementation control will be performed by a joint committee UN – interested country, the both partners bearing, within their possibilities, the investment that international consortium is not able to bear. Ecological agriculture implementation, with material sacrifices of other nations, should increase responsibility of receiving help nation, increasing its efforts for modernization of the connected sectors and for development of the social and demographical politics that will guarantee a future role to be assumed, for the wellbeing of the entire mankind.

» The following stages ate needed:

- Traditional agriculture amelioration, at the same time with preparation for its transformation;
- Improving, industrialization and modernizing the connected domains, such as: fishing, agriculture products processing, hunting;
- A new map of commercial and cooperative network should be drawn;
- FAO and the hosting country will draw maps on the soil quality, biotope conditions, traditional (adapted) plants cultivation, and tables containing data about the existing material

base, together with the development needs;
- General teaching, during the following 3-5 years, of the discipline Ecological Agriculture and connected sciences, in all the world profile universities;
- Establishing of OPEC-type cartels for a supreme valuating, in the wealthy countries, of the products originated from the sub-developed countries (coffee, cacao, rubber tree, biofuel…);
- Outlining the perspective plans in order to reach an optimum repartition of the land: agriculture soil 30-40% (cropland 15-20%), forests – natural ecosystems 40-60% and human establishments 10%.

In order to shorten the implementation periods, there is a need of additional willing and efforts from developed nations and a need of increased capacity to absorb values – including labor and intelligence – from developing countries.

The real humanism will consist in teaching them to help themselves! Anything else … charity aid, aid for stopping those developing nuclear weapons, food briberies for avoiding their transformation into terrorists … are just simple cheatings that bring damage to the quality of the human society. UN can and should encourage work mobilization, in order to transform all economies, step by step and efficiently, and not increase the humanitarian aid for "compensating the prices growth for the food products".

Otherwise, the science achievements, implementation strategies, etc... will remain in a shop window, and the misery and social disturbances will continue living, as before, among people.

Conclusions

(International cooperation)

We saw that for the ecological agriculture application in as many countries as possible, there is a need of cooperation, difficult to be assumed in a world with yet too much hypocrisy.

In developed countries, this type of agriculture will be applied through its intrinsic values imposing it both to producers and consumers. What about the others?

In order to assess the role of ecology in the entire philosophy of human preoccupations we should acknowledge this science as a relationship between human society and environment, generating an opportunity for social reflection. This reflection represented a superior social conscience that tends to create a universal bioethics, a superior spirit condition and a systemic character.

Ecology implementation in agriculture increases the qualities of this activity field and at the same time improves the qualitative level of intelligence and of human character which, working within the science and technique top conditions, develop a superior sociology.

There are many international organizations dealing with the agriculture problems. First of all it is FAO – The Food and Agriculture Organization of the United Nation. Then, the regional centers for agriculture research and exploitation, financial systems, such as IMF and The World Bank, profile universities and institutes, national ministries, with the complex nets of agencies extended all other the territory…

The idea of the French minister Michel Barnier to found a global forum for the food and agriculture topics, for the regional agriculture politics, is associated to the international cooperation, evoked by us.

Nevertheless, implementing this kind of agriculture – we speak about the ecological agriculture – can be realized only with the United Nations' political will that must exceed the stage of declaring some fantasist rights, in an institutionalized pharisaism. And we will remind here the FAO proclamation of 1963 in Rome: Man's

Right to Freedom from Hunger (?!)

In order to reach the achievement of this necessity, normal and banal, there is no need to proclaim a right – both tragic and ridiculous – There is a need to help and teach people how to work and produce for themselves!

Ecological agriculture can do this. International cooperation should solve this type of help… This cooperation should be grounded on two types of measures:

- one - for helping the people willing to apply the modern society progress with their own, permanent and hard-bitten effort;
- another – for avoiding any waste of allocated resources (under different pretexts-interests, usually for conservation of inertia, dictator-ship, aggression and laziness).

But, for this purpose, the United Nations, the community of developed countries, should consider as being unrealized and therefore never lost the union of ideals built up on truth, justice and work.

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A PRELIMINAR ECOLOGICAL APPROACH IN THE DESIGN AND OPERATION OF A FULL-SCALE BIOREMEDIATION SYSTEM

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Abstract: ***Different plant species (Populus nigra (var.italica), Paulownia tomentosa, Cytisus scoparius), earthworms (Eisenia foetida), and organic matter (horse manure) were used as an ecological approach to bioremediate a soil historically contaminated by heavy metals and hydrocarbons. The experiment was carried out at mesoscale level using plots containing about 90 kg of soil. The plant species were able to grow in the polluted soil and to improve the soil bio-physical conditions especially when organic matter and earthworms were applied. Populus nigra and Paulownia tomentosa were the more efficient plant species in the reduction of heavy metals (Pb, Cr, Cd, Zn, Cu, Ni), while earthworms were particularly able to stimulate the processes involved in the decontamination of organic pollutants (hydrocarbons). The ecological approach validated at mesoscale level has recently been transferred at a real scale situation to carry out the bioremediation of a polluted soil located in San Giuliano Terme Municipality (Pisa, Italy).***

Key words: *bioremediation system, soil pollution, organic matter, Populus nigra, Paulownia tomentosa.*

Introduction

Soil pollution by heavy metals and hydrocarbons has become an important environmental problem worldwide. A wide range of physical and chemical technologies have been developed for the remediation of contaminated soils.

However, these treatments irreversibly affect soil properties, reduce biodiversity and they are often very costly methods.

Among the remediation technologies, phytoremediation is a suitable cost-effective biological soil remediation techniques to remove organic and inorganic contaminants without affecting soil fertility. Phytoremediation involves the use of plants to remove, transfer, stabilize and/or degrade contaminants in soil, sediment and water (Hughes et al., 1997). In recent years, the use of earthworms as an efficient method to support the soil bioremediation has been experimented (Ceccanti et al., 2006). Earthworms maintain aerobic conditions through the continuous mixing of the soil. In addition, they ingest soil and expel a partially stabilized product (casting), in this way they ensure the availability of organic substrates for proliferation of the autochthonous microorganisms in the soil, thus increasing the microbiological and biochemical soil activity.

In the present investigation, carried out at mesoscale level, different plant species (Populus nigra (var.italica), Paulownia tomentosa and Cytisus scoparius), earthworms (Eisenia fetida), and organic matter (horse manure) were used as an ecological approach to bioremediate a soil historically contaminated by heavy metals and hydrocarbons.

Materials and methods

» Experimental layout

The experiment was carried out at mesoscale (on site) level using plots containing about 90 kg of a soil historically contaminated by heavy metals and hydrocarbons (San Giuliano Terme, Pisa, Italy).

Three treatments with three replicates were performed:

1) Untreated soil as control (C);

2)soil + horse manure (20:1 w/w) (M);

3) soil + manure + 15 earthworms (ME).

The characteristic of soil (S), horse manure (HM) and soil + manure (SHM) are reported in table 1.

Three different species were used for each treatment: two trees (Populus nigra, var.italica and Paulownia tomentosa) and a bush (Cytisus scoparius) (Fig.1).

Composite samples, consisting of 10 subsamples, were taken from each plot after six months from the beginning of the experiment.

Samples were air-dried, sieved (2 mm), and stored at room temperature until chemical and biochemical analyses.

» Methods

Total organic carbon (TOC) and total nitrogen (TN) content was determined by dry combustion in a RC-412 multiphase carbon and a FP-528 protein/nitrogen determinator, respectively (LECO corporation). Water soluble carbon (WSC) was measured by Yeomans and Bremner (1988) method. Total extractable carbon (TEC), fulvic acids (FA) and humic acid (HA) were determined according to the method of Marinari et al. (2007). NH3 was measured with an ammonia-selective electrode (ORION 95-12), and NO3- was measured with a DIONEX chromatograph. Available P was determined by the method of Murphy and Riley (1962). The heavy metal concentration analysis was performed by atomic absorption spectrometry. The total heavy hydrocarbons

Figure 1. Experimental mesoscale plots with *Cytisus scoparius* (a) and *Populus nigra* and *Paulownia tomentosa* (b) placed in the polluted site (San Giuliano Terme, Pisa, Italy).

a)

b)

were determined by the gravimetric method according to the method of Ceccanti et al., 2006.

Dehydrogenase activity was determined by the method of Masciandaro et al. (2000). The methods used to assay β-glucosidase and phosphatase are described by Garcia et al. (1993).

Statistical analysis was carried out by using STATISTICA data analysis platform (StatSoft inc., USA).

Results and Discussion

» Chemical and biochemical process involved in the remediation practice

The plant species were able to grow in the polluted soil showing the greater development in the treatments with manure and manure with earthworms, probably because of the higher availability of nutrients added with horse manure. TOC and TN, in fact, decreased in C treatments while generally increased in M and ME treatments (table 1).

The WSC, which represent an important pool of soil organic matter turnover in soils since it acts as a readily decomposable substrate for soil micro-organisms (Caravaca et al., 2002), generally increased in M and ME treatment, particularly in presence of Paulownia tomentosa and Cytisus scoparius (table 1). This result suggests the beginning of mineralization of the easily degradable organic matter in each treatment, probably of that added with manure.

This availability of soluble organic carbon was probably the reason of the higher b-glucosidase activity (table1), enzyme related to carbon cycle, in each treatment and, in particular, in that with organic matter. The organic matter also affected the dehydrogenase activity, considered an indicator of the entire microbial metabolism as it occurs only within living cells (Masciandaro et al., 2000), that resulted higher in M and ME treatment (table 1). It is, in fact, well known that organic amendment improve the conditions for the increase of total microbial biomass number and activity.

Earthworms activity resulted particularly evident in the stimulation of N and P cycles as showed by the higher available P, ammonium and nitrate in the ME treatments (table 1). Instead, among the plants, Paulownia tomentosa and Cytisus scoparius seemed to better balance the mineralization and humification soil processes as confirmed by the C/N ratio ranged from 8 to 12 (Alensons, 1995).

» Remediation efficiency.

The efficiency of remediation process was evaluated through the assays of organic (TPH) and inorganic pollutants (total heavy metals). The greatest reduction of TPH (54-75%) was for the treatment with earthworms (ME) while a significantly lower reduction was observed in M treatments (Fig. 2), thus suggesting the combined action of organic matter and earthworms in the degradation of the pollutant organic substrates. This action could be a direct degradation of the organic substrates by earthworms, and/or an indirect effect through the stimulation of soil microbial metabolism by available substrate from organic matter and earthworm casting (Ceccanti et al., 2006).

The starting heavy metal concentration in the polluted soil (S) resulted, with the exception of Cr, higher with respect to the law limit concentration, Table A, D.Lgs. 152/2006 (table 2).

The heavy metal content significantly decreased during the time in each treatment, the higher reduction was observed in ME treatments (Fig. 3).

Among plant species, Populus nigra and Paulownia tomentos, determined a reduction of heavy metal content reaching values under the law limit concentration (Table

Table 1. Chemical and biochemical parameters in the starting materials: soil (S), horse manure (HM), manure plus soil (SHM) and in the treatments: soil as control (C); soil + horse manure (M); soil + manure + 15 earthworms (ME) with *Populus nigra*, *Paulownia tomentosa* and *Cytisus scoparius* after six months of mesoscale experiment. Mean of three replicates ± standard deviation.

	Materials			*Populus nigra*			*Paulownia tomentosa*			*Cytisus scoparius*		
	S*	**HM***	**SHM***	**C**	**M**	**ME**	**C**	**M**	**ME**	**C**	**M**	**ME**
pH	7,90	6,92	7,89	8,27±0,15	8,96±0,26	8,88±0,05	9,04±0,17	9,06±1,01	9,30±1,20	9,18±0,18	9,33±0,04	9,30±0,11
E.C. *(dS m^{-1})*	0,13	3,69	0,17	0,20±0,03	0,16±0,00	0,25±0,01	0,11±0,01	0,18±0,03	0,14±0,02	0,32±0,05	0,32±0,03	0,33±0,04
TN (%)	0,18	1,49	0,197	0,19±0,02	0,17±0,00	0,17±0,01	0,165±0,009	0,23±0,00	0,24±0,00	0,23±0,01	0,30±0,01	0,30±0,01
TOC (%)	1,45	45,1	1,98	0,78±0,08	1,14±0,21	1,14±0,12	1,04±0,18	2,07±0,12	3,72±0,00	1,98±0,37	2,60±0,28	3,40±0,55
C/N	8,01	30,3	10,0	4,04	6,67	6,87	6,30	9,12	15,44	8,46	8,52	11,2
NH_3 ($mgKg^{-1}$)	2,30	118	4,93	1,54±0,30	1,34±0,01	4,10±0,90	2,39±0,01	1,44±0,00	5,41±0,00	2,23±0,43	2,83±0,61	5,11±0,83
NO_3 ($mgKg^{-1}$)	11,3	394	15,1	0,12±0,01	0,15±0,00	0,14±0,02	0,1±0,0	2,55±0,3	13,9±2,1	4,15±0,7	24,7±5,1	93,5±19,0
WSC ($mgKg^{-1}$)	91	36200	133	277±19	303±19	404±78	285±15	375±45	476±56	287±53	463±11	452±86
TEC($mgKg^{-1}$)	2417	59361	3570	1925±340	2574±109	2940±11	2193±143	3709±540	3767±430	3286±335	3900±601	4046±312
FA($mgKg^{-1}$)	1178	33898	1609	1407±150	1630±241	1739±26	1361±41	1795±233	1752±201	1914±237	1813±71	2010±267
HA($mgKg^{-1}$)	1239	25463	1962	518±76	944±132	1202±15	832±102	1914±219	2015±310	1372±98	2087±320	2036±45
Pav($mgKg^{-1}$)	0,06	46,4	0,33	0,04±0,00	0,07±0,00	6,24±1,10	0,71±0,10	0,03±0,00	28,5±3,3	4,19±0,55	3,94±0,32	19,97±3,80
PT($mgKg^{-1}$)	216	394	241	284±16	244±38	222±28,5	256,6±6,2	225±0	301±0,0	260±43	239±9	258±45
DHase (µg INTF/$g^{-1}h^{-1}$).	0,67	64,2	2,04	0,64±0,12	0,85±0,16	1,62±0,20	0,88±0,11	1,51±0,12	2,71±0,22	0,79±0,10	1,35±0,33	1,66±0,17
β-gluc (µg PNP/$g^{-1}h^{-1}$).	14,3	1410	22,1	39,9±9,5	57,3±8,2	58,9±11,3	32,8±3,2	95,9±13,2	134±24	37,8±7,5	68.,9±12,1	91,4±11,4
Phosph(µg PNP/$g^{-1}h^{-1}$).	81,7	2823	106	162±21	154±11	213±36	123±5	138±23	303±44	211±32	255±43	194±25

* Coefficient of variation of the results ranged from 3 to 11%.

E.C., Electrical Conductivity; TN, Total Nitrogen; TOC, Total Organic Carbon; WSC, Water-Soluble Carbon; TEC; Total extractable carbon; HA, Humic acid; FA, Fulvic acid; P_{av}, Phosphorus available; TP, Total Phosphorus; DH-ase, Dehydrogenase activity; β-gluc, β-glucosidase; Phosph, Phosphatase

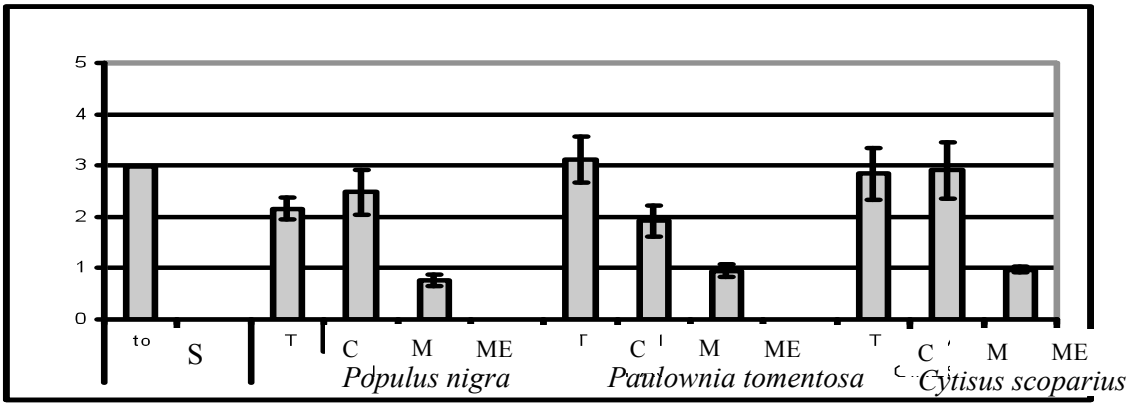

Figure 2. Total hydrocarbons concentration with respect to the limit concentrations reported in D.Lgs. 152/2006 (Table A) in soil before (S) and after treatments: C (control soil); M (manure), ME (manure + earthworms) with *Populus nigra*, *Paulownia tomentosa* and *Cytisus scoparius*. Vertical bars indicate standard error.

Tabella 2.

Total heavy metals and hydrocarbons (C<12 and C>12) limit concentration reported in D.Lgs. 152/2006 (Table A, Table B).

	Zn	Cu	Pb	Cd	Ni	Cr	C<12	C>12
Table A *(mg kg^{-1})*	150	120	100	2	120	150	10	50
Table B *(mg kg^{-1})*	1500	600	1000	15	500	800	250	750

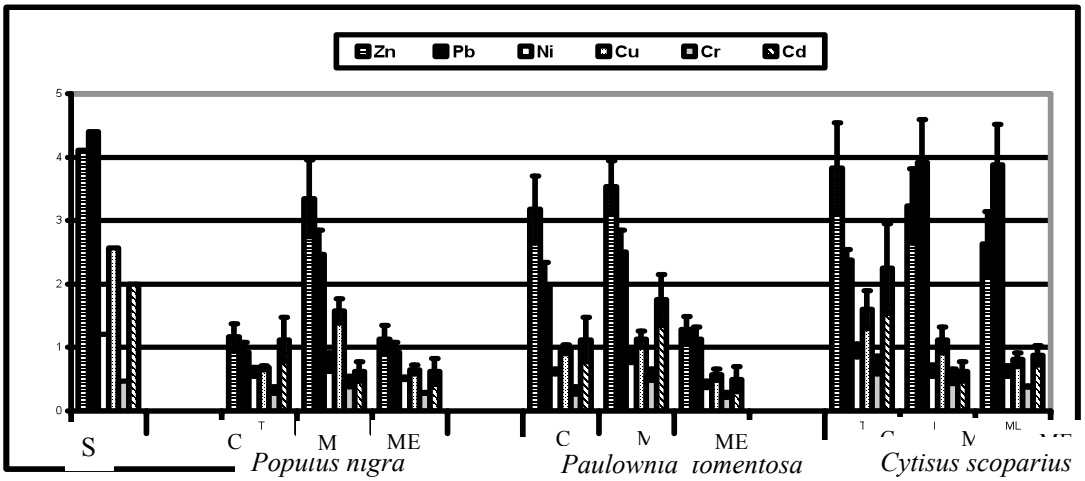

Figure 3. Total heavy metals concentration with respect to the limit concentrations reported in D. Lgs. 152/2006 (table A) in soil before (S) and after treatments: C (control soil); M (manure), ME (manure + earthworms) with *Populus nigra*, *Paulownia tomentosa* and *Cytisus scoparius*. Vertical bars indicate standard error.

A, D.Lgs. 152/2006), and resulting more efficient than Cytisus scoparius in the heavy metal extraction.

Conclusions

The bioremediation treatments carried out at mesoscale level were effective in the reclamation of hydrocarbon and heavy metals polluted soil. A reduction of hydrocarbon and heavy metals was, in fact, observed in each treatment. In particular, the treatments with organic matter and earthworms, stimulating soil metabolic processes, achieved the best result in the hydrocarbon degradation even preserving the biochemical quality of the soil. Populus nigra and Paulownia tomentosa were more efficient than Cytisus scoparius in the heavy metal extraction. Therefore, on the basis of these results, the ecological approach has recently been transferred at a real scale situation to carry out the bioremediation of the polluted soil located in San Giuliano Terme Municipality (Pisa, Italy) (figure 4).

a)

b)

Figure 4. Polluted site (San Giuliano Terme, Pisa, Italy) before the tree plantation (a) and after 6 months from the tree plantation (b)

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NUTRIENT POLLUTION

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Abstract: ***Although the phenomenon of nutrient pollution can be studied using models from the environmental sciences, understanding both the human causes and the human effects of nutrient pollution requires a study of economics. The economic dimensions of the problem of nutrient over-enrichment and the role that economics can and should play in the evaluation and design of policies to reduce nutrient pollution relate to understanding the causes of nutrient pollution, setting targets for reduction or improvement, and designing policies to meet those targets. We summarize the incentives created by alternative policy approaches, including both voluntary approaches (based on education, subsidies, and implicit threats of more stringent policies) and mandatory approaches (such as regulations, taxes, and marketable permits).***

Key words: *nutrient pollution, ecological impacts, nutrient over-enrichment.*

Introduction

Numerous studies have examined the physical and biological causes and ecological impacts of nutrient over-enrichment (e.g., j0rgensen and Richardson 1996; National Research Council (NRC) 2000). Although there is still much to be learned about those causes and effects, their importance is well documented and is the focus of much research. Perhaps less well recognized are the economic dimensions of nutrient over-enrichment. Economic factors play a key role in both the causes and the effects of nutrient over-enrichment, and economic analysis can contribute significantly to the design of effective policies to combat the problem (Turner et al. 1999; Gren et al. 2000). The following questions have important economic dimensions. Why is nutrient over-enrichment occurring? How much should loadings be reduced? How should desired reductions be achieved?

The importance of these questions is evident in a recent report on nutrient over-enrichment by the NRC (2000). That report recommended the development of a National Nutrient Management Strategy with a goal of achieving significant improvements in coastal water quality over the next 20 years. The recommended strategy is intended as a framework for nationwide efforts to provide decision makers and others responsible for implementing management activities within the United States with the information needed to determine and achieve appropriate source reduction goals.

The effective implementation of such a strategy will require economic input at a number of levels relating to the three questions outlined above. At the national level economic factors should play a role in identifying priority areas where federal resources should be targeted. Understanding economic forces can help in identifying and predicting national or even global trends that significantly affect the nutrient cycle (such as increased use of fertilizer or fossil fuels). At the local level economic analysis can help local managers identify feasible restoration or prevention goals and understand the likely impacts of the alternative policies that are available.

We provide an overview of some of the economic dimensions of nutrient pollution. We examine the role that economic analysis

can play in understanding and combating this problem. Our purpose is not to provide an exhaustive review of the economics of nutrient pollution, but to highlight the various economic dimensions of the nutrient over-enrichment problem and suggest ways that economic analysis can contribute to the debate on how best to achieve meaningful reductions in nutrient pollution.

Materials and methods

» Why is Nutrient Over-enrichment Occurring?

Although there is considerable information available about the sources of nutrient loadings (e.g., agricultural use of fertilizers and combustion of fossil fuels), to reduce those loadings effectively it is necessary to understand the factors that drive the behavior or activities that generate them. Many of these factors are economic. Input and output decisions of producers are driven to a large extent by prices, and over-production or over-use can result when those prices do not reflect all of the associated impacts on society. The large increase in the use of fertilizers that has occurred over the last 60 years (NRC 2000) has been driven to a large extent by their low cost and high contribution to agricultural productivity, both of which encourage farmers to choose fertilizer-intensive crops and production processes. Historically, government price support programs also created incentives for farmers to increase production of supported crops, some of which were fertilizer intensive (Just and Bockstael 1991). Because farmers make decisions about fertilizer use based primarily on the net gains that they realize from that use, which are increased by low fertilizer prices and high output prices, they tend to over-use fertilizers. Similar arguments apply to the over-use of fossil fuels, a major source of atmospheric nutrient loadings (NRC 2000).

In addition to the impact of prices, production decisions that affect nutrient loadings are also affected by a number of other factors, including macroeconomic conditions, such as interest rates, exchange rates, trade policies, energy pricing policies, transportation policies, economic growth, and demographic changes. All of these affect the demand for fertilizer and fossil fuels and the geographic distribution of their use (Lakshmanan and Han 1997; Jacobsen 2000; Sadorsky 2000).

Economic analysis can contribute to an increased understanding of the factors that determine the demand for fertilizers or fossil fuels, how responsive demand is likely to be to policy changes, and whether demand can be expected to increase or decrease in the future. This information should be useful to policy makers both in terms of understanding the root causes of over-enrichment and in assessing whether (in the absence of any policy response) the problem is likely to improve or worsen over time.

» How Much Reduction Is Desirable?

Any attempt to combat nutrient over-enrichment generally begins with a goal or target for water quality improvement. There are a number of different bases that can be used to set water quality goals. One possibility is to seek to increase or decrease an ecological indicator by some arbitrary amount (e.g., 25%) or to restore it to its level during some previous period. Alternatively, the target level might be determined by a specific use that is desired (e.g., a fishable and swimmable criterion). Setting targets levels in either of these two ways typically focuses on the benefits of improvement or similarly on what level of improvement is deemed feasible.

Another approach is to set goals in a way that balances these benefits against what would have to be given up in order

to achieve the goal (e.g., reductions in the production of certain goods, or reductions in the amount of money that could be spent on other government programs). The value of what would have to be given up in order to achieve a given water quality goal represents the cost of meeting the goal. To compare benefits and costs requires that both be measured using a common metric, such as dollars. Both the costs and benefits of water quality improvements can be difficult to quantify in dollar terms. While it may be relatively easy to calculate the commercial value of an impacted resource that is bought and sold in a market (e.g., the value of reduced catch of a commercial fish stock or the value of reduced agricultural production), the non-commercial (or non-market) value of natural resources affected by nutrient over-enrichment is difficult to quantify. Non-market values include both non-market use values (values derived from non-market uses of the resource, such as swimming, recreational fishing, wildlife viewing, boating, and beach use) and non-use values derived from the existence of the resource (for its own sake or for the sake of future generations).

There has been a considerable amount of research devoted to the development of techniques for valuing such non-market goods as wetlands, water quality, and animal populations (Ribaudo and Hellerstem 1992; Arrow et al. 1993; Freeman 1993; Lipton and Wellman 1995; Smith 1996; NRC 1997a). These methods are controversial (Diamond and Hausman 1994; Hanemann 1994; Turner 1999), and care must be taken to avoid problems such as aggregation and double counting.

Despite this controversy, non-market valuation techniques have been used to estimate the benefits and costs associated with changes in water quality (Kahn and Kemp 1985; Bockstael et al. 1989; Carson and Mitchell 1993; Freeman 1995; Boyle et al. 1998). Results from this research suggest that non-market values, including non-use values, can be an important component of total value. A study of the value of water quality improvements in the Albemarle and Pamlico Sounds of North Carolina found that non-use values comprised more than half of the total value of water quality improvement (Huang et al. 1997). Bockstael et al. (1989) also found significant non-use values in their study of water quality improvements in the Chesapeake Bay. Estimates of the costs of meeting different goals have been developed. Many of these studies are at a relatively small watershed scale, although a recent study provides a more aggregate assessment for the Mississippi River drainage basin (Doering et al. 1999).

Information about the costs and benefits of achieving different targets is useful both at the federal level, where priorities and aggregate targets must be set, and at the local level, where local officials must decide how ambitious their local water quality goals should be. Setting goals is one of the first steps in the decision process for local managers recommended by the NRC (NRC 2000; Greening and Elfring 2002). It would be difficult and expensive to do a detailed assessment for each estuary. Federal policy makers and local water quality managers can learn from the economic analyses that have been done. For this reason, a web-based clearinghouse for information relating to nutrient pollution was recommended as part of the National Nutrient Management Strategy (NRG 2000). Such a clearinghouse could provide, among other things, a summary of and guide to research on the economic effects of nutrient over-enrichment, with particular emphasis on the role of site-specific characteristics in determining those impacts.

» *How Should Reductions Be Achieved?*

A key component of the National Nutrient Management Strategy called for in NRC (2000) is the local determination of effective nutrient management strategies based on the economic and physical characteristics of local estuaries. Because nutrient over-enrichment is a site-specific problem, the appropriate management strategy or policy choice will vary among estuaries. There are a number of ways in which economic analysis can contribute to better policy design.

Economic models have been used to study whether environmental policies should be set at the national, regional, or local level (Oates and Schwab 1988, 1996). The answer depends on a number of factors, including the key factor of whether the costs and benefits of control extend beyond the local jurisdiction. If they do, then local officials do not face the proper incentives to factor all relevant effects into their policy choices. Local officials do not have the authority to impose controls on sources outside their jurisdiction. In such cases, regional or even federal approaches may be required for effective control. To be effective, they must take into account the site-specific nature of over-enrichment. A cooperative effort among national, regional, and local officials, as envisioned by the National Estuaries Program, might provide an appropriate balance between these two goals.

Economic analysis can also shed light on the question of how public expenditures relating to environmental improvements should be funded (i.e., which level of government should be responsible for providing the necessary resources). Economic theory and evidence suggest that the federal government can raise revenue more effectively than local governments (Atkinson and Stiglitz 1980). Note that federal funding of local expenditures leads to a cross-subsidization of jurisdictions, because a jurisdiction that does not suffer from an over-enrichment problem would contribute to the source of funds but would not be the recipient of those funds. It leads to cost spreading (as is common with many federal programs, such as highway funding). The incentive effects created by federal funding vary with the form of the funding; the incentives created by block grants (fixed sums) differ from those created by matching or cost-sharing grants that require the local government to pay a share of the associated costs (Gramlich 1997).

Once the levels of government responsible for designing and funding policies have been determined and water quality goals have been set, decisions must be made regarding the specific management tools that will be used to achieve these goals. Because of the differences within and among watersheds and estuaries, the appropriate policy choices will vary as well. Economic analysis can help to understand more generally the advantages and disadvantages of alternative policy instruments that might be used to improve environmental quality.

» *What Policy Instruments Should Be Used?*

NRG (1997b) identified a number of general policy approaches or management tools that can be used to improve marine management, including direct regulation, moral persuasion, liability and compensation, direct production of environmental quality, education, economic incentives (for example, subsidies or taxes), and tools that affect the underlying dynamics of the marine system. Of these, both the direct production of environmental quality (through, for example, improved sewage treatment plants or water treatment systems) and modification of the dynamics of the natural system are purely public management options, because they are undertaken and financed directly by public authorities. The remaining tools are aimed

at private source reduction and involve government efforts to force or induce private parties to reduce pollution.

In deciding how to combat nutrient over-enrichment, policy makers are faced with a fundamental choice of whether to adopt a voluntary or a mandatory approach (or some combination of the two). Voluntary approaches include both information-based and moral persuasion-based policies and subsidies that induce voluntary reductions in pollution. Mandatory policies include both regulatory policies and negative incentives (e.g., taxes, fines, penalties, and liability). The crucial distinction is that, under voluntary programs, polluters have a choice regarding whether to participate in the program, while under a mandatory policy, compliance with the regulation or payment of a penalty or tax is not voluntary. Under a voluntary approach managers cannot impose involuntary net costs on polluters, while under the mandatory approach they can.

» *Evaluation Criteria*

In choosing among alternative approaches to reducing nutrient pollution, it is important to specify the criteria used to rank the alternatives. Criteria typically used include cost-effectiveness, dynamic adjustment (flexibility, adaptability, and innovation incentives), and distributional effects and fairness (Bohm and Russell 1985; NRC 1993).

Given a predetermined water-quality goal, cost-effectiveness is achieved when that goal is met at the lowest possible cost (Bohm and Russell 1985; Baumol and Oates 1988). Cost effectiveness is important for several reasons. It ensures that society is not giving up more than is necessary to achieve the goal. To the extent that it reduces the burden on industry, cost effectiveness can also protectjobs, increase production, and reduce the costs of consumer products, which can increase the political acceptance of the steps that may be needed to achieve the water quality goal.

In assessing cost-effectiveness, the measure of costs should include costs to private parties and government agencies. It should include not only the direct cost of reducing loadings (control costs) but also the administrative costs associated with compliance, monitoring, and enforcement. In many cases control costs will vary across sources and, if equally effective, the total cost of meeting the target will be lowest if the lowest cost sources are controlled first. In some cases policies that involve low aggregate control costs may have high administrative costs.

Environmental and economic conditions can change rapidly. It is also desirable to have a policy that is flexible enough to respond to such changes or to new information as it becomes available and that encourages innovation and the design and development of improved control or response strategies. Policies under which private parties realize the gains from innovation provide incentives for investment in pollution control research and development (Prince and Milliman 1989; Carraro and Siniscalco 1994; Laffont and Tirole 1994, 1996;Jaffe and Palmer 1997).

While the above criteria relate to reducing nutrient pollution as cheaply and effectively as possible, policies can also be evaluated on the basis of how they distribute the costs (and benefits) of nutrient control. The costs will be distributed regionally and across sectors (e.g., agriculture, electric utilities, households, and public sector). There are at least two alternative principles for determining an appropriate cost allocation. The first is that the polluter-pays (polluting parties bear the costs of pollution control) (Tobey and Smets 1996). Pollution taxes and to a lesser extent regulatory approaches are

based on this principle. The second principle is that the beneficiary pays (those who benefit from pollution control bear the associated costs). Subsidies and public investment in pollution control are based on this principle, as are water treatment strategies (such as those under the Safe Drinking Water Act) that raise water prices to consumers. When polluters and beneficiaries are separated sectorally and regionally, the two principles imply very different distributions of costs.

Results and discussion

» Alternative Policy Approaches

The above criteria can be used to evaluate the alternative policy tools that are available for use in combating nutrient pollution. In what follows we provide a brief overview of the results that have emerged from economic analyses of alternative policy instruments. Our purpose is not to provide an exhaustive discussion of each instrument but rather to indicate the nature of the economic issues that arise in evaluating different policy tools. For more detailed discussions, see Bohm and Russell (1985), Baumol and Oates (1988), NRC (1993), and Russell and Powell (1999).

» Voluntary Approaches.

Voluntary approaches to pollution control can be divided into three types (Carraro and Leveque 1999; Segerson and Li 1999): unilateral commitments initiated by individual polluters or groups seeking to establish standards for themselves or to self-regulate; public voluntary programs designed by managers or policymakers, who establish eligibility criteria and rewards and obligations of participation; and negotiated agreements under which the obligations of the involved parties are determined through negotiations among the parties.

Empirical evidence suggests that voluntary approaches can be effective if there is sufficient inducement for polluters to participate. There are a number of reasons why a polluter might participate in a voluntary program or voluntarily undertake abatement (Segerson and Miceli 1998; Segerson and Li 1999; Lyon and Maxwell 2002), including a strong commitment to environmental improvement or stewardship; a personal benefit (e.g. when the polluter is also a user of a polluted resource, such as ground water); a perceived payoff in the marketplace (e.g., when a firm feels it will benefit directly or indirectly from having a green image or marketing a green product); a sufficiently large financial inducement or subsidy, and fear that failure to participate will lead to more stringent mandatory controls in the future. Managers can increase the likelihood of participation by affecting one or more of these motivating factors. Through information or moral persuasion, managers can try to increase the public's environmental stewardship and recognition of the benefits of pollution abatement. Managers can also design financial incentives to encourage participation, or make implicit or explicit threats that, if the voluntary approach is unsuccessful, regulation and/ or financial penalties (such as taxes) would be imposed. Such threats are likely to be more effective when small numbers of polluters are involved, so that there is a more direct link between the individual polluter's actions and the likelihood that the voluntary approach will be successful. If the regulatory threat applies to an entire industry, there is the potential that some firms may avoid taking voluntary action in the hope that others will take action and thereby forestall the imposition of the more costly regulation or tax (Li and Segerson 2000). This free-rider problem may be more pronounced among small and medium-sized enterprises, who might not view their individual pollution contributions as pivotal. While small and medium-sized enterprises are individually

insignificant contributors, in the aggregate (e.g., across a drainage basin), they might constitute a significant share of the nutrient load.

When there are sufficient private gains from participation, it may be possible to achieve voluntary source reduction simply through education or technical assistance (NRC 1993). To the extent that win-win situations exist (i.e., opportunities for changing behavior in a way that benefits not only the environment but also the individual), making people aware of these opportunities can facilitate voluntary improvements. For example, under some conditions adoption of conservation tillage may simultaneously reduce erosion and runoff of nutrients and increase farm profitability. Reducing applications of fertilizers, pesticides, and feeding rations or increasing irrigation efficiency may generate this type of double benefit as well. Improvements in energy efficiency can decrease costs by decreasing fossil-fuel use and the associated emission of pollutants such as nitrous oxides (NOx). Even when adoption of an environmentally friendly practice entails some modest costs, a combination of information and persuasive appeal to environmental stewardship ethics may induce adoption.

Evidence on the effectiveness of information and moral persuasion approaches to environmental protection is mixed. Lohr and Park (1995) found that information variables (such as contact with agricultural agencies) were significant determinants of participation in a voluntary program, although the variables that were significant varied across the sites. Bosch et al. (1995) found information and education to be important in the adoption of nitrogen testing of the soil. Information, education, and cost-sharing information were not necessarily successful in motivating landowners to change production practices in the study by Napier and Johnson (1998). A similar mixed picture emerges from evidence in the industrial and commercial sectors. Two recent studies of the U.S. Environmental Protection Agency's (EPA) Energy Star program reported significant energy savings and economic gains (EPA 1997). Other voluntary EPA programs appear to have been less effective (Davies and Mazurek 1996).

When information provision and moral persuasion are not sufficient to induce voluntary action, financial inducements or subsidies can be used. Subsidies designed to induce reductions in loadings can take a number of forms. Farmers can be paid to take land out of production, such as occurs under the U.S. Department of Agriculture's Conservation Reserve Program, or cost-sharing funds can be provided for certain production practices, such as best management practices. The intention is to increase pollution abatement by reducing or reimbursing polluters for the associated cost. If pollution control is costly, then in the absence of any financial assistance, those who voluntarily take control actions are penalized with higher control costs, while those who do not take action are not.

The use of subsidies to induce pollution abatement suffers from at least two important weaknesses. The first is the need to raise the funds necessary to finance the subsidy. In most cases, the taxes that are used to raise the revenue affect other sectors of the economy (Atkinson and Stiglitz 1980) and may impose a net cost on society. Second, polluters who receive subsidies do not pay the full costs of their activities. Because the firm's costs are lower with the subsidy than they would be otherwise, the price of its product is lower as well. With a low price, demand for the polluting product tends to be high, which tends to increase the activity that led to the problem in the first place (Baumol and Oates 1988).

Despite these drawbacks, agricultural pollution control policies have historically been based on technical assistance and subsidies (Reichelderfer 1990; Ribaudo 1998). Agricultural legislators, administrators, and interest groups have been effective at fighting any effort to impose mandatory controls aimed at reducing the environmental effects of agriculture (Reichelderfer 1990). The agricultural sector has also benefited from federal commodity price support programs, which encourage production and in many cases exacerbate environmental degradation (Just and Bockstael 1991). Subsidies in the form of tax credits have also been used to promote energy conservation and conversion to renewable energy sources (e.g., Hassett and Metcalf 1995).

Empirical research has shown that cost sharing and other subsidy-based policies can be effective in inducing voluntary pollution abatement. Cooper and Keim (1996) surveyed farmers to determine whether they would adopt specific farm management practices to improve water quality if they were paid a fixed amount per acre. Lohr and Park (1995) used a similar method to predict participation in a program to encourage the use of filter strips, as part of the Conservation Reserve Program. Both studies found that participation rates were sensitive to financial incentives (i.e., increases in payments increased the probability of participation); previous studies of the Conservation Reserve Program have shown that participation is also affected by non-economic factors, such as education and land quality (Esseks and Kraft 1988; Konyar and Osborn 1990; McLean-Meyinsse et al. 1994; Parks and Schorr 1997).

» *Mandatory Approaches.*

In contrast to voluntary approaches, mandatory policies dictate behavioral changes or payments based on polluter choices. Irrespective of whether the mandatory policy takes the form of regulation, taxes, or fees, it puts the burden and the associated cost of pollution control on the polluters.

» *Direct Regulations.*

Direct regulations can take a number of forms, including mandatory limits on emissions of a pollutant (e.g., NOx emission caps or nitrogen effluent limits), required investment in pollution-control equipment (e.g., use of best available control technologies), or required use of specified production practices (e.g., reduced tillage).

To be cost effective, regulations must be designed to ensure that pollution reductions are achieved in the least costly way. Regulations have not always been designed with this goal in mind, and they have been criticized for their high costs (Hahn 1994). Environmental regulations have relied heavily on the use of technology standards, which require installation of a particular type of pollution control equipment and are generally not cost effective. This one-size-fits-all approach deters firms from developing and taking advantage of alternative, less costly technologies and methods of reducing emissions.

More recently, the United States has moved toward greater reliance on performance standards, which grant polluters the flexibility to meet standards in a variety of ways, and this is expected to lead to greater cost effectiveness (Besanko 1987; Burtraw 1996) and to encourage innovation. Under technology standards firms have no incentive to develop less costly approaches to pollution reduction, because the regulation does not allow them to benefit from such improvements. Under a performance standard any reduction in the cost of meeting the standard (through, for

example, an innovation in pollution control techniques) generates direct benefits for the firm in the form of reduced compliance costs and firms have an incentive to innovate and adopt new, less costly techniques.

Although greater reliance on performance standards rather than technology standards should lead to lower costs for individual polluters, achieving an aggregate target level of water quality in a watershed involving multiple polluters at least cost is more complex. In addition to ensuring that each source meets its required reduction at least cost, it is also necessary to ensure that the required reductions are allocated across sources in a manner that minimizes the total costs. The total cost of meeting an aggregate abatement goal is minimized when the required reductions are allocated so that each source faces the same incremental cost from additional abatement (NRC 1993). If abatement costs differ among sources, this implies different required reductions for different sources and it requires that low-cost sources reduce pollution more than high-cost sources. Such differential regulation can be both administratively complex and politically difficult to implement.

Under regulations, polluters pay only for the cost of nutrient control (i.e., the cost of complying with the regulation) and not for the damages that any remaining pollution causes. As a result, the prices of the products they produce do not reflect all the associated costs of production, including both market and non-market costs. With the product price artificially low, consumption of those products tends to be high. For example, if agricultural producers comply with regulations but some nutrient runoff still occurs, that runoff could still generate costs for society (e.g., increased eu-trophication) that the farmer did not consider when making production decisions. If these costs were reflected in the product prices, prices would rise and the demand for those products would adjust to reflect the full cost of production. Those who bear the environmental costs of the production would no longer be implicitly subsidizing consumers of agricultural products. The use of regulation is somewhat consistent with the polluter-pays principle, because polluters pay for compliance with the regulations; it is not fully consistent because they do not pay for any damages that result despite that compliance.

There have been numerous studies of the effect of nutrient-based regulation, particularly in the context of agriculture. These studies combine economic models of farmer behavior with physical models that capture the associated runoff or leaching of pollutants (Johnson et al. 1991). The type of regulation (e.g., mandated reduction in excess application of fertilizers or limiting animal densities) strongly affects the burden and effectiveness of regulation (McSweeny and Shortle 1989). In some cases substantial environmental improvements can be achieved at relatively low cost (e.g., through the adoption of conservation tillage). Beyond a certain point, further reductions in loadings generally become very expensive because they can only be achieved through significant production changes or the idling of agricultural land. Many studies have found that regulations that are targeted at areas or farms with the greatest pollution contributions are able to meet environmental quality goals more effectively and at a lower total cost. Targeting can increase the administrative cost of regulations substantially, and these administrative cost increases may outweigh the cost reductions that result from varying regulations across sources according to their pollution contributions (Mapp et al. 1994; Moxey and White 1994; Car-pentier et al. 1998; Yiridoe and Weersink 1998).

» *Taxes and Fees.*

In contrast to regulatory approaches which mandate certain changes in behavior, taxes and fees (negative economic incentives) are designed to induce (rather than force) those changes using financial incentives. They can take a variety of forms, including effluent charges, user charges, product charges, administrative charges, tax differentiation, non-compliance fees, performance bonds, and legal liability for damages (NRG 1993). In the specific context of nutrient pollution, possible taxes include carbon taxes, energy use taxes, land use taxes, and pesticide and fertilizer taxes. For example, the state of Florida has a coastal protection tax of two cents per barrel that is charged for pollutants (petroleum products, pesticides, chlorine, and ammonia) produced in or imported into the state. The revenue from this tax goes to the Coastal Protection Trust Fund, which is used by the Florida Department of Environmental Resources for cleaning up spills (NRG 1997b).

A common feature of economic incentives is that they put a price on environmental degradation (Bohm and Russell 1985; Baumol and Oates 1988; Tietenberg 2000). Polluters pay for consuming (or reducing) environmental quality just as they pay for the use of other inputs such as labor and capital. Economic incentives thus put environmental inputs on a par with other inputs used in production. As with other inputs polluters have an incentive to use environmental inputs only up to the point where the polluter's benefit from increased use equals the price the polluter must pay for that use. As that price rises, they face an increased incentive to reduce use of environmental inputs. Those taking control actions are rewarded by having their cost burden reduced, while those not controlling pollution are penalized. If the behavioral response is modest, then the tax policy can generate significant revenues, which can be used to protect and restore the impacted ecosystem.

One of the main advantages of pollution taxes over regulatory policies is that they are generally thought to be more cost-effective (Bohm and Russell 1985; Baumol and Oates 1988; Tietenberg 2000). Because polluters directly benefit from any cost savings, each polluter is encouraged to reduce its emissions in the least costly way. Polluters with low abatement costs have an incentive to reduce emissions more than high-cost polluters. Even if all polluters face a uniform tax, the allocation of emission reductions will not be uniform across sources but will be more heavily borne by low-cost sources, as required for overall cost-effectiveness. High-cost polluters will discharge relatively more and bear larger total tax burdens. In addition, polluters will have an incentive to innovate. Although with new, lower cost pollution control methods they will undertake more pollution control, the cost of this additional control will be more than offset by a reduction in their tax payments.

Although pollution taxes, in principle, should induce polluters to change their behavior so as to improve environmental quality, their actual effectiveness is likely to be uncertain, at least initially. When setting a regulatory standard, authorities can be reasonably certain of the resulting level of emissions (assuming polluters comply); when setting a tax level, regulators often cannot predict accurately how polluters will react and what the resulting level of environmental quality will be. While the level of the instrument can be adjusted over time to ensure that targets are met, such adjustments can be costly and can generate strategic behavior by polluters (Livernois and Karp 1994). It may also be costly to adjust the level of the instrument in response

to changes over time in economic conditions and in the demand for improvements in environmental quality.

Under tax-based instruments, polluters pay not only for the costs of any abatement undertaken but also for the remaining discharges. The resulting cost allocation is hence consistent with the polluter-pays principle. Because polluters have to pay both the costs of abatement and the tax, the total cost to polluters is higher under a tax policy than it would be under a performance standard leading to the same level of total discharges. While this ensures that product prices reflect the full societal cost of production, the increase in total cost may create considerable hardship both for marginal firms and for low-income consumers who would be significantly affected by price increases. This is particularly true when relatively high taxes would be required to induce the desired change in behavior.

The magnitude of the tax increase needed to induce a reduction in discharge depends on how responsive polluters are to the tax. Numerous studies have shown that, in the case of agricultural fertilizers, farmers are not very responsive to price increases (i.e., the demand for fertilizers is generally inelastic) and that relatively large tax rates would be needed to ensure that environmental objectives are met (McSweeny and Shortle 1989; Hea-twole et al. 1990; Johnson et al. 1991; Helfand and House 1994; Pan and Hodge 1994; Weersink et al. 1998). A simulation done by Giraldez and Fox (1995) found that an ad valorem tax rate of 55% would have to be applied to nitrogen to induce farmers to reduce nitrogen use to satisfy drinking water standards. The large impact that such large taxes would have on farmers may limit their appeal (Helfand and House 1994; Moxey and White 1994). While gasoline taxes may promote reductions in fuel use and emissions of NOx, gasoline demand tends to be similarly unresponsive to price increases in the short run and hence large tax increases would be needed to reduce current fuel consumption significantly (Espey 1998). In the long run higher prices encourage the development of more energy efficient products (for example, automobiles that get higher gas mileage) and alternative energy sources, which can in turn reduce demand for fossil fuels in the future.

» *Marketable Permits.*

Some of the shortcomings of both regulatory and tax-based approaches to environmental protection can be overcome with the use of marketable permits (Tietenberg 1985). A marketable permit system starts with an allocation of allowable emissions across sources, as under a regulatory approach. By allowing sources to trade their allocations, the final allocation (after all mutually beneficial trades have occurred) will be such that low-cost avoiders will undertake more abatement than high-cost avoiders, and the aggregate emission reduction will have been achieved at a lower cost. Low-cost avoiders will have an incentive to reduce discharges below their allocation and will sell their excess permits in the market. High-cost avoiders can buy additional permits rather than incur their high costs of pollution control. If there are a sufficient number of buyers and sellers, the resulting market for permits establishes a price for emissions that reflects the total allowable emissions (i.e., the supply of permits) and the costs of pollution abatement for all polluters (i.e., the demand for permits). Unlike other economic incentives that also establish a price, the total impact of marketable permits on environmental quality is known, because the total number of permits is fixed. The use of marketable permits combines the certainty of the regulatory approach with the cost-

effectiveness of economic incentives.
The use of marketable permits also allows a regulator to achieve any desired distribution of total costs by altering the initial allocation of permits. Economic growth is possible without changing the total level of emissions, because new firms can simply be required to purchase permits from the market. The result is an increase in permit prices, but no increase in aggregate emissions.

Numerous economic studies have shown the potential for cost savings when polluters are allowed to trade pollution permits (Tietenberg 1985; Klaas-sen 1996). The success of the sulfur dioxide emissions trading program established under the 1990 Glean Air Act Amendments (Joskow et al. 1998) has heightened interest in this pollution control tool. While this trading program involves sulfur dioxide emissions, to the extent that it leads to overall reductions in fossil fuel consumption, it would also help promote reductions in NOx and the associated atmospheric deposition of nitrogen.

While much of the existing work on marketable permits has been in the context of air pollution, consideration has also been given to the use of trading programs for surface water pollution. Of particular interest in the context of nutrient pollution is the possibility of trading between point and nonpoint sources (e.g., wastewater treatment plants and agricultural sources). Such trading allows point sources to sponsor implementation of nonpoint-source controls rather than further cutting back on their own emissions. Assuming non-point-source loadings are significant and that it would be cheaper to reduce nonpoint source than point sources, ambient water quality goals could be met at a lower cost by substituting nonpoint for point-source reductions (Crutchfield et al. 1994).

There have been several studies of the potential for pollution abatement trading between point and nonpoint sources. Letson (1992) provided an economic analysis of the issue, illustrating the appeal and the difficulties in application of such a policy. Among the difficulties cited by Letson are monitoring, use of market power to manipulate permit price, and the distribution of the financial burden of loadings reductions. The rate at which non-point-source abatement can be substituted for point-source abatement (i.e., the allowable trading ratio) must also be established. The appropriate value of this trading ratio is uncertain because of qualitative differences between the two classes of sources. The optimal trading ratio will depend on the relative costs of enforcing point and nonpoint reductions and on the uncertainty associated with nonpoint loadings (Malik et al. 1993). Crutchfield et al. (1994) identified several practical circumstances that facilitate trading and developed an empirical protocol to determine the extent to which they exist in coastal watersheds. Several efforts are currently underway to implement point-source and nonpoint-source trading programs to improve water quality. Connecticut has developed a trading program for Long Island Sound. A nitrogen-trading plan has been established to achieve reductions in nitrogen discharges cost-effectively and expeditiously. The Connecticut Department of Environmental Protection (1998) anticipates that this plan will reduce the statewide bill for nitrogen removal by more that $200 million (1998). A similar program to limit phosphorus loads exists in the Cherry Creek basin in Denver, Colorado (Sand-quist and Paulson 1998).

The Tampa Bay National Estuary Program uses a cooperative approach that resembles a watershed trading program. No actual trades take place, but some sources make pollutant load reductions that they otherwise would not have been required to make in order to offset increases occurring

at other sources. This approach to watershed management may be applicable to areas where trading is technically or politically inappropriate or unnecessary (Bacon and Greening 1998).

Conclusions

While the phenomenon of nutrient over-enrichment can be studied using models from the environmental sciences, understanding both the human causes and human effects of nutrient pollution requires a study of economics. Economic factors drive many of the human decisions that lead to nutrient over-enrichment, such as fertilizer use and fossil-fuel consumption. Economic principles and methods provide a framework for thinking about and attempting to measure systematically the consequences of nutrient over-enrichment (both market and non-market). Information about causes and impacts (or costs and benefits) should be useful to policy makers as they seek to identify priorities and set appropriate water quality goals.

Economic analysis can also contribute to the debate over how to achieve desired water quality goals. In designing policies to achieve these reductions a fundamental choice must be made between the use of a voluntary approach and the use of mandatory controls or financial penalties. In many instances managers may find that a well-formulated mix of incentives (voluntary approaches) and disincentives (mandatory or punitive approaches) works better than either approach would work alone. In evaluating alternative approaches, a key criterion is cost-effectiveness. Ensuring that policies are cost-effective (i.e., that they achieve water quality goals at the lowest possible cost) ensures that society does not give up more than is necessary to achieve these goals. To the extent that it reduces the burden on industry, cost effectiveness can protect jobs, increase production, and reduce the costs of consumer products, which can in turn increase the political acceptance of the policy.

Voluntary approaches that rely on moral persuasion, information, technical assistance, and possibly financial subsidies can be effective if there are sufficiently strong incentives for participation. While participation can be increased through financial incentives, local managers are not likely to have the local resources to finance subsidies for participation. Even if financial incentives were available, subsidies of this type require that some level of government raise the funds necessary to finance the subsidy, which normally distorts other economic activity and results in product prices that are too low (since they do not reflect the full social costs of production). Voluntary approaches at the local level will generally have to rely on other participation incentives (e.g., appealing to local commitment to water quality improvement). Without sufficient participation incentives, a purely voluntary approach may not provide sufficient protection. Managers may be able to increase the likely success of a voluntary approach by making it clear that, if the voluntary approach does not appear to be working, an approach based on regulation or financial penalties, or both, will be adopted.

A mandatory approach based on regulations or taxes places a greater burden on the pollution sources, but if compliance can be ensured, it can be more effective in achieving water quality goals than a purely voluntary approach. When the costs of control vary across sources, however, uniform regulations will not meet those goals at the lowest possible cost. Cost-effective reduction might be achieved through use of taxes, but research suggests that demand is often not very responsive to price increases and hence large taxes would be needed to

achieve water quality goals. Cost-effective reduction can be achieved by allowing loading allocations to be traded. Allowing trades between point and nonpoint sources might generate significant cost reductions. In addition, managers can distribute initial permits, and hence the ultimate costs, in a variety of ways without affecting the cost-effectiveness of the program. Marketable permit systems can involve substantial administrative and information costs, and they may not work well if the number of sources that could participate in the permit market is small. The likely gains (in the form of cost reductions) must be weighed against the likely costs.No single policy approach will be appropriate in all cases. The size and nature of watersheds and their associated estuaries can vary dramatically nationwide. The number, type, and significance of sources of excess nutrients and the susceptibility of coastal receiving waters to nutrient pollution can vary as well. The incentives for voluntary participation in nutrient reduction programs, the cost of regulatory oversight, or the public acceptance of addition taxes or fees to support efforts to reduce nutrient pollution will also vary. Local policy makers will by necessity be forced to experiment with different mixes of approaches in order to achieve sustainable and meaningful reductions in the impact of nutrient pollution. Federal efforts should be focused on helping local entities set reasonable water quality goals within regional frameworks and on providing technical assistance that may be beyond the reach of local authorities. A fundamental understanding not only of the physical dimensions of nutrient over-enrichment, but also of its economic dimensions, will help local regulators design an appropriate mix of policies tailored to their own circumstances and needs.

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