

DIFFUSION OF ENVIRONMENTALLY FRIENDLY INNOVATIONS IN LOCAL AGRICULTURAL SYSTEMS IN ITALY

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INTRODUCTION

The agricultural area in the Abruzzo region is about 500,000 hectares. The types of agricultural land include: arable land (44%), orchards (19%), meadows and pastureland (37%), mainly in the hilly and mountainous areas. The few plain areas are mostly under intensive crop production. Agriculture contributes about 4.6% to the region's economy. The share has been decreasing gradually, in the early 1980s it was 8.8%. Land property features high reduction and fragmentation: there are about 90,000 landowners, but only 40,000 can be regarded as commercial farms. The limited diffusion of tenancy (12%) has given rise to a number of informal contracting management systems. In light of the main economic indicators, the farming sector appears dynamic. This is mostly due to concentration of production in the most favoured areas and on the gradual substitution of labour factor with high-capital-intensity farming systems. It is sufficient to consider that during the last 15 years the HP per annual worker unit has increased from 25 to 59 with a 7.4% annual growth rate. The reduction in the quantity produced, even when

ABSTRACT

The study on the Abruzzi region analysed the opportunities to change from a conventional or traditional farming system to an environmentally sound farming system; in terms of economic profitability and environmental consequences, while taking into account farmers' perceptions of agri-environmental issues. The evaluation of the different farming systems follows three methodological steps. For the five selected farm types (cereal farming, vegetable growing, grape growing, olive growing and livestock farming), technical production options with different environmental performance have been defined, while taking into account the technical restrictions included in the regional agri-environmental scheme. The shift from a conventional to a low environmental impact farming system implies in several cases additional investments, which restrict the farmer's choices, and the willingness to introduce technical and organisational innovations on the farm. Differentiating factors relating to the structural features and social conditions of family farms are observed between the adopters and non-adopters. However, farmers' behaviour does not always conform to the defined categories. Agri-environmental policies based on specific farm types could be misleading, because other factors such as the role of social capital and public institutions in local economy are important factors in defining farmer's behaviour.

RÉSUMÉ

Cette étude sur la région des Abruzzes a analysé l'opportunité de passer d'un système d'agriculture traditionnelle à un système agricole éco-compatible, en termes de rentabilité économique et de conséquences environnementales, tenant compte de la sensibilité des agriculteurs vis-à-vis des problèmes agro-environnementaux. L'évaluation des différents systèmes agricoles suit trois étapes méthodologiques. Pour les cinq types d'exploitations agricoles choisies (exploitations céréalières, maraîchères, viticole, d'oléiculture et d'élevage), on a défini les options de production techniques avec les différentes performances environnementales, tout en tenant compte des restrictions techniques comprises dans le plan agro-environnemental. Le passage d'un système agricole conventionnel à un système à faible impact environnemental, implique, en plusieurs cas, des investissements additionnels qui limitent les choix de l'agriculteur ainsi que la volonté d'introduire des innovations techniques et organisationnelles dans l'exploitation agricole. Des facteurs de différenciation relatifs aux aspects structurels et aux conditions sociales des exploitations familiales sont observés entre ceux qui adoptent le nouveau système et ceux qui ne l'adoptent pas. Toutefois, le comportement des agriculteurs ne s'adapte pas nécessairement aux catégories définies. Les politiques agro-environnementales basées sur des types d'exploitations spécifiques pourraient être trompeuses, du fait que d'autres facteurs, tel le rôle du capital social et des institutions publiques dans l'économie locale, sont importants pour la définition du comportement de l'agriculteur.

very small (-0.2% per year), shows a trend opposite to what happened at the national level in the same period. The negative trend is mainly due to the loss of farm land and on the closing down of several livestock farms, a phenomenon shared by Abruzzo and the regions of Central Italy. The abandonment of mountain areas and the less agronomically favoured areas in general also depends on the technical change and the adoption of standardised production methods which favour specialised farming and low-labour input methods. The gradual disappearance of traditional rural landscapes and highly valuable natural habitats, too intensive use of natural resources in the more fertile areas and the abandonment of economically non-viable farmland are perhaps the most evident effects of the changes arising from the interactions between agriculture and the environment. On the other hand the crucial role of agriculture in protecting the environment, as it represents the most important form of land use, is getting increasing acknowledgement. The endeavour

to use farming as a means of nature conservation in rural areas conflicts however with its traditional productive function and with the constant drive to increase competition on international markets. The study addresses the environmental issues in the Abruzzo region – which are common to a large share of Italian agriculture – related to the increasing concentration and specialisation of farming systems and – at the same time – the mar-

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ginalisation in areas less suitable to farming. In Abruzzo these trends are very pronounced: on one hand there are areas characterised by high intensive farming and severe environmental degradation, and on the other hand large rural areas close to being abandoned. Returning to a more balanced situation depends on the possibility to shift to an environmentally sound farming system in the intensively farmed areas and making farming in the marginal areas more profitable. The new specific "agri-environmental" policies more and more frequently provide new income opportunities for farms committed to adopt farming practices with low environmental impacts, aiming at reducing the negative effects of agriculture, or to maintain agricultural systems with high nature values. The most widespread incentive scheme today in Italy – reg. 2078 – is a form of voluntary and conditioned support, where the producer gives up some rights on natural resource use and receives a compensation for the income loss (Baldock and Mitchell, 1995). The approach based on voluntary adhesion to the scheme presents a number of specific problems, which make the application very different from other income support measures. The success of these initiatives does not only depend on the definition of a balanced relationship between the financial incentives allocated to farmers and the imposition of technical constraints or environment improvements required. This is a necessary, but not always sufficient condition to make the diffusion of environmental friendly practices relevant. Sociological and structural factors, linked with the farm features, and organisational and institutional ones, concerning the interactions between the actors directly involved in the application (farmers, extension services, farmers' associations, local public bodies) contribute in an equal measure to make agri-environmental schemes effective. The following chapters present the most relevant results of the study, commissioned by the Regional Agricultural Development Agency of Abruzzo (Povellato, 1999), with special consideration for the trade-off between profitability and environmental quality and the identification of the socio-economic factors affecting the adoption of environmentally sound practices. The study has been carried out considering the data gathered in a sample of 266 farms, the economical results of the Regional Farm Accountancy Data Network and, where statistical data were not available, experimental data concerning the most innovative technologies have been used.

TECHNICAL CHOICES: ECONOMIC ANALYSIS AND ENVIRONMENTAL IMPACTS

The evaluation of the different farming systems in the study follows a common methodological path: a) identification of the region's main commodities produces (cereals, vegetables, grapes in vineyards, olives and livestock products); b) acquisition of detailed informa-

tion on farming practices, with a special reference to the quantity of factors of production used; c) economic analysis of farming systems to determine the production cost and net return on the main product; d) analysis of the environmental impacts of each farming system. Production options with different environmental performance have been identified for each farming system, beginning with the most conventional system and taking into account other technical options available within integrated and organic farming. In the case of conventional farming, it is not always possible to establish whether it can be considered a good farming practice, as systematic studies on the subject are not available and there are no specific references in the regional legislation so far. Integrated farming systems and organic agriculture are considered separately, as the former represents a number of low environmental impact techniques without restrictions on the kind of inputs used, whereas in the latter case there are specific EU regulated standards and certification processes banning synthetic chemical inputs. Also in the case of integrated production there are regulated crop specific production standards and processes, related to the framework of agri-environmental measures (reg. 2078/92), the implementation of which is done by the regional administration. The public support for farmers who adopt specific integrated production methods has sometimes a fundamental role in maintaining economic profitability. The final report (Povellato, 1999) includes a detailed description of the farming technologies and of the methodologies for economic and environmental analysis. The research study has mostly focused on the differences in costs, receipts and environmental impacts between the different farming technologies. The conventional farming system was chosen as the reference level, assuming that most farmers start with this farming system and then move towards adopting practices with low environmental impacts. In the figures, which highlight the economic and environmental impacts, each of the production methods has been evaluated against the impacts of conventional farming technology which is the reference level. In considering the economic aspects, physical (yields, manpower, machinery) and financial (output prices, input costs and subsidies) criteria have been accounted for by using partial budget analysis. Measuring environment impacts are no doubt more complex. There was an attempt to provide a sustainability measure for each farming technology, without explicitly taking into account the possible cross-correlations within the whole farming system. The main drawbacks of the field management analysis concern the limited extent to which the ecological infrastructure of the farm is taken into account. This explains the exclusion from the analysis of some environmental issues such as the loss of biodiversity and landscape, which may be evaluated at holding level or even better on a

territorial scale. The reference framework is the one which is being achieved by the EU, where the environmental issues have been classified into categories (policy fields), and indicators have been identified within the logic of the pressure-state-response model (Jesinghaus, 1998). Starting from the assumption that farming is partly responsible for water pollution, noxious runoff, soil quality reduction, some pressure indicators have been identified within these policy fields. Single environmental effects were then aggregated in one index apt to provide a (relative) measure of the impact exerted by each activity. The general index has been built by normalising the absolute values with reference to the values assumed by the indicator in the conventional production option and summing up the normalised values of each policy field. The determination of a single index offers a synthetic evaluation of the environmental impact to be compared with a synthetic profitability index, such as the net income for each crop and technical production option. In the *cereal* sector the analysis highlights how integrated farming systems are profitable compared with the conventional ones: the yield decrease observed with the adoption of these technologies, as an effect of the input reduction, is fully compensated by the agri-environmental premium. Such profitability is however short-lived if we account for the restrictions imposed by compliance with crop rotation, as well as irrigation. On the one hand compliance with agronomic regulations cannot always agree with the signals coming from the market which demand a greater supply flexibility. On the other hand the presence of irrigation water causes input intensification with considerable increase of yield, and therefore of income. The conversion to organic farming proves more difficult to achieve. The premia envisaged by reg. 2078 do not in fact succeed in compensating for both production cost increase and yield reduction. The final result is heavily affected by the absence of a local market for organic cereals. As a matter of fact, no significant differential can be observed compared with conventional product prices. An important outcome to consider in the adoption of farming technologies with low environmental impacts for commodities, such as cereals, is the adjustment of tillage machinery which could improve soil conservation. The new tillage equipment implies high investments for farms whose size in this region almost never favour economies of scale. These innovative tillage machinery management could be run by contracting farmers or farming companies providing their services to several farms, triggering strong structural changes, as the family labour needed on a farm would decrease significantly. The turnover is already taking place naturally, as a market response to the constraints of the too fragmented land property, but without a specific awareness of its environmental value. Ad-hoc measures should be introduced in favour of contracting

firms committed to promoting the adoption of new technologies in environmentally sensitive areas where soil erosion and nitrate leaching control are very important. For the *vegetable* sector, the six most important regional vegetables were studied (carrots, cauliflower, fennel, salad, peppers and tomatoes). The study shows that it is not possible to analyse vegetables as one cluster. Some vegetables require very specific farming technologies and, consequently, the cost structure varies greatly. In some cases (cauliflower, fennel, peppers) the adoption of an integrated production system has not affected the net income significantly, resulting in just slightly lower income than that obtained from a conventional farming system. For the other vegetables, the income difference is much greater. Adjustments should thus be made to the agri-environmental premia within the vegetable sector. In an organic farming system, the net income is equal to that of a conventional farming system only if the price of the organic product is much higher than the price of a conventionally produced product (about twice as much). This high price would then compensate for the loss of income due to lower yields. Establishing a market niche for organic products is important. Marketing and promotional activities can help to achieve this, thus helping to compensate for the income loss. In the case of *olive* growing, the studies emphasise the dependence of the economic outcome on pruning and harvesting management. The reduction of agrochemical inputs is important for the environment but does not appear to result in significant income variations. Conversely the positive environmental impacts of management practices aimed at maintaining soil fertility (green manure, inter-row grassing over) are economically feasible only if the level of mechanisation increases. Economic profitability specifically increases with the conversion from a conventional farming system to an organic system only at medium-high technology levels. It should be stressed that, in absence of agri-environmental premia, integrated production systems are not profitable, while organic farming retains a rather good profitability due to the higher market price of organic oil. Regarding *grape* growing (*vineyards*), the profitability analysis generally shows that conventional farming systems are economically more profitable than alternative systems. The difference becomes even more pronounced in absence of agri-environmental incentives. Environmentally sustainable farming systems, because of the smaller yields, seem to be competitive only if the market price of the grapes remains at a higher level than the price of the grapes produced under conventional farming systems. Abruzzo grape growing is characterised by high yields strictly connected with the prevailing training system (*tendone*, slanting training system) and by positive market price dynamics for grapes and wine. In case of a good marketing appreciation of the present product it is more difficult to make

a quality differentiation (grapes obtained by techniques more respectful of the environment and human health and proceeding from low-yield systems and therefore with higher sugar degree and higher acids contents, etc.), as the expectations of further price increases do not prompt the farmer to modify the farming system. The lack of commercial appreciation for a better quality product encourages grape growers to maintain the present high-yield training system (*tendone*), as their profits are directly linked with the quantity produced. The analyses show that the conversion towards a more sustainable farming system would be more effective if a modern training system was adopted in the vineyards, thus thoroughly changing the system. The GDC training system is economically more profitable than the *tendone* in each production method, mostly in terms of labour productivity, but requires substantial initial investments and reduces the labour requirements significantly. Lack of capital and the obligation to maximise family employment are two decisive factors making farmers stick to conventional farming system, even when the environmental benefits derived from the new training system are apparent.

For *milk, meat cattle and dual purpose sheep* production, the conventional breeding systems were compared with the organic ones. The net income per head is the same under the two farming systems, but the conventional system fares better in terms of labour productivity. The economic performance of organic farming can be improved only when higher prices are obtained for the products, especially meat. Sheep production is characterised by a high reliance on local breeds and crafted milk processing which could prevent Abruzzo livestock farmers from switching to organic farming. The cheese processing technology in use is often inadequate (too small size, outdated technologies and under minimum hygienic standards) and would therefore not improve the economic profitability of organic production. In the case of meat and milk cattle breeding, organic production methods would have higher economic performance than conventional systems only if the prices paid for organic meat were 30% higher than the prices paid for conventionally produced meat. Only in the presence of such price differences, a farmer could change from conventional farming to organic farming without significant income losses. High meat and milk price levels can only exist, however, when there are specific regulations for organic livestock production; good marketing channels for the products; and adequate product-promotion and information campaigns to inform the consumers.

In the Abruzzo region, mountain pastureland is generally used for cattle rearing, which can have significant environmental effects. There are very few alternative land uses for these marginal land areas if they no longer used for agriculture (i.e. are abandoned). The conse-

quences in terms of land degradation and depopulation can be particularly serious. The extensive livestock systems of mountain areas offer several elements of ecological continuity with the adjacent naturalistic areas and contribute to protect animal species (domestic and natural) otherwise in danger of extinction. Public incentives to maintain sustainable cattle rearing in high nature value areas can, therefore, contribute to conservation of biodiversity. It should not be forgotten that the growing demand for recreational environment services (green consumerism) can be effectively combined with the conservation of high nature value agricultural systems and the production of high quality local products. In most of the case studies, the trade-off between profitability and environmental quality is apparent: resource conservation requires a special effort from farmers which is not always compensated for by the incentive mechanisms devised by public bodies. In some cases however the benefit of changing farming practices is obvious enough, but requires a marked holding restructuration not coinciding with the long-term objectives of agricultural holders (e.g. the provision by contractor firms of specialist machinery for minimum tillage in commodity crops, the change of training system in vineyards). See, as an example, **Tables 1** and **2** and **Figure 1** regarding durum wheat and grapes. Finally also some cases of environmental trade-off can be observed for which the reduction of the impact arise from the techniques which are replaced entails an environmental impact increase due to new techniques (e.g. the conversion of conventional pest control to the organic one may lead to accumulation of cupric product in the soil causing fertility decrease). The positive or negative results of the economic evaluation depend on the chosen reference level. In the case study it was decided to consider the conventional farming system as the most widespread which does not necessarily correspond to a technique characterised by minimum sustainability standards. Specialised vegetable farming is a good example of the present situation.

The Italian regulations for farming while conserving natural resources are very general and contain no detailed recommendations. Compulsory codes of good agricultural practice or cross-compliance regulations could reduce the inequality, in terms of profitability, between conventional farming systems and environmentally sustainability ones and make possible the application of a policy of financial incentives not too burdensome for the public budget. It should furthermore be emphasised that environmental indicators have been used in this study mainly for illustrative purposes, and more thought should be put into choosing the most suitable indicators, measuring them and normalising them in order to define an environmental sustainability (synthetic) index.

Defining synthetic indices, perhaps not much appreci-

Table 1 Economic comparison between different farming systems - Durum wheat (per ha).

Indicators	Conventional	Integrated 2078/92	Organic
Yield (tons)	3.5	3.0	2.5
Labour (hours)	15	13	19
Machinery (hours)	14	12	18
Price (Euro/tons)	171	171	171
Gross output (Euro)	1,255	1,271	1,190
Percentage of premia	0%	9%	12%
Specific cost (Euro)	257	192	396
Labour and machinery costs (Euro)	658	606	684
Net Income (Euro)	340	473	110
Net Income without premia (Euro)	340	355	-28
Net Income / labour input (Euro/hour)	22.7	36.4	5.8

Source: INEA, 1999.

Table 2 Economic comparison between different farming systems - Grapes for wine (per ha).

Indicators	Slanting training system			G.D.C.
	Conventional	Integrated (2078/92)	Organic	Integrated (2078/92)
Yield (tons)	19	17	15	15
Labour (hours)	328	316	324	103
Machinery (hours)	68	69	70	44
Price (Euro/tons)	519	519	571	519
Gross output (Euro)	9,858	9,537	9,277	8,499
Percentage of premia	0%	8%	8%	8%
Specific cost (Euro)	1,193	1,414	1,469	1,362
Labour and machinery costs (Euro)	3,334	3,268	3,202	1,954
Net Income (Euro)	5,331	4,855	4,606	5,183
Net Income without premia (Euro)	5,331	4,139	3,890	4,467
Net Income / labour input (Euro/hour)	16.3	15.4	14.2	50.3

Source: INEA, 1999.

ated by scientists, is especially important for providing transparent information for farmers and policy-makers. In addition, a national reference framework that would enable comparing the indicators across different farming systems would be helpful.

THE SOCIO-ECONOMIC FACTORS IN THE DIFFUSION OF SUSTAINABLE AGRICULTURE

The previous chapter stressed the economic factors which encourage or restrain farmers in the adoption of sustainable technologies and farming practices. The farmers' response to economic signals alone is quite unlikely when the choices imply off-farm effects not taken into account by the market.

The decisive role of sociological factors in the decision-making process of the adoption of innovations has been stressed over and over in several studies. American economic and sociological studies on the diffusion of soil conservation techniques began much before the European ones. Ervin and Ervin (1982) include attitudinal and institutional factors in the farmers' decision-

making leading to the adoption of soil-conservation practices, identifying three phases: perception of the environmental problem, decision about specific conservation practices, effort in soil conservation in connection with the effectiveness and applicability of new practices in their own farms.

The role of socio-structural factors increases in case the innovation complexity is high and decreases when the information flow between farms and extension services is poor (Nowak, 1987).

Farm structural and economic features and the sociological aspects of the farmers who adopt the innovations are a crucial element to understand the adoption process and identify the most suitable public interventions.

Starting from a distinction between willingness to adopt and ability to adopt, Morris and Potter (1995) have developed a spectrum of farmers' participation in agro-environmental schemes ranging from "resistant non-adopters" to "active adopters".

The study confirms the hypothesis that more restrictive agreements with more payments may bias participation in favour of active adopters with conservation man-

agement experience. The author argues that farmers are more likely to move towards the active end of the participation spectrum if conservation advice networks are established, although the study results are not completely clear. The rate of neighbouring participants may be the crucial factor to convince reluctant farmers to enrol in a scheme (Wilson, 1997).

Unfortunately the comparison between a number of studies carried out so far does not lead to identify in a univocal way the socio-economic factors which should enable the description of reliable adopter and non-adopter types.

The huge variability of the combination of productive factors in the farm associated with the different conditions of the physical and socio-economic context where the farm operates make the identification of relatively homogeneous types extremely problematic.

The Abruzzo farm sample has been used to ascertain whether it is possible to distinguish between adopter farmers and non-adopter farmers, based on the adoption of one or more technologies with low environ-

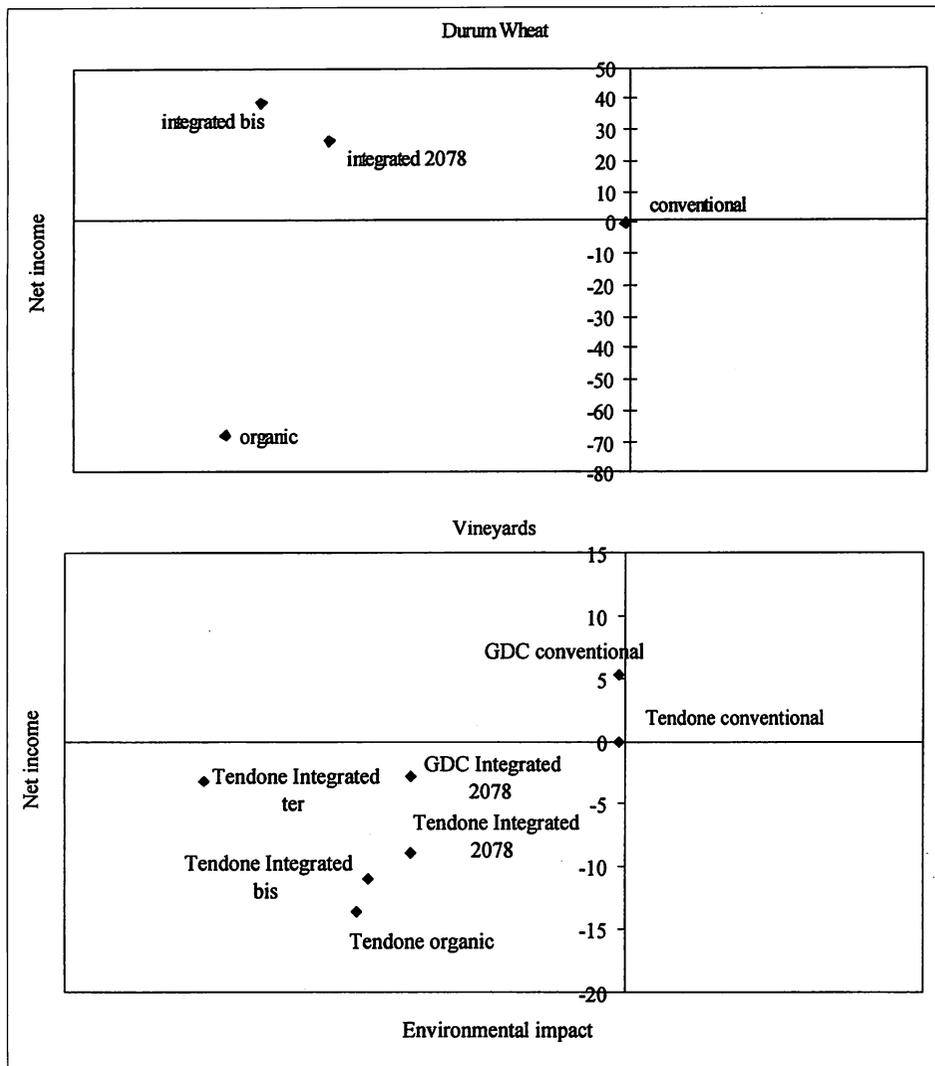


Figure 1 - Trade-offs between profitability and environmental quality.

mental impacts (¹). In Abruzzo the diffusion of practices with low environmental impacts is increasing and most farmers have a good knowledge about the most consolidated sustainable practices, whereas the information on the most innovative practices (e.g. scouting, mating disruption) so far is not very widespread. The actual adoption of these techniques is obviously more limited than mere awareness of their existence. **Table 3** shows that 52% of the farms "adopt" technologies that have low farm environmental impacts. The biggest differences between the two groups concern the type of farming and some structural and socio-cultural features, summarised as follows:

- In the group adopting sustainable practices, the type of farming tends to be more specialised and intensive (grapes in vineyards and, to a smaller degree, vegetables). There is less animal husbandry in the adopters' group. This is not surprising. To begin with, the most intensive sectors are looking for sustainable innovations more than the extensive sectors. In the case of livestock farms, the environmental issue mainly concerns live-

stock density rather than special technical solutions. Finally, specialised farmers are more likely to be able to get more detailed information about available innovations.

- Adopting farms are smaller in area and quite similar to non-adopters in terms of gross income. This outcome contrasts with the results of other studies and is probably due to the greater number of adopters in specialised grape growing and vegetable farms which generally cover smaller farmland. The fact that adopters are more likely to own the land rather than rent it shows the landowners' greater awareness of the need to conserve natural resources.

- Adopting farms are often run by "leader" farmers, generally more accustomed and ready to assume responsibilities, for example, in associations. Adopters are more likely to join a co-operative association, both for the delivery of their products and for the purchase of the technical inputs. Besides greater importance is given to professional training, provided by the public and private sector bodies, and technical assistance from farmers' unions. This better cultural and information base enables the manager to run the farm in a more dynamic way, introduce

the necessary changes in techniques, the type of farming and in farm management. Adopters also show better perception of environmental issues, realising the potential damage from farming activities on the environment and the implications of agro-environmental measures.

- Employment factors and family features are not very different in two groups. In both farmer groups, the size and family composition are essentially similar. A similar situation is found in the age distribution of family members as there is no difference in the average age of the managers themselves. On employment, a similar situation can be found concerning the number of workers on the farm and their average age. Only the share of part-time farmers and the generation turnover appear to be greater in adopting farms.

(¹) The adopting farms have adopted, singly or jointly, at least one of the following techniques: organic crops, sod seeding, integrated pest management, integrated weed control, decreasing livestock density, adoption of codes of practices.

Table 3 Structural and socio-economic comparison between adopters and non-adopters.

	Adopters	Non-adopters
Number of farms	138	128
Agricultural area in use (ha)	14.6	23.0
Rented land (% of total area)	37.0	58.9
Irrigated land (% of total farms)	27.0	32.7
Livestock farms (% of total farms)	32.6	64.1
Type of farming (%):		
– specialised	71.0	59.4
– mixed	29.0	40.6
Average Standard Gross Margin of holdings (EURO)	25,992	28,851
Average Standard Gross Margin per hectare (EURO)	1,776	1,256
Average Standard Gross Margin per annual work unit (EURO)	12,393	13,741
Family labour force (number)	2.6	2.5
Average age of the farmers	46	46
Farmers with medium-elevated training (% of total farmers)	32.8	14.4
Percentage of off-farm employment	17.5	13.6
Presence of intrafamily succession (% of total farms)	41.2	30.5
Source: INEA, 1999.		

The case study highlights that it is not always possible to use sociological factors as fundamental elements in constituting the farm type. Whereas for some factors it seems possible to identify a rather direct correlation with the farmer's behaviour, for others the link is more fuzzy and very likely connected to the different farming sectors or to the single area under analysis. Similar to what has been reported in studies carried out in the United States (Nielsen *et al.*, 1989), the features which may be positively correlated with the introduction of technologies with low environmental impacts appear to be the manager's education level and the contacts with extension services. In these and other studies (Volker, 1992, Bonnieux *et al.*, 1993, Kazenwadel *et al.*, 1999), there are fewer common elements regarding the manager's and the family members' age and therefore, in general, the managing family's individual features which do not seem to differ much between adopters and non-adopters. To confirm the results highlighted by the data, the factor analysis also emphasises that the three most important factors explaining the differences between the farms concern the structure, economic and production features and specifically the average farmland, the rented area, the gross income per farm and the type of farming. The fourth factor only contains sociological variables emphasising the strict correlation between environmental responsiveness, adoption of innovations, willingness to introduce changes in the future and the manager's education level. The variables connected with the manager's and the farm-workers' age and the labour features in the holding are much less relevant in explaining the residual variance. In

short the occurrence of a factor linking the farmers' perception of change to environmental issues makes differentiated farmers' attitudes and behaviours plausible, when the decision-making process concerns the choice of eco-compatible innovative techniques. However it should be stressed that there is no explicit correlation between socio-cultural variables and structural and economic ones, and it proves therefore difficult to assume a specific typology in terms of sustainable innovation adoption.

Also in Abruzzo the diffusion of sustainable technologies is favoured by means of financial incentives which should compensate for income foregone deriving from the change of production techniques. The regional agri-environmental scheme is still in the first years of application and there is no sufficient response from

farmers yet. Some socio-economic factors, besides institutional ones, are likely to concur in determining the participation degree of farmers. A study on farmers' disposition to adopt specific low-environmental impact interventions has been carried out using the same sample. The evaluation of the "willingness to accept" has been achieved by suggesting an agreement providing for the adoption of integrated pest management (IPM) in return for the payment of a financial incentive which is negotiated between the interviewer and the interviewed. It is possible to highlight a "response curve" of the environmental good, meant as low environment impact technique, by comparing the levels of the prices proposed by farmers with the farm area potentially interested in the measure.

From **Figure 2** it can be summarised that there is a good disposition to adopt integrated pest management in the grape growing sector: about 70% of the sample vineyard area appears to be potentially interested in IPM up to an incentive level equal to the one presently proposed, while the remaining part of the sample regards the adhesion as economically profitable only at higher premium levels. When extension services exist, the good dissemination of technical knowledge among producers and the high farm specialisation seem to make the grape growing sector relatively permeable to the adoption of innovations, even if the profitability is not wholly assured (see previous chapter). As to olive farms greater resistances to adopt IPM can be observed: less than 40% of the area farmed by the interviewed appears to be interested in the technical proposal at the conditions proposed by the regional scheme. The relatively

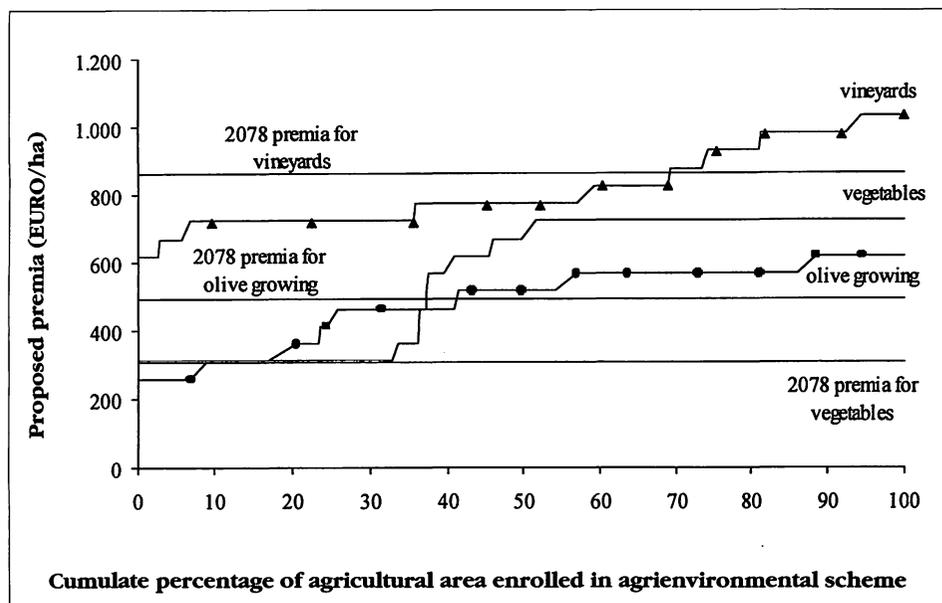


Figure 2 - Response curves for the subsidised practices of different crops.

high occurrence of mixed farms, the less professionalism required by this type of farming and the limits to mechanisation can account for the olive farmers' feeble response. Unlike the grape growing sector there is a certain amount of non-exploited profitability. Lastly, in the case of the vegetable sector, farmer participation is linked to the high values of the premium offered: only with a premium level twice as high as the top envisaged by reg. 2078/92 would be involved 50% of the vegetable-farmed area of these holdings. In this case the demand for high compensations appears to be due to the very intensive character of the production which does not allow the rotation with low income crops to restore the soil fertility conditions and control weed and pests in a natural way. Also the alternative of replacing chemical control with a wider use of labour seems impracticable. The study results lead to infer that the farmers' level of technological and managerial knowledge, the service and information provision and the socio-economic local context can determine remarkable differences in farmers' participation within agri-environmental schemes and in the adoption of environmentally sound practices in general, even when similar farm structures exist as well as clear profitability. A relationship between premium level, knowledge of the innovation and extension services should induce farmers to accept a low premium against the offer of extension services. This has been verified in some Italian case studies (Casieri *et al.*, 1998). The au-

thors stress that the farmers who are ready to take part in Regulation 2078 are also the ones who have already adopted low impact practices and who therefore consider the established premium level generally satisfying. It might be inferred that agri-environmental premia are not sufficient in themselves to encourage farmers to voluntary adhesion unless other factors modify farmers' behaviour and his profitability perception. The adhesion to the scheme will be effective if the premium level proposed by the regulation is at least equal to the expected one (Figure 3). We can assume that the existence of transaction costs associate with non-economic factors may vary the level of the expected premium. The following cases are rather frequent in explaining the low take up of Italian agri-environment measures: when the farmer must cope with technical uncertainty; when he cannot find market outlets for his new products; when he mistrusts the bureaucratic procedures and the extension services; when he has poor environmental sensibility. The presence of these factors may increase the expected premium and vice versa.

CONCLUDING REMARKS

The main purpose of agriculture is to supply food and fibre at reasonable prices while meeting adequate quality standards. Technological progress is essential to meet this objective, given the continuous population growth.

Environmental problems in farming can be overcome by using green technologies that also improve resource

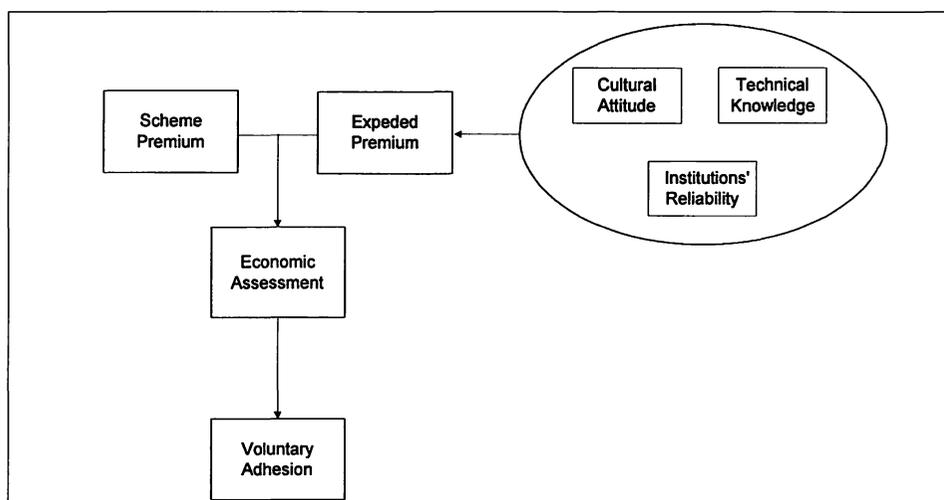


Figure 3 - Factors influencing farmer's voluntary adhesion.

efficiency. It is unlikely that environmental impacts can be reduced just by reducing the intensity of agricultural production, because there is no guarantee these environmentally sustainable products would be competitive.

The somewhat contrasting results of the study on the diffusion of innovations with low environmental impacts highlight the difficulties to find univocal solutions to diverse environmental issues. However, the following conclusions can be drawn from the study on Abruzzo region:

- It is necessary to achieve a constant flow of information to both producers and consumers. Perception of the environmental problem is a fundamental prerequisite to prompting changes in demand and supply. The farmer must be acquainted with the technical, economic and environmental aspects of the new technologies. Consumers must be better informed about the environmental impacts of the products they purchase.
- It is necessary to train professionals, who are primarily responsible for developing and disseminating the new information to farmers, while taking into consideration the site specificity of the local farming system. Farmer-researcher feedback is usually underestimated, as generally the institutional moments when farmers' needs are compared with the provision of public research and development are not very frequent. Technical experts are a fundamental link in the information system, above all for the smaller agricultural holdings.
- The incentive structure must take into account the potential for adopting the innovation in different farm types and farming system's local features, while not being too expensive to administer.
- Reference levels (minimum environmental standards, codes of good agricultural practices, etc.) must be defined, distinguishing between harmful practices and the less harmful ones that allow adequate resource conservation. The enforcement must be gradual but constant in time. Land use rights must be in agreement with the new scientific acquisitions on the relationship between agriculture and environment.
- The definition of reference level could make a public intervention based on a mix of instruments feasible, ranging from command and control policies to cross compliance and voluntary policies. Keeping into account the inevitable raise of transaction costs, it seems more and more advisable to provide farmers with a list of possible options, planned starting with local characteristics and needs.
- A change in property rights, enabling the creation of new markets for environmental goods and services, or linked with a high environmental quality, should be applied wherever possible. Protected label for organic products and high value local products are a first step, but other initiatives, specially to encourage the provision of recreational services and landscape amenities,

could be attracted by means of a better definition of property rights framework of some public goods.

- A monitoring and evaluation system that provides data to assess the sustainability of the current state is necessary – also to explain better how to measure sustainability – and make updated information available to farmers, the general public and policy makers. ●

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